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Understanding the implementation of software process improvement innovations in software organizations

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Abstract. *The development of software is a complex task frequently resulting in unfinished projects, project overruns and system failures. Software process improvement (SPI) approaches have been promoted as a promising remedy for this situation. The organizational implementation of such approaches is a crucial issue and attempts to introduce SPI into software organizations often fail. This paper presents a framework to understand, and subsequently successfully perform, the implementation of SPI innovations in software organizations. The framework consists of three perspectives on innovation: an individualist, a structuralist and an interactive process perspective. Applied to SPI, they emphasize different aspects of implementing SPI innovations. While the first focuses on leadership, champions and change agents, the second focuses on organization size, departmental and task differentiation and complexity, and the third perspective views the contents of the innovation, the social context and process of the implementation as related in an interactive process. We demonstrate the framework's applicability through two cases. We show that the three perspectives supplement each other and together provide a deeper understanding of the implementation process. Such understanding is crucial for the successful uptake of SPI approaches in software organizations.*

Keywords: software process improvement, organizational implementation, process innovations, organizational development

INTRODUCTION

The development of software is known to be a complex task. Despite the progress made by the introduction of methods and techniques, unfinished projects, project overruns and system failures are still common. The limited success of technology-driven approaches has led to a stron-

ger focus on organizational and process-oriented aspects of software development. As a consequence, several innovations in the field of quality management and software process improvement (SPI) have been developed and are promoted for the software industry. Thomsen & Mayhew (1998) as well as Aaen *et al.* (2001) provide good overviews of current approaches to SPI.

The organizational implementation of such approaches is an important and problematic issue and the majority of attempts to introduce some kind of SPI into software organizations fail (Debou, 1999). This is a controversial topic and is intensively discussed in the IFIP Working Group 8.6 on 'Diffusion, Transfer & Implementation of Information Technology' (Levine, 1994; Kautz & Pries-Heje, 1996; Ardis & Marcolin, 2001).[1]

Our primary aim in this paper is to achieve a better understanding of the processes influencing the introduction, organizational implementation and adoption of SPI innovations in and by software companies. Such an increased understanding may lead to processes that more successfully support the uptake of SPI approaches throughout software companies.

We have been actively involved in several projects where we assisted various organizations in the introduction of SPI measures (Kautz, 1998; Iversen *et al.*, 1999; Kautz, 1999; Kautz *et al.*, 2000; Nielsen & Nørbjerg, 2001). When we jointly reflected upon the course of these projects and discussed our experiences, we felt that we lacked an analytical device to go beyond superficial explanations and to connect anecdotal fragments to a more coherent and comprehensive whole.

Thus, we studied the literature on innovations in organizations and found a framework, which originally served to classify the existing literature in the field. This framework was developed by Slappendel (1996) and she distinguishes between an individualist, a structuralist and a so-called interactive process perspective on innovations in organizations.

Especially this third perspective, which comprises the first two and emphasizes their interaction through the context, content and process of innovative change in organizations, appealed to us as it proposes to perform the analysis of change in terms of a constant interplay of its three constituting elements over time. It intends to overcome the shortcomings of other highly linear and rational models.

We have expanded Slappendel's interactive process perspective with a longitudinal process view from Pettigrew (1985), which had been introduced to the field of information systems development and use by Walsham (1993) to understand the relationship between organizational change and information systems. It had also been used by one of the authors (Kautz, 1996) to explain the introduction of an electronic mail system into an organization.

Therefore, we decided to test the applicability of the whole extended framework in the attempt to understand the introduction of SPI as an example of another type of innovative organizational practice. We utilized the framework in the analysis of two cases. As a

[1]The introduction, implementation, adoption and diffusion of other information technology (IT)-related innovations have been a subject of research since the 1970s and one prominent example of this work is Perry & Kraemer (1978); it has also been discussed in the Diffusion Interest Group in Information Technology and the IEEE (Institute of Electrical and Electronics Engineers) working group on technology.

result, we are able to better understand and explain their processes and organizational outcome. A secondary aim of this paper is therefore to demonstrate the usefulness of the framework.

In this paper, we will first introduce the developed framework in more detail and outline our general research approach. Then we apply the framework and present separately the two cases of introducing SPI into organizations. Subsequently the cases are discussed together within the developed framework and finally some conclusions concerning the suitability of the framework are drawn.

RESEARCH FRAMEWORK

Rogers (1983) provides a now well-established definition of the concept of innovation as an idea, practice or object that is perceived as new by an individual or other unit of adoption. It has also been accepted that, while not all change involves innovation, all innovations imply change [Slappendel, 1996 citing Zaltman *et al.* (1973)]. Thus, for the purpose of this study we will in the following largely use the terms innovation and change interchangeably.

Research on innovations in organizations has been carried out with a focus on different levels of analysis and, as a consequence, with differing, partly contradicting results. Slappendel (1996) has performed a comprehensive literature review and provides a framework which distinguishes the existing work in the field in three categories based on the applied perspective on innovative organizational change, namely an individualist, a structuralist and an interactive process perspective. The three perspectives can – following Slappendel (1996) – be described in terms of their basic assumptions about who and what causes innovations, and what the accompanying core concepts in such descriptions are. The innovation itself and the innovation process are also conceptualized in these descriptions.

The *individualist perspective* on innovation assumes that single individuals are the main source of change in organizations. Their actions are not seen to be constrained by external factors; instead, they are understood to be self-directing agents who are guided by the goals they have set. In this view, individuals are rational and make decisions in order to maximize value or utility. The approach assumes that some individuals have personal qualities which predispose them to innovative behaviour. Consequently, individual characteristics, such as age, sex, educational level, values, personality, creativity and cognitive style, define the antecedents for innovation and concepts, such as leader, champion, entrepreneur, innovator and change agent, are in the centre of interest.

The *structuralist perspective* assumes that innovation is determined by objectively existing organizational characteristics. It has not been possible to establish definite relationships between innovation and a range of structural parameters, but various contingency models have been developed. The focus lies on often separately investigated variables, such as an organization's size, its task structure differentiation, its task complexity, its employees' job specialization and their professionalism, as well as on the organization's degree of job formalization, and centralization of execution of power and decision-making. Finally, this perspective also

includes the attention to the relationship between the organization and its environment in terms of the role customers, suppliers, competitors and government play as structural variables influencing an organization's innovativeness.

Both in the individualist and in the structuralist perspective, innovations are seen as static objects or practices, which again can be described objectively. The process of innovation follows simple linear stages typically denoted as periods of design and development, followed by adoption and implementation, and finally diffusion. Both perspectives largely focus on the adoption phase, the phase where the decision is made to invest resources to accommodate implementation of the innovation (Cooper & Zmud, 1990).

The *interactive process perspective* assumes that innovation is a dynamic, continuous phenomenon of change over time in which various factors have mutual impact on each other. As the actions of innovative individuals cannot be divorced neither from the activities of other individuals nor from the organizational structures within which they operate, innovation is the result of continuous interaction of the actions of individuals, structural influences and the innovation itself. Slappendel (1996) acknowledges the limitations of the assumption of innovations as static, objectively definable objects and practices, of the stage-to-stage conception of the innovation process, and of the focus on environment as the only contextual variable, but makes in her original framework only a limited effort to explicitly overcome them. This has, however, been addressed by Pettigrew (1985) when trying to understand strategic change. It has also been taken up by Walsham (1993) when studying change in the context of information system development and use where he utilizes the concepts of content (of innovation), the social process (of innovation) and the social context (of innovation) as interlinked units of analysis.

We follow Pettigrew and Walsham and utilize these concepts for our investigation of SPI innovations in organizations. In such a perspective the content of an innovation, be it a product or a process, is perceived subjectively and is subject to ongoing reinvention and reconfiguration. The context of an innovation is explicitly understood as a wider social context comprising both social relations and social infrastructure in and outside the organization, which allow initial ideas to proliferate into several ideas and innovations as the process ensues. This also comprises the historical circumstances from which an innovation emerges. Here quite regularly shocks to which the organization is exposed can be traced as the origin of an innovation. The social context, e.g. in terms of a combination of motivational factors and individual competence, is also considered to have an influence on an organization's innovative capacity as a whole.

Finally, innovation as a social process is characterized by politics concerning the distribution of power and the control and autonomy of the individuals involved and their culture, subculture and interactions between different stakeholder groups and subcultures play a significant role as well. As such innovation is a complex, messy process, which is inseparable from its broader context, it should therefore be analysed and understood in terms of the continuous interplay of content, process and context of change.

The resulting framework, which builds the basis for the following analysis, is summarized in Table 1.

Table 1. Perspectives on innovations in organizations

	Individualist	Structuralist	Interactive process
Basic assumptions	Innovation is caused by rationally acting individuals	Innovation is determined by objectively existing independent structural characteristics	Innovation is produced over time by the interaction between the actions of individuals, structural influences and the innovation itself
Core concepts	Leader Champion Entrepreneur Innovator Change agents	Size Differentiation Complexity Specialization Professionalism Formalization Centralization Environment	Contents Social context Innovative capability Social relations Proliferation Social infrastructure History Shocks Social process Political perspective Distribution of power Autonomy vs. control Cultural perspective Stakeholders' interaction Subcultures' interaction
Conceptualization of an innovation	An innovation is a static object or practice which is defined objectively	An innovation is a static object or practice which is defined objectively	The contents of an innovation is subjectively perceived and constantly reinvented and reconfigured
Conceptualization of the innovation process	Innovation is seen as a simple, linear process with focus on the adoption stage	Innovation is seen as a simple, linear process with focus on the adoption stage	Innovation takes place in a complex social process in which political and cultural aspects play an important role

RESEARCH METHOD

In the next sections, we will present our case studies from two software organizations in which we participated actively in their SPI initiatives. The research method applied in both organizations can be characterized as action research. Action research is an approach that simultaneously attempts to achieve practical value for the client organization and to contribute to the theoretical body of knowledge (Avison *et al.*, 1999). A number of explanations of action research cover our approach; in particular Rapoport (1970), Hult & Lennung (1980) and Checkland (1991).

In both cases, one of the authors was a part of the research team. In Case I, three researchers worked with the organization over 3 years. The researchers provided support for the organization's SPI. The researchers met regularly with the organization's SPI agents in full-day monthly meetings during the whole project. The purpose of these meetings was to discuss and work on SPI. In addition, the researchers assisted and facilitated many *ad hoc* SPI activities.

In Case II, two researchers worked with the organization on a regular, daily basis for 2 years. A third researcher was occasionally active, mainly as supervisor and additional adviser. The two researchers who worked daily in the organization soon became the local SPI specialists. Together with a project leader, they formed a software engineering process group (SEPG). The group performed several software process assessments and on this basis developed and revised an improvement plan. Parts of this improvement plan have been implemented or are under implementation.

The research process was documented in several ways. Minutes were taken from all meetings and shared with all involved. In Case I, meetings were also recorded on tape and made available for later transcription. Interviews were in Case I also recorded on tapes, and in addition, immediately afterwards, elaborate minutes were written. In Case II, in addition to minutes and the documented results from formal assessments, data were collected in form of researchers' diaries as well as statements from informal interviews and conversations. Finally, the engagement in both organizations resulted in several presentations and reports, which all served as background material for the research presented here.

CASE I: HTM

The company High Tech Measurement (HTM) is more than 50 years old and has long been a leading manufacturer of high-precision measurement instruments. When the SPI project was launched, the company had been under pressure for some years as the market demanded inexpensive and advanced measurement systems. The company had transformed its business from developing products based on mechanical and electronic components to producing measurement systems consisting of a PC with a few hardware extensions and much specialized software. The company had been through a significant downsizing phase. Most projects were organized as integrated projects including hardware, software, sales and marketing staff. The development processes were documented in an ISO9000 certified quality system with separate hardware and software parts, yet with a development model perceived by the developers as largely oriented towards hardware. Several other quality improvement activities took place, largely performed by one single person whom we refer to as the SPI practitioner.

Individualist perspective

There were several significant individuals with different roles and attitudes: the principal SPI practitioner, the project managers, a technical director as part of management and the researchers.

The SPI practitioner had been working with SPI for some time mostly on his own to identify beneficial improvements. He had investigated existing error reports and, based on their classification, he had been able to induce where an error should have been avoided. Few in the organization had noticed his work despite an effort to communicate the findings. When the SPI project was started, he was fairly pessimistic about a revival of SPI in HTM. Nevertheless, he became a very active and important participant in the subsequent work.

The project managers played a prominent role in all activities in HTM. They regarded product development as more prestigious than all other activities, including management and process improvement. Only a few regarded SPI activities as directly relevant to their projects and they were hesitant to use their own resources on improvement activity.

Management had originally not asked for improvements as they focused primarily on marketing the company's products. But they encouraged the work. Moral support was given at large meetings, but few resources nor clear authorization were granted. The technical director had been newly appointed and had little knowledge of SPI. He continued to reward the project managers for their product development.

Three action researchers advised HTM on SPI. They participated in the SPI group. The project managers had severe reservations about the researchers and their ideas.

Structuralist perspective

HTM is an old company, divided into departments. The main departments are development, production, marketing and sales. The managerial hierarchy consists of the CEO and the technical director above the project managers. This provided the project managers with a powerful position and considerable influence.

Development was organized in projects with significant autonomy. The work focused on being professional in the technical activities and on high product quality. Little emphasis was put on management and processes. In this setting, incomplete requirements, insufficient resources, unreasonable deadlines and market pressure were not considered as internal project concerns, but as environmental and outside forces.

The SEPG consisted of the principal SPI practitioner, three of his colleagues and one of the project managers. The extended SEPG with the three researchers and two external consultants was called the SPI group. The mandate of the group was somewhat unclear, as the SPI effort was not set up as a formal project. Subgroups of the SPI group acted as support teams assisting development projects in evaluating and implementing possible improvements.

The SPI practitioners and the project manager worked part time on SPI, and the researchers and consultants used 2–6 days a month.

HTM's quality management system was certified according to ISO9000. The quality management system had initially been defined with hardware engineering in mind, but was subsequently also applied to software development. Most project managers experienced it as not very useful. That created resistance towards SPI as they feared that SPI would be just as useless.

Interactive process perspective

The contents of the innovation

SPI started with introducing the very concept of software process and a formal assessment following the Bootstrap methodology,[2] which triggered the SPI activities and a thorough problem diagnosis involving seven project managers. The SEPG was formed and, without following any established SPI approach, activities were started in: development models, project tracking procedures, requirements specification, configuration management and software reuse. A support team was established for each of these activities. The support teams' work included changing the organization's attitude from only acknowledging product quality to also acknowledging the relevance of development processes.

The context of the innovation

The context was largely determined by the crisis that HTM had been through. HTM had a fragile market position caused by a dramatic collapse of an entire market. The company followed its usual survival tactics, i.e. to produce better products as soon as possible. A deviation from that was unthinkable. The crisis had become the governing force for the R&D department. SPI was perceived as an overhead in the short run. The perception was that it might pay off in the future, but they might not be in business in that future. Thus, all the innovative capabilities and competence of the project managers and the software developers were directed at creating new and better products. There was little innovative capability for software processes.

Management was reluctant and provided little support for the SEPG. Consequently, development and dissemination of new ideas and practices, i.e. proliferation, was almost absent and visions of a better future were vague.

The effort to systematize errors had both been a failure and a success. It had failed to overcome the immediate defences in the organization. It had, however, given the SPI practitioner experience in what did not work in HTM. The actual techniques, concerning usability testing and code inspections, developed during this effort slowly gained momentum. Most new projects will in the future engage these in their development activities. In the end, the interaction process between the one proactive individual and the hesitant organization turned out to be successful.

A small, but visible effort to perform an assessment had been sufficient to determine the need for SPI. However, little happened when the assessment report was delivered to management. The project managers remained largely untouched by the findings. Later, however, the SPI project was launched as a consequence of that assessment.

[2]Bootstrap (Kuvaja *et al.*, 1994) is a European software process assessment and improvement methodology which is based on an underlying model of software 'best' practice, a standardized questionnaire and interview technique, and a model of the improvement process itself.

The social process of the innovation

From both a political and a cultural perspective, the project managers were at the centre of all social processes. They had not initiated the SPI programme. But already in the initial phase of the SPI initiative, the researchers recognized that it would only be feasible to implement SPI if the project managers were able to see the problems to which SPI was a possible solution. If they would not understand and give these problems a high priority, the implementation would fail from the very beginning. As a consequence, all SPI was directed at the project managers.

The project managers' professional values dominated HTM: producing solutions today was perceived as being better than improving software processes in preparation for tomorrow. This defined the culture in which the implementation of SPI took place. The project managers' conservatism and suspicion towards innovations not developed by HTM determined their relationship to the researchers who initially were perceived as outsiders and had to struggle for recognition. The researchers therefore had to put much energy into establishing credibility and to deflate their doubts. Consequently, the improvement activities did not follow established models, but the SPI group developed their own approach explicitly directed at the project managers.

Management had all their attention directed at the project managers and enforced the product-driven attitude by providing considerable autonomy as long as they delivered products within the given time constraints. Management expected the SEPG to change the software processes, but they did not explicitly request specific improvement results. They approved the initiative and provided symbolic support, but gave few resources and limited authority. Consequently, none of the project managers would at first openly admit that they had any problems with software processes. The project managers did not see that their attitudes and perceptions were a major obstacle for implementing SPI and for benefiting from it. Given the project managers' reluctance towards approaches from the outside, the SPI group performed a situated problem diagnosis based on an interview guide developed for HTM rather than a traditional maturity assessment. The problem diagnosis showed significant problems with software processes. However, according to the project managers, these were related to top management issues, such as insufficient resources and political deadlines, and not to their project management procedures as such. Initially, only a few project managers recognized that their own practice might be problematic.

The project managers' relationship to the SPI group was ambivalent. From a political point of view, the SPI group's position and mandate was both unclear and weak. Only one project manager was active in this group. Its work was not organized as a formal project in a culture where project work was the usual form of organizing work. The original SPI strategy had been to let the project managers handle the improvement assisted by the SPI group, but as it turned out the SPI group handled the improvement initiatives assisted by the projects.

Nevertheless, the problem diagnosis was useful, as it enabled the SPI group to build on the project managers' perceptions. The project managers regarded the interviews as very useful, as they resulted in a strategy where all improvement efforts had to be relevant to their projects. The project managers each chose an improvement area that they considered important for their project, e.g. the definition and utilization of a new development model with time boxing. It

also explained why other efforts not connected to specific projects failed, e.g. reuse where all had agreed that it was important while there was no direct need in any of the projects and the work stopped after a few meetings without much noticing.

The creation of the support teams through the SPI group was a success. The support teams were made responsible for transferring new ideas to the projects and they were appreciated as designated support for the projects. The teams were constantly offering useful advice and met regularly with their projects to assist them. As a result, the project managers had finally acknowledged the importance of the SPI initiative and after 3 years it was in a position where it made sense to improve processes on a large scale.

CASE II: NP

Network Products (NP) is a very young company. At the start of the study it was little over 1 year old. Its two managing directors had founded it.

In the growing market of web-based information systems, it produced standard solutions for local business. The main R&D project aimed to develop a groundbreaking solution for the presentation of information on 20000 warehouse items on 14″ screens within slow network infrastructures in a fast and structured way. The aim was to have this product on the market before the competitors. To pursue this aim, the company was organized into two departments: standard solutions and R&D. It started with 25 employees, of whom 15 were software developers. In 2 years the software department grew to 60.

The company was partly funded by the European Union (EU). The sponsoring contract stipulated the company to establish a quality function. Management showed a genuine interest and wanted to establish all basic software processes as soon as possible. This step was judged particularly important as the company wished to sell their product on the American market and saw software processes defined and performed in line with the Capability Maturity Model (CMM) (Humphrey, 1989) as a competitive advantage. In addition, the company expected a considerable increase in staff. Thus, NP contacted the researchers and the company started a formal co-operation with the local university and launched a SPI initiative within 2 weeks of the initial contact.

Individualist perspective

The business manager was the driving force behind the improvement effort. He had felt that there was a need for knowledge and implementation of improved software processes. As a member of a local network of IT professionals, he had heard about the SPI specialists at the local university. He took the first initiative, contacted the researchers and invited them to the organization.

Both managers agreed upon the importance of the initiative and consequently provided the necessary resources. They assigned one of the company's project managers to the project, hired the researchers and allocated a certain amount of all developers' time to SPI. They also took part in meetings with the SEPG and software developers, especially in the start-up phase. Management was present and encouraged the employees to pursue SPI continuously. At

times, the business manager was perceived as too enthusiastic. He entertained quite high expectations concerning the time frame and visible results.

The researchers acted as specialists in SPI. After the introductory contact meeting, two of them introduced the concept of SPI in detail to both management and all developers in two follow-up meetings. Immediately afterwards, they performed a weeklong assessment to investigate the company's general organizational procedures and its capability compared to the CMM level 2 (of 5) focusing on project management and planning, requirements management and quality assurance issues. They delivered oral presentations and written reports of the results and prepared an action plan for the implementation of their proposals. Subsequently, they worked as facilitators during the implementation process. As mentors and coaches, they supported the developers throughout the planning and realization of the different improvement activities.

The developers were actively involved in each phase of the SPI initiative. Together with management and the SPI specialists, they prioritized the proposals and implemented these actively themselves.

Finally, one of the project managers played a significant role. He was a knowledgeable and highly respected developer with a deep interest in SPI. He acted as mediator between the SPI specialists, the management and all other developers. Together with the two researchers, he built a SEPG and organized the first improvement activities in two technical working groups.

Structuralist perspective

The management hierarchy was flat. The two managing directors were involved in all decisions one way or the other.

The R&D department was staffed with young, mostly newly graduated and thus well-educated IT professionals who represented among others the fields of decision support systems, systems development, human computer interaction and databases.

Three project managers connected top management and the developers. The project managers co-ordinated a number of subprojects where the developers in groups of four to five persons performed all development tasks. These less formal project groups emerged on an *ad hoc* basis when an identified problem had to be solved or a new idea had to be worked upon. These subprojects were approved and staffed by the project managers, according to the personal preferences of the developers.

No firmly rooted procedures had to be followed, nor was a formal development model used. No special quality-related structures existed. The young developers acknowledged the necessity of professionalizing and improving the organization's software processes and they were open to this. In this context, the equally young SPI specialists with similar education were not considered outsiders.

A formal contract between management and the researchers defined the SPI initiative as a project with initially a half-year duration. It contained a preliminary project plan, determined the resources of the project and the expected deliverables.

A SEPG was established during the first week and staffed with one of the project managers and the two researchers. It was given the mandate to supervise, support, perform and facilitate

all improvement activities. The project manager worked half time on the SEPG, and the two researchers full time. After the initial project, the researchers were hired by NP to support the organization's continued SPI.

The developers were split in two groups and given 2 weeks to perform the first two improvement activities. They were then dissolved and subsequently other working groups were established and dismantled when new improvement activities arose.

Interactive process perspective

The contents of the innovation

Apart from introducing of the concept of SPI itself, the contents of SPI comprised: the adaptation of a well-known model, the IDEAL model,[3] for performing SPI, the formation of an SEPG, a general organizational analysis, an initial formal and a further follow-up assessment inspired by the CMM (Iversen *et al.*, 1998) and the Bootstrap methodology (Kuvaja *et al.*, 1994), the production of a first assessment report, and a resulting action plan. Technical working groups were formed to deal with the lack of meeting structures and the lack of code documentation routines. The SEPG introduced a life cycle model, project and task management procedures for project planning and tracking, techniques for estimation and risk analysis, measurement schemes, definition and implementation of quality assurance, testing, and configuration management processes. Continuous evaluations and the production of several evaluation reports containing lessons learnt and new action plans completed the contents of SPI at NP.

The context of the innovation

The context was dominated by the NP's strong desire to be among the best on the market. NP aimed at becoming known for its professional competence and emphasis on quality. Early on, management had realized that SPI was a useful strategy to achieve this. Despite time pressure and growing competition, the company had not experienced any dramatic setbacks or shocks. Yet, the company's whole philosophy was based on taking risks that everyone was fully aware of. The aim was to develop just one major product hoping that it would be superior to others and sell well on the market.

Partly and temporarily financed by the EU fund to support structurally weak regions, NP had committed itself to create a quality assurance function. Part of the public funding had to be used for this objective.

NP had previously co-operated with university researchers in database technology. Most software developers had just graduated from university and management continuously encouraged them to innovative thinking. The software developers' attitude was characterized by curiosity and interest in learning new ideas and practices. This and NP's sense for prolif-

[3]The IDEAL model (McFeeley, 1996) was developed to guide the implementation of SPI improvement initiatives. It was developed especially with the CMM in mind, but can also be applied together with other approaches. It consists of five phases: the Initiating, the Diagnosing, the Establishing, the Acting and the Leveraging phase.

eration manifested itself in various ways. NP went beyond simply adopting a certain SPI methodology. When applying the IDEAL model, it tailored it to its own environment. It combined SPI ideas with theories of organizational change. It also combined approaches for improved project and quality management with techniques for organizational learning and knowledge management.

The social process of the innovation

The social process of implementing SPI was characterized by NP's entrepreneurial, action-oriented and frank atmosphere. There was no established modus operandi for development activities. On the other hand, improvement activities were organized with a proper contract, an official project organization, an approved project plan and the adaptation of the IDEAL model.

At the individual level, there was a high degree of internal communication, social interaction and mutual adjustment. NP's young developers were adaptive and open to many newfangled ideas. There was trust and definite signs of mutual respect for other's capabilities. They showed commitment, motivation and, although not always appreciated, often worked overtime. NP was team-oriented and creative. The atmosphere was often dynamic, energetic and at times hectic.

Although management had the overall responsibility and took the strategic decisions, no stakeholder group dominated. Most were engaged in the continuous dialogue and involved in all organizational changes.

The project managers had the overview of technical tasks. The developers had some autonomy extending to the solution of technical problems and the purchase of tools. The developers had the opportunity to specialize and were partly responsible for which tasks and problems to work on.

The implementation of SPI and the specific improvement activities followed the five phases of the IDEAL model. The adaptation of the IDEAL model was also part of the assignment (for details, see Kautz *et al.*, 2000). Here, we illustrate the social interaction and relationships between the stakeholder groups.

In the Initiating phase, the expectations of all involved stakeholder groups were clarified and the immediate and long-term goals for the initiative were established. As a result, a contract including a project and improvement plan was signed and the SEPG was established as part of the infrastructure. In this process, the researchers provided information about software development and SPI in general. The project managers and management provided information about NP and their wishes and objectives. The developers were informed about the background and the plans for SPI at a meeting where it was discussed openly and a consensus was reached on how to proceed.

In the Diagnosing phase, the researchers performed a general organizational analysis and started assessing the organization's software processes through a questionnaire-based survey. The researchers were present during the sessions to clarify possible questions. The questionnaires were then supplemented through interviews with more than half of the developers. Specific experiences and problems were in focus and the developers contributed with significant proposals for improvement. Through these sessions the staff and the researchers got to

know each other. That facilitated the further co-operation. The diagnosis phase resulted in a maturity profile and identified acute problems and long-term improvement needs. These were documented in an assessment report, presented to and approved by management in a meeting and subsequently communicated to all staff at a meeting.

The SEPG was very active in the Establishing phase. It produced a further refinement of the improvement proposals, a prioritization of the proposals and the final plan for improvement actions. At the meeting with developers in the diagnosing phase, two acute problems were identified: lack of meeting structures and lack of code documentation guidelines. They immediately split into two technical working groups to solve these problems. The SEPG members scheduled meeting dates, assigned working group leaders from among the staff members and participated in the first meeting of each group.

This led to the Acting phase where the two groups quickly developed proposals for solving both problems. On a joint meeting with the SEPG, the two groups informed each other about their results and approved the prepared proposals. These were subsequently piloted and implemented. No other special action had to be taken for these tasks, as all staff had been involved in the definition process.

The Leveraging phase in the sense of learning took place during the whole period. The researchers played the most active role. At the end of the first cycle, they evaluated the whole process and provided an additional report documenting the results and some lessons learned which they again communicated to all developers after approval through management. The improvement that had been implemented fully in the first cycle consisted of the rules for the performance of meetings. After some use, the implementation of the code documentation guidelines was postponed and realized at a later date.

In this process, the two young researchers who had a common background with the developers were quickly accepted and integrated socially among them. Management decided after the initial improvement cycle to hire the two researchers as full-time SPI specialists and, for a period of nearly 2 years, they were in charge of implementing the refined action plan. This resulted in the subsequent establishment of technical working groups and the implementation and usage of a life cycle model and new processes for quality assurance and testing, followed by procedures for configuration management, and finally routines for project planning and task management, as well as for performance measurement and the continuous improvement of the existing processes.

DISCUSSION

When we revisit the two cases, it appears that the implementation of SPI had less immediate impact on HTM than on NP. HTM struggled with a frequent loss of momentum in the implementation process, which lead to a limited range of direct improvement actions. NP has been more effective in their efforts to improve some software processes. To compare the two cases we utilize again Slappendel's framework and focus especially on the interactive process perspective.

According to the individualist perspective, certain individuals have personal qualities, which predispose them to innovative behaviour and to take over roles, such as leadership, champions or change agents that favour innovation more than others. Table 2 summarizes the main differences from this perspective.

Applying the individualist perspective provides useful insights, but it is limited and gives only partial explanations. The structuralist perspective offers support for both complementary and additional explanations. Table 3 summarizes the main differences from this perspective. Differentiation of work, formalization and centralization are in general associated with innovative behaviour, while professionalism has been identified as both enabler and inhibitor of innovation.

In HTM it was unclear to what extent and in which way the SEPG had a mandate to involve developers in the implementation process. The group fought a constant battle to commit others and to gain sufficient resources. Although in charge of the implementation process, the SEPG members had many other obligations that competed for their time and resources. The SPI initiative as well as the SEPG were rather marginalized in many of their activities. At NP a formal project with a project plan, a clear mandate and accompanying resources was defined, and two of the SEPG members were exclusively allocated to the implementation process. NP's initiative and the SEPG were central in the organization.

The structural characteristics contribute to the understanding of the cases. But it also becomes evident that the individuals' roles and the structural features are related as the role

Table 2. An individualist perspective view on HTM and NP

	HTM	NP
Leader(ship)	Vague leadership	Clear leadership
	Management weakly committed	Management strongly committed
	Project leaders doubtful	Project leaders dedicated
Champions	No clear champions	Top management acting as champions
	Management sympathetic, but not resolute	Management enthusiastic and supportive
	Some project leaders resistant	A project leader led the SPI project
Change agents	No clear change agents	Clear change agents
	Role of SPI practitioners and researchers varied from weak to influential depending on tasks	Role of researchers and project manager clearly defined and practised

Table 3. A structuralist perspective view on HTM and NP

	HTM	NP
Differentiation	Strongly departmentalized leading to segmentation and inhibiting innovation	Integrated organization supported innovation
Professionalism	Protective interest groups inhibited innovation	Open professional groups with a desire to improve professionally supported innovation
Formalization	No formal project and imprecise mandate; few resources	Formal project with project plan, clear mandate and assigned resources
Centralization	Marginalized SEPG	Central initiative with central SEPG

of the project leader who championed the initiative with regard to its central position at NP shows. The interactive process perspective takes these relationships into account and goes beyond a mere combination of elements from the two other perspectives. It considers the complex interplay of the various factors and focuses on the process aspects of innovation-related change. Thus, utilizing the interactive process perspective allows a more detailed analysis of the two cases. Table 4 summarizes the differences between HTM and NP in this perspective.

At HTM the social context was largely shaped by the crisis caused by decreasing sales figures. The activities to survive focused on known and previously successful strategies, thus

Table 4. An interactive process perspective view of HTM and NP

	HTM	NP
Contents	Concept of SPI introduced Marginalized SEPG Respected support teams Planned and performed: • maturity assessment, problem diagnosis and error analysis • implementation of iterative process models and improved processes in some areas Lack of implementation of improved processes in significant areas	Concept of SPI and IDEAL model introduced Influential SEPG and technical working groups Planned and performed: • organizational and software process maturity assessments • implementation of a life cycle model and improved processes in project, quality and configuration management
Social context	Crisis survival centred	Market competition as challenge
• Innovative capability	Product-centred	Process- and product-oriented
• Proliferation	Prior process assessment with little impact and effect	Positive co-operation with university researchers
• History		
• Social relations	Researchers as outsiders	Researchers accepted
• Social infrastructure	Process agents' roles unclear	Clear distribution of roles
Social process	Centred around powerful project managers	Based on involvement of all stakeholder groups
• Political perspective Distribution of power	Project managers principal decision-makers SEPG less influential Little to no involvement of developers Management strengthened project managers' position	Participative decision-making No dominating stakeholder group
• Cultural perspective Stakeholder groups' interaction	Characterized by reluctance Project managers hesitant concerning ideas coming from outsiders Project managers attributing problems to management Co-operative effort to diagnose problems perceived beneficial Support teams to assist project managers appreciated	Characterized by openness High degree of internal communication, mutual trust and respect, commitment and motivation prevailed

innovation capabilities and proliferation of new ideas concentrated on new products, and not on improving development processes. In addition, the social relations between the project managers and the researchers who tried to promote the process changes were tense: the researchers were considered as outsiders and not helpful in pursuing the objective of securing survival. The situation was further characterized by a social infrastructure in which the role of the process agents was not clear at all.

This context reinforced social processes that from a political perspective were mostly driven by very powerful project managers taking all decisions with regard to their projects, less by process improvement agents, and very limited by systems developers. The technical director strengthened the project managers' position and rewarded them for product innovations. Thus, there was no incentive to contemplate process innovations.

Context and social processes resulted in the establishment of a marginal SEPG and support teams based on a problem diagnosis where improvement actions were planned and taken, but with less impact and scope than desired. This in turn explains the comparable slow changes in the social relationships with regard to the acceptance of the researchers and a culture where the interaction between the stakeholders was characterized by product-orientation and the project managers' reluctance. In this culture, they were originally able to shield themselves against change by blaming all problems on their work environment as provided by management with regard to deadlines and allocated resources. When the problem diagnosis and the following establishment of the dedicated support teams showed benefits, the project managers' attitude and their relationship to the researchers and the other improvement agents changed gradually and a new ground for implementing SPI was laid.

At NP the social context for their achievements was characterized by fact that the company had willingly entered the market. They saw the competition as a challenge. They pursued a position among the best vendors on a market where they so far had not experienced any major setbacks.

The appreciation of SPI as a possibility and the young, well-educated employees provided innovative capabilities for both the product and for development processes, which, when needed, were strengthened by hiring qualified staff from the outside. The history of an earlier, successful co-operation with a university built the background for the recruitment and smooth acceptance and integration of the academic researchers. This in turn intensified the proliferation of product-related and process-related improvement ideas within a social infrastructure where the role and the mandate of the different stakeholders as members of the SEPG, technical working groups, management, project leaders, process specialists and system developers were clearly defined and distributed.

Given this context, a social process unfolded, in which all stakeholders were actively involved through their contributions in the assessment sessions, the working groups and their participation in the regular meetings to inform and discuss the plans, progress and decisions made in the project. Based on management approval, a participative decision process prevailed where no group dominated.

This process was reinforced by a culture of openness, where a high degree of internal communication, mutual trust and respect for each others work as well as commitment and motivation were found and, as a result, SPI became an integral and continuous part of the daily work practices.

CONCLUSION

In this paper, we presented a framework that consists of three perspectives: the individualist, the structuralist and the interactive process perspective. The three perspectives supplement rather than exclude each other. Individual and structural elements are found also in the interactive perspective. It can, however, be discussed whether we would have got the same in-depth knowledge if we had only applied the interactive process perspective. On the other hand, our case descriptions and discussion show that when undertaking an interpretive case study it is hard even in the individualist and the structuralist perspective to avoid statements concerning social relationships or political and/or cultural issues. In the interactive process perspective, it is demanding and not easy to identify and decide what falls into content, context and social process. What is content for some observers might be context for others, and what is context for some might be part of the social process for others. Yet, as the emphasis lies on the interplay of activities, events, structures and features, difficulties of this sort seem less significant. The overall outcome of studies of this kind is still a comprehensive picture of the innovation implementation process as a whole.

Our discussion shows that neither the individualist nor the structuralist perspectives alone provide a deep understanding of the innovation implementation process. This process occurs through a complex interaction between individual action and structural influences and thus is better understood through an interactive process perspective. Using the framework to examine our experiences helped us to gain better insights of this multifaceted process and provided a partial roadmap for successful SPI implementation. We demonstrate that the framework can be fruitfully used in the field of SPI. Thus, beyond supporting a comprehensive appreciation of the two cases, we are confident that the framework is useful for planning and reflecting on SPI implementations in other organizations. When using the framework as a practical instrument, it is important to focus on identifying potential obstacles and potential countermeasures that can be taken to support the implementation of software process innovations.

Explicit emphasis should also be put on the role of resources. They were not particularly focused on in the framework, but played an important role in both cases and were implicitly dealt with as either a structural or a contextual issue.

As no two organizations are alike, the framework has to be understood and will be particularly useful when it is viewed as providing general knowledge about change rather than direct advice on what to do in a specific situation. It is therefore the organization's task to adapt the insights the framework provides to the organization's particular situation and needs. The framework's ultimate strength lies in how it points out the complexities in relationships that are often viewed as much more simplistic.

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