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# MANAGING RISK IN SOFTWARE PROCESS IMPROVEMENT: AN ACTION RESEARCH APPROACH[1]

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## *Abstract*

*Many software organizations engage in software process improvement (SPI) initiatives to increase their capability to develop quality solutions at a competitive level. Such efforts, however, are complex and very demanding. A variety of risks makes it difficult to develop and implement new processes.*

*We studied SPI in its organizational context through collaborative practice research (CPR), a particular form of action research. The CPR program involved close collaboration between practitioners and researchers over a three-year period to understand and improve SPI initiatives in four Danish software organizations. The problem of understanding and managing risks in SPI teams emerged in one of the participating organizations and led to this research. We draw upon insights from the literature on SPI and software risk management as well as practical lessons learned from managing SPI risks in the participating software organizations.*

*Our research offers two contributions. First, we contribute to knowledge on SPI by proposing an approach to understand and manage risks in SPI teams. This risk management approach consists of a framework for understanding risk areas and risk resolution strategies within SPI and a related*

*process for managing SPI risks. Second, we contribute to knowledge on risk management within the information systems and software engineering disciplines. We propose an approach to tailor risk management to specific contexts. This approach consists of a framework for understanding and choosing between different forms of risk management and a process to tailor risk management to specific contexts.*

**Keywords**: Risk management, software process improvement, action research, collaborative practice research

## Introduction

Software process improvement (SPI) is a continuous and evolutionary approach to improve a software organization's capability to develop quality software in response to customer requirements (McFeeley 1996). The approach emphasizes stepwise improvement of software processes, systematic assessment of an organization's current operation, and application of normative models for organizing a software operation. These models describe different levels of software process maturity. They also serve as a basis for assessing current practices and as a guide for directing improvement initiatives. The best-known of these maturity models are the Capability Maturity Model (CMM) (Paulk et al. 1993), Bootstrap (Kuvaja and Bicego 1994), and Software Process Improvement and Capability dEtermination (SPICE) (Rout 1995).

Anecdotal evidence suggests that SPI initiatives have led to dramatic improvements of productivity, cycle time, and quality (Diaz and Sligo 1997; Haley 1996; Humphrey et al. 1991). Recent data from the Software Engineering Institute (SEI) at Carnegie-Mellon University (SEMA 2002) on firms that engage in SPI initiatives suggest, however, that there is a high number of failures. Out of 1,638 organizations self-reporting initial assessments, only 34 percent had proceeded to a second assessment. Of those that proceeded, 13 percent did not improve their capability to develop quality software and 3.1 percent moved to a lower level of capability. The time frame to move up one level (out of five) varied from 16 to 32 months. These numbers are not surprising. SPI efforts are complex change processes in which software organizations seek to change the conditions for and the actual behavior of the professionals involved in the software operation (Aaen et al. 2001). SPI initiatives, as well as other change initiatives, are faced with a number of risks (e.g., lack of management support, inability to learn from experiences, an overly strong belief in technical solutions, and resistance to change) that make it difficult to successfully improve the software operation (Grady 1997; McFeeley 1996; Zahran 1998).

This research was initiated at the IT department of Danske Bank, one of the largest financial institutions in Scandinavia. The IT department was one of four organizations involved in a large-scale Danish research program from 1997 to 2000 (Mathiassen et al. 2002). The aim of the program was to improve the software operation in the participating organizations and to contribute to the body of knowledge on how to design, conduct, and manage SPI efforts. The SPI teams at Danske Bank's IT department found it difficult to set up, organize, and manage their efforts in ways that would lead to satisfactory results. Some team members had positive experiences using risk management in software projects so they decided to address the problems they faced by adopting an approach to analyze risks in SPI teams (Grady 1997; Humphrey 1989; McFeeley 1996; Statz et al. 1997). This approach left many questions unanswered, it did not provide the SPI team with a good overview of their project, and it was difficult for the team to reach a shared understanding of the situation. There were no other approaches available for managing SPI risks so the team members asked us to help them address risks as an integral part of their efforts.

Our research was based on two questions: At the specific level, how can SPI teams within Danske Bank's IT department understand and manage risks to help achieve satisfactory results? In general, how can risk management help SPI teams understand and manage their efforts? We

wanted to solve a specific problem in Danske Bank in collaboration with the SPI team members, and in doing so we wanted to make progress toward improved knowledge about SPI and risk management. Our research was therefore carried out as action research to help facilitate change within Danske Bank, and at the same time to pursue our research interests (Avison et al. 1999; Baskerville and Wood-Harper 1996; Checkland 1981; Hult and Lennung 1980).

Action research, as originally proposed by Lewin (1951) and influenced by work at the Tavistock Institute (Rapoport 1970; Trist 1976), uses intervention into problematic social situations as a means to develop scientific knowledge. Different action research approaches have been developed, one of the best known being Susman and Evered's action research cycle consisting of diagnosing, action planning, action taking, evaluating, and specifying learning (Davison et al. 2004; Susman and Evered 1978). Also, action research has been adopted and developed successfully as an approach to information systems research (Avison et al. 1999; Baskerville and Wood-Harper 1996; Checkland 1981; Hult and Lennung 1980). Our research followed a particular form of action research called collaborative practice research (CPR) (Mathiassen et al. 2002). CPR was developed as part of a Scandinavian information systems research tradition during the 1980s and 1990s and has the following characteristics (Checkland and Scholes 1990; Mathiassen 1998): First, the aim is to understand, to develop support for, and to improve specific professional practices within the participating organizations. Second, the activities are carried out in close collaboration between researchers and the involved practitioners. Third, the research process is guided by a pluralist methodology (Mingers 2001), with action research as the dominant approach and other conventional methods (e.g., case studies or field experiments) as supplementary approaches. Finally, each CPR effort can lead to a portfolio of focused research projects based on the ongoing and emerging problem-solving efforts in the participating organizations (see Mathiassen 2002; Mathiassen et al. 2002). The Danish SPI research program was organized according to CPR; one of the focused action research projects within the program is reported here.

Our research combines two streams of theory. First, it draws upon the literature on SPI. A number of comprehensive texts are available (e.g., Grady 1997; Humphrey 1989; Zahran 1998), a number of surveys of the SPI literature have been developed (Aaen et al. 2001; Fuggetta and Picco 1994; Paulk 2002), and there is an ongoing, critical debate about the feasibility and practicability of SPI initiatives (Bach 1995; Bollinger and McGowan 1991; Brodman and Johnson 1995; Curtis 1994; Fayad and Laitinen 1997; Herbsleb et al. 1997; Humphrey et al. 1991; Ngwenyama and Nielsen 2003). Second, we found inspiration in the software risk management literature. Many approaches have been developed to cope with software risks (Alter and Ginzberg 1978; Boehm 1991; Charette 1989; Davis 1982; Fairley 1994; McFarlan 1981). These approaches help practitioners question critical assumptions underlying specific projects and identify and handle critical incidents that threaten the success of their projects (Lyytinen et al. 1998).

The research offers two contributions. First, we propose an approach to understand and manage risks in SPI teams. The approach consists of a framework for understanding risk areas and resolution strategies within SPI and a related process for managing SPI risks. Second, we contribute to knowledge on risk management within the information systems and software engineering disciplines. We propose an approach to tailor risk management to specific contexts. This approach consists of a framework for understanding and choosing between different forms of risk management and a process to tailor risk management to specific contexts. The next three sections describe the theoretical framework, the research approach, and the research practice. After that, we present the results and discuss the research in relation to criteria for CPR-based action research. We conclude by summarizing the results and their implications for both practice and research. The detailed risk and action tables for the SPI risk approach are included as an appendix.

## Framework

### Software Process Improvement

SPI covers a wide range of activities, from basic project management disciplines such as project planning and tracking to sophisticated continuous improvement of development processes (Caputo 1998; Grady 1997; Humphrey 1989; Zahran 1996). A major driver behind this paradigm has been the world's largest consumer and producer of software, the U.S. Department of Defense. Faced with increased reliance on software suppliers, the Department of Defense established SEI in 1984 to guide software-developing organizations toward better practices.

One characteristic that distinguishes SPI from earlier improvement paradigms is that efforts almost always are initiated by an assessment of current practices. The purpose is to find out where improvements are needed most and can be applied with the greatest effect. In the improvement cycle, such an assessment is repeated every 12 to 18 months (Dunaway and Masters 1996; Jansen and Sanders 1998; McFeeley 1996). Another characteristic is the use of an underlying model. The most influential and popular of these models is the CMM (Paulk et al. 1993), which was developed at SEI (see Figure 1).

In CMM, higher levels indicate higher maturity of the organization's capability to develop software. Each level is characterized by a set of key process areas (e.g., project management, configuration management, quality control) that an organization should practice adequately to be on that level. The assessment will characterize the level of maturity and recommend which processes to improve. These processes usually will be found within the model. The results from the assessment are used to generate a strategy for improving some or all of the areas detected in the assessment. The strategy typically has the mentioned time frame of 12 to 18 months and it involves forming several SPI teams—one for each improvement area. With some coordination among the teams, and involvement of the rest of the organization, the improvements will be piloted and, if found to be adequate for the organization, implemented and institutionalized throughout the organization. The experiences from this entire effort are analyzed and followed by a new improvement cycle.

This overall approach to SPI is well described in the IDEAL model (McFeeley 1996) developed at SEI in response to problems experienced by organizations involved in SPI. The IDEAL model provides a cyclical process for SPI that is described in five steps (see Figure 2).

1. Initiating the SPI effort. This involves setting goals, obtaining commitment, and establishing an improvement infrastructure.

2. Diagnosing current practices through a maturity assessment. This typically is based on a maturity model, which is used to characterize the current state and develop and prioritize recommendations for improvements.

3. Establishing specific, focused improvement initiatives. An SPI team is established to deal with each of the recommended improvement areas from step 2.

4. Acting out these initiatives. The SPI teams develop and implement solutions for each improvement area.

5. Learning based on the results and experiences from the initiatives. Data on the improvements are collected and preparations are made for a new maturity assessment.

In most organizations, SPI efforts consequently are organized at two levels (Grady 1997; McFeeley 1996; Zahran 1998): The organizational level with the software engineering process group (SEPG) (Fowler and Rifkin 1990) and the more specific project level with dedicated SPI teams (see Figure 3). At the organizational level, SPI is organized as a long-term effort aimed at evolutionary improvements to the maturity of the software organization. The main responsibilities of the SEPG include conducting maturity assessments,

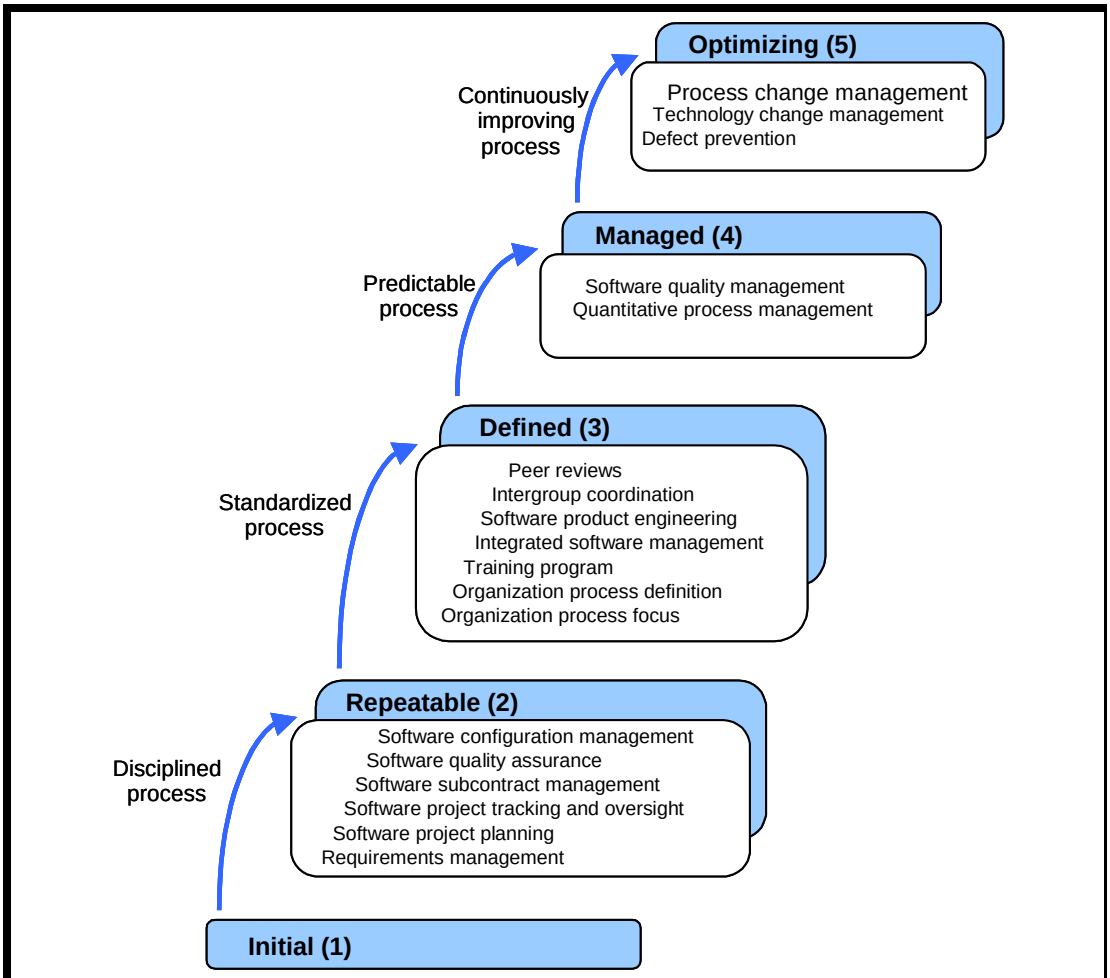


**Figure 1. Maturity Levels and Key Process Areas of the CMM (from M. C. Paulk, B. Curtis, M. B. Chrissis, and C. V. Weber, "Capability Maturity Model, Version 1.1," *IEEE Software* (10:4), 1993, p. 25. Copyright © 2004 IEEE. Used with permission.)**

organizing and coordinating SPI teams, and ensuring management involvement and support for SPI. At the project level, the SPI teams are charged with carrying out activities to improve a specific process within the organization, as shown in Figure 3.

Despite models and frameworks developed to assist practitioners in carrying out SPI projects, such efforts remain difficult and risk-filled, as described in the introduction. We therefore agree with others that SPI initiatives can benefit from risk management (Grady 1997; Humphrey 1989; McFeeley 1996; Statz et al. 1997). Several key sources on SPI mention risk items and risk resolution actions related to specific SPI issues (Grady 1997; Humphrey 1989; McFeeley 1996). The IDEAL model prescribes, for example, that risks should be handled at both the organizational level through a document called "SPI Strategic Action Plan" and at the project level through a document called "Tactical Action Plan." However, no specific risk items or resolution actions are mentioned. Risk issues are only addressed impli-

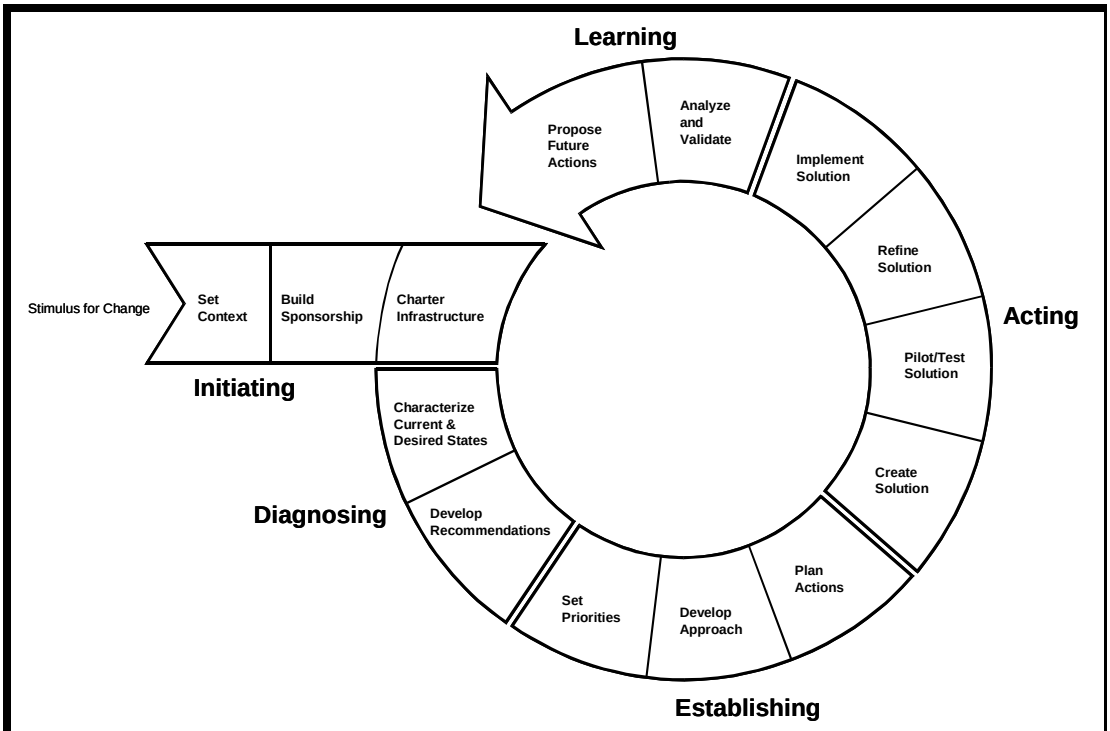


**Figure 2. The IDEAL Model (from B. McFeeley, "IDEAL: A User's Guide for Software Process Improvement," CMU/SEI-96-HB-001, Software Engineering Institute, Pittsburgh, PA, 1996. Used with permission.)**

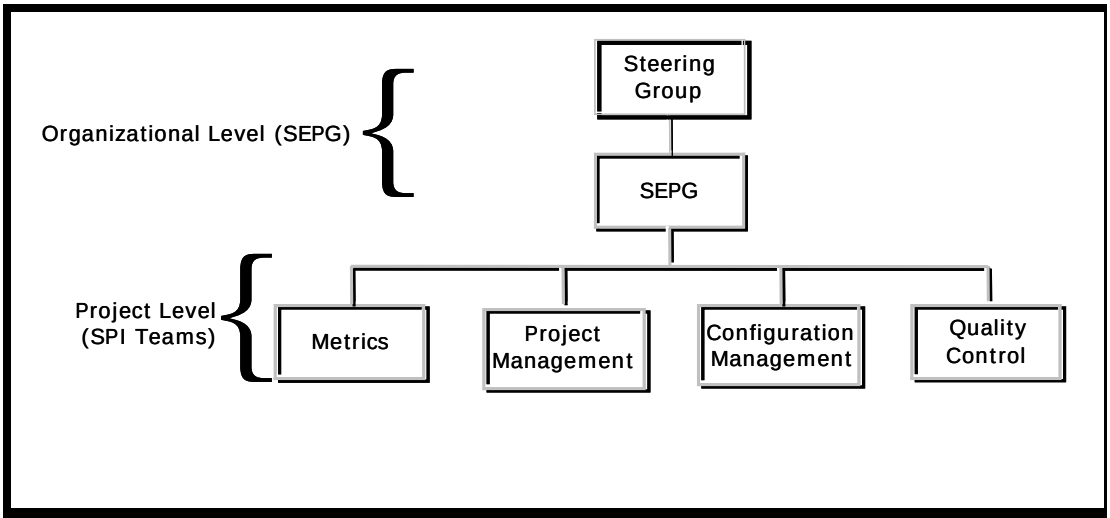


**Figure 3. SPI Project Organization**

citly through the advice provided by the IDEAL model. The initiating phase, for instance, recommends setting improvement goals and establishing senior management commitments and sponsorships, without which the program would have no direction and be in grave danger of cancellation. The key sources on SPI provide no comprehensive treatment of SPI risk management and no systematic advice for practitioners attempting to mitigate risks.

The only published work dealing explicitly with risk in SPI is a simple approach based on 63 risk items organized into 13 categories (Statz et al. 1997). This approach can be used to identify risks at both the organizational level and the project level. Statz et al. recommend that SPI teams conduct a post-project review during which they evaluate how successfully risks were managed during the improvement project. They also recommend that the SEPG performs similar evaluations, which should be used to update the organization's list of SPI risk items for use in subsequent applications of the approach. The approach is straightforward to use, but it provides no explicit guidance in identifying risk resolution strategies beyond calling for the project members to identify actions for each high-ranking risk. Moreover, it does not help team members develop a shared, strategic overview of the SPI project. As such, there is currently no comprehensive approach to discover and mitigate the many risks that SPI teams face.

## Software Risk Management

Risk management has been adopted and developed within a variety of areas, including warfare, space exploration, nuclear reactors, security, and financial investments. In this case, we chose to focus on risk management approaches within software development. Risk management ideas have been applied successfully to software development over the past decades in response to various forms of system failure. There is, consequently, a rich and differentiated literature on software risk management (Lyytinen et al. 1998), and this literature is inspired by and draws upon insights from other areas of risk management. In addition, the SPI practitioners at Danske Bank's IT department had experience with software risk management and knew several approaches to manage software risks.

A software risk denotes a particular aspect of a development task, process, or environment, which, if ignored, will increase the likelihood of project failure (Lyytinen et al. 1998). The degree of risk is assessed either in quantitative terms as the probability of unsatisfactory events multiplied by the loss associated with their outcome, or in qualitative terms by referring to the uncertainty surrounding the project and the magnitude of potential loss associated with project failure (Barki et al. 1993). Barki et al. suggest that software project managers see risk management as a key to success. Project managers in this survey believed that their ability to shape a project (in terms of internal integration, user participation, and formal planning) to fit its risk exposure influences the project's ability to meet budgets and produce quality results. The advantages of using risk management in software projects are that it helps the practitioners focus on many aspects of a problematic situation, it emphasizes potential causes of failure, it helps link potential threats to possible actions, and it facilitates a shared perception of the project among its participants (Lyytinen et al. 1996, 1998). Risk management approaches have been developed to identify, analyze, and tackle project portfolio risks (Earl 1987; McFarlan 1981), systems development risks (Barki et al. 1993; Boehm 1988; Charette 1989; Donaldson and Siegel 2001; Fairley 1994; Keil et al. 1998; Moynihan 1996; Ould 1999; Ropponen and Lyytinen 2000), requirements risks (Burns and Dennis 1985; Davis 1982), or implementation risks (Alter and Ginzberg 1978; Keen and Scott Morton 1978; Kwon and Zmud 1987; Lucas 1981; Lyytinen and Hirschheim 1987).

To build on this knowledge, we studied the ways in which software risk management approaches are designed. Lyytinen et al. (1998) suggest that risk items are used to detect risky incidents, resolution actions help identify possibly relevant actions, and different kinds of heuristics help link identified risks

**Table 1. Four Types of Approaches to Software Risk Management**

| Type of Approach | Characteristics | Assessment | Exemplars |
|---|---|---|---|
| Risk list | A list of prioritized risk items | + Easy to use<br>+ Easy to build<br>+ Easy to modify<br>+ Risk appreciation<br>– Risk resolution<br>– Strategic oversight | (Barki et al. 1993; Keil et al. 1998; Moynihan 1996; Ropponen and Lyytinen 2000) |
| Risk-action list | A list of prioritized risk items with related resolution actions | + Easy to use<br>+ Easy to build<br>+ Easy to modify<br>+ Risk appreciation<br>+ Risk resolution<br>– Strategic oversight | (Alter and Ginzberg 1978; Boehm 1991; Jones 1994; Ould 1999) |
| Risk-strategy model | A contingency model that relates aggregate risk items to aggregate resolution actions | + Easy to use<br>– Easy to build<br>– Easy to modify<br>+ Risk appreciation<br>+ Risk resolution<br>+ Strategic oversight | (Donaldson and Siegel 2001; Keil et al. 1998; McFarlan 1981) |
| Risk-strategy analysis | A stepwise process that links a detailed understanding of risks to an overall risk management strategy | – Easy to use<br>– Easy to build<br>+ Easy to modify<br>+ Risk appreciation<br>+ Risk resolution<br>+ Strategic oversight | (Davis 1982; Mathiassen et al. 2000) |

with possible resolutions. Based on this understanding, we identified four different ways in which approaches to software risk management address the three elements: risk items, resolution actions, and heuristics (see Table 1). We have assessed the relative strengths and weaknesses of the four types by comparing and contrasting their key features. We have selected exemplar approaches from the literature to illustrate each type.

First, there are a number of risk lists. They contain generic risk items (often prioritized) that help a project manager focus on possible sources of risk; they do not contain related information about appropriate resolution actions. We suggest that these lists are easy to use in assessing risks; they are easy to build, drawing upon published sources on risks or experiences within a particular context; and they are easy to modify to meet conditions in a particular organization or as new knowledge is captured. While these approaches offer strong support to help project managers appreciate risks, they do not support identification of relevant resolution actions and they do not provide a strategic oversight of the risk profile and relevant strategies for action. Based on previous research, Barki et al. (1993) offer a detailed and precise definition and a measure of software development risk together with a systematic assessment of the reliability and validity of the instrument. Moynihan (1996) elicited a comprehensive list of risk items based on how software project managers construe

new projects and their contexts. Keil et al. (1998) present a list of nearly a dozen software risk factors that project managers in different parts of the world agree to rate high in terms of their importance. Ropponen and Lyytinen (2000) report six aggregate risk components (e.g., scheduling and timing risks) that experienced project managers found important in a recent survey.

Second, there are a number of risk-action lists. They contain generic risk items (often prioritized), each with one or more related risk resolution actions. Compared to the risk lists, they are easy to use in assessing risks; they are quite easy to build, even though they require additional knowledge of the potential effects of different types of actions; and they are easy to modify when needed. The risk-action lists offer the same support as the risk lists to appreciate risks. In addition, they adopt a simple heuristic to identify possibly relevant actions that might help resolve specific risks. However, by focusing on isolated pairs of risk items and resolution actions, they do not lead to a strategy for addressing the risk profile as a whole. Alter and Ginzberg (1978) list eight risk items related to system implementation (e.g., unpredictable impact; they offer four to nine actions for each risk (e.g., use prototypes). Boehm (1991) developed a top-ten list of software development risks, with three to seven actions per risk. Jones (1994) presents specialized risk profiles for different types of software projects, together with advice on how to prevent and control each risk. Finally, Ould (1999) suggests maintaining a project risk register for identified risks, assessment of the risks, and risk resolution actions to address them.

Third, there are risk-strategy models. These contingency models relate a project's risk profile to an overall strategy for addressing it. They combine comprehensive lists of risk items and resolution actions with abstract categories of risks (to arrive at a risk profile) and abstract categories of actions (to arrive at an overall risk strategy). The risk profile is assessed along the risk categories using a simple scale (e.g., high or low), which makes it possible to classify the project as being in one of a few possible situations. For each situation, the model then offers a dedicated risk strategy composed of several detailed resolution actions. Compared to the other types, risk-strategy models provide detailed as well as aggregate risk items and resolution actions. The heuristic for linking risk items to resolution actions is a contingency table at the aggregate level. The approaches are easy to use because of the simplifying contingency model, but they are difficult to build because the model must summarize multiple and complex relationships between risks and actions. They also are difficult to modify except for minor revisions of specific risk items or resolution actions that do not challenge the aggregate concepts and the model. Models like these help appreciate risks and identify relevant actions, and the project manager can build an overall understanding of the risk profile (at the aggregate level) directly related to a strategy (in terms of aggregate actions). The best known of these approaches is McFarlan's (1981) portfolio model linking three aggregate risk items (project size, experience with technology, and project structure) to four aggregate resolution actions (external integration, internal integration, formal planning, and formal control). Keil et al. (1998) developed a model that combines the perceived importance of risks with the perceived level of control over risks. The model suggests four different scenarios (customer mandate, scope and requirements, execution, and environment) with distinct risk profiles and action strategies. Donaldson and Siegel (2001) offer a model categorizing projects into a high, medium, or low risk profile. They suggest a different resource distribution between project management, system development, and quality assurance, depending on a project's risk profile.

Finally, there are risk-strategy analysis approaches to software risk management. These approaches are similar to risk-strategy models in that they offer detailed as well as aggregate risk items and resolution actions, but they apply different heuristics. There is no model linking aggregate risk items to aggregate resolution actions. Instead, these approaches adopt a stepwise analysis process in which the involved actors link risks to actions to develop an overall risk strategy.

Compared to the risk-strategy models, there is a looser coupling between the aggregate risk items and aggregate resolution actions. In comparison, we find these approaches more difficult to use because they require process facilitation skills. They are equally difficult to build as the risk-strategy models, but they are easier to modify because of the loosely defined relationship between aggregate risk items and resolution actions. Davis (1982) provides such a stepwise approach to address requirements risks where the overall level of risk is assessed and then associated with four different strategies to cope with requirements uncertainty. Mathiassen et al. (2000) offer a similar approach to develop a risk-based strategy for object-oriented analysis and design.

Our study of these approaches suggests comparative strengths and weaknesses that are summarized in Table 1. The comparison between the list approaches and the strategy approaches suggests that the former are easy to use, build, and modify, whereas the latter provide stronger support for risk management. The comparison between risk-strategy models and risk-strategy analysis approaches suggests that the former are easier to use, but they require that a contingency model be developed. The latter are easier to modify because they rely on a looser coupling between aggregate risk items and resolution actions. Later, in the research practice section, our considerations in choosing the risk-strategy analysis approach in this project are described in detail.

## Research Approach

The research project emerged as part of the Danish SPI research program that was organized as a three-year CPR effort (Mathiassen 2002). This program focused on understanding, supporting, and improving SPI practices in four software organizations. The program was organized with local research groups in the four organizations, and it involved close collaboration among more than 10 researchers and 30 SPI practitioners. CPR is an action research approach that makes it possible to launch a number of focused research initiatives based on different research methodologies as the organizational problem-solving evolves. When the risk management problem emerged, we chose to adopt CPR-based action research for two reasons. First, we wanted to respond to the specific needs for support at Danske Bank's IT department. Second, we aimed at a high level of relevance of the general outcomes of our research by addressing organizationally complex problems related to SPI practices (Avison et al. 1999). In the following sections, we detail the project's CPR-based action research approach by describing the researcher-client agreement, the overall action research cycle, the detailed steps of the research process, and the research criteria that guided our efforts.

### *The Researcher-Client Agreement*

When the risk management problem emerged in Danske Bank, a formal researcher-client agreement (Davison et al. 2004; Susman and Evered 1978) was in place, governing the SPI program and sanctioning the SPI research theme and the CPR approach. The agreement also included a budget and specified the responsibilities of the involved actors (Mathiassen 2002). The researchers' participation was financed through public research funds, while each of the four software organizations financed its own involvement. A local research infrastructure was established in each software organization; workshops were organized involving all researchers and SPI practitioners across the participating organizations; and separate meetings of all of the involved researchers took place to identify emerging research themes, to plan focused research projects, to debate relevant theory, and to develop research publications (Mathiassen 2002).

The research infrastructure in Danske Bank included a local research group (four researchers and four SPI practitioners), the SEPG, a number of SPI teams, and a steering group (see Figure 3). The research group met monthly from January 1997 to December 1999, and this action research

project was executed as part of these activities from October 1997 to February 1999. Three researchers (the authors) in the local research group were the primary drivers of the research; the other members of the research group participated in the project. Risk management approaches were developed and tested in collaboration with the SPI teams. No specific, formal agreement regulated this research, but the project was established, executed, and reported as an integral part of the local research group's agenda.

The wider CPR program served as context for the project. Our research was presented and debated continuously as part of the separate meetings involving all researchers in the CPR program. We also presented initial ideas and risk management approaches at the workshops involving SPI practitioners and researchers from all four software organizations. These activities provided useful inspiration and critique as the study progressed.

## The Action Research Cycle

Action research links theory and practice in a cyclic process (Baskerville and Wood-Harper 1996; Hult and Lennung 1980; Susman and Evered 1978; Warmington 1980). The intention is to create a synthesis with specific knowledge that provides actors in the situation the capability to act and general knowledge that is useful in similar situations. Based on Checkland's (1991; Checkland and Holwell 1998) action research cycle, this study combined theory and practice as follows:

- Research theme: The general area of interest was SPI, and in particular, how SPI teams can manage risks.

- Research framework (F): Theory and concepts about SPI and software risk management framed the study as outlined in the framework section.

- Research methodology (M): The action research methodology that guided the study is described in this section.

- Real world problem situation (A): The research addressed risk management problems in SPI teams at Danske Bank's IT department and unfolded as researchers and practitioners worked to improve the organization's risk management capability related to SPI.

- Reflection based on F and M: While working on A, the researchers continuously made sense of the accumulating experience based on F and M.

- Findings: The researchers eventually exited from the situation and critically reviewed the results and experiences to identify research contributions and to document the research.

Klein and Myers (1999) observe that the epistemological foundation for action research may be positivist, interpretivist, or critical in nature. The M adopted in this study is interpretive (i.e., it is based on the assumption that knowledge is socially constructed) and theories and models within F should be seen as ways of making sense of A rather than being objective (Walsham 1995).

## The Research Process

The research was conducted as a collaborative and iterative process with problem diagnosis, change, and reflection as core activities (Avison et al. 1999). Following Baskerville and Wood-Harper's (1998) framework:

- The process was *iterative,* involving a repeating set of activities. This supported the development of a risk management approach based on a range of experiences.

- The guidance was *fluid,* with loosely defined activities. The established CPR infrastructure created a robust basis for the process, which helped us adapt to emerging needs in the situation.

- The researchers' involvement was *facilitative* to help the involved practitioners adopt and apply risk management in SPI teams.

**Table 2. Overview of Action Research Processes**

| | (Susman and Evered 1978) | (Checkland 1991) | (McKay and Marshall 2001) | Our CPR-Based Process |
|---|---|---|---|---|
| ***Initiating*** | Establish the client-system infrastructure | 1. Enter problem situation | 1. Identify: problem and research theme<br>2. Reconnaissance: problem context and research literature<br>3. Plan and design: problem solving and research questions | 1. Appreciate problem situation<br>2. Study literature<br>3. Select risk approach |
| ***Iterating*** | 1. Diagnosing<br>2. Action planning<br>3. Action taking<br>4. Evaluating<br>5. Specifying learning | 2. Establish roles<br>3. Declare framework (F) and methodology (M)<br>4. Take part in change process<br>5. Rethink 2-4 | 4. Action steps<br>5. Implement<br>6. Monitor: problem solving and research<br>7. Evaluate in terms of problem alleviation and research questions<br>8. Amend plan based on 7 | 4. Develop risk framework<br>5. Design risk process<br>6. Apply approach<br>7. Evaluate experiences |
| ***Closing*** | | 6. Exit<br>7. Reflect on experience and record learning in relation to F, M, and problem situation | 9. Exit, if: problems alleviated and research questions resolved | 8. Exit<br>9. Assess usefulness<br>10. Elicit research results |

- The purpose was *organizational development* and *scientific knowledge*. This dual goal is expressed through the research questions outlined in the introduction.

There are many different ways to organize the steps and iterations in action research (Baskerville and Wood-Harper 1998), and each specific CPR effort adopts its own unique process (Mathiassen 2002). Table 2 summarizes key inspirations for CPR and outlines the detailed process we applied in this study.

Susman and Evered's (1978) classic process emphasizes diagnosing, action planning, action taking, evaluating, and specifying learning (1 through 5 in Table 2), similar to the cycle in the IDEAL model (McFeeley 1996). Davison et al. (2004) describe research associated with this iterative, rigorous, and collaborative process as canonical. Checkland (1991) references Susman and Evered and emphasizes the role of the F and M, in which research lessons are to be expressed. As a consequence, he adds an explicit exit from the iterations (6 in Table 2) and an activity in which

the researcher reflects on the experience based on F and M to record learning (7 in Table 2). Finally, McKay and Marshall (2001) reference Susman and Evered as well as Checkland. They argue that action research involves a problem solving cycle and a research cycle. Their activities 4 and 5 in Table 2 cover both, while all other activities have two instances (e.g., activity 6 is present as "monitor problem solving" and as "monitor research"). The problem solving and the research process are interrelated and, in practice, they often merge. This approach helps address and manage the dual goals of action research.

Our CPR-based process (right-most column in Table 2) was inspired by these sources and tailored to the situation in Danske Bank's IT department. The process was collaborative and iterative, as suggested by Susman and Evered. The researcher-client infrastructure already was established, and the problem we faced remained stable (how can SPI teams within Danske Bank use risk management to support their efforts?). We therefore conducted diagnosing (Susman and Evered 1978) initially, as suggested by Checkland (1991) and McKay and Marshall (2001) (1 in Table 2). We knew that the SPI and software risk management literature (i.e., F) would prove helpful in developing the risk management approach, so we followed McKay and Marshall's advice to initially study F and plan the problem solving (2 and 3 in Table 2). Subsequent iterations contained four steps inspired by Susman and Evered's canonical problem-solving cycle (Davison et al. 2004) and tailored to developing a risk management approach (4 through 7 in Table 2). Each iteration consisted of two action planning steps (targeting the risk framework and process), followed by action taking and evaluating. Specifying learning, following Checkland (1991), was conducted after exiting from the iterations by reflecting on our experience in light of F and M (8, 9, and 10 in Table 2). Finally, we used McKay and Marshall's separation between the problem solving and research processes to help manage the dual goals of the research. These considerations resulted in a CPR process rooted in the action research literature and tailored to the challenges we faced in Danske Bank, as described in below.

Entering the problem situation, practitioners and researchers bring in prior knowledge and experience to help understand the issues related to risk management (1). Researchers search and study the literature on SPI and risk management to identify types of approaches and relevant risk items and resolution actions (2). They then select a type of risk approach (see Table 1), which suits the problem situation (3). It is assumed in the iterative activities that this approach is based on a framework (4) and performed using a process (5). The sequence between activities 4 and 5 only points to the logical dependencies between the activities. The application of the process to SPI projects (6) leads to the projects' risks being managed and to experiences using the approach (7). The iterations stop when the practitioners and researchers agree that the problem is alleviated and the research questions are resolved (8). Whether the application of the risk approach was useful in practice is assessed relative to the problem situation (i.e., A) (9). Whether the risk framework and process are contributions to research is assessed relative to F and M (10). The iterative activities 3 through 7 and activities 9 and 10 produce the necessary research documentation and lead to a refined risk framework and process.

## *The Research Criteria*

Action researchers seek relevance in their results by committing to a particular problem situation. This, unfortunately, leads to a number of limitations and pitfalls (Baskerville and Wood-Harper 1996): (1) lack of impartiality of the researcher; (2) lack of discipline; (3) mistaken for consulting; and (4) context-dependency leading to difficulty of generalizing findings. We, therefore, explicated a set of criteria to ensure both relevance and rigor in the execution of the CPR process. The criteria were designed to avoid the pitfalls identified by Baskerville and Wood-Harper. In addition, they assume the preexistence of the larger CPR program and draw upon the action research literature. Following Davison et al., we formulated the criteria guiding our CPR process as a set of questions.

- **Roles:** What are the researcher and practitioner roles and how do they develop over time?

- **Documentation:** What data are collected to support the problem solving and research goals; how are these data collected; and how is data quality ensured?

- **Control:** How is the researcher-client relationship established; who exercises authority over the process; and to what degree are formalized control mechanisms adopted?

- **Usefulness:** How is usefulness of the solution established in the problem situation?

- **Theory:** How are frameworks used to support the study; and how are the results subsequently related to these frameworks?

- **Transfer:** Under what conditions can the results be transferred to or adapted in other contexts?

**Roles.** Clarifying roles can help establish our impartiality as researchers and explicate the discipline in collaborating with practitioners (Baskerville and Wood-Harper 1996). Action researchers cannot be disinterested observers (Checkland 1981, p. 152; Susman and Evered 1978, p. 589). Several roles in action research overlap (e.g., sponsor, practitioner, and researcher) and they sometimes interchange in ways that cannot be fully anticipated (Clark 1972). An action researcher "acts and simultaneously observes himself acting" (Mansell 1991, p. 30). A reflective practitioner is, conversely, a researcher into his own practice (Clark 1972, pp. 72-73). Action research requires in this way "a partnership of practitioner-researchers and researcher-practitioners" (Schön 1983, p. 323). CPR is collaborative in nature and we should explicate and explain the changing roles of researchers and practitioners over time.

**Documentation.** Describing the data collection approach in detail is a key discipline that distinguishes research from consulting (Baskerville and Wood-Harper 1996). Action research is empirical research. "There are two kinds of processes to record in social action research, the learning process of the host [practitioners], and the discovery and interpretation process of the guest" (Jönsson 1991, p. 391). Longitudinal research on organizational change (Pettigrew 1990) offers a useful approach to documentation of CPR studies (Mathiassen 2002). Pettigrew's approach is based on three assumptions: (1) change processes should be studied in the context of change at another level of analysis; (2) the importance of revealing temporal interconnectedness; and (3) the need to explore context, and action where context is a product of action and action is a product of context (pp. 269-270). These assumptions have implications for collecting data. Pettigrew's data collection techniques are in-depth interviews, documentary and archive data, and observational and ethnographic material. To this list, we add diary writing (Jepsen et al. 1989; i.e., the researchers' written reflections on events, ideas, and actions as they evolve over time). These techniques address how we may collect data. Indicators of the quality of data are (1) the extent to which the data cover Pettigrew's three assumptions and (2) the extent to which the techniques have been applied systematically. In addition, we can use multiple data sources to reduce bias. A useful strategy is to achieve triangulation of sources (Yin 1993).

**Control.** Explaining the control measures can help establish our impartiality as researchers, and it explicates a key aspect of a disciplined research effort (Baskerville and Wood-Harper 1996). CPR is collaborative and emergent in nature (Mathiassen 2002). Control issues are, therefore, particularly relevant in making sense of the research process and its outcomes. Avison et al. (2001, p. 38) propose that we should be aware of and report on three control structures: control over initiation, determination of authority, and degree of formalization. Initiation may (1) be by the researchers (if they have theories or approaches to be tried in practice), (2) be by the practitioners (if they are facing difficult problem situations), or (3) evolve from existing collaboration. Authority may be determined largely by (1) the client organization and the existing structure, (2) migration of power between stakeholders as part of the action

research process, or (3) the researchers being identical to the practitioners. The degree of formalization may be characterized by (1) formal contracts between researchers, practitioners, and the client organization, (2) informal agreements and commitments between the partakers, or (3) the formality evolving over time as part of the action research process.

**Usefulness**. Establishing usefulness of results in the problem situation supports the impartiality of our research and creates a baseline upon which the results might be transferred (Baskerville and Wood-Harper 1996). Experienced usefulness is the pragmatic basis for evaluating CPR (Mathiassen 2002). Checkland (1981, p. 253) states that

> [the] criterion by which the research was judged internally was its practical success as measured by the readiness of actors to acknowledge that learning had occurred, either explicitly or through implementation of changes.

Baburoglu and Ravn (1992) argue similarly that action research generates action knowledge (i.e., knowledge upon which actors either are ready to act or actually act). We, therefore, look for traces in the documentation of the practitioners' perceptions of the usefulness of the developed risk approach or their subsequent usage of the results of their risk management efforts.

**Theory.** Relating results to existing frameworks supports the impartiality of our research. It is a key discipline in all research that distinguishes it from consulting, and it provides a basis for discussing transferability of results (Baskerville and Wood-Harper 1996). Checkland and Holwell (1998, p. 24) argue that

> it is clear that the recognition that the changes have occurred and lessons have been learnt will be much helped if we have declared in advance the intellectual framework within which 'lessons' are defined.

We should, therefore, explicate the theoretical foundation and approach (i.e., F and M) for the research, including the underlying interests of the researchers and practitioners (McKay and Marshall 2001). In this way, we turn the focus from the experiences *per se* to how the experiences and results draw upon and relate to existing bodies of knowledge.

**Transfer.** Explicating conditions for transferability of results addresses the context-dependency of our action research and reveals the limitations that apply to generalizing the findings (Baskerville and Wood-Harper 1996). By relating results to existing bodies of knowledge, we explicate the research contribution and increase the transferability to similar situations. In addition, we need to explicate the general characteristics of the findings and the conditions for transferring them to other situations. The findings of this study are new approaches that may be characterized as follows:

(1) What is the area of application outside which the approach is likely not to be useful?

(2) Under which conditions (e.g., time and resources) is the approach applicable?

(3) Is it possible to make the approach understandable to others?

(4) What are the skills and capabilities that facilitators and other actors must possess?

(5) To what extent is the approach kept general to increase transferability, as opposed to being made specific to increase usefulness in the organization?

## Research Practice

Danske Bank's IT department grew out of the bank's accounting department. It was a systems development organization that had seen several technologies come and go. Its main customer was the bank. The rigor of banking procedures traditionally pervaded its culture, although that gradually changed in recent years as emerging technologies and strategic change projects became the order of the day. Danske Bank joined the CPR

program in January 1997 and established an SEPG to coordinate and drive SPI activities with management's explicit desire to increase productivity (Mathiassen et al. 2002). The local research group was staffed with a dedicated project manager and a consultant from the methodology department, two information systems managers, and four researchers (including the three authors). The IT department's software process maturity was assessed initially by the SEPG through a systematic data collection and analysis approach (Iversen et al. 1998). The assessment report pointed to seven improvement areas. SPI teams subsequently addressed several of these areas. The request for appropriate risk management support emerged in autumn 1997 as part of these efforts and resulted in this study. Table 3 provides a timeline for the research, together with an overview of activities and roles played by researchers and practitioners.

### Initiating

The key activities of this study took place from October 1997 to February 1999. The collaboration was initiated in a stepwise, bottom-up fashion. First, a workshop was held to identify key sources of risks and relevant resolution actions in SPI in general. Present at the workshop were the four SPI practitioners and the four researchers (including the authors) that were involved in the local research group. The researchers presented a report on risk items in SPI and a classic risk management approach for software development. Following these presentations, the entire group brainstormed to identify relevant risk items for SPI based on experience and the literature. The group subsequently attempted to categorize the risk items. There were, however, conflicting viewpoints on what the categories covered, so the classification was deferred to the authors after the workshop. A second brainstorming session produced possible resolution actions. Both lists were long and very detailed (31 risk items and 21 resolution actions). In particular, the researchers felt that there was a need to provide an overview through development of aggregate categories of risk items and resolution actions.

Following the workshop, the authors studied software risk management in the literature and identified four types of approaches (see Table 1). They chose to adopt a risk-strategy analysis approach inspired by Davis (1982) for several reasons. First, the practitioners explicitly wanted a risk approach that would help them gain an overall, strategic understanding of each SPI project. Second, the stepwise analysis approach would help each SPI team obtain a shared, detailed understanding of risks and possible actions. Third, we were not confident that we would be able to develop a contingency model that would summarize the many different sources of risks and ways to address them in SPI. The first consideration pointed toward a strategy approach over a list approach; further, the second and third considerations pointed toward the risk-strategy analysis approach over the risk-strategy model approach (see Table 1). The action research subsequently went through four full iterations before closing.

### First Iteration

Based on the lists of risk items and resolution actions from the workshop and insights from the SPI literature, the authors synthesized the brainstorming sessions and formulated a prototype of the risk management approach. A key challenge was the development of a framework to understand risks and actions. Our initial classifications were challenged and further developed through a detailed examination of risk items and resolution actions mentioned in the SPI literature (Grady 1997; Humphrey 1989; McFeeley 1996; Statz et al. 1997). This included an examination of the 63 risk items organized into 13 categories in the Statz et al. approach. The risk management process then was based on detailed lists of risk items and resolution actions for each category in the framework (see Appendix A), and designed similarly to Davis' risk management approach. Finally, we designed strategy sheets and simple scoring mechanisms to encourage actors to engage in detailed risk and action assessments as a means to arrive at an informed, strategic understanding of how to address risks.

**Table 3. Action Research Performed by Practitioners and Researchers**
**(Key: p*n* is practitioner *n*, with p1-4 being the SPI practitioners. r*n* is researcher *n*, with r1-3 being the authors)**

| | Initiating 10.97-12.97 | First iteration 01.98-02.98 | Second iteration 03.98-08.98 | Third iteration 09.98-11.98 | Fourth Iteration 11.98-02.99 | Closing 02.99-02.00 |
|---|---|---|---|---|---|---|
| 1. Appreciate problem situation | Part of ongoing research collaboration [p1-4; r1-4] Brainstorm risk items and actions [p1-4; r1-4] | | | | | |
| 2. Study literature | Study SPI [p1-4; r1-4] Study risk management [r1-2] | | | | | |
| 3. Select risk approach | Synthesis [r1-3] | Confirmed selection [r1-3] | | Appreciation of actors' competence [r1-3] | | |
| 4. Develop risk framework | | Synthesis [r1-3] Review of framework of risk items and actions [r3] Revised framework [r1-3] | | | | |
| 5. Design risk process | | List of risk items and actions [r1-3] Strategy sheets [r1-3] | Additional step and items reformulated [r2-3] | Improved documentation scheme [r1-3] | | |
| 6. Apply process | | Risk assessment of quality assurance [p5-7; r2-3] | Risk assessment of Project Management [p3-4; r1-2] | Risk assessment of metrics program [p2; p8; r3] | Risk assessment of diffusion [p9-10; r4; r3] | |
| 7. Evaluate experiences | | Lessons learned [p5-7; r2-3] | Lessons learned [p3-4; r1-2] | Lessons learned [p2; r3] | Lessons learned [p9-10; r4; r3] | |
| 8. Exit | | | Delay after 2nd iteration | | | Action part closed |
| 9. Assess usefulness | | | Assessment of first two projects [p1-4; p11; r1-4] | Discussion of risk approach at CPR workshop [r1-r3] | | Assessment of Metrics and Diffusion projects [p1-4; r1-4] |
| 10. Elicit research results | | | | | | Result and lesson elicitation [r1-3] |

A risk analysis subsequently was performed, with the three practitioners responsible for improving quality assurance. We presented the risk framework and the process, but we let the practitioners themselves apply the process, assisting only when they got stuck. The main experience was that the basic idea and structure of the approach was useful. During this first trial session, we managed to cover only half of the risk areas. The practitioners suggested that the process needed to be facilitated and managed by someone trained in the process (i.e., the researchers). The practitioners found it especially difficult to interpret the questions in the risk tables into terms more closely related to their specific project. Some of the risk items needed to be reformulated. Finally, to ease the interpretation of the risk items, the session should have started with an interpretation of the general terms in the particular SPI team context.

## Second Iteration

The second iteration started with reformulating the risk items and introducing a first step in which the SPI team should interpret the risk model in their particular context**.** A risk analysis then was performed with the two SPI practitioners responsible for improving project management. Both practitioners were skilled project managers with experience in risk management. The session included a complete risk analysis with identification of key risks and resolution strategies. The participating practitioners and researchers agreed on the major lessons. First, the framework and the process assisted even skilled project managers through a more disciplined analysis than they usually would do on their own. Second, we could take advantage of documenting the risk analysis in a way that would allow the SPI team to add interpretations and specific risk items continuously as they arose during the session.

At subsequent meetings in the local research group, the two risk management sessions were discussed and assessed in terms of which actions had been taken later by the two SPI teams. Present at the meetings were the four SPI practitioners, the three authors, and the fourth researcher. Both SPI teams found that the suggested framework provided a comprehensive overview of risk items and resolution actions. Many comments to the detailed lists of risk items and resolution actions led to subsequent modifications and reformulations, but the aggregate structure that was created based on the initial brainstorming sessions and a study of the SPI literature was not changed.

The quality assurance improvement project was not very active during that period. The manager of the quality assurance project was not present at the risk analysis session and had not yet devoted full attention to quality assurance. The other project members were, therefore, mainly in a reactive mode, and little had happened. Risks surfaced during the analysis, but none of the practitioners were able to resolve these risks in practice. From this, we learned that realizing a risk and identifying a set of resolving actions do not ensure that actions are or will be taken. The practitioners that need to commit to the results of a risk analysis session should be present and involved in the session. After seven months, there was no agreed-upon plan for the organizational implementation of quality assurance procedures. After 10 months, the quality assurance project had rolled out its procedures, but the identified risks never were managed effectively and many of the foreseen consequences were experienced.

The project management improvement project, in contrast, had considerable activity. The main risk was that project managers would not find the improvement attractive and worth their effort. The strategy was, therefore, directed at creating incentives for the project managers. After one month, an appropriate incentive structure was in place. After five months, project manager education was a huge success and all project managers wanted to participate (Andersen et al. 2002).

## Third Iteration

We started the third iteration by appreciating the lesson from the first two iterations that successful application of the risk approach required compe-

tent practitioners with sufficient authority to address key risks. They also are required to ensure that identified actions are enacted. The participants, rather than the approach, eventually make a difference. We also introduced a new way to document the process directly on transparencies and paper versions of the templates (see Appendix A).

A risk analysis then was performed in a project that was responsible for establishing an organization-wide metrics program (Iversen and Mathiassen 2003). The new documentation scheme made it easier for the participants to relate risk questions to their particular situation. We documented each risk in more detail by answering the following question: What are the specific issues that make this risk particularly important? As we progressed through the risk assessment, this made it easier to determine why something had been given a specific characterization. The session included a complete risk analysis. The practitioners found the identified actions useful and relevant, and they emphasized the benefit of having reached a shared, overall understanding of risks and actions. The practitioners suggested including the traditional distinction between consequences and probability of a risk into the process. We decided not to implement this idea to keep the approach as simple as possible.

During this period, we also presented the risk management approach at a workshop for the SPI practitioners and researchers involved in the four software organizations within the CPR program. The overall feedback was positive and confirmed that the framework of risk areas and strategies provided a useful and comprehensive overview of SPI risk items and resolution actions. Detailed comments helped us improve the contents and formulations of the detailed lists.

## Fourth Iteration

The risk approach was used again, this time without any changes. It was applied in an improvement project responsible for improving diffusion and adoption practices (Tryde et al. 2002). The session had three participants: two practitioners from Danske Bank's IT department and the fourth action researcher involved in this project. All three found the approach generally useful, but found the analysis of the risk areas and the specific actions particularly useful, whereas they found summarizing the strategies not particularly helpful. The participants emphasized the importance of not merely following the suggested lists of risk items and resolution actions, but also of supplementing this with a more open-minded exploration. "We haven't asked ourselves, what can go wrong?" said one participant. They merely had considered each risk separately as it was presented to them.

## Closing

The third and fourth risk analysis sessions were discussed and assessed among the four SPI practitioners, the three authors, and the fourth researcher at a later meeting in the local research group. The metrics program had suffered several setbacks due to political turmoil when previously hidden data about the performance of software projects were publicized (Iversen and Mathiassen 2003). Nevertheless, the risk analysis session led to actions that the project took later. The two main actions decided at the risk management session were (1) to create and maintain top management's support and commitment and (2) to create immediate results that are perceived useful by software projects. At a meeting three months later, it was reported that the project successfully had convinced top management that the collected metrics results should be publicized in all of Danske Bank's IT department announcements, which subsequently occurred (Iversen and Mathiassen 2003). The diffusion and adoption project was successful (Tryde et al. 2002). Many of the performed activities came out of the risk analysis. It was decided to exit the iterations at this point because the experiences from the four iterations suggested that the risk management approach was in a stable and useful form. Our final activity was eliciting lessons for the overall action research endeavor.

## Research Results

Our research results in two approaches. Characterizing these approaches, we can adopt the same concepts we used earlier to describe our action research approach (Checkland and Scholes 1990; Mathiassen 1998). Each approach addresses a potential application area (A), provides a framework (F) for understanding A, and provides a methodology (M) for problem solving within A based on F (see Checkland 1991). First, we propose an approach to manage risks in SPI teams. Second, we propose an approach to tailor risk management to specific contexts within information systems and software engineering. The results are summarized in Table 4 and described in detail below.

### *Managing SPI Risks*

The proposed approach to manage SPI risks is based on a framework that aggregates risk items into areas and risk resolution actions into strategies. The first part of the framework describes the relevant SPI risk areas; the second part outlines the potential SPI risk resolution strategies. Figure 4 illustrates the four different areas in which SPI teams might identify risks:

- ***The improvement area****: those parts of the software organization that are affected by the SPI initiative.*
- ***The improvement ideas****: the set of processes, tools, and techniques that the SPI initiative seeks to bring into use in the improvement area.*
- ***The improvement process****: the SPI initiative itself and the way in which it is organized, conducted, and managed.*
- ***The improvement actors****: those involved in carrying out the SPI initiative.*

As an example, consider an SPI team concerned with introducing configuration management in software engineering projects. Here the *improvement area* is the software development projects that will use configuration management and the people supporting the process after institutionalization. The *improvement ideas* include the configuration management principles that the SPI team relies on and the tools and methods that are developed to support these principles. The *improvement process* is the improvement itself, the way it is organized, and the involved stakeholders. The *improvement actors* are the members of the SPI team.

The risk resolution actions that SPI teams can apply are aggregated into five different types of strategies, as shown in Table 5. The strategies are listed according to the degree of change we suggest the SPI team's risk-based intervention will cause. *Adjust mission, modify strategy*, and *reorganize* target the improvement project's orientation and organization; *increase knowledge* targets the involved actors' level of expertise and knowledge; and *mobilize* targets alliances and energies that will increase the project's chance of success.

The mission of an SPI team on configuration management may be to introduce configuration management on all documents (including documentation, code, etc.) in all software engineering projects in the company. This mission could be *adjusted* to include fewer projects (perhaps only large projects, critical projects, or projects in department Y) or to exclude certain types of documents. The SPI team's strategy might be to involve a few key developers to give input to the process and, based on this, select a standard configuration management tool that every project then has to use. *Modifying the strategy* may entail involving more (or fewer) developers or implementing the chosen tool gradually in each project. *Mobilizing* may involve establishing agreements with an existing method department, a production department, or other departments or people that have a vested interest in the results of the team's effort. The SPI team could *increase its knowledge* by attending courses on configuration management or SPI, or by hiring knowledgeable consultants. If the project is not organized optimally for the task at hand, the effort could be *reorganized*

**Table 4. Research Results Based on Checkland (1991)**

| Research Result | Managing SPI Risks | Developing Risk Approaches |
|---|---|---|
| Application area (A) | • Management of risks in SPI teams in software organizations. | • Development of risk management approaches for specific contexts. |
| Framework (F) | • Framework of risk areas in SPI teams (Figure 4).<br>• Framework of risk resolution strategies for SPI teams (Table 5). | • Framework of different types of risk management approaches (Table 1). |
| Methodology (M) | • Process for managing risks in SPI teams (the *Managing SPI Risks* section and Tables in Appendix). | • Process for developing risk approaches for specific contexts (Figure 5). |

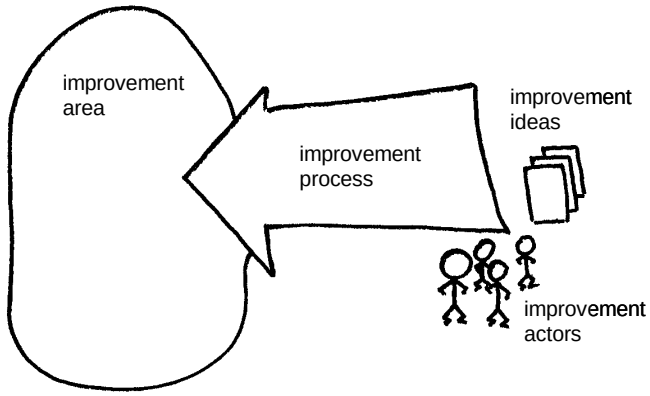


**Figure 4. Risk Areas for SPI Teams**

(e.g., by establishing a formal project, negotiating a project contract with management and the software engineering projects, or developing a new project plan).

The proposed heuristics that help SPI practitioners relate identified risk areas to possible resolution strategies are offered through a stepwise process. Based on the risk framework and inspired by Davis (1982), the process offers four steps.

1. **Characterize situation** by interpreting the profile and scope of the elements of Figure 4.
2. **Analyze risks** to assess where the most serious risks are.
3. **Prioritize actions** to decide on a strategy that will deal effectively with the identified risks.
4. **Take action** by revising project plans to reflect resolution actions.

**Step 1: Characterize Situation**

The SPI team first must share an understanding of the situation they face and the roles they and

**Table 5. Risk Resolution Strategies for SPI Teams**

| Type of Action | Concern |
|---|---|
| 1. Adjust Mission | What are the goals of the initiative? Goals may be adjusted to be more or less ambitious (e.g., targeting only projects developing software for a specific platform). |
| 2. Modify Strategy | What strategy is the initiative going to follow? Covers the approach to develop the process as well as for rolling it out in the organization. Roll-out may, for instance, follow a pilot, big bang, or phased approach. |
| 3. Mobilize | From what alliances and energies can the initiative benefit? The likelihood of success of an improvement initiative can be improved significantly by adjusting which organizational units and actors are involved and by increasing their commitment. |
| 4. Increase Knowledge | On which knowledge of software processes and improvement is the initiative based? Knowledge can be increased by educating team members, by including additional expertise into the team, or by hiring consultants. |
| 5. Reorganize | How is the initiative organized, conducted, and managed? Covers the organization, planning, monitoring, and evaluation of the initiative. |

others play. The team interprets Figure 4 and discusses the profile and scope of the four risk areas in their specific situation. The agreed interpretation is for future reference.

**Step 2: Analyze Risks**

For each of the four risk areas (Figure 4), a table of risk items and a table of risk resolution actions are presented to the team in a template (sections A.1 through A.4 in Appendix A). Starting with the improvement area and going through each of the four areas, the actors go through both tables. First, the team agrees on a score of 0 (low risk), 1 (medium risk), or 2 (high risk) for each risk included in the risk table. The scores are based on a qualitative assessment of both the probability and the consequence of the risk in question. The scores are written directly on the template, with supporting comments or interpretations. Second, the team indicates (in the corresponding table of resolution actions) which actions they believe can reduce the identified risks (the numbers in these lists refer to the type of strategy to which each individual action belongs; see Table 5). To establish a rich basis for a resolution strategy, it is recommended to include many actions rather than a few. The identified risks and actions comprise detailed lists of possible risks or actions. The team also is asked to identify risks not included in the tables.

The analysis step is completed by determining which risk areas carry the highest risk. The scores for the risk items are summarized for each risk area (see Table 6). The priorities are decided subsequently by the team through a discussion of the scores supplemented with qualitative insights from the analysis. As a consequence, the final priority need not follow the scores. This may indeed happen if one area has very few, but very severe, risks.

**Step 3: Prioritize Actions**

Having decided on the areas that carry the highest risk, attention turns to determining which overall strategies should be chosen to deal with these risks. Figure 5 shows two of the five strategies and the associated resolution actions (the com-

| Table 6. Prioritizing Risk Areas | | | |
|---|---|---|---|
| | **Sum** | **Score** | **Priority (1-4)** |
| Improvement Area | ___ / 22 = | ___ % | ___ |
| Improvement Idea | ___ / 20 = | ___ % | ___ |
| Improvement Process | ___ / 22 = | ___ % | ___ |
| Improvement Actors | ___ / 16 = | ___ % | ___ |

plete table appears as section A.5 of Appendix A). The actions listed in this table are the same as were found in the four action tables under the analysis, but they now are grouped by strategy rather than by risk area. The X's mark under which risk area the action is listed in the risk tables. The table is used as follows:

1. The selected resolution actions are marked and counted. The team considers whether the selected actions provide a reasonable coverage of the risk areas with the highest risks. More actions are added if needed.

2. Each team member distributes the weights 10, 8, 6, 5, 4, 3, 2, and 1 to the actions believed to address the identified risks most effectively. The weights are entered into the template for each member as Ind. Weight.

3. The sum of the individual weights is entered as Grp. Sum.

4. The team discusses how to distribute group weights 10, 8, 6, 5, 4, 3, 2, and 1 on the actions. The team members have to account for and reconcile their differences and enter a common ranking as Grp. Weight. This rarely will follow the calculated Grp. Sum.

5. The team then assigns priorities from 1 (most important) to 5 (least important) to the five resolution strategies based on an overall qualitative discussion. Some merely sum up the previous agreement in step 4, whereas others obtain a deeper understanding of the challenges they face by discussing which primary strategy to follow.

Alternating between making individual judgments (step 2) and having to decide in a group (steps 4 and 5) supports a balanced decision process.

**Step 4: Take Action**

The last step is to adjust the SPI team's plan. This may involve establishing a special task force to handle specific problems, reorienting the initiative, or requesting more resources. It is important at this stage that the SPI team be open-minded and consider the chosen strategy broadly. For example, if the primary strategy is to adjust the mission, and focus the initiative and adjust level of ambition are the only two resolution actions chosen, other actions likely will be necessary to adjust the mission adequately. Such actions could be listed under adjust mission in the table, they could be listed under other strategies, or they could be derived from specific experiences and insights of the involved actors. There may be situations where two of the strategies are considered to be fairly equal in importance, and specific actions are drawn from both.

## *Developing Risk Approaches*

The action research also led to a process and a framework for developing risk management approaches. We developed a risk management approach for SPI in the context of Danske Bank's IT department. We suggest that a process similar to the one we followed (see Figure 6) can be used in other contexts within information systems and software engineering. In adopting the process,

| Strategy | Actions | Impr. Area | Impr. Ideas | Impr. Proc. | Impr. Actors | Ind. Weight | Grp. Sum | Grp. Weight | Grp. Prio. |
|---|---|---|---|---|---|---|---|---|---|
| Adjust Mission (1) | Focus the initiative | X | | | | | | | |
| | Specify the objective | X | | | | | | | |
| | Create results that are conceived to be usable | X | | | | | | | |
| | Focus on business results | X | | | | | | | |
| | Use culturally acceptable solutions | X | | | | | | | |
| | Consider identified needs for improvement | | X | | | | | | |
| | Adjust the level of ambition | | | | X | | | | |
| Modify Strategy (2) | Document and emphasize best practice in the improvement area | X | | | | | | | |
| | Affect the expectations towards the initiative. | X | | | | | | | |
| | Base the initiative on facts and experiences | X | | | | | | | |
| | Create clear and shared visions | | X | | | | | | |
| | .... | | | | | | | | |
| ... | | | | | | | | | |
| | Number of chosen actions: | | | | | | | | |

**Figure 5. Prioritizing Strategies**

actors are advised to consider specific criteria that will help them achieve satisfactory relevance of the outcome and sufficient rigor in the process, see the research criteria section. Davison et al.'s (2004) comprehensive list of principles and criteria for canonical action research can assist in this process, keeping in mind that CPR is collaborative, iterative, and inspired by Susman and Evered's (1978) process model without following it rigorously (see Table 2). Actors are advised to use the framework of software risk management approaches presented in Table 1 to guide their design.

The proposed process is based on the 10 activities of our CPR process (see Tables 2 and 3) and consists of three phases: initiating (activities 1 through 3), iterating (activities 4 through 7), and closing (activities 8 through 10). The sequence between activities 4 and 5 may not hold in practice, and it only points to the logical dependencies between the activities. The sequence from 4 through 7 is based on the canonical problem-solving cycle. It is assumed that the resulting risk management approach is based on a risk framework and performed based on a process. The iterating phase leads to risk management within the area of concern. The closing phase produces a refined risk management approach together with an assessment of its usefulness.

The actors in this process enter the problem situation, bringing in their prior experience and knowledge of the area of concern (activity 1). The actors should (1) have experience within the area, (2) perceive the situation as problematic, and (3) need to find out to what extent and in which way risk management would be beneficial. A part of this activity is to assess whether these prerequisites are met and to establish a project with goals and plans to develop a risk approach. Activity 1 leads to an appreciation of the risk items and resolution actions perceived to be important within the area of concern. Activity 2 takes as input the relevant risk management literature. This complements activity 1 and leads to a comprehensive set of risk items and resolution actions that are used in activity 4. The type of risk approach is selected in activity 3 (see Table 1, based on the desired features of the approach to be developed. The chosen type defines the structural foundation on which the risk framework and process are developed.

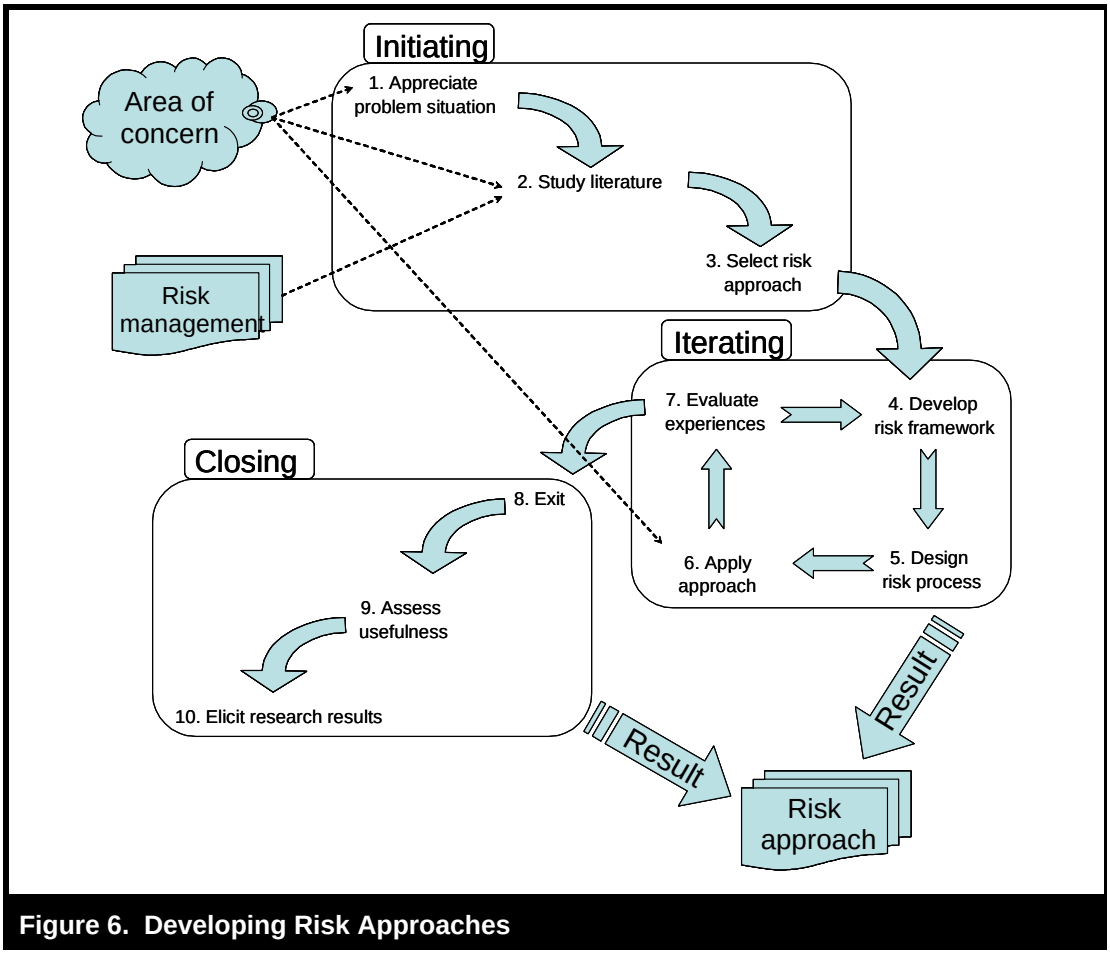


**Figure 6. Developing Risk Approaches**

Activity 4 aggregates the identified risk items and resolution actions into a risk framework of the area of concern (see Figure 4 and Table 5). Then a risk process is developed in activity 5. The process is based on the framework and specific risk items and resolution actions. The risk approach subsequently is applied to specific situations or projects within the area of concern (activity 6). This leads to risks being managed and to experiences using the new approach (activity 7).

The iterating phase ends when the actors agree that the risk approach is developed sufficiently and the problems in the area of concern are alleviated (activity 8). Whether the applications of the risk approach were useful in practice is assessed relative to the problem situation at hand (activity 9). A simple way to do this is to ask the participants in the risk assessment if they found the risk approach useful and to document whether risk management led to actions and improvements. In which ways the new risk approach contributes to the discipline in general is assessed relative to the relevant body of knowledge (activity 10).

## Discussion

The following sections discuss the action research process and its contribution relative to the stated criteria (see te research criteria section). The

criteria on roles, documentation, and control relate to the research process and are addressed in the section on conducting CPR-based ation rsearch. The criteria on usefulness, theory, and transfer relate to the two contributions and are addressed in the sections on managing SPI risks section and the developing risk approaches.

## Conducting CPR-Based Action Research

The following discussion validates the research process by clarifying the roles played by the actors involved, reviewing the approach to data collection, and explicating how the process was controlled. Each of these issues played a key role in ensuring a satisfactory level of relevance and rigor.

### Roles

The research was part of a larger CPR program (Mathiassen 2002). Many practitioner and researcher roles were, therefore, established in advance and inherited and refined in our research. Table 3 shows which practitioners and researchers performed the activities. Altogether 11 practitioners participated. Four [p1-4] were active members of the local research group and participated in the initial brainstorming and appreciation of SPI in the context of Danske Bank's IT department (activities 1 and 2). Eight [p3-10] were active in the SPI teams and participated in applying the risk approach under guidance from the authors [r1-3] and in evaluating the experiences (activities 6 and 7). They added extensive organizational insight to the application of the risk approach and to the subsequent evaluation of its usefulness. The authors [r1-3] were members of the local research group and organized the action research effort. With their background in action research, risk management, and SPI, they were the key drivers. One or more of them participated in all activities presented in Table 3. The authors performed the core activities jointly (e.g., activities 1 through 5 and 9 and 10. A fourth researcher [r4] was a member of the local research group and participated in the activities performed at local research meetings (activities 1, 2, and 9). The practitioners involved in activities 1 and 9 acted in the role of practitioner-researcher. In all other activities, the role of the practitioners was to provide context and a social test bed for the joint application of the risk approach. The role of the researchers was to develop and document the risk approach, to plan and facilitate its use in SPI teams, to collect and interpret data, and to plan and manage the research process.

### Documentation

All of the activities presented in Table 3 produced data and were documented in several ways: (1) directly in the risk approach as part of applying it; (2) in researchers' notes; (3) in comments to the different versions of the framework and process; (4) in audio tapes from meetings in the local research group; (5) in minutes from these meetings; (6) in audio tapes from risk assessment sessions; and (7) in e-mail correspondence between partakers. The data cover the broader context of change, temporal interconnectedness, and relationships between context and actions taken (Pettigrew 1990). First, the collected data cover the broader context of change, rather than just risk management, as the local research group meetings (sources 4 and 5) addressed the organizational-level SPI project as a whole. Second, the data were collected throughout all activities and represent a time span of several months, making it possible to trace relations between actions and changes. Third, the actions taken in risk management, or as consequences of risk management, were related to the organizational-level SPI project (the context) through the meetings in the local research group. The context, on the other hand, influenced the development and application of the risk approach (primarily through activities 1 and 6 in Figure 6). Most data were available as documents or as written traces from the risk management sessions. Audio taping was used at all meetings between practitioners and researchers, thereby covering the most significant activities. These tapes were searched for information that was deemed important for the risk management research, and transcriptions were not necessary. Triangulation was adopted based on

these multiple sources of data, and bias was reduced further by involving different SPI teams, several practitioners from Danske Bank's IT department, and practitioners and researchers from the larger CPR program.

#### Control

The CPR program was governed generally by a formal contract between the four software organizations and the researchers, and stipulated goals, research infrastructure, responsibilities, and available resources. This contract gradually was complemented by informal commitments between the practitioners and researchers in the local research group. Our research was commissioned by the SPI organization at Danske Bank. It inherited the established commitment structure and was not governed by a separate formal contract. We reported progress to the SPI organization, and the research was integrated into the agenda of the local research group.

The request for the risk management research came from practitioners in SPI teams. The research was initiated jointly by the practitioners and researchers in the local research group [p1-4, r1-4] as shown in Table 3. The research was, however, performed largely on the authority of the authors. We basically maintained control over activities 1 through 10 presented in Table 3, while the practitioners participated actively as described above. That allowed us to ensure that data were collected and that insights from software risk management and the SPI literature were utilized. If control had been shifted to the involved practitioners, it most likely would have resulted in a risk management approach more specific to Danske Bank. The adopted approach to control facilitated the development of a more general approach to risk management.

## *Managing SPI Risks*

The primary outcome of this research project, the proposed risk framework and process, was experienced as a useful way to understand and manage risks by the four SPI teams at Danske Bank's IT department. We argue in the following that this approach adds to SPI theory, and that it may be transferred to other organizations.

#### Usefulness

The validity of an action research contribution depends intrinsically on whether some desirable change was created. In all four sessions, the SPI practitioners changed their perception of the risks they were facing; they realized that other options were available; plans were changed as a consequence; and the teams took action to avoid the identified risks. The framework and the process became increasingly useful in the four sessions. Moreover, the four situations were different in terms of organizational context, issues, actors, relationships, goals, risks, and feasible risk resolution actions. This variety of contextual factors suggests that the framework and process apply to a variety of conditions.

We designed the framework to be simple, and we designed the process based on the framework so it was easy to understand. However, as we discovered early on, there was a need to facilitate the process. As we did not attempt to package the approach to be self guided, it is likely that the presentation could be improved further. Several parts conceivably could be packaged as a self-guiding computer-based system. It would be straightforward to automate the involved calculations and provide more details on each risk item and resolution action. Such modifications could, however, hardly substitute for the support and feedback that a facilitator is able to provide to ensure consistent interpretation of all aspects of the approach.

#### Theory

The framework and the process represent an advancement of state-of-the-art in SPI. The research is based on the existing body of knowledge on SPI and software risk management, the initial F of the action research cycle

(Checkland 1991). We combined these to develop a new approach, the resulting reflection over F (Checkland 1991). The literature on SPI deals with a number of risk items and possible resolutions (Grady 1997; Humphrey 1989; McFeeley 1996). While these insights have been integrated into our approach, the literature currently does not offer either a framework for understanding SPI risks or a comprehensive process for practicing SPI risk management. As mentioned in the software process improvement section, the only existing risk approach for SPI (Statz et al. 1997) treats risks at a detailed level with a large number of risk items (63) and categories (13), and offers a simple process that guides the user through each of these in turn. The approach does not address resolution actions, it does not offer heuristics for relating risks to actions, and it does not offer frameworks that assist the user in developing an overview of primary risks and resolution strategies.

The contribution of the presented research to SPI, given this background, is twofold. First, the framework (Figure 4 and Table 5) offers a structured understanding of the risk areas and resolution strategies that SPI teams face. Similar frameworks in the literature help understand systems development escalation (Keil 1995), software project risks (McFarlan 1981), and requirements engineering risks (Davis 1982), but the SPI literature so far has lacked such aggregate level concepts. The usefulness of the framework was demonstrated through its practical application in the four SPI teams within Danske Bank's IT department. Also, we developed a comprehensive framework by making sure that it covered all risk items and resolution actions mentioned in key sources on SPI (Grady 1997; Humphrey 1989; McFeeley 1996; Statz et al. 1997). Second, the associated process provides managerial support for SPI teams through heuristics that link specific risks to appropriate actions. The process provided useful support for the four SPI teams within Danske Bank's IT department. Similar processes have been developed to support risk management in requirements engineering (Davis 1982) and object-oriented analysis and design (Mathiassen et al. 2000). This is, however, the first comprehensive process that helps SPI teams manage risks.

Lyytinen et al. (1998) compared the way in which risk approaches shape management attention. They categorize risk frameworks according to Leavitt's (1964) general model of organizational activity with the four key elements: task, technology, structure, and actors. Applying this scheme to the activity of an SPI team, the proposed SPI risk areas (Figure 4) are categorized as follows: improvement area (task), implementation ideas (technology), improvement process (structure), and improvement actors (actor). The proposed risk resolution strategies for SPI teams (Table 5) are categorized to address the following elements: adjust mission (task), modify strategy (process-technology), mobilize (process-actor), increase knowledge (actor), and reorganize (process). This characterization suggests that the proposed SPI risk framework covers the important aspects of SPI team activity. Lyytinen et al. (1998) also suggest distinguishing between quantitative risk approaches based on rational decision theory and qualitative approaches based on a behavioral view of risk management. The proposed approach in these terms is based on a qualitative analysis of SPI risks, and its behavioral orientation helps SPI practitioners master their environment by bringing risks under control. This choice of approach worked well in the four SPI teams in Danske Bank's IT department and, in general, is well suited to the complex and highly dynamic nature of SPI initiatives.

### Transfer

To what extent the framework and the associated process will be useful in settings dissimilar to Danske Bank's IT department cannot be assessed directly based on our research. However, as most of the risk items and resolution actions are derived from the general SPI literature, it is quite conceivable that other organizations implementing SPI programs may benefit from using the approach. It is, furthermore, easy to include other aggregate or specific risk items and resolution actions in the approach. These may be added to or substituted for existing elements. Such dynamic features make the approach adaptable to other organiza-

tional settings. The framework and the process are presented as a generic approach rather than a procedure to be followed blindly. Using the approach does, however, require facilitation. Our research suggests that the facilitator must have experience with risk management, be knowledgeable within SPI, and possess general competence in organizing and conducting collaborative workshops between software professionals.

## Developing Risk Approaches

The second contribution is the proposed approach to tailor risk management to specific contexts. We argue in the following that this approach adds to risk management theory within information systems and software engineering, and that it may be transferred to other situations outside the Danish CPR program.

### Usefulness

We designed a process (see Figure 6) as part of the CPR program to develop risk management within Danske Bank's IT department. The process constituted the initial M of our action research (Checkland 1991; Checkland and Holwell 1998) and helped us combine general knowledge about software risk management and SPI (F) and specific knowledge about SPI (A) at Danske Bank. A key aspect of the process was to draw upon the extensive literature on software risk management. We identified a framework with four different types of approaches to software risk management (Table 1), and the process and the framework guided our efforts at Danske Bank. The four SPI teams found the resulting risk approach useful, and the risk approach is arguably transferable to similar SPI contexts provided that appropriate facilitation is provided. Our subsequent reflections on M (Checkland 1991; Checkland and Holwell 1998) suggest, therefore, that the adopted approach to develop risk management for SPI teams within Danske Bank can be used to tailor risk approaches to other contexts within information systems and software engineering.

### Theory

Software project managers see risk management as a key to success (Barki et al. 1993). Such approaches help software developers appreciate many aspects of a project: they emphasize potential causes of failure, they help identify possible actions, and they facilitate a shared perception of the project among its participants (Lyytinen et al. 1996, 1998). This indicates that software organizations can benefit from adopting software risk management and that we can take advantage of transferring risk management practices to other contexts within information systems and software engineering. We suggest that the approach in Figure 6 can be used for both purposes.

The approach offers two contributions to the literature on risk management within information systems and software engineering. First, we propose a framework for understanding and choosing between different forms of risk management (Table 1). The framework, based on the literature on software risk management, identifies four different ways to design risk approaches and suggests strengths and weaknesses of each design option. Lyytinen et al. (1998) provide a different understanding of the software risk management literature that focuses on how risk approaches shape the attention of project managers. Currently, to our knowledge there are no other studies of risk management approaches that help designers understand and choose between different forms of risk management. Second, we propose a process to tailor risk management to specific contexts (Figure 6). The suggested process builds on the action research literature as outlined in Table 2. It is, in this way, anchored in established experiences on how to address organizational problems effectively while at the same time contributing to scientific progress. The process offers a way to further develop risk management within information systems and software engineering by tailoring new approaches to specific contexts. The literature offers similar guidance to tailor knowledge on software estimation to specific contexts (Bailey and Basili 1981). This is, however, to our knowledge the first approach within information systems and software

engineering that provides such guidance on risk management.

### Transfer

Our own practice developing risk approaches was based on a number of competencies. First, we had intensive domain (SPI) and risk management knowledge. Second, we had general competence in modeling organizational phenomena that we used to identify and classify risk items and resolution actions. Third, we had experimental competence that we used to collect feedback from the test situations to iteratively arrive at the resulting approach. Each of these competencies is required to apply the proposed approach in other contexts. It is also important to stress that the approach, like most action research processes, is a template that needs to be adapted and supplemented in action, depending on the conditions under which it is applied.

## Conclusion

We used CPR-based action research to combine knowledge from SPI and software risk management to respond to practical needs of SPI teams. The findings of the research have implications for both practice and research.

CPR aims explicitly at contributing to research, while at the same time producing and disseminating relevant knowledge for practice (Mathiassen 1998, 2002). We, therefore, published parts of the presented results to SPI practitioners (Iversen et al. 2002) and advised them to address risks systematically. This advice is consistent with state-of-the-art literature on SPI (Grady 1997; Humphrey 1989; McFeeley 1996; Statz et al. 1997). In addition, we offered a practical approach to address risks systematically in each SPI team. Depending on the size and structure of the team, such risk-based interventions can be carried out when initiating the project and repeated later as the project unfolds. Risk management is, in general, a very inexpensive and non-risky type of intervention that helps focus the attention of practitioners on the challenges they face (Lyytinen et al. 1998). We suggest that risk management efforts in SPI teams will reduce the likelihood of failure and help software organizations better take advantage of SPI insights and experiences. More research is, however, needed to further develop these ideas. The proposed SPI risk framework and process need to be validated and refined through empirical studies and practical use in other organizational contexts. Also, we need longitudinal studies that show how organizations over time can benefit from and further develop risk management approaches to SPI. Such studies could provide deeper insights into the relations between risk management activities, the actions that are initiated based on risk management activities, and the effects that such actions might have on improving software practices within the organization.

Our studies also suggest that action research can help tailor risk management approaches to specific contexts within information systems and software engineering. Individual organizations can benefit from developing risk management approaches that are tailored to their specific needs. As a discipline, we can benefit by developing risk management approaches to other contexts such as e-commerce, ERP implementation, and supply chain innovation. Any form of organizational change enabled by information technology is complex and difficult. Risk management, as illustrated well in relation to software development, is a highly effective way to bring relevant knowledge within a particular organization or domain into a form in which it can support and improve professional practices. Researchers and practitioners within information systems and software engineering are, therefore, encouraged to adopt action research to tailor risk management to new contexts. We documented and illustrated an approach that can be applied for that purpose. More research is, however, needed in this area. In particular, a thorough design-oriented review of the literature on risk management within information systems and software engineering could lead to further validation of the proposed framework (Table 1) and to additional support for designing risk approaches.

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# Appendix A

## Risk and Action Tables

Our approach to managing risks in SPI teams has been presented to practitioners (Mathiassen et al. 2002). This appendix contains the risk item and action tables of the approach. Note that the numbers in parentheses in the risk resolution action tables refer to the strategy to which the action is related (see section A.5).

### *A.1 Improvement Area*

| Risk Items |
|---|
| Are the processes in the improvement area and their actors clearly delimited? |
| Is the current practice in the improvement area well understood? |
| Are the problems acknowledged among the actors in the improvement area? |
| Is there a desire to change among the actors in the improvement area? |
| Do the actors in the improvement area have realistic expectations to the improvement initiative? |
| Is adequate attention and energy in the improvement area directed towards the improvement initiative? |
| Are traditions and cultures homogenous in the improvement area? |
| Are the interests towards the initiative shared and similar throughout the improvement area? |
| Are the actors in the improvement area open for new ways of thinking? |
| Will the actors in the improvement area benefit from the improvement? |
| Does the process action team enjoy recognition and trust from the actors in the improvement area? |

| Risk Resolution Actions |
|---|
| Focus the initiative. (1) |
| Specify the objective. (1) |
| Create results that are conceived to be useful. (1) |
| Focus on business results. (1) |
| Use culturally acceptable solutions. (1) |
| Document and emphasize best practices in the improvement area. (2) |
| Initiate discussions about experiences and problems in the improvement area. (3) |
| Understand and document the current practice in the improvement area. (4) |
| Create an understanding of the necessity of the initiative. (3) |
| Affect the expectations towards the initiative. (2) |
| Base the initiative on facts and experiences. (2) |
| Exploit and adapt incentive schemes. (3) |
| Sell the idea. (3) |

### A.2 Improvement Idea

| Risk Items |
|---|
| Is the improvement activity clearly focused? |
| Does the process action team agree on the improvement idea's professional foundation and practical design? |
| Has the improvement idea been adapted to professional and business needs in the improvement area? |
| Is the improvement idea culturally acceptable, and can it be adapted into the current practice? |
| Are the improvement idea's consequences well understood? |
| Does the process action team have sufficient knowledge about and experience with the improvement idea? |
| Do the actors in the improvement area have sufficient knowledge about and experience with the improvement idea? |
| Has the potential for innovation been exploited? |
| Is the improvement idea coordinated with other ongoing improvement activities? |
| Can the improvement idea's effect be measured? |

| Risk Resolution Actions |
|---|
| Formulate measurable goals. (5) |
| Create clear and shared visions. (2) |
| Initiate discussion about possible means of change. (3) |
| Identify and solve specific problems. (2) |
| Use an incremental improvement strategy. (2) |
| Evaluate the consequences of the improvement idea. (4) |
| Study state-of-the-art. (4) |
| Consider alternative improvement ideas. (2) |
| Reuse others' successes. (2) |
| Take advantage of experiences from other organizations. (4) |
| Adapt well-known standard solutions. (2) |
| Buy a tool or a method. (2) |
| Experiment. (4) |
| Consider identified improvement needs. (1) |
| Educate actors in the improvement area. (2) |
| Take advantage of the relationships to other improvement initiatives. (2) |

### A.3 Improvement Process

| Risk Items |
|---|
| Has an agreement or contract been made regarding how the improvement initiative is organized and conducted? |
| Does the process action team have a well-defined success criterion? |
| Is the improvement process planned? |
| Does the organization and allocated resources for the improvement process, correspond to the extent and complexity of the task? |
| Are the relevant levels of management sufficiently committed to the improvement initiative? |
| Is the improvement initiative sufficiently integrated with the rest of the organization? |
| Has the rest of the organization been informed sufficiently? |
| Has visible results at appropriate intervals been planned throughout the course of the initiative? |
| Are improvements and progress documented? |
| Is the process action team's results and progress monitored? |
| Is there a realistic plan for implementing the improvement idea? |

| Risk Resolution Actions |
|---|
| Get sponsors. (3) |
| Organize the improvement initiative as a project. (5) |
| Establish a contract with management regarding the improvement initiative. (5) |
| Arrange an event to create attention at project start-up. (3) |
| Plan the improvement initiative. (5) |
| Adapt the strategy to the task. (2) |
| Co-ordinate with other improvement initiatives. (5) |
| Plan implementation from the outset. (5) |
| Plan visible results every 6-9 months. (2) |
| Design effect measures. (2) |
| Initiate discussions about the improvement process. (3) |
| Create and maintain management commitment and backing. (3) |
| Establish and maintain collaboration with the improvement area. (3) |
| Try out improvement ideas in pilot projects. (4) |
| Communicate plans, problems, progress, and results. (5) |
| Conduct reviews at regular intervals. (5) |
| Make the results visible. (5) |

### A.4 Improvement Actors

| Risk Items |
|---|
| Do the participants in the process action team have sufficient resources to carry out the improvement? |
| Does the process action team have concrete knowledge about the current practice in the improvement area? |
| Does the process action team have sufficient knowledge about the improvement idea and its professional foundation? |
| Does the process action team have sufficient knowledge about and experience with improvement work? |
| Is each of the participants in the process action team sufficiently committed towards the improvement initiative? |
| Does the process action team function as a team? |
| Has the necessary expertise and experience been allocated to the process action team? |
| Has the process action team established co-operation with all the relevant parts of the organization? |
| Is the improvement idea coordinated with other ongoing improvement activities? |
| Can the improvement idea's effect be measured? |

| Risk Resolution Actions |
|---|
| Obtain resources for the actors. (3) |
| Educate the process action team in the improvement idea's professional foundation. (4) |
| Get good facilitators. (5) |
| Incorporate experienced change agents. (5) |
| Exclude participants who do not contribute. (5) |
| Adjust the level of ambition. (1) |
| Involve voluntary actors from the improvement area. (5) |
| Educate the process action team in improvement work. (4) |
| Teambuilding. (5) |
| Enter into alliances. (3) |
| Inform about the group's work. (5) |
| Use consultants.(4) |

## A.5 Prioritizing Strategies

| Strategy | Actions | Impr. Area | Impr. Ideas | Impr. Proc. | Impr. Actors | Ind. Weight | Grp. Sum | Grp. Weight | Grp. Prio. |
|---|---|---|---|---|---|---|---|---|---|
| Adjust Mission (1) | Focus the initiative | × | | | | | | | |
| | Specify the objective | × | | | | | | | |
| | Create results that are conceived to be usable | × | | | | | | | |
| | Focus on business results | × | | | | | | | |
| | Use culturally acceptable solutions | × | | | | | | | |
| | Consider identified needs for improvement | | × | | | | | | |
| | Adjust the level of ambition | | | | × | | | | |
| Modify Strategy (2) | Document and emphasize best practice in the improvement area | × | | | | | | | |
| | Affect the expectations towards the initiative. | × | | | | | | | |
| | Base the initiative on facts and experiences | × | | | | | | | |
| | Create clear and shared visions | | × | | | | | | |
| | Identify and solve specific problems | | × | | | | | | |
| | Use an incremental improvement strategy | | × | | | | | | |
| | Consider alternative improvement ideas | | × | | | | | | |
| | Reuse others' successes | | × | | | | | | |
| | Adapt well-known standard solutions | | × | | | | | | |
| | Buy a tool or a method | | × | | | | | | |
| | Educate actors in the improvement area | | × | | | | | | |
| | Take advantage of the relationships to other improvement initiatives | | × | | | | | | |
| | Adapt the strategy to the task | | | × | | | | | |
| | Plan visible results every 6-9 months | | | × | | | | | |
| | Design effect measures | | | × | | | | | |
| Mobilize (3) | Initiate discussions about experiences and problems in the improvement area | × | | | | | | | |
| | Create an understanding of the necessity of the initiative | × | | | | | | | |
| | Exploit and adapt incentive schemes | × | | | | | | | |
| | Sell the idea | × | | | | | | | |
| | Initiate discussion about possible means of change | | × | | | | | | |
| | Get sponsors | | | × | | | | | |
| | Arrange an event to create attention at project start-up | | | × | | | | | |
| | Initiate discussions about the improvement process | | | × | | | | | |
| | Create and maintain management commitment and backing | | | × | | | | | |
| | Establish and maintain collaboration with the Improvement area | | | × | | | | | |
| | Obtain resources for the actors | | | | × | | | | |
| | Enter into alliances | | | | × | | | | |
| Increase Knowledge (4) | Understand and document the current practice in the improvement area | × | | | | | | | |
| | Evaluate the consequences of the improvement idea | | × | | | | | | |
| | Study state-of-the-art | | × | | | | | | |
| | Take advantage of experiences from other organizations | | × | | | | | | |
| | Experiment | | × | | | | | | |
| | Try out improvement ideas in pilot projects | | | × | | | | | |
| | Educate the process action team in the improvement idea's professional foundation | | | | × | | | | |
| | Educate the process action team in improvement work | | | | × | | | | |
| | Use consultants | | | | × | | | | |
| Reorganize (5) | Formulate measurable goals | | × | | | | | | |
| | Organize the improvement initiative as a project | | | × | | | | | |
| | Establish a contract with management regarding the improvement initiative | | | × | | | | | |
| | Plan the improvement initiative | | | × | | | | | |
| | Co-ordinate with other improvement initiatives | | | × | | | | | |
| | Plan implementation from the outset | | | × | | | | | |
| | Communicate plans, problems, progress, and results | | | × | | | | | |
| | Conduct reviews at regular intervals | | | × | | | | | |
| | Make the results visible | | | × | | | | | |
| | Get good facilitators | | | | × | | | | |
| | Incorporate experienced change agents | | | | × | | | | |
| | Exclude participants who do not contribute | | | | × | | | | |
| | Involve voluntary actors from the improvement area | | | | × | | | | |
| | Team building | | | | × | | | | |
| | Inform about the group's work | | | | × | | | | |
| | Number of chosen actions: | | | | | | | | |