

Software Process Improvement Framework Based on CMMI Continuous Model Using QFD

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Abstract

In the rapid technological innovation and changes era, the key to the survival company is the continuous improvement of its process. In this paper, we introduce Software Process Improvement (SPI) and Quality Function Deployment (QFD); and for combining also the staged model and the continuous model in CMMI, the Software Process Improvement framework with CMMI has two parts: 1) Software Process Improvement framework with CMMI staged model based on QFD and 2) SPI framework for CMMI based on QFD continuous model. Finally, we also draw conclusions.

Keywords: *Software Process Improvement, CMMI, QFD*

1. Introduction

Software Process Improvement (SPI) is the modification of current software process methods in many software development organizations. Its aim is to improve the organization's ability to produce better software products (Humphrey, 1990)[1]. The Capability Maturity Model Integrated (CMMI) is a SPI models, which came from the Software Engineering Institute. But in the process of improvement, models and standards can not be used in business or other requirements in an company independently.

At present, many international models or standards are developed for Software Process Improvement (SPI). For example, these standards have ISO standard, CMM (Capability Maturity Model), CMMI (Capability Maturity Model Integrated). And CMMI is a SPI models from the Software Engineering Institute. With regard to process and quality improvement, these standards and models have a share in some common consideration. CMMI emphasizes continuous improvement, but the ISO standard emphasizes the minimum criteria with the quality system. It is unfairness to do a judgment with which one is much more better(Caulk, 1994) [2].

During process improvement, these models and standards cannot be applied independently in commerce and other departments in an section. However, in consideration of the more detailed guidance and bigger scope offered from CMMI, it may be a better choice for some software development organizations (Francois Coallier,1994) [3]. Philosophically, the CMMI is a specific implementation of Total Quality Management (TQM). Drawing upon the works of Deming(1986)[4], the CMMI is the framework by integrating systems and ameliorateing systems and software engineering systems. Process improvements have been shown to increase productivity, quality, and cycle times, and result in organizations more accurately predicting schedules and budgets. CMMI is intended to cover both product and service throughout their life cycle of development, deployment, and maintenance, as well as being extensible to incorporate new bodies of knowledge (Chrissis et al., 2003)[5]. The current four bodies of knowledge supported in the current CMMI, also referred to as disciplines, are systems engineering, software engineering, integrated product and process development, and supplier sourcing (Chrissis et al., 2003)[5].

On engineering improvement systems, look as all the other models and standards, CMMI addresses the question of "what to do it" by departing from "how to do it" to organizations system. Consequently, more measure is required to transform CMMI Practices to a series of activity which are more carefully that can be abided by software engineering improvement systems.

In this research , architecture was shapeed to assist directing business or some other procedure necessary condition in one Commercial enterprise to CMMI key element, and help shape action orientation to fulfil those necessary condition making use of Quality Function Deployment (QFD).

Quality Function Deployment (QFD) has been applied in the world in almost any business and department of precedence customer requirement from 1966. In order to

change the requirement into behaviour and project like technological property and standards. So can set up and transmit the quality merchandise and service through concentrating on accomplishing one identical target of one customer aspiration.

There are three original contributions in the proposed framework, all with the help of QFD. First, commerce and the other necessary condition in one institution or business should apply for target and behaviour in CMM. The link line is set up in order to make the mechanism can predict accurately how CMMI assistes in the mercantilism. Second, Business requirements and software system process necessary condition from different sources are assembled and optimized. Third, QFD is applied to assist change key elements of the company to machining actions by CMMI. Study shows that these observable recordes in the progress of the organizational process.

2. QUALITY FUNCTION DEVELOPMENT

When most of the quality models offer supervise for either the accomplishment of a much more better procedure or the evaluating of the nowadays proceeding, all of them have a share in only one common performance , and the models Scopes "what to do" , and not Scopes "how to do it" to personality corporation. It is satisfactory that have a method to conduct the corporation by a development with action projects in SPI. All of these activities should be on account of the software process necessary condition by correlation resources. Quality Function Deployment (QFD) is an suitable instrument in the convertting from customer requirement into goods. From software process requirements, it is available in providing the objective of originating from action proposes to SPI.

In the late 1960s, Quality Function Deployment was developed by Professor Shigeru Mizuno and Yoji Akao in Japan, and was recommended including the United States and European countries, and other countries of world, in the early 1980s. Setting up the sound from the customer is a method, not only spoken but also not spoken, with regard to one product. There are big difference in QFD and the other quality methodologies, and the most difference is Quality Function Deployment increases values about the product, by way of maximizing the product's positive quality, but the traditional product quality systems target to minimize negative quality about one product [6].At present, QFD has been practically applied to almost every commerce and industry, containing software process development [7][8].

The tools used in QFD are the Seven Management and Planning Tools, which are listed in table 1:

Table 1: Seven Management and Planning Tools

the Seven Management and Planning Tools
1, Relations Diagram
2, Matrix Diagram
3, Tree Diagram
4, Affinity Diagram
5, Activity Network
6, Process Decision Program Chart
7, Matrix Data Analysis Chart

The most significant measure in QFD is the House of Quality (Figure 1). The house of quality is one table which links between the Engineer's sound and the Customer's sound.

There are six large ingredients in The House of Quality:

1. Customer requirements (WHAT's).
Customer requirements is a formal structured summarizing of the necessary condition originates from the customer's declaration.
2. Technical correlation (Roof) matrix.
Technical correlation matrix can be made use of ensuring what technological necessary condition backing or prevent one another in the merchandise's design. It can emphasize reformation chances.
3. Technical requirements (HOW'S).
Technical requirements assemble a structured of concerned and quantifiable manufacture characteristics.
4. Interrelationship matrix.
Interrelationship matrix accounts for one team's of the QFD concept of correlation within customer and technology.

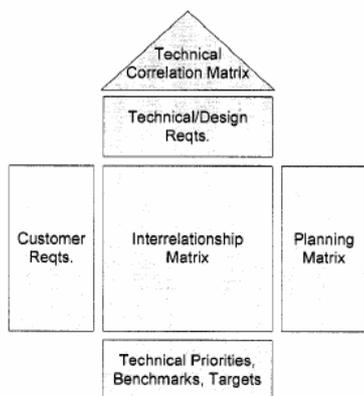


Fig. 1 House of Quality in QFD

What is demonstrated through making use of sign and diagram. How to heap the member in the matrix, includes researches and accordance of one team. Focusing on critical connection, and how to minimize the quantity of necessary condition are available skill to decrease the requirement from resources.

5. Planning matrix.

Planning matrix clarifies customer conceptions surveyed from marketplace. Consists of correlative significant customer necessary condition, corporation or contender representation when encounter these necessary condition.

6. Technical priorities, benchmarks and targets.

Technical priorities, benchmarks and targets are applied to take notes: The precedence specified to technological necessary condition through the matrix; Estimates of technological capability attained by rival products; The level of hard contained in expanding every necessary condition.

When Professors Akao and Mizuno presented the notion of QFD, this conception was predicated to contain two constituent part: 1) Product Focused QFD or Quality Deployment (QD), 2) Process Focused QFD or Narrow definition QFD [9] [10]. The first key element, like the name's suggestion, centers on raising the products quality through becoming customer necessary condition to product property. These have been comprehensively accepted by more and more enterprises and industries in the world. The second key element, centers on raising the quality of procedure, was contrived to confirm that constituent procedure and activity are in subordinated to established criterion, for example as ISO 9000, ISO14000, or Some other criterion. Like software corporations, these "narrow definition QFD" can assist them to heighten

software optimization procedure by the standards put forward clearly in criterion like ISO 9000, CMM, and so on. But these necessary conditions have been ignored by most of the QFD followings of the commerce, particularly in the scopes of software system development [11].

3 . SPI FRAMEWORK FOR CMMI CONTINUOUS MODEL BASED ON QFD

QFD is used to help SPI framework with CMMI, which is become more and more popular in the industry. First of all, enterprises and other organizations' demands are mapping to the CMMI process areas and practices. To establish a connection, so that how CMMI helps to do with its business objectives that can be seen clearly by organization. Second, software process requirements from multiples perspective priority, the requirement is more and more stronger affect other demand can get higher priority value. Third, QFD helps convert process of the organization into action through the process area (PAs) and practice in CMMI. Therefore, sorts of action taken is based on how they and two software process requirements and the corresponding practice in CMMI.

How is the framework designed? Always in the way that through the proposed framework plan of action, the process demand can be reflected. Using priority evaluation technique that is introduced in section 4.1, requirements from various angles are related to each other. So each requirement's priority value are adjustment from the influence of other needs assessment.

Two parts were contained by the SPI framework based on CMMI: 1) the CMMI staged model of SPI framework and 2) CMMI continuous model of SPI framework.

A. SPI framework for CMMI staged model using QFD

Figure 2 shows that the SPI framework for CMMI staged model.

For every four maturity levels, the group requirements are related to target. This goal is based on the process requirements priority. Therefore, if the higher target achieve, the higher importance was get by the overall satisfaction process requirements.

In order to achieve these goals, CMMI staged model has general practice which is divided into four common characteristics and specific practice corresponding "activity implementation" common feature in the CMM. The practice is preferred to their correlation and target.

Therefore, general practice in each common characteristics and specific practice based on prioritized target respectively. Practice aims to achieve higher overall satisfaction goal will get higher importance value. Different action plan is from the general practice in each common characteristics and specific practice. This action helps supporting the more important practical get the higher priority.

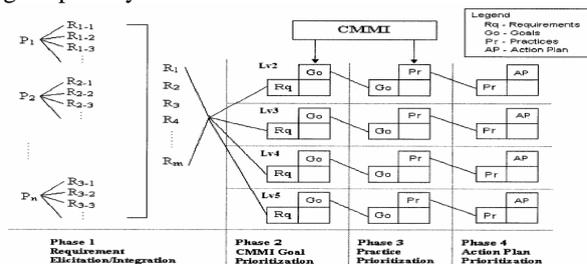


Fig. 2 Software Process Improvement through CMMI Staged Model Using QFD

Therefore, in the CMMI model, the actions follow the operation of the process maturity standard and meet the demand of the process. The higher importance value of the actions could help to achieve higher process demand satisfaction.

Because the CMMI staged model and CMM model are similarity in some extent, four stages of SPI framework based on CMMI staged model shown in figure 2.

In figure 2, the first stage is the identical SPI framework based on CMM. All sorts of views expressed as P1 to Pn. Each sort of view includes more than one need. In perspective 1, software process needs expressed as R1-1, R1-2, and so on. These views software process needs can priority integrated into a single set of requirements based on their relative importance within the organization. In figure 2, the integrated demand for R1 said by Rm, where m is the total number of software process requirements from all angles. Ensure that the priority of needs are comparable to each other from different angle, integrated reflects the needs of correlation from different angles. This phase of the deliverable is a set of priority and integrated software process demands, as input to the next stage.

The second stage to the fourth stage of the SPI framework is used to the CMMI model's part 2 to part 5. The priority and integrated demands from the first stage with all the goals in every four level in the CMMI model with relationship matrix stage. The first goal is used as a fundamental practice. Finally, the first practice transfer into first action plans by House of Quality (HoQ).

In the second stage, the target of all Pas in specific maturity level in "CMMI goal priority," which were chosen first based on demands of all the stage before. This stage can help to realize two important goals. First of all, the organization must follow CMMI standard. Of course, a specific maturity level must to achieve, this process is also meet business and the needed demands.

In phase 2, there is a connection between requirements of organization and goal in the CMMI, and in order to establish the connection, the relationship matrix is used to. The matrix proof that comply with the CMMI standards also helps to meet business and other needs of the organization. The second stage is that the last action plans which is based on priority needs to be priorities, so that if want to gain more resources, the more important action should to do. Priority target, the requirement from the organization can be transformed into practice in the third stage, the final action plan in the final stage. In this way, a group of perform behavior not only to achieve a specific maturity level in CMMI, also in order to meet the needs of the organization's process.

In the third stage, it illustrates "practice priority", including the priority of practice in a particular level of all PAs. All these practice must carry out in order to achieve a specific maturity levels because he CMMI specifications. These practice as a bridge between the demands, the final action, it is necessary to know the practice reflects the needs of the software process. In order to show the connection request and the action plan, which must give first priority to the practice on the basis of the goal of, now, this reflects the demand priority. Some CMMI document show that there is mapping between the target and the practice [12].

In the fourth stage, it illustrate the "action plan development and priority", a group of behavior from the priority practice. These actions should reflect demand integration in the first stage. At the same time, they also need to implement the state in order to achieve a specific CMMI maturity levels. These actions are guided by process improvement. Therefore, more resources should be allocated to these behaviors with high priority.

As shown in the figure above, through will demand from the organization for the action plan through the goal and practice relationships, organizational goals and CMMI maturity level becomes clear.

B. SPI framework for CMMI continuous model using QFD

There is great difference between the SPI framework for CMMI continuous model and other staged framework. However, the same technology related basic priority help QFD used to frame. In the continuous model of CMMI, ability level is assigned to individual disrespect. Different PAs can be on different ability level.

Every PA has two types of goals: the first one is general objectives and the second one is specific objectives. General objectives make the CMMI level institutionalized with a general objective for each level. Specific objective describe practice, which must achieve to meet the process area. The goals should make the general practice and specific practice satisfied. Figure 3 illustrates how to practice and act to distinguish priority SPI framework using QFD in continuous CMMI model. The process requirements are used in both PAs and practice. The first thing to do is to calculation of the priority value disrespect. Then practice is the first two process requirements and disrespect. It depends on the PA a practice is, priority value needs practice is multiplied by the PA priority. Finally, the action of the priority value is computed from practice priority value.

Therefore, as shown in figure 3, PAs are priority based on the process requirements and PAs, helping to achieve higher overall satisfaction process demanding higher importance.

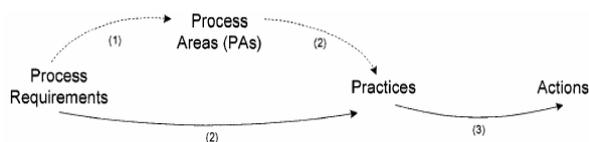


Fig. 3 Priority Calculation in SPI Framework Based on CMMI Continuous Model Using QFD

At the next part, in order to improve the PAs, the different ability level of generic and specific are prioritized. Different priority practice ability level depends on their correlation with the same set of process requirements. As is known that in CMMI continuous model, different PAs has different priority ability level so that the practice does individual PAs. Therefore, in the framework for the CMMI model, practice each level of personal assistant can priority respectively. Practice aims to achieve higher overall satisfaction's key objectives that will get higher importance value. Priority value each PA in the previous stage can be used to calculate the priority of the practice.

Therefore, the Pas, practice, and action reflect process requirements. Both of them follow the operating process capability standard in CMMI and meet the production requirements. The higher importance value to do that the higher process demand satisfaction could achieve.

In figure 4, the first stage is the identical with SPI framework based on CMM. All sorts of views were expressed as P1 to Pn. Each view includes more than one need. Software process needs in perspective 1 expressed as r1-1, r1-2, and so on. These views software process needs can priority based on their relative importance within the organization and integrated into a single set of requirements.

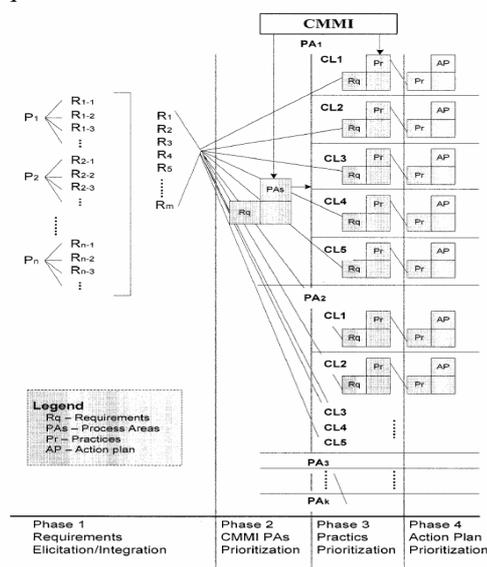


Fig. 4 Software Process Improvement through CMMI Continuous Model Using QFD

In Figure 4, these integrated demands are expressed as from R1 to Rm, where m is the total number of the software process from all angles. In order to ensure that the demands priority from different angles is comparable with each other, the integrated reflect demand correlation from different angles. This part deliverables are a group of priority and integrated software process demands, as input to the next stage.

Then the framework is applied to the Pas in CMMI continuous model from the second stage to the fourth stage. Because of in the CMMI continuous model, different ability level, suitable for different power PAs, the framework of the stage model cannot be applied. And from first stage to the second stage, mapping priority and comprehensive demands in a particular maturity, which are connected together in two stages and appraisal system

level, depends on the ability of target, the practice of connected together, in the third stages using relation matrix. Finally, using the House of Quality, the priority approach changed into priority action plans.

In the second stage, this is "CMMI PA prioritized," based on the demands priority from all the stage before; all PAs are prioritized and selected. This stage can help to realize two important goals.

First of all, the organization should follow CMMI standards. While, organizations need to ensure that by improving process field to higher ability level, this process is also meet business within the organization and other needs.

In Phase 2, in order to establish connection between the requirements organization and each Pas, the relation matrixes were used which illustrate that comply with the CMMI standards also helps to meet business and other needs of the organization.

Second, based on the priorities of demands, the final set of action plans need prioritized, so that more important action to get more resources. The PAs is bridge between demands and the action plan. Priority's personal assistant, the organizations' demands can be changed to practice in the third phase by prioritizing the Pas. The final plan of action to do is in the final stage. In this way, a group can perform a behavior not only to reach a higher level in different PAs, but also to meet organizational process needs.

In the third phase of framework, it mainly discussed "practice priority" which concludes the priority approach, a specific ability level in each PA. According to the CMMI specifications, all these practice ability level in the PA must be carried out, so that the PA could reaches a certain level of performance. However, they may not need the same amount of resources. These practices are bridges between the demands and the final action, and how to put these practice reflects the software process requirements which is need to know. The link between demands and the final action plan is also reflected demand priority.

In the fourth phase of the framework, it mainly discussed "action plan development and priority," groups of action originated from priority practice in different PAs. These actions should reflect demand integration in the first stage. At the same time, they also need to implement state what to be executed in order to achieve a specific ability level of a particular PA. These actions guide SPI. Therefore, more

resources should be allocated to these behaviors with high priority.

Pictured above framework, the requirement from the organizations to take action plan goal and practice the connection between the organization's goals and PA ability level become clear.

As is shown in the framework, the demand from the tissue into action plans by goals and practices the linking between the target and the PA ability becomes clear.

4. CONCLUSIONS

This research is to solve this problem that using QFD as a kind of tool to established connection between demands in the organization and action plans in SPI. After carefully look back on some improvement methods, and the Software Engineering Institute (SEI) was selected as the basis of the proposed method. The new framework of SPI is on the basis of mature and development of the research. This new framework, discussed in detail how to arrange and integration demands, how to map demands of the various components, and how to priority action plan. The framework has three goals: 1) mapping process demands, including business demands, by using quality function deployment, 2) developing a new method, based on quality function deployment to the integration and priority demands from various angles (group); and 3) can prioritize SPA that is on the basis of process demands.

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