A Proposed Framework for Enhancing Capability Maturity Model Integration implementation in Small and Medium Enterprises in Egypt

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ABSTRACT

Software industry is an important economic activity in industrial countries. Nowadays, the investment in this field is measured in millions of dollars. The Egyptian government has paid special attention for software industry in Egypt via providing it with a competitive advantage which makes this emerging industry promising.

For many years, researchers have developed several Software Process Improvement (SPI) models which are developed to fulfill the needs of large organizations, but they do not take the needs of small and medium-size enterprises (SMEs) into consideration. SPI is a crucial task in SME due to scarce resources, small development teams, too costly services, and heavy workload. The paper works on SME to institutionalize process improvement practices, which aligns with Capability Maturity Model Integration (CMMI) as one of SPI models.

This paper highlights and investigates, in detail, the problems and weaknesses that appear during CMMI implementation based on the current situation and characteristics of SME's in Egypt. In addition, it introduces a proposed conceptual framework which presents success factors about how small enterprises can more successfully manage SPI. The framework is suitable for SMEs to implement CMMI with better results in software projects, product quality, and customer satisfaction in order to put an end to the project overruns and failures. These factors will raise the level of Software industry in Egypt and will form their own core competing power. Consequently, it can participate in international competition.

Keywords— Software Process Improvement; Small and Medium-sized Enterprise; CMMI.

I. Introduction

A software development process comprises a group of people, organization structures, rules, politics, activities, software components, methodologies and tools used or created specifically to conceptualize, develop, serve, innovate or extend a software product. [1] Building on a decade of work with process improvement models, Capability Maturity Model Integration (CMMI) is a framework for assessing and improving the quality of the software development processes of an organization. Designed originally for U.S. Department of Defense software contractors, CMMI has become a widely accepted model and standard for software development organizations worldwide. [2] CMMI provides standard process disciplines for a company to smoothly achieve its business goals which represents a "common sense engineering" to software process improvement (SPI) with its maturity levels, key practices and goals. [3]

CMMI has been widely promoted and applied in enterprises around the world and have achieved great success, especially in China's and India's software development industries. In 2005 there were 150 CMMI firms appraised at level 5, the highest level, in the world. Interestingly, 75% of these CMMI level 5 firms are from India, which have a great position of exporting their local Information Technology services. [2,3]

Although it is true that CMMI was not explicitly built for small companies, it is also true that it was not explicitly built for large companies. So, we must ask: Is it feasible to implement CMMI in SMEs environment? , and how will CMMI need to be adapted, developed and packaged to address for SMEs effectively? [4] Judging from past experience, the answer is yes. Figure 1 shows the SEI (Software Engineering Institute, Carnegie Mellon University) statistical assessment of scales of global enterprises that have obtained CMMI certifications. [5]

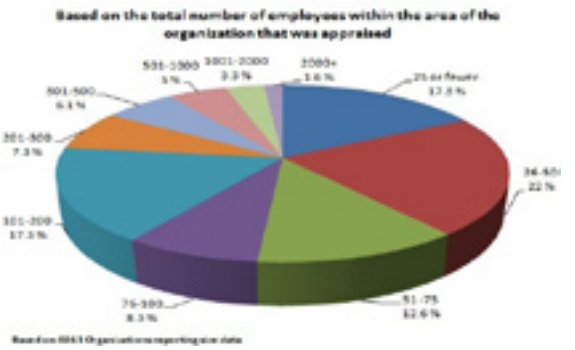


Figure (1): Scale Analysis of Global Enterprises having CMMI SCAMPI appraisal results on September 2010.

As shown in (Figure 1) enterprises with less than 200 persons which have obtained CMMI Level 2 certification in the world are 77.5% which are considered to be small and medium-sized enterprises. That is to say, more than half of the enterprises which implement CMMI belong to small and medium-sized enterprises. [5] CMMI can be a way for SMEs to gain better projects and customers, by demonstrating their competency in process management while preserving their agility and flexibility. [6]

The aim of this paper is to introduce a conceptual framework for SME's to overcome the constraints and to increase the applicability of CMMI in developing a detailed software process for small organizations. This paper is divided into four sections. First, we begin to study why SME's resort to improve their process via a questionnaire introduced to 5 Software SME's in Egypt. Next, we illustrate CMMI implementation Process. Then, we focus on the Problems that face SME's during CMMI implementation. Finally, the paper introduces the framework that will help SME's to implement CMMI with great benefits and success.

I. Key Challenges in SPI for Small and Medium Enterprises

Software engineering is not only done for large organizations like Microsoft, Nokia or Siemens, that belong to the world's largest Software development organizations. Small and Medium software organizations are very important to the economic growth of many countries and constitute the majority of software

organizations around the world. [7,8]

SMEs everywhere play very important cog in world economy, especially in developing countries. It represents up to 85 % of all software organizations all over the world. However, to persist and grow, small software companies need efficient and effective software engineering solutions. [9] According to the Arab Human Development Report, 90% of the Arab economy depends on small and medium-size enterprises (SMEs). [6] The development of SMEs is thus a priority for any government that would like to ensure its economic development. [10]

SMEs have been considered, by scholars, to have an important role in economic growth. The characteristics of these small-sized enterprises are as follows: Firstly, small-scale, creative, and flexible, [11] which preserve their flexibility when they need to make changes in their processes. [12] Secondly, SMEs are more customer-driven and their main goal is to respond to customer requirements quickly. [13] Thirdly, Intrapersonal communication is very strong and open in SMEs and it's easy to communicate between staff members. [11,12] Most persons are called all-rounder, most of them are technology developers who give some attention to management, but there is shortage in experienced and specialized management staff members. [11]

Currently, no single universal definition of SMEs, researchers consider small organizations is defined as (<100 employees) and medium-sized (100-200 employees) company might find hard to justify. A study commissioned in 2010 for the Egyptian Software Industry showed that more than 90% of the around software firms in the country are small to medium enterprises (SMEs) with less than 100 staff.

Range of enterprise scales	Number of employees	Proportion
1	1001–	0.8 %
2	501 – 1000	1 %
3	301 – 500	1.5 %
4	101 – 300	5.8 %
5	81 – 100	2 %
6	61 - 80	5.7 %
7	41 – 60	11.8 %
8	21 – 40	27.6 %
9	– 20	43.8 %

Table (1): Scale analysis of software enterprises in Egypt [14]

SMEs in Egypt, as is the case with many countries, generally use simple traditional technologies, cater for their local vicinity, and mainly produce low quality products through inefficient and poorly managed simple operations. The vast majority of these enterprises suffer from constraints that threaten their growth. [15]

Many Egyptian SMEs compete with big organizations for project from prospective clients. [16] Our study conducted a survey to know the software process level and the major challenges which faced software small and medium-sized enterprises in Egypt .The data for the survey was collected from 5 Software SME's in Egypt, via sending emails and interviews directly with the company's managing directors, project managers and senior software development professionals. The major Challenges that are common in small organizations are summarized as follows:

1. Lack of process assessment or process improvement activities that are carried out in big organizations, which not only help to improve the project standard but also help to minimize the time, labor and fiscal budget of the project. [16]

2. Working with tight budgets and resources, which makes the deliverables, depends on the heroic efforts of a few people. [17]

3. Late delivery and Low Productivity, cause a lot of customer complaints, and too much rework.

4. Company managers define the knowledge transfer as the 'master-apprentice' method. However, their response time for a change request is long and sometimes the level of quality of services is poor. [17]

5. The employee may play multiple roles in the company, for example a programmer might play the role of a technical architect, developer and tester simultaneously. [16]

6. Heavy reliance on engineers rather than processes. [17]

7. Generally negative process attitude. For the that most persons pay attention to the function of products rather than quality and maintenance. [4]

8. Poor management and non-standard development, most enterprises lack standard of management. [11,17]

9. The degree of documentation is not enough, no peer reviews and no formal process management. [17]

10. Each project has been developed by a single professional. Thus, the success of the project totally depends on the performance, knowledge and capability of that person. Additional enhancements and modifications based on customer requests should also be implemented by the same person. This brings total dependency on a single professional and an increase in the workload of developers. [17]

11. High training costs and insufficient training especially for new employee. [16]

12. Do not measure the effort, defects, code quality and schedule. So, they do not have any knowledge about the reliability of their final product. [17]

Table (2): Company Objectives in line with SPI [17]

Management objectives	Goals of SPI
Standardization of software processes	Definition of organizational policies, procedures and templates
Efficient resource allocation, predictable project cost and schedule	Implementation of software processes
Gradual integration of common Methodologies	Process improvement with CMMI guidelines
Cost reduction	Decrease testing effort, Defects Rate
Conflict resolution with Customers	Requirements management, documentation, reducing defects
Reduce training effort	Documentation of processes
Reduce response times to customer requests	Requirements and change management

As a result of these problems which prevent the companies to grow into new markets and expand their business, software quality management might be a challenge for software firms in Egypt. The challenge for software development enterprises is to find a path to apply SPI technologies to realize their company's improvement goals. [16] CMMI should be seen as an opportunity to enhance the management level of Egyptian small and medium-sized software development enterprises which became a problem that needs to be solved urgently.

It is urgent for SMEs, to develop their operations so as to become up to international standards. [10] Therefore, they have decided to start a process improvement project to produce reliable software products. We have defined the goals of Software Process Improvement (SPI) program and matched it with the company's management objectives as summarized in Table 2.

I. CMMI implementation Process

Companies would like to control and manage their complex development lifecycles and, hence, they take measures to institutionalize their process improvement practices. [18] CMMI model is developed to provide an organization with guidance for improving organizational processes and capabilities of manage development, acquisition, and maintenance of products or services. [19] CMMI has been an effective process improvement model for not only big companies, but also small and medium size enterprises (SMEs). [17] CMMI incorporated those proven methods into a framework to help organization evaluate its maturity level (ML) or process area capability level (CL), in order to set priorities for process improvement, and then to perform these improvement activities.

The first step toward institutionalization of CMMI is to establish how it will be implemented in an enterprise. The enterprise should make awareness sessions, Kickoff meetings and formal training for the employees to increase their awareness and their motivation of the importance of CMMI implementation.

CMMI framework contains "Staged Representation" and "Continuous Representation"; the former emphasizes the concept of organizational "maturity level" and the latter emphasizes the concept of organizational "capability level" to perform a specific process, a company can choose one according to its requirement. [19] CMMI allows each enterprise to select the model representation that best suits their own different business objectives and development strategies. So, the enterprise should choose which model it wishes to follow, to make sure that Process Improvement goals directly support the business. [3,20]

Gap analysis is used to measure the distance between the organization's current status and the standard procedure defined by CMMI. Through the self-evaluation based on gap analysis, the project development team first discusses problems and makes process improvement suggestions, which are then submitted to the Software Engineering Process Group (SEPG). In accordance with CMMI requirements the SEPG will subsequently formulate CMMI implementation strategies, analyze and classify processes of each department, and finally establish organization-specific processes and documentations. [19]

Using the feedback obtained during the evaluation process, organizations can get more understanding about their current maturity levels, and further improve their processes, as the basis to attain a higher CMMI level. An organization wishing to be appraised for its CMMI maturity level must use the Standard CMMI Appraisal Method for Process Improvement (SCAMPI). Assessment determines the maturity of an organization's processes and serves as baseline for a process improvement program. An appraisal is led by an experienced SEI-Authorized Lead Assessor. Using a SCAMPI assessment model helps organizations to benchmark their process capability or organizational maturity by identifying strengths and weaknesses of their current processes towards the processes and practices of the CMMI. [21,22]

There are 3 types of SCAMPI assessment, SCAMPI Class A appraisals are the "official" appraisals, done by SEI-authorized lead appraisers. The other two classes, SCAMPI B and C, are scaled-down assessments, which are usually used as less expensive "pre-appraisals" for determining the feasibility of (or the probability of a successful) SCAMPI A. [2,20]

Systematic field studies have been performed and reported by the SEI, which has achievements from applying CMMI in software enterprises. The results are summarized by the six performance categories: cost, schedule, productivity, quality, customer satisfaction and return on investment. Most of the organizations have provided multiple results, sometimes several in the same performance category.

II. CMMI implementation problems in SMEs

Although CMMI is a framework developed and maintained by the Software Engineering Institute (SEI) of Carnegie Mellon University for improving and appraising the quality of the processes of a software organization, it is difficult to be implemented as many of the smaller companies oppose the CMMI model due to the fact that the implementation of mature methods is hard, requiring highly trained and experienced people. [1,20]

This section sheds light on some key constraints hindering implementing process improvement according to CMMI model in small and medium-sized enterprises in Egypt; the common problems are as follows:

Firstly, CMMI is considered too large by SMEs; [4] the purpose of implementing CMMI is to have an organic integration with the business objectives, which is easy to cause the problem during the process of implementation and it is difficult to see the effect. [4] In addition, there are some common misconceptions in the industry about process. It is assumed that a process interferes with creativity, creates bureaucracy, is useful only for large projects and implementing a process costs high. [16]

We have discussed the necessity of improving the process of implementation as well as the advantages of CMMI, which are absolutely right, and we have already had a good understanding of them. However, in the implementation of CMMI, the frequently encountered problems are: Hard to select, deploy efficiently/ effectively new technologies [4] and the enterprises have invested a lot of energy and resources but the effect appearing after the implementation is not as satisfying as expected and do not reflect the business objectives. [11]

Secondly, Although CMMI represents advanced scientific management thoughts; it still embodies the culture of western countries. [20] Therefore, it may have conflicts with the culture of Egyptian software enterprises and with some of our business operations, such as the development of some projects, which affects the

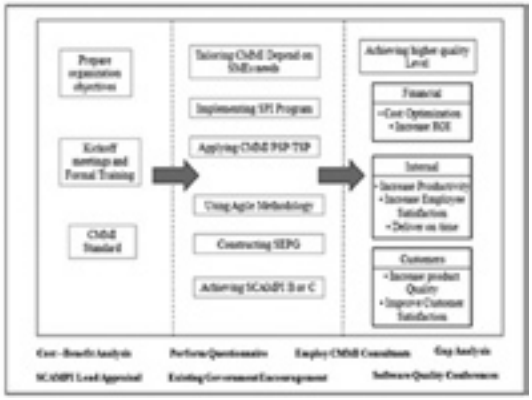
current implementation of some projects. [11,20]

Thirdly, the threshold of CMMI [20] and the investment cost overruns and resource acquisition is too high. The same is true from the CMMI implementation situation in Egyptian enterprises. [11] Most SMEs are still at the initial level, so it is hard for them to consider all-around things of CMMI during the process of software developing. [20] So, when we follow the CMMI model to implement process improvements, enterprises must invest significant resources, including money, manpower, software, hardware, the corresponding increase in workload and so on. This may lead to relatively large expropriation of resources or even go beyond the enterprise's budget.

Fourthly, Quality awareness is weak and there is a lack of specialized personnel responsible for quality in SMEs, few people have experience in software process improvement and related training. [11] Even if some of them know the basic concepts and techniques, they lack an implementation knowledge, infrastructure and resources to translate process framework into value added operational processes. [11,23] Staff is limited; So Large number of roles must be filled by a limited number of people. [4] In small-sized software enterprises, it is difficult to form a full-time team for process improvement. Quantitative data is limited. Small sized software enterprises usually do not collect data to measure the process and implementation, which is closely relative with their lack of well-defined processes and the inherent development patterns. [11]

The last one is that in the process of process improvement, Quantity of information that must be absorbed to properly interpret the model. [4] Enterprises invite consulting firms or consultants to carry out the implementation. Enterprises may depend overly on consultants and take their work as a necessity, which result in such a situation: an enterprise may have obtained CMMI certification and is in accordance with CMMI model to set up a standard system, but in actual implementation, the effect is rather poor.

III. CMMI Implementation Framework in SMEs



The previous section presented CMMI implementation problems. This section proposes a Framework for small and medium software enterprises in Egypt. The framework in Figure (2) has been constructed on the basis of the description of problems which faced SMEs during CMMI implementation.

Figure (2): A Conceptual Framework for enhancing CMMI implementation

The framework as shown is divided into 3 sections: the first section shows the initial steps for CMMI implementation, the second section introduces the suitable steps that will facilitate the implementation problems and the final section shows the benefits and the outcomes of CMMI implementation. The framework intended to help software development organizations to improve their software processes by following an evolutionary path from ad hoc, chaotic to mature, disciplined software processes. The Framework will be useful and practical for addressing SPI initiatives. The objective of this framework is to identify, address and remove the main constraints facing the SME in implementing CMMI to transform their current perspective into global IT scenario.

A. Tailoring CMMI depends on SMEs needs

CMMI principles were used primarily by large organizations. Because of these successful implementations, small organizations wanted to know how they could tailor the CMMI for use in their environments. [24] CMMI allows small organizations to realize the benefits of following a structured process which allows tailoring

and aligning the process according to their business objectives. [3] CMMI models, namely, staged and continuous, allowing an organization to pursue different improvement paths. [2]

The Continuous Representation of the CMMI Appraisals is measured against Goals and Practices for a Single Process Area, [6] which distributed among four categories (project management, process management, engineering, and support). It allows SMEs to focus on improvements that have the highest payoff for the company, via selecting from 1 to 25 Process Area (PA), read it and connect it to SMEs business issues, and see if it can find simple changes to their existing practices that would adhere to the model and give their more benefit than their current practice. The organization may choose which areas to focus on, as well as the degree of focus that fits their business objectives.

For example, In Egypt we have experienced technical team but there is a lack in management process level. While an organization at this level with talented and heroic developers can produce products that meet minimal customer requirements, these products would frequently exceed budget and schedule. [2] The organization in this case also requires a tailoring in the implementation of CMMI, just like the customization of software according to the business objectives, requirements, and the composition of organizational standard that is defined. Therefore, it is suitable to follow the continuous representation model. With this approach, an organization may select which process areas best fit their needs and concentrate on those areas only, instead of using staged model which focuses on specific process areas per level. SMEs that are not pressured to implement CMMI fast, should take one Process Area per month and read it, connect it to their business issues, and see if they can find simple changes to their existing practices that would adhere to the model and give more benefit than their current practice

As a result, for Egyptian enterprises it should choose the Engineering category which includes 6 process areas: (Requirements Management, Requirements Development, Technical Solution, Product Integration, Verification and Validation), that is consistent with the traditional waterfall model of software development requirements definition, analysis, design, coding, integration, and testing. In this case the enterprise will establish a suitable platform to achieve Process Improvement goals which directly support the business goals. [2,3,11] So, CMMI is actually very flexible, which has been successfully applied in small organizations. And all organizations should no matter what the size is; it must realize that a significant investment in time, resources, and money must be made to be successful.

B. Existing Government encouragement for applying CMMI in SMEs

The development of Small and Medium Enterprises (SMEs) in Egypt is considered to be one of the most crucial components of the Government's social and economic development agenda for Egypt. [4] Software Engineering Competence Center (SECC), a governmental entity, has begun an SPI program for SMEs. The period of the program is 7 months. [25] The program, designed especially to support SMEs and to raise the quality of the software products with the purpose of qualifying them to participate in exporting their products and services, as well as become reliable partners while cooperating with international offshore enterprises and organizations for offshore development or even other local IT companies.

The model is based on SW-CMM/CMMI, IEEE and other related standards. The scope of the model is drawn from CMM/CMMI levels 2 and 3 and can be used in conjunction with the other Processes defined within the SPI Guide for SMEs. [26] The SPIG includes the instructions, procedures and detailed models for enhancing methods of operations and facilitating the software quality improvement procedure. The purpose of the program is to encourage SMEs to follow the operations of software development in order to raise their competence in a bid to acquire the CMMI.

Applying SPI program in SMEs by using the SPIG can help the software enterprises reduce the cost of CMMI implementation as it will be an initial step to start defining and implementing its process, to promote Software

Process Maturity in Egypt and to promote cooperation between Egypt Software industry and SEI with respect to Software Process Improvement (SPI) technology, and thus shortening SMEs journey towards CMMI appraisal.

C. Applying CMMI/PSP/TSP for SMEs

A frequent misconception about adopting CMMI is that it works only for large organizations. Its cost and complexity appear to make it impractical for smaller organizations to implement. Therefore, CMMI implementation complemented with the Personal Software Process (PSP) and The Team Software Process (TSP) might even be more beneficial to smaller businesses because it allows them to grow more and make it easier in implementation. [1]

Among the different processes defined to increment the personal productivity, PSP is a framework that consists of a set of methods, forms, scripts, measures, and standards that help software engineers to measure their personal work in terms of the following aspects: Planning, Design, Coding, Compilation and Testing. By using PSP concepts engineers can improve their estimating and planning skills, make commitments that they can meet, manage the quality of their work, and reduce the number of defects in their products. When engineers use the PSP, the recommended process goal is to produce zero-defect products on schedule and within planned costs. When used TSP, the PSP has been effective in helping engineers achieve these objectives. [1,24]

To improve organizational performance you must improve the performance of teams and team members. TSP is prescriptive, defining a whole product framework of customizable processes and an introduction strategy that includes building management sponsorship, training for managers and engineers, automated tool support, coaching, and mentoring. Projects using TSP are implementing most of the project management, engineering, support, and some process management process areas. TSP is an instantiation of an effective and high maturity process when adopted in small organizations.

To achieve significant improvements in the product quality and to reduce the schedule deviation of software systems in SMEs, It should be a supplementary relationship among CMMI/PSP/TSP and software process improvement in a small organization. PSP shows engineers how to address their tasks in a professional way. TSP shows managers how to guide and coach their software teams to consistently perform at their best. The software process frame should be the integration of CMMI/PSP/TSP, as shown in figure 3.

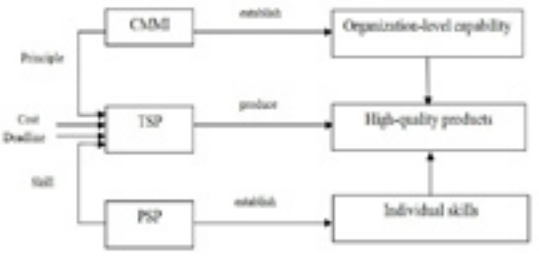


Figure (3): Software process frame in small organization [24]

CMMI, PSP, and TSP provide an integrated three dimensional framework for process improvement in a small organization. This Framework will help SMEs to establish an initial step and overcome the challenges faced during CMMI implementation.

A. Cost-benefit analysis of CMMI implementation

Each enterprise should make cost-benefit analysis of CMMI implementation, in order to be able to take the right decision for selection of numbers and quality. So, let's talk about the basic ideas of cost-benefit analysis.

Cost analysis: the main problem that still surfaces concerning CMMI and small organizations is cost. The costs of implementing CMMI in any organization are high. Costs include consulting and certification fees, training your own organization, assigning personnel at least on a part-time basis to perform process improvement work that is non billable to your client, and perhaps hiring external consultants for process improvement and appraisal assistance. [3] In addition, after the entire new

system of process improvement has been established and imported into the existing projects, developers need some time for adaptation. During the adaptation, their workload will be increased gradually, which is also included in the input of the human resources. This may have some impact on the time of current project, which, of course, cannot be measured in monetary terms, but should also be contained in the cost of inputs.

Benefit analysis: There are many benefits that an enterprise can gain from CMMI implementation. In 2004, SEI performed an investigation on 13 companies which implemented CMMI process improvement, and it was found that all of these companies gained improvements on all aspects of cost, scheduling, productivity, product quality, customer satisfaction and return of investment: As to the cost aspect, companies gained improvement between 5%- 83% of enhancement. As to the scheduling aspect, companies gained improvement between 15%-95% of enhancement. As to the productivity aspect, companies gained improvement between 11% - 60% of enhancement. As to the product aspect, companies gained improvement between 20% -72% of enhancement. As to the customer satisfaction aspect, companies gained improvement between 10% -55% of enhancement. As to the return of investment (ROI) aspect, companies gained improvement between 2-13 times, as the normal ROI quoted is usually 5 to 1, that is, for every dollar invested, five dollars are returned. [3,19]

Besides, a great benefit still exists, which is the big income. The implementation of CMMI can give enterprises some new business opportunities that increase the competitiveness of enterprises, enhance their ability in market development or increase their financing opportunities which actually should be a part of the benefits. [11]

B. Establish Software Quality Conferences to encourage CMMI implementation in SMEs

The Egyptian government has paid special attention to the software industry to provide it with a competitive advantage that makes this emerging industry promising. [10] Today, use of CMMI in Software industry in Egypt has been increasing to improve software processes. Since 2009, more than thirty software companies achieved CMMI accreditation levels, from Level 2 to Level 5. One of the problems that faces CMMI companies in Egypt is lack of conferences that enable specialists to meet to share their experience about software engineering processes. [23] Therefore, the Egyptian Ministry of Communications should contribute to make conferences for software enterprises in Egypt every year, in which the Egyptian enterprises which achieved CMMI in different levels, should display their achievements and their improvements factors on all aspects of cost, scheduling, productivity, product quality, customer satisfaction and return of investment. All these improvement aspects that the companies gained, will increase the awareness of the software enterprises specially SMEs and encourage them to work on improving their process via CMMI implementation.

C. Achieving SCAMPI B or C Appraisals

No doubt that, the greatest challenge that software SMEs face is the total cost of the appraisal, including not only the fees of SEI-authorized appraisers but also the time away from work for staff to be interviewed and for the internal appraisal team. CMMI process appraisal is to be executed by the SEI officials, according to SCAMPI to conduct with 3 classes: Class A (integrated appraisal), Class B (partial self-appraisal) and Class C (quick appraisal), and finally grant CMMI Official Certification of Appraisal to the Class A parties. [19]

The Egyptian government is aware of these challenges and financial constraints so it should introduce possible funding sources to implement a program that would partially subsidize SCAMPI A appraisals for selected software SMEs which applying successfully SCAMPI B or C. This support will raise productivity, products quality, competitive advantages for software enterprises, and the number of SMEs that certified CMMI in Egypt.

D. Implement Agile Methods and Quality

CMMI has been successfully adopted in many different types of organizations using many different de-

velopment approaches. However, there are complaints from the complexity of operations, there is an urgent need to review the operations approved by each company in the system to alleviate any burden carried by these processes. So, it is proposed that companies apply another Simple Process to speed the completion of work such as the Agile Model, and thus Subject all company projects whether has complex processes or simple operations, to the internal quality system according to the standards set by the companies to follow the appropriate processes. [2,3,23]

Agile methods, when used by competent developers, are nevertheless capable of rapidly yielding quality software through the use of such innovative, quality-oriented practices as short releases, test-driven development, pair programming, and refactoring. Short releases, like prototyping, enable users to more readily experience part of the software as early as possible, thus helping them to better understand and articulate their requirements. Test-driven development involves writing (automated) test cases before coding, and then coding on the basis of these. Pair programming involves two developers using one computer, with one partner (the "navigator") performing code review and planning of the code being written by the other partner, the one who has the keyboard and mouse (the "driver"). Refactoring involves changing the design or structure of code, usually after it has passed the test cases that had earlier been designed, without changing its behaviour. [2]

In our Framework we recommend that companies work on some ideas inspired by the Agile Models and trying to integrate them in their quality system which is compatible with the CMMI, especially as most companies are small and thus need flexible and simple processes.

I. Conclusion

CMMI has been well accepted by the world as a standard for project development, process control, quality improvement, and capacity evaluation. Egyptian small and medium-sized enterprises process improvement in accordance with CMMI standard which might play an important role in their development and success. More formally, a software process is a framework for the tasks that are required to build high quality software .This paper, according to the status and characteristics of Egyptian's small and medium enterprises has a detailed analysis on the problems that faced SMEs during their implementation of CMMI, so the paper proposed a framework which presents success factors about how small enterprises can more successfully manage SPI .This Framework suggested some alternatives to a formal (SCAMPI A) appraisal. These alternatives include the use of less formal (SCAMPI B and C) appraisals, the use of TSP/PSP, make conferences to encourage and increase awareness of CMMI implementation. We also suggested the use of agile methods such as XP, or agile practices such as small releases, test-driven development, pair programming, and refactoring, as an alternative way of increasing product quality while increasing a project's ability to respond to change. It would have a great significance for SMEs to enhance their results in software projects, product quality, and customer satisfaction in order to put an end to the project overruns and failures. CMMI enables performance improvement focused on business objectives, but the level of success depends on the implementation.

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