Evaluating the Readiness to Adopt CMMI in Malaysian Software SME

Ammar Mutahar AL-Ashmori¹*, Babak Bashari Rad¹, Ahmed Salem Saeed AL-Ameri¹ and Zahra Ahanin²

¹Asia Pacific University of Technology and Innovation (APU), Technology Park Malaysia, Bukit Jalil, Kuala Lumpur 57000, Malaysia; ammar014@hotmail.com, dr.babak.basharirad@apu.edu.my, ahmd_171@yahoo.com
²University of Malaya (UM), Jalan Universiti, 50603 Kuala Lumpur, Malaysia, zahrahnnx@gmail.com

Abstract

Background/Objectives: Delivering high quality software is a big challenge for software companies specifically for SMEs but it is significant asset. This research objective is to evaluate the readiness of Malaysian SME to adopt CMMI with consideration of agile methods and principles. **Methods/Statistical Analysis:** A survey was conducted with random 40 respondents of the company's employees like developers, quality engineers and managers and it was a cross sectional survey because the data was gathered in a period of time in order to achieve the objectives. The data was analyzed using statistical analysis technics like bar graph and pie chart. **Findings:** Based on the survey results, the company is not ready to adopt CMMI officially because the results show that most of the employees agreed on the need to adopt more agile methods and to exercise more agile principles in the company. additionally, the results show that some CMMI practices like establish estimates of work product, task attribute, and plan for project resources were used effectively. On the hand, some essential CMMI practices like identifying configuration items, establishing a configuration management system, and creating baselines were not used sufficiently besides some other CMMI practices like controlling configuration items were exercised very badly. **Application/Improvements:** In interests of enhancing the succeed of SPI initiatives based on CMMI for any SMEs, this study suggests SMEs to check their readiness first.

Keywords: Agile, CMMI, Malaysia, Readiness, SPI, SMEs

1. Introduction

In Malaysia, among different industries, the software development industry is viewed as the most profitable, stable and rapidly growing. The most noticeable characteristic of this industry is, it is mostly formed by Small andMedium Enterprises (SMEs). Therefore, this industry in Malaysia is still facing problems related to maturity, productivity and quality as compared to the software development industry in United States and European Union countries, which is generally formed by large scale enterprises¹.

In fact, the process of designing and developing a software is complicated and challenging. It entails a pro-

*Author for correspondence

cedure where products experience unmet requirements and deals with expected software quality failure. Even the products function normally, but there remainissues related with the design, development and support. There are also problems associated to the development process which has to produce and carry forward the number of software products and also to handle with growing demand for quality software².

It is clear that a software development enterprise's success depends on a continuous process of improvement. It progresses from the rigorous traditional software models, processes and methodologies to more mature and agile software processes and models. There are different kinds of Software Process Improvement (SPI) models such as ISO 9000, Six Sigma and Personal Software Process (PSP). On the other hand, adoption of the Capability Maturity Model Integration (CMMI) model by SMEs is a kind of challenge because of the high cost of expenses, the time constraint and the resource limitation, which clearly increase the possibility of failure. Usually, it takes 54.50 months to reach the highest level of the CMMI which is level 5^{1} .

The international software market is more open to developing countries. It is, giving the SMEs an opportunity to take the advantage of increasingly competitive conditions³. Therefore, the SMEs must implement and demonstrate worldwide SPI practices, such as CMMI, so that these may benefit from the given opportunity and compete with local and global competitors³. However, taking the decision to implement the CMMI in their SMEs without proper preparation could cause loss of money, reputation in the market, customers and the trust of staff members.

In light of the above-mentioned challenges and issues to SMEs, this research aims to evaluate the readiness of a SME in Malaysia in adopting the CMMI (Key Process Areas) KPA model in their day to day businesses. In this regard, it will investigate the agile methods and practices used by the company. Based on the findings of the research, recommendations will be given to the company for improving its software development process.

In Malaysia, SMEs companies areleading the software development industry. By 2008, globally more than 85 % of the software development companies in USA, Ireland, India and China were SMEs⁴. In order to improve software development companies' products and increase their development processes, productivity SPI was recommended as the most effective and efficient way⁵. One of the well-known SPI models and methodologies is the CMMI. SW-CMM V2.0, Integrated Product Development (IPD), and SSE-CMM models were blending by Software Engineering Institute (SEI) to create the CMMI; which can guide an enterprise for improving the development process. The CMMI has five levels of maturity for the software development process that includes initial, repeatable, defined, qualitatively managed and optimized².

Across the world, SMEs have been operating and managing their businesses. However, in each country, SMEs have their own definitions and standards of operating and managing their businesses. The European Commission (EC) has created following four yardsticks and criterions to define the SMEs¹:

- The number of employees in the enterprise
- The annual volume of turnover
- The total of assets in the enterprise balance
- The degree of independence of the enterprise or the ownership over it.

Despite the fact that SMEs is defined different from one place to another, however, SMEs still share some common characteristics. SMEs economic resources are limited or scarce: SPI is often an expensive procedure that normally yields profits after a significant amount of time has passed, in small firms this alone might be a major reason to not involve with SPI initiatives⁶. In addition, categorized their problems as shown in Table 1.

Table 1. SPI initiatives problems¹

| Category | Problem | | |
|-------------------------|---|--|--|
| Organization | It has a flat organizational structure. | | |
| Financial Resources | It has limited resources, because they do not have sufficient economic capital to invest in SPI. | | |
| Human Resources | Lack of personnel because their employees number tend to be limited. | | |
| | There are no roles defined, for this reason the employees perform multiple tasks. | | |
| | The employees have a lack of knowledge related to SPI. | | |
| | Lack of communication among the employees. | | |
| Processes | They do not have defined processes then, the software is developing as a craft. | | |
| | It is very expensive for SMEs to implement SPI initiatives and producing results quickly. | | |
| Projects | Work with very small size projects so the projects are developed in fast time. | | |
| | Implementing a process takes much time. | | |
| Models and Standards | They do not use any model and/or standard. | | |
| | They do not have experience in the adoption of a SPI model/standard. | | |
| | It is very difficult to adopt a SPI Model and/or Standards to achieve the SME's goals and vision. | | |

The CMMI can help the management to make right or appropriate forecasts of the business by supporting effective management and predictable schedules, which give value to the stockholders. The CMMI gives much attention to on job training process and disciplines. It also focuses on recruiting skilled and motivated human resource for a quality work. Moreover, it concentrates on planning, measuring, monitoring and predictability to help the enterprise to meet the cost, produce high quality products and meet schedule targets for the customers' satisfaction. The CMMI takes measurement practice as a managerial tool to choose the best practices that will save the cost of developing software; Also, various SMEs seek the defined maturity rating of their products through the CMMI. These want excellent service recognition in the software development industry^z.

There are several advantages for the SMEs if they implement ${\rm SPI}^{6}{:}$

- Increases productivity and the produced software quality.
- Accomplishes fast quantifiable output in project.
- Improves can be done in multiple cycles.
- Makes SME more effective.
- Addresses SMEs goals and vision.
- Develops motivation to get better results.
- Trains to improve their processing skills.
- Processes the documentation.
- Involves everyone in the SMEs.
- Assigns trained SPI staff to help the work in the implementation of SPI.

SMEs usually targets the highest level of CMMI. The CMMI is a model that can be used as guidance by the organizations in improving the process for their projects, divisions, or for the entire organization. In the CMMI, levels are used to describe the revolutionary path to improve the processes. Capability levels and maturity levels are two types of levels; these two can improve the processes and help to achieve business objectives. Though both have many of the same components and configurations, the differences in processing improvements are also significant⁸. Capability levels are used to determine an organization's process of improvement related to individual process areas, whereas maturity levels are applied to characterize the organizational improvements across multiple process areas. Each of these types of levels can improve an organization's processes but it entirely depends on organization's objectives.

In software CMM, staged representation approach is used to define improvement paths in advance for an orga-

nization. It is based on established clustering and ordering of processes and associated organizational relationships. In order to determine the improvements, the company has made in its processes, and to identify the areas which can be further improved, an evaluation can be conducted. The CMMI can be appraised through earning a maturity level rating (1-5), or achieving one of four-capability levels. The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) introduces a set of appraisal methods to perform appraisal using the CMMI models. The SCAMPI appraisal planning process is carried out in compliance to the Software Engineering Institute (SEI) Methodology. It helps to get insight into an organization's capability by identifying the weaknesses and strengths in carrying out and continuing with the current practices and processes, and it also determines ratings. Moreover, it discovers the possible business risks that stem from efforts to achieve capability or maturity ratings⁸. Agile and iterative software development lifecycle are two models and processes which enablethe developer to revisit the phases of a cycle or stagegs of a process over and over. The characteristics and principles of agile indicate that appropriate management for the SPI processes is required for companies that become agile; agile methods are usually adopted in SMEs because small initial investment is required to apply agile processes, thus it can speed up⁴.

There are given several reasons for not adopting the CMMI in companies. The most common reasons are, the CMMI models are costly, these do not provide clear idea about benefits to companies and companieshave other priorities than the CMMI. As it is mentioned earlier, it is expensive to implement SPI in companies; Companies need resources like money, time and expertise (skilled people). However, the size of companies is viewed as a constraint for companies to implement the CMMI as their SPI. For a small company- with less than 50 employees-, is not difficult to implement the CMMI model than a big company with thousands of employees. Considering this reason, it is make the position of SMEs become infeasibility to implement CMMI inside their company².

For SMEs, it is a difficult to make a decision for the implementation of the CMMI model because feeling offailure to implement it. In this case, it would cause a serious loss money, reputation customers and trust of staff members. Therefore, it is suggested that SME companies must check their readiness by inspecting how agile are their companies and are their software development practices able to meet with the CMMI level KPAs practices. If the company is ready and has resources, the management can decide to implement CMMI. It also can just find or develop an alternative SPI framework which could be more suitable for the company.

2. Research Methodology

Keeping in view objectives of this research, positivism paradigm was chosen because it involves the scientific discovery and the scientific methodology, and it relies on facts and data¹⁰. This research started with review of the relevant books, chapters in books, research articles in journals, research theses, conference papers, and general reports available on the websites. In light of research gaps, research objectives were created. In order to collect data for this research, a survey method was chosen. For a deductive approach, survey method is suitable¹¹.

An online survey was created at google survey service. The survey was designed considering the aspects of this research. The survey was divided into three sets of questions; the first set of questions was about personal information which aimed to understand the respondents' experience. There were total sevenquestions in this set. The second set of questions aimed to determine the agility of the company and the respondents by finding out the most used methods and practices of agile in the company and this set had 9 questions. The third set of questions was related to the respondents' opinion about how well some software practices were used in the company with consideration of the CMMI KPAs. In total, 14 questions were in the third set in which the researcher has used a matrix of the CMMI KPAs and 5 opinion scales between very poor to very good. In total 30 questions were framed. A web link of the survey was sent to 40 staff members of the company. They allfilled in the questionnaire online. The summary of the survey was analyzed with statistical methods like bar charts to achieve its purpose.

3. Analysis

This analysis is based on the responses of 40 respondents from the company. Following is the analysis of the data gathered through the survey.

3.1 Respondents' Expertise in Agile Methods

Figure 1 shows that only 3 respondents (7.5 percent) had not experience and knowledge about agile practices and methods. Overall, the data shows that most of the respondents knew about the agile methods and practices of the total 40 respondents, only 3 respondents (7.5 percent) were expert in agile practice and methods; 14 (35 percent)

8- How expert are you relevant agile?



| No agile experience | 3 | 7.5% |
|---------------------|----|------|
| Beginner | 14 | 35% |
| Medium | 20 | 50% |
| Expert | 3 | 7.5% |

Figure 1. How experts you are about agile methods and practices.







| Strongly disagree: 1 | 0 | 0% |
|----------------------|----|-------|
| 2 | 1 | 2.5% |
| 3 | 6 | 15% |
| 4 | 21 | 52.5% |
| Strongly agree: 5 | 12 | 30% |

10- Which Agile method you mostly used?



Figure 3. Which agile method you mostly used.



Establish estimates of work product and task attributes [18- Establish estimates]



respondents are beginners and 20 (50 percent) respondents had medium level knowledge.

3.2 Should Company Adopt Agile Methods

Figure 2 indicates that most of the respondents agreed that their company should adopt agile methods and practices. No respondent said that he strongly disagreed that the company should adopt agile methods and practices; 1 respondent simply disagreed; 6 respondents (15 percent) selected the option of neutral; 21 respondents (52 percent) simply agreed; and 12 respondents (30 percent) strongly agreed.

3.3 Types of Agile Methods

Figure 3 reveals about the types of agile methods used by the respondents. RAD and SCRUM are the two agile methods mostly used. 11 respondents were using SCRUM and 17 respondents, RAD. While, there was only 1 respondent who used Unified Process and 1 Lean; 2 respondents used agile modelling; and 3 respondents applied Extreme Programming (XP). Following methods were not used by any of the respondents in the company and also had no experience of these: Kanban, Feature Driven Development, Crystal Clear and Team Software Process.

3.4 Approach in Establishing Estimates

Figure 4 is about respondents' approach in establishing estimates of work product and tasks attributed to specific practices. Of the 40 respondents 16 respondents (40 percent) believed that the practice of establishing estimates of work product and tasks attributed in the company was good whereas 7 respondents (17.5 percent) believed that the practice in the company was poor. However, there were 37.5 percent (15) respondents who thought that the establish estimates of work product and task attribute practice in the company was neutral a process. 1 respondent indicated that the practice in the company was very poor and 1 respondent believed that the practice in the company was very good.

3.5 Plan for Project Resources

The respondents were asked about the state of company's plan for project resource. Figure 5 shows that 18 respon-



Plan for project resources [19- Develop a project Plan]

Figure 5. Plan for project resources.



Manage corrective action [22- Manage corrective action to closure]

Figure 6. Manage corrective action.

dents (45 percent) believed that the plan for project resources practice in the company was good as compared to only 2 respondents (5 percent) respondents believed that practice in the company was poor. There were 16 respondents (40 percent) who believed that the plan for project resources practice in the company has natural process. Whereas 3 respondents thought that the practice was very good and only 1 respondent considered it very poor.

3.6 Managing Corrective Action

In Figure 6, respondents' reactions about the management of corrective actions are given. Of the total 40 respondents, 14 respondents (35 percent) believed that the managing corrective action practice in the company was good as compared to only 8 (20 percent) respondents who believed that the practice in the company was poor. However, 15 (37.5 percent) respondents were neutral about the managing corrective action practice within the company. They took the middle way. 1 respondents said that the practice was very poor and 2 respondents believed that practice was very good in the company.

3.7 Review Requirements

Of the total 40 respondents, 17 (42 percent) were neutral and did not offer views about the company's review requirement. However, the majority (17 respondents, 38 percent) believed that the company had poor review requirements including 2 respondents who emphasized on very poor review requirements. 4 respondents (10 percent) believed that the practice was good, and 2 respondents said that the practice was very good in the company as shown in Figure 7.

4. Results and Discussion

The survey shows interesting results and analysis of the company's readiness to adopt the CMMI model (methods and practices). The most important finding was, majority of the employees agreed that the company needed to be more agile. Whereasthere were mentioned some important agile methodologies like Kanban, feature driven development, crystal clear and team software process, hadnever been used in data analysis. Only 7.5 percent of



Review requirements by QA team [17- Requirements management]



the employees were expert of/on agile methods, tools and practices. Additionally, most of the agile tools, techniques and practices were hardly used. Most importantly, modeling notations like use case diagram and class diagram were not used at all by the company. This shows that the company was not utilizing or applying software engineering practices and agility methods.

More than 70 percentof the respondents were working for the company for less than 2 years and 85 percent of the respondents were below 40 years of age. These findings raise questions on the company's (its staff members) expertise and its experience in software engineering. It was also reported that there was high turnover, that is why, staff had a few years of experience of company's agile methods and practices. The quality of the company's management and its success to apply the Total Quality Management are the factors to evaluate the readiness of adopting the CMMI levels. One more factor is the change resistance. It is a serious issue and most of the companies face it. It is problematic when there is new model to be adopted and there is no transparent and open communication between the management and the staff members (workers).

In the survey, it was revealed that some practices like establish estimates of work product, task attribute, and plan for project resources were used effectively but surprisingly some fundamental practices were not used adequately.

It also shows that reviewing requirements by quality assurance team and establishing software quality assurance plan were done inadequately. In addition, some practices regarding baselines like identifying configuration items, establishing a configuration management system and creating or release baselines were not used properly. Moreover, respondents had negative feedback about controlling configuration items, tracking change requests and controlling configuration items which are important track and control changes practices.

The findings indicate that the company was not ready to adopt the CMMI. Therefore, the company's management is advised to do some changes and improvements so that it could be ready to adopt the CMMI model.

There are two main recommendations for the company. First, the company should improve its agility by adopting the missing agile methods like kanban, feature driven development, crystal clear and team software process. These methods can increase the productivity of software development processes. The company should pay more attention on the use of modeling notations and CASE tools as it's suggested on the third step of SPI "selection and justification of process elements, software engineering methods and tools²".

Second, the company management should implementTQM and create positive work environment by adopting a transparent and open communication with employees. It should also involve them in positive activities and provide them appropriate trainings with focus in continuous development, recognizing their hard work, and giving them motivation to build teamwork and spirit. Additionally, the company can develop reliable statistical methods for measuring improvement since TQM is a continuous culture to improve products and services. Besides, it should encourage changes through the employees by explaining the advantages and benefits for the company and the employees

5. Conclusion and Future Work

In order to address to evaluate the readiness of a Malaysian SME to adopt CMMI certificates a survey was

carried out. In this readiness the research attempted to check the agility of the company and employees' opinion about how well some software practices were being used in the company. The data was collected and analyzed with the help of a statistical data analysis method. The results clearly show that the company is not ready to adopt the CMMI practices and methods; however, the relevant and specific recommendations were given so that the company improve its software development process.

Since the company is not ready to adopt CMMI practices and methods, any attempt to do so would possibly result in a failure or loss of business. Therefore, the company should look an alternative way to improve its software development process. The company can develop integrated framework for reforming its operations by mapping suitable agile methods, techniques, tools and practices with the equivalent CMMI practices, in addition to consider the organizational and managerial changes. The new integrated framework should help the company to control and improve its software development process as a main remedy to the issues related to budget, scheduling and non-conformity to the requirements. Each process area of the integrated framework should be unambiguously explained in the company with suitable agile methods that offer the necessary elements for that process. The future steps are to design, build and evaluate the integrated framework to demonstrate the implications based on practical application of the approach. Once the framework is evaluated detail analysis of components will be performed to get rich insight of associated implications.

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