Knowledge Engineering for Software Development Life Cycles:

Support Technologies and Applications

Muthu Ramachandran
Leeds Metropolitan University, UK

Information Science
REFERENCE

Chapter 15
Knowledge Management in Software Process Improvement:
A Case Study of Very Small Entities

Shuib Bin Basri
Lero, Dublin City University, Ireland & Universiti Teknologi PETRONAS, Malaysia

Rory V. O'Connor
Lero, Dublin City University, Ireland

ABSTRACT

This chapter discusses knowledge management (KM) aspects of how software process and software process improvement (SPI) is practiced within very small entities (VSEs) in the context of Irish software development industry. In particular, this study is concerned with the process of software development knowledge management in supporting the SPI. In order to understand the support process, the authors of this chapter have studied how KM processes are practiced within VSEs which includes communication, learning, sharing, and documentation process. This study also focuses in detail on the issues of the knowledge atrophy problem in VSEs. The findings explain how KM has been practiced and influenced the software development process and process improvement in VSEs. This result indicates that KM processes in VSEs are being undertaken in a very informal manner and also in indirect way. This is due to a small team size, autonomous working and macro-management style and caused VSEs to be more informal in their KM processes specifically and SPI generally. In addition, the results have indicated that the informal environment and culture helped VSEs to easily create and share knowledge between staff members and also assisted VSEs to mitigate the knowledge atrophy problem in their organization.

INTRODUCTION

Small and very small companies are the fundamental growth of many national economies. It is important to notice that the contribution from the small companies should be seen as important and significant as compare to the large one. The majority of software companies are small (Richardson & Von Wangenheim, 2007) and for example in Ireland the majority of the Irish indigenous software firms are employed between 10 to 99 employees (Crone, 2002) and average size is about

16 employees (Coleman & O'Connor, 2008). The same scenario occurs in many other countries especially in Europe, Brazil and Canada (Laporte et al, 2008a), where Very Small Entities (VSEs), which employed less than 25 people (Laporte et al, 2006) are the majority software companies in the respective country. Therefore in order to be always relevance in software industry, small companies need to maintains and enhances their products and for that they need to improve their development process (Valtanen & Sihvonen, 2008; Reed & Kelly, 2002). Even though several methods and guidelines (e.g. Moprosoft and CMMI) have been produced in order to enhance software companies' development process, there are still a lot of challenges and obstacles have to manage (Laporte et al, 2008b). Hence, small companies whose have limited resources; particularly in financial and human resources; and practicing unique processes in managing their business have influenced their business style compare to large companies which are very formal and well documented (Sapovadia, 2006; Mtigwe, 2005).

Therefore consider to the above characteristics and situations, have shows that most of the management processes activities (e.g. decision-making, communication and problem solving) are done in informally way (e.g. orally and less documented) and more towards to human-oriented and communication factors (Valtanen & Sihvonen, 2008; Laporte et al, 2008b). Therefore it is belief that these issues will also influence software development VSEs in organized their software development knowledge. Furthermore the influence of well organized software development knowledge is seen could assist small companies or VSEs in maintain their product relevancy in market. This process also could mitigate from knowledge atrophy problem from affecting their company.

BACKGROUND

Software Process and SPI

The software process is all the stages and activities that are followed by organization to develop a software product (Zahran, 1998). The software process has four distinct roles; (i) to present a guidance as the guideline of the activities to be undertaken; (ii) to specify the artefact that should be developed and when; (iii) to direct the task of the development team; and (iv) to offer ways of monitoring and measuring a project progress and output (Kruchten, 2000). Moreover based on the first role, (Sommerville, 2004) has claimed that development process must be update, improve and maintain in order to meet current business and customer requirement. In addition, the issues SPI has gained increasing importance in software engineering area. The main aims of SPI are to understand the software process used in the organization and to guide the implementation of changes of that process in order to achieve specific goals such as to improve software development time, on budget and with the desired functionality. According to several authors, SPI has a close link between the quality of the development process and the quality of the product developed using the process (Kruchten, 2000; Olsen et al, 1989). In regards to small companies, improving software process is like improving a business process and both are related (Sanders, 1998; Ward & Aurum, 2004). In addition 4 categories; economic, people, organization and implementation; are believed as SPI influencing factors in an organization (Hall et al, 2002).

Moreover, SPI also goes through a lifecycle as exist in software development process (Cook & Wolf, 1998). The SPI lifecycle is constantly changing software processes and it consists of two phases; (i) analysing process phase and (ii) changing process phase (Stelzer & Mellis, 1998) and this process will be continuously as depicted in Figure 1.

Figure 1. SPI change process
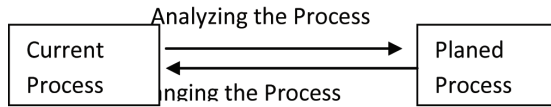
Knowledge Management (KM)

Knowledge can be divided into two classes, explicit and tacit (Polanyi, 1966). Explicit knowledge is easier to communicate, transmit and reuse across an organization (Desouza, 2003). While tacit knowledge is highly personal knowledge that is gained through experience and deeply rooted in action, commitment and involved in a specific context (Argesti, 2000). In software engineering, individuals are the most important actor in KM, who perform tasks for achieving goal that been set by the organizational level. Through social and collaborative work among the people in an organization, process knowledge is created, shared, amplified, enlarged and justified on organizational setting (Nonaka & Takeuchi, 1995). Moreover knowledge is about action-outcome and the effects of the firm environment (Weick, 1995) and was created through a conversion between tacit knowledge and explicit knowledge (Nonaka et al, 2000).

KM is a discipline that crosses many areas such as economics, informatics, psychology and technology. KM is seen as a strategy that creates, acquires, transfers, consolidates, shares and enhances the use of knowledge in order to improve organizational performance and survival in a business environment (Zhang & Zao, 2006). This scenario becomes a challenge to the companies in managing their organizational knowledge (Kvale, 2007). Therefore specific plans and suitable tools will guide the knowledge management process (Dingsoyr & Conradi, 2002). This plans and tools must be promoted in applying the old knowledge to new situations in an organization (Kukko et al, 2008).

In KM, knowledge creation and sharing is a continuous process whereby individuals and groups within the organization and between the organizations share tacit and explicit knowledge. The organization capability to create knowledge is important in order to sustainable competitive advantage (Nonaka et al, 2000; Parent et al, 2000). Knowledge creation process is believed started when an individual recognize the related and useful data and information and then able to transform it into a new knowledge that brings a future value to an organization. Organizational knowledge is not only created within the organization but also can be acquired externally and this can be done through knowledge sharing (Grant, 1996; Awazu, 2004; Nonaka & Takeuchi, 1995). The important of knowledge sharing and knowledge creation in any organization will help organization to continuously innovate and help organization to sustain their competitiveness (Rhodes et al, 2008). These activities are usually supported by a social network within an organization and through the development between departments in an organization link (Szulanski, 1996). In addition, Turner and Makhija added that in sharing and creating knowledge, trust and organizational control plays an important role in how individual transferring and sharing their knowledge with others in an organization (Turner & Makhija, 2006). Moreover, (Dingsoyr & Conradi, 2002) have investigated knowledge management approaches in eight case studies; proposed with a framework of knowledge management program that must exist in the companies, as depicted in Figure 2.

Figure 2. A framework of the components of a knowledge management
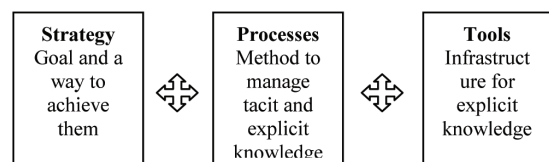
Knowledge Loss Issues

Knowledge is vital for every organization because it is needed to perform a work in an organization. According to (Hendricks & Vriens, 1999) an organization cannot survive and sustain their competitiveness without knowledge. Therefore knowledge needs to be managed to ensure that the right knowledge gets into the right place. This also will increase the innovation power of organization and its knowledge worker. In addition knowledge in organization also will be eroding over the time and will contribute to loss of knowledge in organization. This condition is often implicit and its loss is often not recognizing until too late. According to (Shaw et al, 2003) knowledge erosion is referred as the loss of knowledge resulting from people leaving an organization or changing jobs within it. Several author claimed that knowledge erosion became one of the main problems as the organization expanding over the time (Litern, 2002). The lacking of resource and time in small company in implement knowledge management will introduce a knowledge erosion situation through employee retirement and resignation (Bjorson & Dingsoyr, 2008). In addition, 4 important criteria in organization; the staff development, team building, communication of role and function, and formal continuous process improvement; was believed could help organization in mitigated this issue (Shaw et al, 2003).

KM and SPI

Software process is not standardized in all software projects (Borges & Falbo, 2002). Software process must be updated and improved frequently in order to cope with any environment changes. Such environment required KM in supporting software process definition and activities (Sirvio et al, 2002). (Hansen & Kautz, 2004) explained that SPI could strengthen KM abilities for software development organization. In term of small organization, (Meehan & Richardson, 2002;

Kettunen, 2003), argues that KM is core to a software process improvement model and that the relationship between SPI and organizational learning are very strong. They points out that people in an organization will create, acquire and share knowledge continuously in order to improve software development practices. Moreover, in nowadays business environment where software development project becoming more complex, the greater reliance upon the knowledge processes to resolves problems are really important (Aurum et al, 2003; Bjornson & Dingsoyr, 2005). (Bjornson & Dingsoyr, 2008) stated in their review that proper managing of organizational knowledge is important in SPI efforts and it is a major factor for success. (Mathiassen & Pourkomeylian, 2003) in their survey on practical usage of KM to support innovation in a software organization claims that KM and SPI are very close related. They added that knowledge management is used to update practices within software organization generally and SPI specifically. According to (Sirvio et al, 2002) software organization needs to improve their practices in order to cope with market changes. These situations have lead to considerable interest in how organization can effectively respond to changing environment or agile environment (Aaen et al, 2007) (Sirvio et al, 2002). Therefore KM is seen as critical to SPI process.

Therefore, based on the above discussion we proposed a study model as depicted in Figure 3. From the diagram, it shown that the SPI and software development KM are related to each other. This relationship is vital in preventing knowledge atrophy and process erosion problems. In addi-

Figure 3. The study model
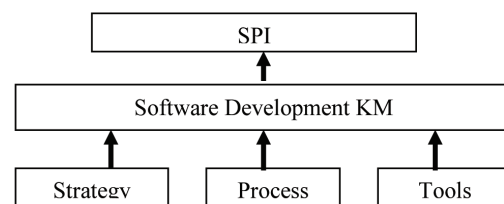
tion, a proper KM process could help software teams become more effective in performing team task and making a decision (Salas et al, 2000; Kettunen, 2003). (Aaen et al, 2002) added with an appropriate knowledge creation and sharing process could provide team members with clear SPI goals and sustain their interest.

METHODOLOGY

Data collection consisted of two complimentary methods, individual and focus group interviews. These processes are done almost simultaneously. For the interview and focus group purposes, we have been guide by an interview guide and focus group question guide (Taylor & Bodgan, 1984). The individual interview approach was used in this study in order to discuss the research issues in depth, to get respondents' candid discussion on the topic and to be able to get the depth of information of the study situation for the research context (Kvale, 2007). A semi-structured interview includes the open-ended and specific question. It been designed to gather not only the information foreseen, but also unexpected type of information (Li, 2006). The respondents for this individual interview session are the managers from the identified Irish Software VSEs. The interview session happened approximately 40 to 90 minutes. In overall, we have interviewed 4 managers from various software VSEs; which their main activities is software development; around Dublin, Ireland at their respective company.

The second interview method is the focus group interview. The focus group interview approached was used in this study in order to get a detail explanation and viewed from the development team which involved directly with the development process. Moreover, the existence of team interactions in this activity could help to release inhibitions amongst the team members. Furthermore, this method could activate forgotten details of experiences and also could generate more data through wide range of responses. Focus group interviews were also chosen because it was the most appropriate method to study attitudes and experiences; to explore how opinion were constructed (Kitzinger, 1995) and to understand behaviours, values and feelings (Patton, 2002). According to (Valtanen & Sihvonen, 2008; Powell & Single, 1996), the advantage of focus group is the ability to help the researcher in identifying quickly a full range of perspectives held by respondents. They added that focus groups expand the details that might have been left out in an in-depth interview. The focus group participants for this activity are from the same company as the individual interviews participants. 14 development people have been involved in this activity and have been conducted at their respective companies'. In analysing all data we have followed the qualitative contents analysis method (Elo & Kyngas, 2008) and adopted the Grounded Theory (GT) (Strauss & Corbin, 1998) data coding process in order to have a systematic data coding activities. In this part all qualitative data that gathered from individual interviews and focus group interviews were analyzed and coded. This process involves the development of the codes, code-categories and inter-relationship of categories which is based on the GT process and coding strategy (Strauss & Corbin, 1998). The *Atlas.Ti* software also was used to help us to code the interview transcript and linking these codes to produce the semantic network diagrams, which are illustrated later in the chapter.

FINDINGS AND DISCUSSIONS

Based on the analysis process we have identified 7 main related categories that shape up the SPI environment in VSEs. Figure 4 illustrates all the categories that influence VSEs SPI initiatives. In additional these categories are the main categories and variables that gave an influence to the software development process environments in VSEs. The details of the main categories are

Figure 4. The overall main category diagram
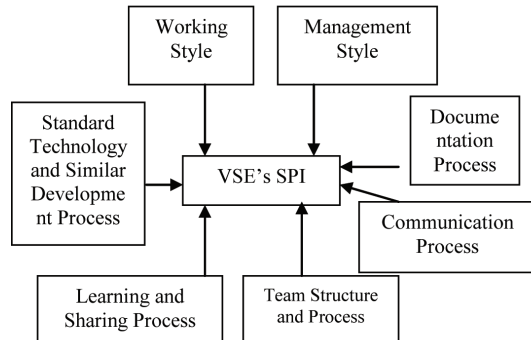
presented below, which grouped and listed out in details the important variable that gathered from the analysis process.

Team Structure and Process

The analysis result shows that the team environment in VSEs could be divided into 2 categories as tabulated in Table 1. The organizational and team structure category indicates that due to small number of people working in the organization, the team size also small and this lead to a flat team and organizational structure. From the interviews analysis results indicates that all interviewees admitted that the companies having no real team structure or team structure is only exist occasionally and it depends to the company project. For example, one company says of its team structure *"Since we are 3 people in development plus the*

manager we have very direct contact with each other and with the manager".

In additional we also found that due to the small number employee, flat organization and team structure and informal environment, interviewees are perceived that all peoples in the companies or department are in the same level. In addition the analysis show that they have the same level of working experience, skills and very much depends to each others in performing their task. Beside that the close working space or area and high frequent and informal communication are also influence this perception. All these criteria have lead VSEs in narrow down the gap between the management and the team development, as illustrated by this interview extract:

"The management and staff relationship is very close, it is probably we are in the similar age and similar interest. No body works in this company that not interested what we do in this company.".

The second category have indicates the team role, team involvement and team culture issues. The analysis shown that the staff role which includes the role in team and the task they perform in development process is very informal and very general. This could apply that the development staff could worked or assigned as different role in one time in organization development project. In addition they also can work with others or different people and different position as and when they are required. These situations have explained

Table 1. Team structure and process

Sub Category	Category	Main Category
Team Size - Small	Organizational and Team Structure	Team Structure and Process
Organizational and Team Flat Structure -		
Team Role - informal	Team process	
Team Involvement - direct		
Team Culture – informal		

that team involvement process in VSEs is direct and informal in development activities.

Working and Management Style

The analysis has shown that the team structure and process category gave an impact on VSEs working and management style. It is indicates that staffs have autonomy on their work which make them more self dependent, self responsibility, work independently and self learning as in Table 2.

The result from the analysis emphasises that people in VSEs working style is more toward individually or been assigned task according to their expertise. This situation has been defined as 'team of one' by one of the interviewee. The formal interactions of between the team member is more on the strategic area only such as problem solving or knowledge sharing in particular issue that related with the software development issues. But most of other interaction or communication are more indirect, casual and very informal. This situation gave researcher an indication that notion of team work in VSEs only appears or happened in informal way or periodic basis. The following interview quotes represents this situation: *"It depends and because we are small company sometime we have big project but most of it is small. It depend the scope of the project if big we might do it in team and again most of it is individual basis. Basically people work quite autonomous and specific."*

In relation to autonomous work, the analysis also indicates that, the people in VSEs also exercise an autonomous communication style in performed their works. Informal communication, less structure and direct communication, self learning and explore, frequent informal guidance, and informal meeting code that produce from the analysis indicates the autonomous communication process happened in VSEs. Several interviewed quotes below explain the autonomous communication issues in VSEs, such as this: *"They tend to communicate when they want a problem answered. They are very autonomous and everybody helps to solve a problem"*. The analysis process also indicates that there are similar management styles adopted within VSEs. During the study, it shows that the small team size elements in VSEs are also gave an impact on the management style in the companies. Table 3 indicates how the management style has been adopted in VSEs.

Trust, relationships, flexible environment and loose project management are the subcategories that indicate the based management style in VSEs. This type of management approaches is defined as 'Embrace and Empower' (Coleman and O' Connor, 2008) regime as similar to 'Theory Y' management style (McGregor, 1985). In this context the idea and opinion from all subordinate have a values and been adopted in the development process and policy. There are also indicators that the element of trust in development team and their ability to carry task with less direction. This

Table 2. Working Style

Sub Category	Category	Main Category
Autonomous work		
Autonomous Communication		
Work independently		
Strategic area	Working Style	
Sole Responsibility		
Self Learning		
'Team of One'		

Table 3. Management style

Sub Category	Category	Main Category
Trust		
Family and Flexible Environment	Management Style	
Loose PM		
Open Environment		

could be identified in Table 3 which identifies the working style on how the development staffs perform their task. For example, this extract clearly shows a flat management structure, which is representative of these study VSE participants: *"Is very informal, very flat structure not huge hierarchy and have a freedom to implement what they think is working to the task. We just control very loosely over time."*

Standard Technology and Similar Development Process

The analysis also indicates 2 subcategories appear in this category as list in Table 4.

We found that type of development tools and development process being used and adopted are varies in VSEs. These are depends on companies main technology platform and framework in developing their software product. The analysis has indicates that VSEs are adopted similar development technology, tools and method in developing company software product, as illustrated by this interview extract: *"Yes, the development processes are quite identical and small changes depend to situation but overall the development process is same."*.

The analysis of the interviews data also indicates that developers in VSEs adopting the agile development philosophy and approaches in developing systems. This could be identified with the method and process they are adopting in performing software development task. The details of this process will be explained in later parts that related with this issue. In overall this part explains the issue of development technology and method that have been adopted in VSEs. The analysis has explained that VSEs are using the same development tools and method in developing the system. This is due to a few reasons that have been stated above. The analysis has indicates that the combination of both issues has given an impact to the others processes.

SPI Process

In this main category, we could be detailed into 2 categories as illustrates in Table 5.

The first subcategory that exists in process status category is process loss and focus subcategory. The results indicate the SPI process started when the process loss and/or process focus happened. Process loss happened when the technology change, customer requirement creeps, software function creep, and a new idea or sug-

Table 4. Standard technology and similar development process

Sub Category	Category	Main Category
Standard Technology	Applied standard technology and similar development method	
Similar development Process		

Table 5. SPI process

Sub Category	Category	Main Category
Team Structure and Process		Improvement Development Process
Informal/Indirect	Process status	
Small Scale		
Process Loss and Focus		
'Agile' Development Style	Development method	

gestion from the staffs exist in their business activities. Meanwhile, process focus happened when new customer requirements, market changes, business procedure and requirement upgrade, software module or product update and expert/staff suggestion and idea occurred in their business environment. In addition, the analysis also indicates that VSEs are work very close with the customer in improving the software product and process.

The second subcategories are the small scale and informal or indirect subcategory. The analysis indicates that the SPI process in VSEs has been done in a small scale but very frequent. This process could be identify the analysis code such as organic, natural change, reactive vs. proactive, try and error, module orientation, minor changes and profitable orientate that extract from the interviews quotes represents the scale of SPI process in VSEs. Meanwhile from the analysis axial code such as RAD development, frequent change, direct and rapid change, and 'agile' process are reflected the frequent level of changes in SPI. This point is illustrated in this interview extract: *"we doing it little by little and that way we going to do we going to improve the process kind of and we open the discuss ask about what to do next, what is the basic/biggest problem of current process and what we could do to address that"*

Beside smalls scale and high frequent changes in SPI process, the analysis also indicates that the improvement process in software development is performed in informal or indirect process. Not following any standard and guideline, not structure

improvement process and informal post mortem process are the indicator that the SPI process are being performed in informal and indirect way. Meanwhile the development method category indicates that VSEs are more likely to follow an agile development approach in their software development process than the other developments method This could be identified in the communication process, documentation process, change process and customer collaboration which have been identified and explained above indicates that VSEs have fulfilled the 4 main general characteristic as in Agile Manisfesto (Fowler & Highsmith, 2001).

KM PROCESS

In order to understand VSEs KM process, we have combines 3 main categories into one section as follows:

Communication Process

From the analysis, we could divide the communication process in VSEs in 2 categories namely open and informal communication category and online communication category. It also shows that the communication processes in VSEs are influence by the companies team structure and process and the working and management style Table 6 shows the details communication process categories produced from the analysis.

Table 6. Communication process

Sub Category	Category	Main Category
Team Structure and Process Working and Management Style		Communication Process
Open Communication	Open and Informal Communication	
Informal Communication		
Communication tools	Online and Electronic Communication	
Internet/ Electronically		

In the open and informal category, we have identified several interviews quotations that indicate the communication process where people are more towards informal and direct/casual communication. This could be identifies in the way of meeting have been conducted which are more informal, 'stand up', periodic and individual. This is due to the working environment, team size and working style in their company. Furthermore relationship between staffs in the company also influences the communication process in VSE. The family and flexible environment, frequent socialize between staff; flat organization structure and closeness working space have given an impact on communication process in VSEs.

The analysis also shows that the use of communication tools such as email, phone, blog and internet are very active in VSEs. This communication tools is more vital to the company that have a staff who works outside Ireland or having others offices in different locations. The use of these tools is believed could close the gap between remote and collocate staff and allow staffs to share and document all work related information or knowledge in informal way.

The following interview extract summarises a typical study participants communications processes: *"Formal meeting are not held very often because we always communicate each other…so a formal meeting isn't required…we do might have a kick off project meeting and generally people discuss the work all of the time"*.

Learning and Sharing Process

The analysis has shows the learning and sharing process in VSEs as in Table 7.

In self learning category, the analysis shows at in VSEs there are no formal trainings are given or provides to employees in enhancing their

Table 7. Learning and sharing process

Sub Category	Category	Main Category
Communication Process Working and Management Style Team Structure and Process		Learning and Sharing Process (Knowledge Management)
Training	Self Learning	
Self Learning		
Continuous Guidance		
Internal Training	Sharing	
Meeting		
Document		

knowledge or skills. The analysis also has explained that people in VSEs are more depends to self learning in mastering the technology or process that used in the organization. Besides self learning, the analysis also shows on the job training, self exploring and continues guidance from expert within the companies are the main process that frequently been practised in enhanced staff knowledge and skills.

The second category in this part is sharing category. The analysis shows that in VSEs knowledge sharing process happened in informal training, informal meeting and document sharing. Informal training happened through informal and guidance from expert, peer to peer programming process, shared books and others material, internal training, high frequent open and direct discussion with team member and online sharing with others. Meanwhile the informal meeting process happened through an informal stand-up meeting, direct and open discussion and online meeting via email, Skype and blog. In relation, the analysis results indicate that the learning and sharing process in VSEs is been influenced and shaped by 3 existing main factors which are VSEs team size and process which are small team size and flat organization structure; working and management style which are more toward autonomous work and macro management process and, communication process which are indirect and informal process. In additional from the interviews data analysis shows that in general knowledge sharing activities either via electronic or personal are important in main-taining and evolving the current VSEs software development process. The following interview extract is typical of VSE who participated in this study: *"We shared books and we talk… Generally it is informal process just asking questions, maybe grab someone and talk to them"*.

Documentation Process

The results have indicates 2 category that falls in main documentation activities as in Table 8.

The analysis has indicates the documentation processes are very informal process and individual initiatives. In additional, in VSEs documentation process are not given high priority because of time constraints and small team size. The results from the analysis also indicate in VSEs most of the information is documented in an electronic format rather than a paper format. The interviewees also admit due to similar technology and development method applied in all development projects, details documentation process is not necessary and important. They claimed that the staffs are more focused to software development activities rather than the documentation process. In additional from the analysis indicates that due to the autonomous work culture in VSEs, which based on person experience and skills, most of the documentation process in VSEs is individual and personal basis. Besides that, the analysis also shows that programming codes, technical issues and business procedures are the

Table 8. Documentation process

Sub Category	Category	Main Category
Working and Management Style Team Structure and Process		Documentation Process (Knowledge Management)
Informal documentation	Informal and Individual Documentation	
Individual Documentation		
Technical Business related document	Specific Information and Procedure	
Client related Document		

main documentation in the VSEs which fall under specific information and procedure category.

The following two interview extracts best represent the documentation process: *"We haven't clearly defined and documented it yet. We considered our process to be evolving and is not finished. We started of with formal old style model then we change continuously until we happy on it. We can improve it anymore, so that kind of project of itself"* and *"The documentation is only for our internal need, so means there no general standard how we documented it everyone who is participate just preparing it in the future"*.

Knowledge Loss Issues

In conjunction of the above, the knowledge loss issues also have been explore in order to understand the interviewees views and companies actions in order to mitigate this problems. From the analysis indicates that due to economy situation nowadays, the use standard technology and similar development process in every company project, and company nature in VSEs, indicates that knowledge loss problem is not an important and serious issues in VSEs. In additional, the interviewees' claimed that with the informal and autonomous work environments will create an atmosphere that people in the company are more willing to share and work closely each others.

The following interview extracts are representative of typical VSE approach to this issue: *"Really knowledge is secure by the process, the development process, the tools and framework. We put in place we follow the same tool and process and framework. So if anyone left could company would be loss of knowledge to them"* and *"Sometime we make people working together and ensure that no one exclusively work in one project. But sometimes it hard to apply due to our size."*

OVERALL THEORITICAL MODEL

From the overall discussion above, a theoretical and relational model is illustrated as in figure 5. This illustrates that the software process and process improvement strategy which started from process loss or process focus which was influences by several variables which has been discuss above. The process formation is created and will indicate the process that need to improve, change or upgrade. As discussed above the software development process in VSEs are done in informal, indirect and small scale at one time but in a high frequent. The analysis in this part also shows that VSEs followed or adopted the agile development approaches which involved a lot of interaction or communication either with the customers or the developers, high focus of the development process and having minimal documentation process the organization. Due to small team size, flat team and organization structure, staffs or management geographical location, autonomous working style and macro project management the communication process are more become informal and autonomous. Beside that the uses of the com-

Figure 5. Overall theoretical diagram
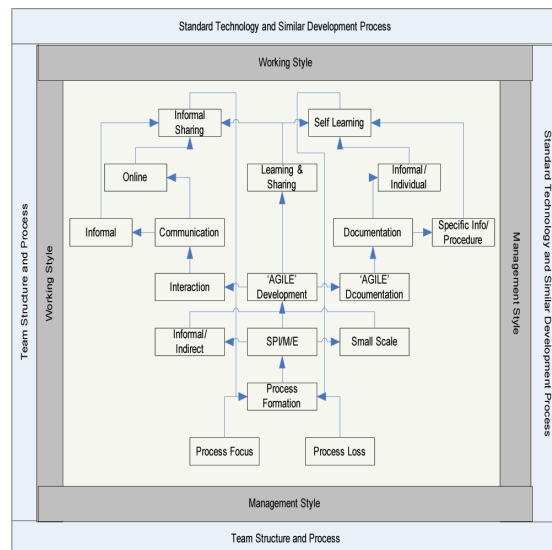
munication tools are also being used extensively among peoples in communicate and shared their knowledge. In term of documentation process, the analysis indicate that in VSEs the documentation process have been practiced either informal or individual. The analysis also shows that due to macro project management style, autonomous working style and influence standard technology and similar development process have lead to the these situation. Moreover the interviewees admitted that only the issue related to business procedure and technical specification are being formally documented. Moreover the analysis also indicated that due to the informal communication, informal documentation and autonomous work have created the informal and personal organization learning and sharing process. Therefore from learning and sharing process a new idea and weakness of the area that need to improved, change and upgrade. This process will start back at the process formation and iterative.

CONCLUSION AND CONTRIBUTION

It was collectively agreed by the respondents that the documentation process in VSEs is done very informally, individually and specifically. In term of knowledge management issues, the result showed that all respondents claimed that they have a clear KM strategy in the organization. However the analysis showed that this process are done informally and is not organised. In addition the result show that even though the KM was done informally either in communication, management, working style and team structure in VSEs, 90% of the respondents believed that this environment have lead them to mitigate the knowledge and process loss problem in their organization. Moreover the results also indicated that in overall the size of the company given an impact to all the process that have discussed above.

The main contribution of this study is an expanded understanding of SPI research area by merging the issues of KM from both a general and VSE specific perspective. Our results indicate that KM factor gave indirect influences to the process of improving current software process and process improvement activities in software development companies. Others contribution of this research is providing an additional knowledge to the SPI research area focused more on VSEs, which have been least explored by current literature. The research has found the variables that influence the software process and process improvement issues that could be explored individually in further detail in future. The last contribution is the type of strategies used to carry out research methodology work, especial in analyzing the qualitative data which was the output from the interviews (interview and focus groups) activities. If survey questionnaire approach is a familiar approach and was often used in the software engineering field, the interviews data analysis research technique which adopted qualitative contents data analysis and GT coding approach, is rarely been used in the analysis of the software process improvement and in software engineering research in general. Therefore we believe that we are adding to the body of knowledge associated with suitability of the GT research method to software engineering area.

ACKNOWLEDGMENT

REFERENCES

Aaen, I., Arent, J., Mathiassen, L., & Ngwenyama, O. (2002). A conceptual map of software process improvement. *Scandinavian Journal of Information Systems*, *13*(13), 81–101.

Aaen, I., Börjesson, A., & Mathiassen, L. (2007). SPI agility: How to navigate improvement projects. *Software Process Improvement and Practice*, *12*(3), 267. doi:10.1002/spip.309

Agresti, W. (2000). Knowledge management. *Advances in Computers*, *53*(5), 171–283. doi:10.1016/S0065-2458(00)80006-6

Aurum, A., Jeffery, R., Wohlin, C., & Handzic, M. (2003). *Managing software engineering knowledge*. Germany: Springer.

Awazu, Y. (2004). Knowledge management in distributed environments: Roles of informal network players. *Proceedings of the 37th Annual Hawaii International Conference on System Sciences*, (p. 6).

Bjornson, F. O., & Dingsoyr, T. (2005). *A study of a mentoring program for knowledge transfer in a small software consultancy company. (LNCS 3547)*. Berlin / Heidelberg, Germany: Springer.

Bjørnson, F. O., & Dingsøyr, T. (2008). Knowledge management in software engineering: A systematic review of studied concepts, findings and research methods used. *Information and Software Technology*, *50*(11), 1055–1068. doi:10.1016/j.infsof.2008.03.006

Borges, L. M. S., & Falbo, R. A. (2002). Managing software process knowledge. *Proceedings of the International Conference on Computer Science, Software Engineering, Information Technology, e-Business, and Applications* (CSITeA'2002), (pp. 227–232).

Coleman, G., & O'Connor, R. V. (2008). The influence of managerial experience and style on software development process. *International Journal of Technology. Policy and Management*, *8*(1), 91–109.

Coleman, G., & O'Connor, R. V. (2008). Investigating software process in practice: A grounded theory perspective. *Journal of Systems and Software*, *81*(5), 772–784. doi:10.1016/j.jss.2007.07.027

Cook, J. E., & Wolf, A. L. (1998). Discovering models of software process from event-based data. [TOSEM]. *ACM Transactions on Software Engineering and Methodology*, *7*(3), 215–249. doi:10.1145/287000.287001

Crone, M. (2002). *A profile of software Irish industry. Northern Ireland Economic Research Center (NIERC)*. Belfast NI.

Desouza, K. C. (2003). Facilitating tacit knowledge exchange. *Communications of the ACM*, *46*(6), 6. doi:10.1145/777313.777317

Dingsoyr, T., & Conradi, R. (2002). A survey of case studies of the use of knowledge management in software engineering. *International Journal of Software Engineering and Knowledge Engineering*, *12*(4), 391–414. doi:10.1142/S0218194002000962

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, *62*(1), 107–115. doi:10.1111/j.1365-2648.2007.04569.x

Fowler, M., & Highsmith, J. (2001). The agile manifesto. *Software Development*, *9*(8), 28–35.

Grant, R. M. (1996). Prospering in dynamically-competitive environments: Organisational capability as knowledge integration. *Organization Science*, *7*(4), 375–387. doi:10.1287/orsc.7.4.375

Hall, T., Rainer, A., & Baddoo, N. (2002). Implementing software process improvement: An empirical study. *Software Process Improvement and Practice*, *7*(1), 3–15. doi:10.1002/spip.150

Hansen, B. H., & Kautz, K. (2004). *Knowledge mapping: A technique for identifying knowledge flows in software organisations. (LNCS 3281)*. Springer.

Hendricks, P. H. J., & Vriens, D. J. (1999). Knowledge-based systems and knowledge management: Friends or foe. *Information and Management Journal*, *35*, 113–125. doi:10.1016/S0378-7206(98)00080-9

Kettunen, P. (2003). Managing embedded software project team knowledge. *IEEE Software*, *I*(6), 359–366.

Kitzinger, J. (1995). Introducing focus groups. *British Medical Journal*, *311*, 299–302.

Kruchten, P. (2000). *The rational unified process*. Reading, MA: Addison Wesley.

Kukko, M., Helander, N., & Virtanen, P. (2008). Knowledge management in renewing software development processes. *Proceedings of the 41st Annual Hawaii International Conference on System Sciences*, (pp. 332-332).

Kvale, S. (2007). *Doing interviews: The Sage qualitative research kit*. Thousand Oaks, CA: Sage.

Laporte, C. Y., Alxender, S., & O'Connor, R. V. (2008). A software engineering lifecycle standard for very small enterprise. *Proceeding of the 15th European Conference, EuroSPI 2008 Industrial Proceeding,* (pp. 10.33-10.41).

Laporte, C. Y., Alxender, S., & Renault, A. (2008). Developing international standards for very small enterprises. *Journal of Computer*, *41*(3), 98. doi:10.1109/MC.2008.86

Laporte, C. Y., & April, A. (2006). *Applying software engineering standards in small setting: Recent historical perspectives and initial achievements*. International Research Workshop in Small Setting, Software Engineering Institue, Pittsburgh, Oct 19-20.

Li, J. Y. (2006). *Process improvement and risk management in off-the shelf componenet-based development*. Unpublished doctoral dissertation, Norwegian University science and Technology.

Litern, G., Diedrich, F. J., & Serfaty, D. (2002). Engineering the community of practice for maintenance of organizational knowledge. *Proceedings IEEE 7th Conference on Human Factors and Power Plants,* (pp. 7-13).

Mathiassen, L., & Pourkomeylian, P. (2003). Managing knowledge in a software organization. *Journal of Knowledge Management*, *7*(2), 63–80. doi:10.1108/13673270310477298

McGregor, D. (1985). *The human side of enterprise: 25th anniversary printing*. McGraw-Hill/Irwin.

Meehan, B., & Richardson, I. (2002). Identification of software process knowledge management. *Software Process Improvement and Practice*, *7*(2), 47–55. doi:10.1002/spip.154

Mtigwe, B. (2005). The entrepreneurial firm internationalization process in Southern African context: A comparative approach. *International Journal of Entrepreneurial Behaviour and Research*, *11*(5), 358–377. doi:10.1108/13552550510615006

Nonaka, I., & Takeuchi, H. (1995). *The knowledge creating company*. New York, NY: Oxford University Press.

Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership: A unified model of dynamic knowledge creation. *Long Range Planning*, *33*(1), 5–34. doi:10.1016/S0024-6301(99)00115-6

Olsen, T., Humphrey, W. S., & Kitson, D. (1989). *Conducting SEI-assisted software process assessments*. Pittsburgh, PA: Software Engineering Institute. (Technical Report CMU/SEI-89-TR-07).

Parent, M., Gallupe, R. B., Salisbury, W. D., & Handelman, J. M. (2000). Knowledge creation in focus group: Can group technologies help? *Information & Management*, *38*(1), 47–58. doi:10.1016/S0378-7206(00)00053-7

Patton, M. Q. (2002). *Qualitative evaluation and research methods* (3rd ed.). Newbury Park, CA: Sage Publications, Inc.

Polanyi, M. (1966). *The tacit dimension*. London, UK: Routledge.

Powell, R. A., & Single, H. M. (1996). Focus groups. *International Journal for Quality in Health Care*, *8*(5), 499–504. doi:10.1093/intqhc/8.5.499

Reed, T. F., & Kelly, D. (2002). The skill gap in the Irish software industry. *Irish Journal of Management*, *23*(2), 95–110.

Rhodes, J., Hung, R., Lok, P., Lien, B. Y., & Wu, C. M. (2008). Factors influencing organizational knowledge transfer: Implication for corporate performance. *Journal of Knowledge Management*, *12*(3), 84. doi:10.1108/13673270810875886

Richardson, I., & von Wangenheim, C. G. (2007). Guest editors introduction: Why are small software organizations different? *IEEE Software*, *24*, 18–22. doi:10.1109/MS.2007.12

Salas, E., Burke, C. S., & Cannon-Bowers, J. A. (2000). Teamwork: Emerging principles. *International Journal of Management Reviews*, *2*(4), 339–356. doi:10.1111/1468-2370.00046

Sanders, M. (1998). *The Spire handbook: Better, faster, cheaper software development in small organization*. Dublin, Ireland: Centre for Software Engineering.

Sapovadia, V. K. (2006). *Micro finance: The pillars of a tool to socio-economic development*. Development Gateway. Retrieved on October 9, 2008, from http://ssrn.com/abstract=955062

Shaw, D., Edward, J. S., Baker, B., & Collier, P. M. (2003). Achieving closure through knowledge management. *Electronic Journal of Knowledge Management*, *1*(2), 197–204.

Sirvio, K. S., Mantyniemi, A., & Seppanen, V. (2002). Toward a practical solution for capturing knowledge for software projects. *IEEE Software*, *19*(3), 60–62. doi:10.1109/MS.2002.1003457

Sommerville, I. (2004). *Software engineering* (7th ed.). Reading, MA: Addison Wesley.

Stelzer, D., & Mellis, W. (1998). Success factors of organizational change in software process improvement. *Software Process Improvement and Practice*, *4*(4), 227–250. doi:10.1002/(SICI)1099-1670(199812)4:4<227::AID-SPIP106>3.0.CO;2-1

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage.

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within firm. *Journal of Strategic Management*, *17*(2), 27–43.

Taylor, S. J., & Bodgan, R. (1984). *Introduction to qualitative research method*. John Wiley & Sons.

Turner, K., & Makhija, M. (2006). The role of organizational controls in managing knowledge. *Academy of Management Review*, *31*(1), 197–217.

Valtanen, A., & Sihvonen, H. M. (2008). Employees' motivation for SPI: Case study in a small Finnish software company. *Proceeding of the 15th European Conference, EuroSPI 2008,* (pp. 152-163). Berlin/Heildelberg, Germany: Springer–Verlag.

Ward, J., & Aurum, A. (2004). *Knowledge management in software engineering-describing the process*. Australian Software Engineering Conference (ASWEC'04), (pp. 137-146).

Weick, K. E. (1995). *Sense making in organization*. Thousand Oak, CA: Sage Publication.

Zahran, S. (1998). *Software process improvement: Practical guidelines for business success*. Boston, MA: Addison Wesley.

Zhang, D., & Zao, L. (2006). Knowledge management in organization. *Journal of Database Management*, *17*(1), 1–8.