Process Improvement and Knowledge Sharing in Small Software Companies: A Case Study

Minna Kivihalme, Anne Valsta, Raine Kauppinen
HAAGA-HELIA
Ratapihantie 13
FIN-00520 Helsinki, FINLAND
{minna.kivihalme, anne.valsta, raine.kauppinen}@haaga-helia.fi

Abstract — **Process improvement, knowledge sharing and management are challenging issues for small software companies. In this article, the experiences of three small software business organizations, one research and development (R&D) -project team in hotel business using Taimi-tool [16][26] to support process improvement and knowledge sharing were studied and analyzed with grounded theory. The findings of the case study show that systematic process improvement is not very familiar to small software companies. Modeling and writing down processes are considered old-fashioned, too strict and rules given from above. Process improvement does not fit in to the self-image of an innovative, agile and flexible software company. However, for the R&D-project team, Taimi-tool gave good insights for modeling processes and finding the best ways to improve them. This implies that the problems are not with the tool, but rather with the small software business organizational culture towards process improvement and knowledge sharing. There is a clear need for collaboration with research and development in the field of workplace learning and competence development in small business working life and vocationally oriented educational institutions.**

Keywords-process; project; knowledge sharing; education

I. INTRODUCTION

Small organizations as well as the larger ones need software process modeling, development and improvement. However, traditional models and frameworks, such as CMMI or SPICE are often much too complicated and rigorous to be used in small software business. During the earlier study done at HAAGA-HELIA University of Applied Sciences, it was found that in process modeling and process improvement for small businesses the key purpose is to encourage and develop the organizational and individual knowledge [16]. In addition, the need for a tool supporting an agile process development in the small companies was identified. Based on these findings, a prototype of Taimi-tool was introduced.

Taimi-tool is designed to support communication and sharing of best practices which can be found in any company during an excellent project or lessons learned from a troublesome project. These experiences remain literally unique unless they are shared between colleagues. An excellent project is worth modeling and should be distributed as best practices or as a model, and as widely as possible. In the next section the research approach and methods are described. In the third section Taimi-tool is introduced. The fourth section presents the current state of art of relevant related work. In the fifth section case study companies are introduced briefly and finally findings, conclusions and future work end the paper.

II. RESEARCH APPROACH AND METHODS

In this research the aim was to understand and specify the relations between software process improvement and knowledge sharing in small software companies. The approach is qualitative and the methods used to analyze data are based on grounded theory [9]. The research questions are:

1) How important systematic process improvement is for small software businesses? How do small software businesses share knowledge internally and externally?
2) What kind of a connection there is between process improvement and knowledge sharing in small software organization?
3) What kind of issues the small software businesses have faced in integrating knowledge sharing and management to normal daily-routines? Could a tool like Taimi be helpful in these situations?

The hypothesis based on the previous study [16] is that the small organizations will benefit using a process modeling tool like Taimi. It will make their work more systematic and at the same time it allows them to be flexible and even more agile in their daily work. Process improvement is not only for those who fancy processes. Taimi will encourage everyone in the organization to participate process improvement achievements.

The data collection was done using case-study approach [28] during eight months in 2010. To start the research group organized workshops in every case study company. These workshops were documented as group interviews. In every workshop there were at least two company representatives and two members of the research team. Different roles like management and leadership roles, project management and project team member roles were involved. During the workshops, Taimi-tool was introduced and a brochure and guidelines of use were given to the case study companies. After the workshops, each company could

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either install Taimi to their own server by downloading the software from Internet or they could use the service hosted by the research team during the experiment. Research team named a specific contact person for every company to help with the details. After few months, the date was fixed for the final interviews. Everyone involved in the workshops were interviewed except one process developer who was retired. These interviews were semi-structured, recorded and transcript personal interviews.

During the months between the workshops and final interviews, the research team noticed that it seemed as if the companies were not experimenting much with Taimi. This was later confirmed in the interviews. Because of this, an R&D-project team in hotel business was added as a case study company. The R&D-project team had started a project a bit earlier. After they were contacted and introduced to Taimi and this case study they wanted to test Taimi in their project. The research group thought this was a good way to evaluate the suitability of Taimi for a different type of processes and organizations. A workshop was arranged with the project team giving them the necessary material and information.

III. TAIMI – A MODELLING APPLICATION

Taimi is an open source web application used via a web browser such as Firefox or Internet Explorer. Taimi [26] is developed using Ruby on Rails [22] and it runs on a standard web application server such as Apache Tomcat [27]. In Taimi, each process model and project is visualized as a matrix containing phases and tasks to be stored in the database (MySQL). The phases of a process model or a project can be named and colored as the user wants (see Figure 1). The task boxes get a color code based on the phase they belong into, so it is easy to read the matrix. Tasks can be copied to another process model or project, even several times in the same one if necessary. It is also possible to add attachments and comments to the tasks.

In Taimi, a task in a process model can be seen as a best practice with supporting templates or other guidance. The tasks can be completed with as specific or general descriptions as needed for the common benefit of the organization. The users of a process model can comment on their experiences related to the model as well as suggest improvements to the model immediately when an issue arises during a project.

Figure 1. Adding a new phase into a process model

In Taimi, a process model can be copied into a project and vice versa. After that, the new project is a look-alike copy of the original process model. Tasks that are not part of the new project can be erased. It is also possible to add and edit new tasks (see Figure 2) to the project or copy tasks from other projects or process models.

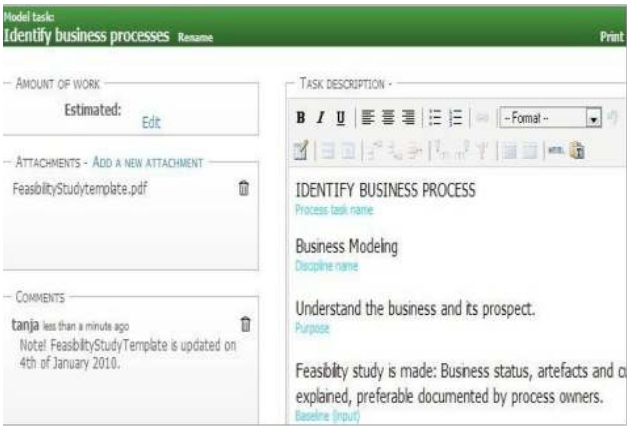

Figure 2. An added task in a process

It is possible to estimate the amount of the work needed to complete a task and define start and end dates for each task. When a task in a project is completed, it can be marked as done. Thus, the progress of the project can be monitored visually (see Figure 3).

The information gained in a project is immediately visible throughout the organization and to the relevant interest groups since a project manager is able to share the project with the necessary interest groups. The members of these groups can also comment on the tasks in the project and add attachment files to them as seen in Figure 2. In this way, Taimi can be used as a collaborative platform supporting the evolution of process models and projects in an agile way based on the shared lessons learned in different projects.

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Figure 3. A project with two completed tasks

IV. RELATED WORK

Software process improvement (SPI) is closely related to the knowledge management (KM) strategy of an organization [18]. Especially in IDEAL [8], CMM [17] and SPICE [23] the focus is in achieving a certain level of maturity. The knowledge management strategy should vary according to the maturity level [18]. Knowledge management strategy can be viewed from two different levels: 1) based on coding [11][25] and 2) tactical level [20] According to Dixon [7] there are five different types of knowledge transfer: serial transfer, near transfer, far transfer, strategical transfer and expert transfer. In order to succeed in knowledge transfer and knowledge management, an organization needs to define what activities and operations it will have and choose its knowledge management strategy accordingly [18].

Sulayman and Mendes [24] have studied the small and medium sized organizations specialized in web technologies. They found that issues in SPI, which were important to the success in business operations, were very closely related to the knowledge management strategy of the company as well. According to the survey made for software developers about the web 2.0 tools, those tools have already changed the way software developers communicate with each other, for example, about testing, marketing and developing [1]. Cockburn has indentified term 'osmotic communication' in his book about agile software development and emphasized its meaning to software engineering especially in the agile development [3]. It is very common to see SPI as a mean to achieve better quality with less cost. SPI can also be seen as a way of rationalizing the activities in an organization. It is very important that an organization is able to handle uncertainty and instability because "Chaos is often a sign that the implementation process is on its way and that you are about to receive valuable information helping you succeed" [2].

It is important to recognize the need for improvement when the company management anticipates the future. When the company is in its peak condition, the work is often very ambitious, even aggressive and the need for change can easily be left unnoticed [10]. Company after company has seen its management fixing pieces instead of redesigning the processes applied to get the work done [5][10].

In a study [4] made in Ireland, the target was to figure out why small companies are reluctant to use known best practices in their activities. It was found that process improvement is considered to be so expensive investment that small companies do not see or do not want to see it as a profitable effort [4]. The small software companies have easily adapted principles of lean thinking and the question often raised by them is whether the customer is willing to pay for this kind of work or not. This is a potential conflict, because there is evidence of customers wanting to see proof of quality and stable working habits within the small and especially young companies [16].

The study in Ireland also showed that start-up companies saw the formal SPI as an obstacle to creativity, innovation and flexibility. From their viewpoint, SPI was not about improving the process, but instead a set of strict instructions forcing them to follow the given process and blocking creativity and flexibility. Also, it was found out that the educational background, experience and know-how of the technical management had a lot of influence on the willingness to commit to the best practices.

A similar study [19] was made in Vietnam focusing on the obstacles of applying process models and SPI. In that study it was found that depending on the size of the company the issues were emphasized differently. For the small organizations, the most important issue was the lack of resources. In the bigger organizations, in addition to the previous issue, the lack of communication, the commitment of the management and timetable pressure were identified. These findings were compared to the research made in the UK where the timetable pressure was identified as the key issue. The conclusion was that while in Vietnam, the lack of resources meant that the process improvement was not really happening, in the UK it was, but there still were problems related to the resources in the form of timetable pressure. In addition, the staff in Vietnam was quite young compared to the staff in the UK. The conclusion was that young inexperienced managers did not see process improvement so important that they would have allocated resources for such initiatives. [19]

In a Finnish study [15] about the agile future organization, it was found that organization needs versatile talented people and that the agility needs to be part of the business operation strategy as well. The software development alone cannot be agile if the business around it is not. In addition, an agile process framework is needed for teams to be able to tailor their process for the particular situation [15].

In a study [21] of project managers' knowledge transfer made in the USA, it was found that inexperienced project managers relied more on social networks in order to get the knowledge they were looking for than their more experienced colleges who used more formal knowledge sources. The conclusion of this study [21] was that inexperienced project managers were sensitive or even timid to search and ask information from knowledge management

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systems used in their company. According to the study social norms and organizational culture either encourages IT project manager to share their knowledge or inhibit it.

Wiki technology has been found to be very powerful technique to transfer knowledge to large groups of people in ad-hoc and other dynamic situations [12]. But there is a lot more than just ad-hoc and other dynamic situations in knowledge transfer and knowledge management. Davidson and Rowe [6] defined different levels of knowledge management. At the first level, the team learns from the previous project and answers to questionnaire to find out the lessons learned. This information is delivered to the second level, where it will be analyzed and passed on to the next level, which is a strategic level. It is obvious that this formal knowledge management will benefit from a suitable supporting tool and, in most cases, this process needs a knowledge manager to handle the tool and process [6].

V. CASE STUDY COMPANIES

The companies participating in the case study are small or medium sized Finnish software engineering companies (companies A-C, see Table 1) and a hotel entrepreneur (company D).

Table 1. Some business features in 2009-2010

Company	Personnel	Turnover, MEUR	Established
A	110	7.7	2000
B	50	4.5	2005
C	60	5	2002

A. Company A

Company A is a Finnish software engineering company creating applications ranging from intranets to business intelligence and social services. Their emphasis is on the lean philosophy – removing waste and concentrating only on producing something useful and having a strong focus on usability at the same time. This company has been growing quite fast. The atmosphere of the company is very informal and free-minded. The slogan for this company could be "Things can always be done better". The company recruits people having the attitude of wanting to give his or her best as an individual and as a team member.

B. Company B

Company B is a Finnish software engineering company specializing in tailor-made customer-specific software projects, consulting, maintenance and support for large information systems. Processes are quite a new concept to the company B. The management has mainly focused on creating innovative environment for people to work in. Company B views process models from the standard point of view: as a way to implement company strategy. However, company B sees processes and modeling very situational.

C. Company C

Company C is a Finnish software consulting company specialized in software quality. The aim of the company C is to assist their customers to ensure the quality of their IT systems. Because of their service strategy, the process meta models (CMMI, SPICE) are well known and those models are used to improve customers' processes.

D. Company D

Company D was not a partner at the beginning of the research study and it differs from the previous ones. Company D was actually one team from HAAGA-HELIA's R&D-project team for developing processes for hospitality and hotel business.

VI. FINDINGS

Systematic process improvement was not very familiar to the companies in this case study. This is the case even in the company having more than 100 employees. Instead, knowledge management and knowledge transfer are very much appreciated. However, they are on the level of near transfer [7] and not on strategic level. Modeling and writing down processes are considered old-fashioned, too strict and as rules given from above. Process improvement does not fit into the image of an innovative, agile and flexible company. According to Mark Kennaley the word process is not valued in the agile approach [14]. Instead of process Kennaley recommends 'standard work' in the meaning of how daily work is performed and described.

Process and creativity are seen as opposites and companies want to emphasis creativity, passion for work and freedom to be creative. Similar results were found in the research conducted in Ireland [4]. The daily work is seen too artistic to be modeled as a process. Still, knowledge transfer and knowledge management are highly appreciated and there are lots of different unsystematic methods for transferring knowledge within the company and via networks. These methods are not treated as processes even though they might be seen that way. Nevertheless the atmosphere of knowledge sharing is very free and open. The organizational culture in these case study companies encourages project managers to share their knowledge. The same results were also found in the study made in the USA [21].

In every interview we made, one common denominator was found; at a certain point people do not have the time to do anything in addition to the deliverable result. The deeper you dig into the world of project managers the more you sense that it is hard to invent the wheel all over again. Project managers eventually see the pattern, but they do not have time or resources to make the pattern visible even if they would like to. The results of the research in Vietnam support this as well [19]. Project managers are bound very tightly to the ongoing project. They would like to have more guidance, methods and help instead of being forced to invent the wheel again. However, the management and leaders in the small companies think that there are many ways and opportunities to transfer knowledge, for example, 'brown bag sessions', 'company Fridays' and study or learning groups. All these methods are actually methods for near transfer and only they work if face-to-face methods are available. But, these methods are unavailable if you cannot be present, for example, if you are working in the customer

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premises and the customer will not allow collaboration within the company's social network. This was the case for one of the project managers working at customer premises. Companies use and have been using all sorts of tools to communicate such as discussion forums, wikis, social networks and network drives, but they also feel that the information gets buried into these systems. Major disadvantage for these tools is the fact that you need the time to gain all the visible or hidden information and time is a scarce resource in the small or medium enterprise (SME).

Four groups were identified using the open coding of grounded theory: knowledge management and transfer, creativity, process and process improvement and lack of time. In axial coding, the relationships among these concepts are identified. These relations are illustrated in Figure 4.

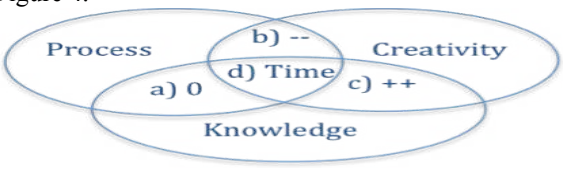

Figure 4. Creativity, process, knowledge and time in a SME

The SME's see knowledge management and transfer worth chasing for while processes and especially process improvement is something SME's are not so keen on doing. One of the managers said, "We should forget analyzing and think about what to do next, because analyzing doesn't really create anything. Process is something given from above ".

Processes were even seen as an obstacle to creativity. When the creativity is high, processes are low. Negative correlation between process and creativity is illustrated by letter b) in the Figure 4. Another manager said, "The work we do for our customers is very creative: people get familiar with things and tell about them, so it is very informal. We have not defined our process, and we are talking about our work as artistic work."

Knowledge transfer and management are directly comparable to creativity in SME's self-image. The positive correlation between knowledge and creativity illustrated by letter c) is seen in the Figure 4. One of the project managers said, "We are encouraged to teach each other. We should give small sessions out of our own interest and will. These demo days have been ok. It has been possible to go deeper into some interesting subject area".

According to Sulayman and Mendes [24] and Mathiassen and Pourkomeylian [18] knowledge management and transfer are closely related to processes and their improvement. For the companies in this study this was not the case. In these companies the knowledge transfer happens ad-hoc without visible processes involved. This relationship is illustrated by letter a) in the Figure 4. One of the managers said, "We try to give people as much freedom as possible and encourage them to use their creativity and passion. That's how we create self-organized workplace and knowledge sharing". By this the manager revealed in fact that there was not a process involved in knowledge sharing.

These findings show that SME's are not ready for a tool like Taimi. There were some positive signs especially from the project managers' point of view: they would have appreciated this kind of a tool if they would have had time to take a bit deeper look at it. This also means that they would have liked to concentrate on the process, process improvement and knowledge sharing as well. One of the project managers said, "I don't need any new features for Taimi. The matrix is just great. The main features of Taimi are really good. And we could have used Taimi for real as a tool between project managers and company management, but the lack of time was my problem". According to Davidson and Rowe [6] companies would benefit from a suitable tool to support the knowledge management and transfer as well as knowledge manager to handle the tool and process.

The project managers in the case study companies were too busy in their ongoing project to be able to take a wider perspective to their work. They needed the support from their superiors, which they did not get this time. One of the project managers said, "I would have liked to test the tool, but in the company there were others who didn't want to test it or they wanted to have free hands and not to use any tool at all. The decision was made by management to not to trial the tool".

In the Figure 4 the letter d) illustrating the lack of time has connections to all the other themes. The lack of time rounds up to the fact of project managers wanting to have the support from their superior even in the atmosphere of informal and innovative company. One of the project manager said, "There could be concrete recommendation what tool to use in projects. Now everybody is using the tools they want and you have to compare the plusses and minuses of the product by yourself. If there were some guidance, it would be nice. Face-to-face meetings are of course nice. A tool, project database or something would be a good bonus for later use or reference." By this the project manager meant that, for some of the staff, it would be helpful and timesaving to have a process and a supporting tool for the process and knowledge sharing.

Findings from the company D differ from the rest of the case study companies. Taimi got good feedback from the company D. The idea of user interface as a process matrix, the idea of being able to link different information to tasks and being able to change the process easily and quickly if necessary were appreciated by the company D. The tool gave good insight to process modeling and finding the best ways of improving the process in the hotel involved in the R&D-project team. Company D wanted to start using Taimi, but they were somewhat worried about the continuity of Taimi's future. These findings about the tool and the idea behind it are promising.

VII. CONCLUSION AND FUTURE WORK

The conclusion of this study is that process improvement is on very early stage in the small and medium sized software engineering companies. Modeling processes is on learning phase and it is not yet something that is seen important and necessary. There is always something more important to be done. Also, the lack of time and resources does not promise more process improvement to happen in

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the near future. Sharing knowledge happens ad-hoc or in a project between its members.

A new tool or method needs to be learnt first and it takes time. And spare time is something the small companies do not have. Internal improvement gets left behind. Outside stimulator or supporter, research time and money is needed to get the internal improvement on the road. The first step is always the hardest. Next steps are easier to take. A comprehensive tool would help sharing and transferring knowledge wider in a company.

How could we support SME? According to Illeris [13] radical changes and development have been taking place in recent years concerning work-based and work-related learning and competence development. Globalization, the knowledge society and human competence are becoming an increasingly decisive resource of competition. Illeris notes vary of general qualifications with terms such as organizational learning, experimental learning and spirituality at work. According to Illeris even professionals find it difficult to negotiate these areas, not to speak of small companies with no time and no particular educational function. The situation is different in educational institutions, where time is available and whose function is vocational education. The lesson learned from this study is that there is a need for much tighter collaboration with research and development in the field of workplace learning and competence development in working life with small software development companies and vocationally oriented educational institutions.

During the curricula, students should be adapted to operate with a shared tools and knowledge ware. The young professionals need good understanding and skills on processes and methodologies. Further research is needed to study the attitudes of students choosing software development as their area of expertise and how these attitudes reflect to their future career as professional software specialists. Another, maybe more important, question is what are the mechanisms, including teaching methods, especially in vocationally-oriented education to promote the internal process improvement both in business processes, entrepreneurship and software processes as a part of workplace learning and competence development.

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