KNOWLEDGE INTEGRATION ACROSS PROJECTS - EXPLORING THE ROLE OF BOUNDARY CROSSING ACTIVITIES

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ABSTRACT

This paper explores knowledge integration between projects and their organizational context. Due to the increasing strategic importance of knowledge in organizations and of projects as an organizational form, there is a need to better understand knowledge integration between projects and their organizational contexts. Hence, *the purpose of the paper is to describe and explain how knowledge is integrated between the projects and its intra-organizational context and how company management can enable this.* A longitudinal case study approach was chosen to study knowledge integration across projects. The main contribution of this study is an enhanced understanding of how knowledge integration between projects is positively related to project performance. There are three main findings of this study. First, the process of knowledge integration is dependent on interaction between the projects and the organizational context of the projects. Second, the process of knowledge integration depends on the concerned actors' "time for reflection", "the nature of the activities in the project", and "interest and motivation of the involved actors". The third finding concerns the role of management for knowledge integration. The attention from management, e.g. by providing the necessary boundary crossing activities, affects the extent to which knowledge is integrated across projects. The standards and routines developed by corporate management are essential for mainly two reasons; (1) they represent accumulated knowledge from past projects, i.e. 'best practices', and (2) they facilitate the integration of knowledge from on-going projects. However, there is also a need to take into account both the social and a technical dimension.

1 INTRODUCTION

Knowledge has become one of the key assets for superior performance, and the importance of leveraging knowledge in companies for gaining competitive advantage is widely accepted (Grant, 1996; von Krogh et al., 2001). The leveraging of knowledge is achieved through adopting different organizational mechanisms that support knowledge creation and

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sharing. One such organizational mechanism that has become more and more imperative in the last decade is the project organization (Eppler & Sukowski, 1995). Projects have become increasingly common means by which activities are organized and performed within large companies (Hobday, 2000; Lindkvist, 2004; Enberg et al., 2006), since they [projects] are recognized as 'arenas' for knowledge leveraging (Shoefield & Wilson, 1995; Ekstedt et al., 1999). Projects are founded upon the basic organizational principle of assembling knowledge and resources in a temporary unit with the objective of solving a specific task, e.g. product- or process development. Novel knowledge can be created by combining existing knowledge possessed by the individuals assigned to participate in the projects and as a result, new ways of making use of this knowledge is explored.

Research on projects and knowledge integration has to a large extent focused on knowledge processes within projects (e.g. Ayas & Zenuik, 2001; Prencipe et al., 2005; Hargadon & Bechky, 2006), rather than on the relationship between projects and their organizational context (Newell et al. 2006; Scarbrough, et al, 2004; Prencipe et al., 2005). The context is seen as posing problems for the project, where there is a need for decoupling the project from the environment in order to end it (Lundin & Söderholm, 1995). However, the separation of the project and decoupling it from the context may cause re-invention of the wheel, and difficulties connected to a changing environment. As a result of companies performing an increasingly larger part of their activities in projects, there is an ongoing discussion - among researchers and practitioners - of the need to understand how knowledge integration between projects and their organizational contexts is managed. An increased understanding of knowledge integration across projects and between the project and the permanent organization (i.e. intra-organizational context) offers the potential to improve and to render the project-based organization more efficient. However, knowledge integration between projects and their intra-organizational context is associated with challenges due to the characteristics of the knowledge, the intra-organizational context and the relationship between the projects and the intra-organizational context (Ekstedt et al., 1999; von Krogh et al., 2001; Nonaka, 1994: Szulanski, 1996). Carlile (2004) argue that the integration of knowledge between projects and their organizational contexts depends on the existing differences and similarities that exist between the sender and receiver of knowledge.

Due to the increasing strategic importance of knowledge in organizations and of projects as an organizational form, there is a need to better understand knowledge integration between projects and their intra-organizational context. The effective management and understanding of knowledge integration between projects are critical from both practical and theoretical stand points. There is particularly a need for research on knowledge integration over time. Depending on the phase of the project, the knowledge integration differ (e.g. Bengtsson & Eriksson, 2002). Company management plays an important part in shaping and providing the boundary crossing activities that enable knowledge integration processes. With this follows a need to better understand if and how company management can enable and support knowledge integration across projects. Hence, *the purpose of the paper is to explore to what extent, and how knowledge is integrated between projects and their organizational context and how company management can enable this.*

A management perspective on how to integrate knowledge on the one hand, and the possibilities for knowledge integration between the projects and their intra-organizational contexts on the other, still exist as two different streams in knowledge research. In the

engagement of these two fields lies the potential for an important fusion of perspectives, a fusion more carefully attuned to explaining the nature of integrating knowledge across projects. More precisely, a fusion between the two fields needs to take into account the specific characteristics of projects and the different phases of the project and how these affect knowledge integration.

The paper proceeds with an outline of the theoretical framework, where we discuss the project-based organization and knowledge integration. We then address the managing of knowledge between projects. The following section presents the research approach and an introduction of the cases, where after the cases are presented and analyzed. The last section discusses the conclusions of the study.

2 THEORETICAL FRAMEWORK

2.1 The project-based organization

The project, as a way of organizing work, has become increasingly common as a countermeasure to cope with the dynamics of competition (Ekstedt et al, 1999). Sahlin Andersson, (2002) stress the double-sided effect of projects as they are organizational mechanisms by which companies can accomplish flexibility *and* control (Sahlin-Andersson, 2002). To accomplish flexibility and control simultaneously is particularly desirable in large industrial corporations (Ekstedt et al., 1998). Projects can lead to change, renewal, innovation and organizational learning; keywords in contemporary organizations. It is argued as an organizational mechanisms suited for costumer involvement (Ekstedt et al., 1999), another key to competitiveness.

The most common characteristics of projects is that they are temporary organizational units, meaning that they are designed and planned against a fixed time horizon, i.e. they are terminated when the original assignments the projects were created for are completed (Goodman and Goodman, 1976; Cleland & King, 1983; Kreiner 1995; Packendorff, 1995). Furthermore, the work to solve the assignment is to be accomplished within the budget frames set for the project and in line with the functionality/performance standards decided upon for the solution prior to the establishment of the project (Ayas 1998; Packendorff 1995; Scarbrough et al., 2004). The composition of projects is often not stable, but rather varies over time. The project members are likely to come and go as their priorities and assignments change. Another common characteristic of projects, especially in large firms, is that they constitute of individuals being located in different places (Govindarajan & Gupta, 2001; Goodman & Wilson, 2003), sometimes even representing different organizations. Furthermore, the execution of a project follows different phases. Lundin & Söderholm (1995) suggests an action-based approach, which considers different actions performed in the project. This means that the activities performed in the project are in focus contrary to the traditional decision-based approach (ibid.). The project phases should not be understood as linear, but rather as an iterative process. The different phases need different kind of actions, thus affecting the boundary spanning activities (Bengtsson & Eriksson, 2002).

Apart from the characteristic features, there is one often mentioned when discussing projects, which is the uniqueness of the project. Projects have traditionally been viewed as distinct and isolated activities that can be designed and executed, independent of its

organizational context (Engwall, 2003). According to this view, knowledge integration is neither possible nor desirable due to the uniqueness of every project undertaken. Recent research on projects suggests that even if there are obstacles due to the uniqueness of the project, there are possibilities and benefits of integrating knowledge between projects and the organizational context (Brady & Davis, 2004; Scarbrough et al, 2004; Bresnen et al., 2005).

2.2 Knowledge integration

Considerable research on knowledge has distinguished knowledge as explicit and tacit, e.g. two sides of a coin, where each side exists relative to the other (Nelson & Winter, 1982; Polanyi 1966). It is possible to articulate explicit knowledge and put it into print (Nonaka 1994; Penrose 1980), while tacit knowledge, as it is inextricably interwoven with experiences and situational contexts, is difficult to articulate and put into print. The context-boundness of knowledge also implies that knowledge is being developed according to the specific requirements of the organization. The knowledge processes take place in specific settings and contexts, having different structures and mechanisms. These are pre-existing the knowledge processes and affect how knowledge is shared and used in other contexts, i.e. integrated. Knowledge is thus both the input and the result in these processes (Cook & Brown, 1999). From this point of view, knowledge is formed and used in a "continuous" process, where there is a connection between "knowing" and "doing" (Gherardi, 2000). A perspective where knowledge is understood as collective, situated and context-specific shares much in common with the practice-based view (Brown & Duguid, 2001; Gherardi, 2000). This means that the integration of knowledge is understood as taking place in the activities performed.

Knowledge integration is viewed in this paper as the process of transferring, translating and/or transforming knowledge (i.e. Carlile, 2004) to be of use to other organizational actors within the same organization. In his work on knowledge integration and the boundaries that exist between different groups, Carlile (2004) argues that depending on the characteristics of the boundaries; in the shape of dependencies, differences and novelty in knowledge, the ability to share and assess knowledge varies. Different boundary types require different boundary objects and integration methods. Boundary objects are different concrete or abstract "bridges" that allow groups with different perspectives and different aims to contribute to a more comprehensive objective (Star, 1989; Star & Griesemer, 1989). Company management serves a vital role in shaping and supporting the knowledge integration in organizations (Krogh et al., 2001; Hansen et al., 1999).

2.3 Managing knowledge integration across projects

Although knowledge is understood as a company's most valuable asset and the increased interest by management in Knowledge Management and the Learning Organization, research has shown that the management's solution often has been the introduction of IT-solutions (Swan, 2003; Bresnen et al., 2005) and/or the re-use of personnel (Ekstedt et al., 1999). Other researchers have shown enablers and strategies for managing knowledge in organizations (Krogh et al., 2001; Hansen et al., 1999; Bollinger & Smith, 2001). This shows that management to a certain degree has acknowledged the need for managing knowledge in organizations. However, due to the increasing use of projects, and the vital importance of knowledge integration, there is a need to take into account the specific conditions that exists when knowledge integration taking place in a project-based

organization. Projects are part of a larger context and are involved in boundary spanning activities (Grabher, 2002; Scarbrough et al, 2004; Bresnen et al., 2005) where knowledge is shared between projects. Nevertheless, little effort has been made to study the boundary spanning activities that take place between a project and its context. Although this research area has recently received more attention, Scarbrough et al. (2004) state that there is still a need for further empirical research on the relationship between learning within projects and learning in other parts of the organization.

The boundary spanning activities and objects in focus in this paper are those provided by corporate management. Boundary spanning activities have a social and a technical dimension (Gherardi & Nicolini, 2000; Carlile, 2004), which co-exist. The social dimension of the boundary spanning activities comprises of organizational culture and people. Organizational culture builds on the establishment of an appropriate culture that encourages individuals to create and share knowledge as well as defining what knowledge is valuable. People represent the collection of individuals who possess both appropriate and complimentary knowledge. Information and Communication Technology (ICT), encompassed by the technical dimension, is an important contributor for companies' capacity to manage knowledge (Hansen et al., 2001). However, ICT needs the social dimension in order to be of importance for knowledge integration (Walsham, 2001).

In this paper, we explore the knowledge integration across projects within two projects that goal was to deliver automation products to customers. We argue that in order to understand the knowledge integration we need to address the longitudinal aspect of the project, and analyze the process of executing a project, i.e. the different phases. We suggest that using the concepts of transfer, translation and transformation of knowledge, and at the same time acknowledge the specific characteristics of the project, we can enhance the understanding of how knowledge is integrated in practice.

3 METHODOLOGY

A longitudinal case study approach was chosen to study knowledge integration across projects, which is appropriate when explorative questions are asked (Van de Ven & Huber, 1990; Yin, 1994). According to Merriam (1998) the focus of case studies is on process and context rather than results and specific variables, and to discover rather than prove. Significant for studies of processes is that activities in a certain stage are interlinked with activities in a prior as well a later stage, implying that all stages have to be captured by the chosen research method. By doing a process study, we could follow the sequence and flow of events over time.

The study comprised of two projects in a multinational corporation in the automation industry. The projects were chosen as to represent projects with different duration as well as organizational structure. The Gamma-case was a one-year project organized on a national basis. The Delta-case was a three-year project organized on an international basis. By studying two different projects it was possible to explore the role of management for knowledge integration across projects, and to identify differences across projects.

Case study research can make use of several means of data collection (Yin, 1994). In this study, the most important means was semi-structured and open-ended interviews. In total 49 interviews were conducted on different levels of the organization. The interviews, which

lasted for approximately two to three hours, followed interview guides to ensure that certain topics were addressed and that there was coherence between the interviews. The informants were asked about their role in the different projects, and to describe the activities during the project and what sources of knowledge were used. Other sources of data collection were written material concerning the projects and the different templates used in the project process.

For the analysis, the data was organized chronologically in order detect the process of knowledge integration over time. The interviewees were classified into four groups, based on role and responsibilities in the organization and/or projects. The groups were management, project leaders, sub-project leaders and project members. The case study is presented as a coherent whole, but also includes measures to enable discretion of views held by different groups of interviewees. Quotations are used to emphasize important points and issued that shed light on the research question.

4 THE CASE STUDY – AN INTRODUCTION

4.1 Mill – the project based organization

The case company is an international engineering company[†], Automation Ltd., with 104 000 employers, and an annual turnover of 17.6 billion US dollar. The company helps customers to use electrical power effectively and to increase industrial productivity in a sustainable way. The local business unit in focus of this case study - hereafter referred to Mill - has approximately 90 employees. The organizational structure is a functional matrix organization, divided into four functional areas: Sales, Project Management, Engineering and Installation & Implementation. Mill is a project-based organization, i.e. main activities are performed in project, and the employees, from different functional areas, are appointed to different projects based on availability and competencies. At the time of the study, there were 40 on-going projects. The projects vary in size, from a budget of 0.1 MUSD to 24 MUSD, and they were mainly business projects. The automation products or services that Mill delivers are to a large degree customized, but there is a strong emphasis within the organization to standardize the work routines and services as much as possible.

Mill has a low turn-over of personnel; the employees have worked at the business unit on average ten years. Consultants, from other units within the same business area or external consulting firms, are often re-hired and many of them have been working at Mill for many years. The low turnover of personnel combined with the fact that the consultants often have worked for or at Mill before have two implications. First, there are often established relationships among project members upon initiation of a project, and second, a familiarity with how projects are carried out. The established web of relationships also facilitates the search for information and knowledge. As the sub-project leader in one of the studied projects said: "*I have worked here such a long time that I start/begin to know who to talk to concerning certain issues. Often you also know who has worked with what and who exceptionally good at other things and so forth*."

[†] The corporation is anonymous at its' own request.

At the same time, some of the interviewees also expressed worries that the low-turn-over of personnel could result in stagnation. The employees tend to do things a certain way and are not open for new ideas or ways of working.

Much of the activities in Mill are standardized, for example the design and delivery of basic components. Based on a top management directive from Automation Ltd, the Mill has developed templates and routines to support the daily activities with the objective of making the work more time-efficient and facilitating the integration of knowledge between projects.

4.2 The boundary crossing activities provided by management

The results show that the Mill makes use of different ways to enhancing knowledge integration between projects. The office premises of Mill are an office landscape and the employees are located according to functional area of expertise. The project groups in Mill are cross-functional, which implies that project members have different functional competencies. The project members however remain located according to their position in the permanent organization. The set up is viewed as favorable for interaction and communication. As a project member expressed it: *"There are greater advantages to be located according to functional area, instead of by project, as it makes it easier to discuss common problems and issues with co-workers."*

As most of the employees have worked in Mill for a long time they know each other and each other's competencies well. The set up of working in an office landscape environment also makes it possible to overhear other employees' conversations. The consultants are located according to functional area. This arrangement made it possible for the consultants to interact with other members in the same project *and* with other parallel projects. For a period, they [the consultants] had been sitting in a special 'consultants area' in order to prevent them from learning too much of the ongoing activities. However, after discussions within the organization, the management decided that the advantages of interaction and communication between the temporary and permanent employees offset the possible negative effects, and the consultants were re-located with the other permanent employees.

Management aims at standardizing the work processes as much as possible, although still giving leeway for customization whenever needed. The standardization is assured by employing certain templates and guidelines for documentation and for the design and use of specific product components. The templates are of two different categories, process- and sales/marketing-related. The process-related standards adhere to hardware- and software design and images. The template for the sales- and marketing process are accessible through a web-based tool. A common problem with the templates, according to the interviewees, is that they are too general and not up-to-date.

Lotus Notes is used as the e-mail client in Mill as well as the groupware system for shared documents and discussions concerning specific projects. The latter thus serve as a way of documenting "lessons learned", which management stresses as a good way of integrating knowledge between projects and its intra-organizational context. Overall, management tries to establish a common structure for how information and experiences are stored in the organization in order to facilitate and motivate the employees to re-use knowledge. A common issue raised by the interviewees was how to assess what was relevant to store in

the databases and what was not. In general, the projects produced a lot of documentation which meant a lot of work just to document it all. Another opinion raised by the interviewees was that on many occasions, it was easier to turn to the person who had stored the information than to read the information in the database.

On a global basis, the multinational corporation had implemented EDMS (Electronic Documentation Management System); a document management system with search functionality. In the two studied projects however both project groups still used the old document management system, PPHS. Most of the interviewees did not see the point in changing to EDMS as it was considered time and resource consuming to work with. As a project manager said: *"There is a general problem within Automation Ltd that they want to create new tools that solves all problems for all people in all countries in all possible situations and that is NOT possible."*

Our findings also show that the ones that actually knew how to use EDMS found it useful in order to find templates and instructions etc.

4.3 Mini-case 1: Gamma

Project Gamma was a relatively small project with a total budget of 1.5 MUSD and duration of one year. The objective was to deliver and replace the control equipment to a hydraulic engine in a rolling mill. This type of technology was unusual in that specific industry, and therefore the customer's request required technical skills that were complex and out-of the ordinary for the company. Further, the project members knew from the start that the knowledge developed during the course of this project was of low use for future projects. A challenge for the project group was to integrate the delivered solution with the conventional control equipment already in place. This control equipment had been delivered by the Alpha project, a year prior to the initiation of Gamma. The customer of Gamma requested the same project group that had been on the Alpha project. However, only one of the project members from Alpha was available and could join the Gamma project. The core project group of Gamma was cross-functional and it comprised of a project leader and sub-project leaders from three different functional areas. Halfway into the project, four consultants were also engaged in the project group.

4.4 Mini-case 1: Delta

Project Delta was a relatively large project with a total budget of 15 MUSD and with duration of over three years. The overall goal was to re-build and modernize the production process of a factory. The overall goal was divided into different sub-goals for different sub-projects. The focus of this study is the sub-project that was to deliver new engines and automation systems.

The man-hours in this specific project were 500, allocated over two and half years, which implied that the core project group was relatively small. The core project group comprised of a project leader and two sub-project leaders from two functional areas. The project was international and the project members were located in Sweden, whilst the customer and suppliers where located in Taiwan, Finland and Italy. The assigned project leader had previously managed the Gamma-project. Management of Mill stressed the importance of taking advantage of the competence and experience of the project leaders. One way of doing so was to assign project leaders to larger projects as they got more experienced.

Overall, the project was managed as to encourage the integration of knowledge from other projects. During the course of the project, people from related projects were allocated to the Gamma in order to benefit from their competencies. For example, project members from the two projects, that had developed the system platform ZXY used in the Delta project, were engaged. Management of Mill saw it as beneficial from a knowledge integration point of view to involve these project members. Another argument was to prevent mistakes from being repeated.

5 CASE ANALYSIS - MANAGING KNOWLEDGE INTEGRATION

Our analysis is based on how knowledge was integrated throughout the two studied projects. Projects within Mill are run according to a standardized project management model comprising of four generic phases; initiation, engineering, installation and start-up. The analysis of the two projects is organized according to these four phases.

Prior to the initiation phase

The overall work process within Mill starts with a sales phase. The sales phase, which precedes the initiation of the project, is independent of the focal project. During the sales phase, the requirements and needs of the customer were specified and documented. All created documentation was required to be stored in Project Management Databases, in order for the project group to have access to it upon initiation of the project. According to the routines and rules at Mill, the sales representative hands over of the contract and other relevant documentation before a project starts.

Upon the initiation of Gamma, it was revealed that there was very little written documentation from the sales process. The little documentation to be found was superficial and lacked vital details. Gamma was related to the project Alpha, not only technically as previously described, but more importantly, the two projects were part of the same sales contract, and thus customer. This circumstance turned out to have implications for knowledge integration.

The sales people who had worked with Alpha and Gamma mainly put efforts into documenting for the Alpha project as that project was the first to be initiated, of the two. As the Gamma-project was to be initiated two years later, it got second priority in terms of documentation. Upon the initiation of Gamma, the sales people had no connections to the project any longer. Due to the time elapsed between the sales phase and the Gamma project, the sales people were already occupied in other sales activities and therefore were not interested or motivated to transfer their knowledge to the Gamma project. The sales people are only responsible for the actual sale which results in very little, if any, interest in the subsequent business projects. As one of the sales persons said: *"My task ends with a finished contract, and then I go to the next business case."*

Due to the technical complexity of Alpha and Gamma, a group of experts was assigned specifically to write the specifications during the sales phase. These specifications were detailed but not written according to the template and therefore lacked context and certain important details. The time elapsed between the actual writing of the specifications and the initiation of Gamma, made it difficult for the project group to contact the members of expert group for clarifications. At the time of initiating the project, the group of experts was not even known to the project group. It was not until later on, that it came to the project

group's knowledge who had written the specifications. It seems like management efforts to create routines for documentation and for the hand over of the documentation is difficult to implement if there are weak ties between the sales phase and the actual project. Moreover, time lags also have a negative impact on the success of knowledge integration.

Finally, the project leader of Gamma turned to the project leader of Alpha for gaining an understanding of what happened and what was agreed upon in the sales phase. Through face-to-face meetings, the project leader of Gamma gathered knowledge about the customer and his business, as well as 'lessons learned' of the project processes. The knowledge transfer facilitated the relationship between Gamma and the customer, thus serving as a prerequisite for a sound cooperation.

In comparison with the Gamma project, the time elapsed between the sales phase and the actual start up of the Delta project was short. It resulted in a closer cooperation when the sales group and the project group. Two of the technical experts from the sales phase participated in the initiation phase of the project. Moreover, two other technical experts were involved throughout the project. We thus conclude that the closer the time spans between the sales phase and the initiation of the project, the easier the knowledge transfer. This finding is in line with Prencipe et al. (2005), who argue that the time span between two projects affects knowledge transfer.

The Delta project had a greater focus on knowledge integration from the sales phase. However, as in the Gamma case, the documentation from the sales phase was poorly written. The sales representatives were engaged in other sales simultaneously, which led to insufficient time to write Minutes of Meetings with adequate information. Furthermore, not all documents were stored the Project Management folders. The integration of knowledge depended, just as in the Gamma case, on face-to-face interaction. Many of the project members stressed the advantages of having people from the sales phase working on the Delta project. It made it possible to integrate knowledge, even that type that often are referred to as tacit.

Initiation phase

In the initiation phase of the two projects, the activities were focused on getting the project group together and on defining the prerequisites of the project. The first mentioned task was facilitated, in both projects, by the fact that many of the project members had worked together before. Another important activity was to establish channels of communication, internally as well as externally. The external channels of communication aimed at informing and engaging actors indirectly involved in the project. For the management of the project, the external channels of communication were important for efficient knowledge flows between the project group and the customer's project group.

To design the control equipment, the project group of Gamma had to exploit existing knowledge as well as to develop new knowledge. This in turn required the project group to search for knowledge and engage several sources of knowledge. One vital source of knowledge was documentation from one of the suppliers of the existing equipment. The required documentation dated back to the beginning of the 1990s and the supplier could not convey all the details. In addition, the documentation was not very detailed, and hence of minor use to the Gamma-project. In order for the Gamma-project to integrate the knowledge they needed the help of the original supplier. The original supplier could

contextualize the documentation. This was an unexpected and not planned for event in the project plan, and resulted in delay in the engineering phase. However, the meetings with the supplier gave opportunities to discuss the documentation and the hydraulic system in detail and in the end resulted in a more rapid knowledge integration. What could have resulted in a project exceeding budget and schedule constrains was managed through interaction and personal contact, hence the differences in knowledge domains was managed and the knowledge could be translated and transformed to fit the need at Mill. This is in accordance with Carlile (2004) who states that differences in knowledge domain results in a need for translation, and even transformation, for the integration of knowledge. Another source of knowledge was the internal supplier X that delivers different types of control equipment to rolling mills. One of the sub-project manager said that he benefited from having worked with similar questions for a while. He said*:" It all comes down to informal contacts and that you know the company well, both your own unit and other units."*

The objective of Delta was to deliver a new automation system. This automation system was to be installed on the new technical platform ZXY. Based on an initiative from management of Mill, the experiences from the development projects of ZXY had been carefully documented to serve as 'lessons learned' for future project. This time, the management stressed the importance of allocating time to reflect upon the lessons learned. In the initiation phase, the project members of Delta therefore read the documented 'lessons learned'. The main reason, according to the interviewees, for reading these documents, was the directives from management. In hindsight, the projects members admitted that the 'lessons learned' were both relevant and applicable in the Gamma project. It was very uncommon in Mill that documented experiences from projects actually were studied by members of subsequent projects. One of the sub-project leaders tried to contact the original project members to get more "hands on" information. This, however, was difficult as many of them were - at the time - working on temporary overseas assignments. Two of the project members from the development projects of ZXY participated in Delta, which was viewed as very valuable by the project group. An interviewee said: " … *without the valuable experience that X and Y had, it would not have been possible to carry out the Delta project successfully."*

Engineering phase

In the engineering phase, the activities focused on designing the hard- and software. The project members received functionality specifications, from the suppliers and the customer, which were used to develop the automation system and to make alterations according to the suppliers' and the customer's requirements.

In the Gamma project, the activities were guided by both unique and repetitive tasks. There were unique elements in the project, requiring development, but also repetitive tasks, which made it possible to use templates, as well as common working methods. Similar solutions from previous and/or parallel projects also facilitated the activities of Gamma. The project members could rely on either their accumulated experience or their networks, where they knew who to ask. The project member, who worked with HCI (Human Computer Interaction), serves as an example for how the activities of Gamma, to a large extent, were managed. She had previously worked with HCI on the Alpha-project. Her activities mainly were to use the images from Alpha and to adopt them to the specific characteristics of Gamma. In identifying what modifications was necessary, EDMS proved to be a valuable tool. The example shows that by appointing the same employee to the same position in two

projects, knowledge integration was made possible. It also shows that templates served as a facilitator in integrating knowledge between projects. For the project as a whole, the smooth knowledge integration implied time gains and the lowering of costs.

Another example for how the activities of Gamma were managed concerns how a problem was solved during the final testing of the system. The problem needed fast attendance, but there was no standardized solution for how to solve it. The project members, however, knew that other previous, projects had faced similar problems. By talking to people who had worked in these projects, the problem was swiftly solved. It was thus more efficient to go outside the projects boundaries than to work things out within the project. The well established relationships within the organization and knowledge of each other's competencies, thus served as important factors.

All through the engineering phase, the project group of Delta had to communicate with the sales group on a regular basis as the documentation from the sales phase was insufficient. The documentation especially lacked technical details which affected the progress of the project negatively.

As previously described, Delta was dependent on documentation from the customer in order to develop the automations systems. However, inconsistencies in the documentation made it necessary for Delta to meet with the customer to clarify these. The existing system, which partly would be left at the customer's site, was not an Automation Ldt. System, but a system from another supplier. Compared to the Gamma project, which delivered to a national customer, of which many had Mill systems already installed, it was harder to find already existing solutions and design a new system that would support the old system.

Another issue that caused delays in the engineering phase was differences in how the templates were employed within Automation Ltd. Some of the internal suppliers worked in a different way with documentation which caused frustration among the project group members of Delta. One of the project members said: *"We have tried to make them change the way they document but it is difficult. Often, their documentation is too long and very difficult to follow. It complicates things for us."*

Delta was the first business project to use the newly developed platform ZXY. The specific functionalities of the new platform implied challenges for the project member during the whole project as they were not familiar with the technique. During the engineering phase, the project members therefore needed input from members of the two projects that had developed ZXY, especially concerning the underlying technical functionality. However, different functional backgrounds and experiences complicated the transfer of knowledge. The transfer became more of a translation than an actual transfer. This finding is in line with the argument that the more novel the knowledge is the more difficult is the integration of that knowledge (Bengtsson & Eriksson, 2002; Carlile, 2004).

The findings show that the ambition of Mill of using standardized components and work processes in projects was not always compatible with the specific requirements and needs of customers. Customization of tasks made it difficult to use ready-made solutions in all situations. We thus argue that how unique as well as repetitive the task of a project affects the possibilities for integrating knowledge between projects. Custom-made solutions are difficult to re-use since they - by their nature - are more contextually embedded compared

to standardized solutions. However, by interacting and communicating across project boundaries, the context-bound knowledge is translated and transformed to fit the focal context (i.e. Carlile, 2004). Knowledge integration has to be understood as a social process where action is an important part (Swan, 2003).

Installation & Start-up

The installation and start-up phase – the two last phases – comprised of delivering the solution of the business project to the customer. The common way in Mill was to allocate new personnel for the installation and start-up phase. However, at the installation phase of Gamma, there were no personnel available so the project members from the engineering phase stayed on the project. Maintaining the same project group throughout the project cycle turned out to be beneficial for project performance. When installing the automation system, some 'bugs' were revealed in the delivery. These bugs adhered to the engineering phase of the project. Similar problems had occurred in previous projects, but due to time pressure, the project group failed to draw upon those experiences. Instead, they made use of knowledge within the project group to find solutions to the problems. The time pressure, which was aggravated due to the problems upon installation, resulted in poor documentation of the experiences from Gamma. In Mill, documentation of experiences, both positive and negative, was required with the purpose of integrating knowledge in future projects. The project members also perceived the solution developed in the Gamma project so unique that the knowledge was of no interest or relevance to future projects. This finding is in line with Swan (2003) that the simple storage of experiences is not enough to trigger knowledge integration to future projects.

Time pressure also had affects on the documentation of experiences from the Delta project. A project member had been appointed by the project leader to document the problems that occurred during the start-up phase and how these problems were solved. The appointed project member, however, was too occupied – with tasks in other projects - in the final stage of the project to carry out the documentation. The findings from both projects show that time pressure; motivation and the perceived relevance for future projects are the main causes for failure to document experiences from projects (cf. Keegan & Turner, 2001). We propose that failure to draw upon previous experiences within the organization may have negative effects on project management. With no time to write down the experiences from a project, puts limitations on the possibility for (1) reflection and learning at the individual level, and (2) the development of templates and guidelines.

In the Delta project, the project leader responsible for installation and start-up joined the project at a late stage, and he had no time for studying and gaining an in-depth understanding of the project. Time was yet a factor that influenced the integration of knowledge. In addition, the installation of the automation system was performed off-site, which implied that the newly appointed project leader communicated with the project group and the customer, mainly via e-mail. This form of communication was perceived by the interviewees as putting constraints on the possibilities of gaining an in-depth understanding.

6 CONCLUSIONS

This paper has explored to what extent, and how knowledge is integrated between projects and their organizational context and how company management can enable this. The

analysis of the project execution over time shows both possibilities and difficulties when it comes to knowledge integration. The main contribution of this study is enhanced understanding of how knowledge integration between projects is positively related to project performance, in terms of achieving its goals, meeting the requirements as well as being on time and budget. There are three main findings of this study.

First, low turn-over of personnel and the re-use of consultants implicated that the project groups were not as unique as described in much of the project management literature. The acquaintance among the project members made it easy to initiate projects as not only did project members know how projects were managed within the organization but more importantly they had an initial insight into each others' competencies. We thus conclude that an established social network, both within the project and intra-organizationally, facilitates the search for knowledge as well as the integration of knowledge (cf. Bengtsson & Eriksson, 2002).

Second, knowledge integration was enabled by the different boundary crossing activities provided by management. However, the findings from the case study show that the objectives of the boundary crossing activities, to various extents, coincided with how they were applied. In this study, the management of knowledge integration was complicated, due to the characteristics of projects, differences in knowledge base and different perceptions of the boundary objects. The extent to which knowledge was integration depended on mainly three factors.

1. The amount of time available for reflection, i.e. to document as a means to upgrade and develop templates, guidelines and standards. However, time pressure also gave incentives for searching and integrating knowledge from sources outside the project. It proved to be more time efficient to go beyond the project boundaries when the knowledge of the project group was insufficient.
2. Nature of the activities, in terms of being unique or repetitive. The need for integrating knowledge across projects when the activities are unique is in accordance with the finding of Ekstedt et al. (1999). They claim that unique solutions require openness and active search across the boundaries. Contrary to Ekstedt et al. (1999), this study also shows that repetitive activities also call for the project to open its boundaries to other projects and the permanent organization.
3. The interest and motivation of the involved actors. The findings show that interdependency between activities and/or between projects is positively related to the interest and motivation to contribute with as well as to receive knowledge. When the boundary crossing activity was mainly based on the technical dimension and lacked the social dimension, knowledge integration was hampered. For example, the boundary object provided by management to facilitate knowledge integration between the sales phase and initiation of a project was documentation according to templates and guidelines. The sales personnel however lacked an understanding of how important adequate documentation was in order not to hamper the progress of the subsequent project. This finding is in line with the need for a social dimension in order for the technical dimension to operate at its full potential (Walsham, 2001).

The third finding concerns the role of management for knowledge integration. The standards and routines developed by corporate management are essential for mainly two

reasons; (1) they represent accumulated knowledge from past projects, i.e. 'best practices', and (2) they facilitate the integration of knowledge from on-going projects. The focus of management is still on standardization of processes by creating ICT tools, this, in spite of recent research on the problems with ICT and knowledge integration. There is a failure to incorporate the unique characteristics of projects. Through standardization and the use of ICT tools, there is a belief that knowledge will be integrated across projects. However, the customization of the deliverables makes it difficult to transfer knowledge across projects. Management tends to oversee that knowledge, to various degrees, is connected to its context, which has implications on the easiness by which knowledge is transferred. We therefore suggest that there is a need to acknowledge the importance of translation and transformation of the de-contextualized knowledge through interaction and reflection. This meaning that we need to take into account both the social and a technical dimension, which is in accordance with the discussions by Gherardi & Nicolini (2000) and Cook & Brown (1999).

An important limitation of this paper is the decision to study one case in depth, rather than a larger number, which made it difficult to draw strong generalizable conclusions. This study certainly enhanced our understanding of knowledge integration between projects and how this is managed but we propose the need of future empirical work that include multiple units and combine qualitative and quantitative approaches.

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