Attaining level of 3 of CMMI in R & D organization

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Abstract

Appraisals are used to obtain two kinds of benefits. One of them is improvement in the business processes or in the process of self-assessment and the other is to evaluate the processes. The study aims to cover a research in the areas including (i) understanding the basic difference between assessments and appraisals (ii) study the purpose, scope, benefits, issues and classes of CMMI appraisal (iii) study and select the appraisal methodology particularly for Research and Development organization (iv) plan and prepare to conduct the SCAMPI appraisal in R&D organization and (v) report the findings, ANOVA analysis and recommendation after conducting the appraisal in the Research and Development organization.

Keywords: Appraisal, CMMI, SCAMPI.

1. Introduction

Successful delivery of software products or solutions requires integration among different disciplines and improved process to manage them efficiently. CMMI provides a framework of best practices to promote integrated approach for the development of products and offering solutions. CMMI implementation reduces confusions, helps in achieving business objectives for the organization, and provides quality products to the customers.

2. CMMI Appraisal for R&D Organization

Appraisal is an umbrella term that refers to both assessments and audit-like evaluations. The first is the software process assessment method, which uses by R&D organization to gain insight into their own software development capability for process improvement. The second is the software capability evaluation method, which uses in outside evaluations of the software process of an R&D organization.

Evaluations such as the Software Capability Evaluation is for investigations of an organization conducted by an outside entity. Software Capability Evaluations are conducted to evaluate the level of an organization process maturity [1].

R&D organization is selected for CMMI appraisal to get the benefits of SPA and SCE. The expenditure of resources to carry out such appraisal will be justified by the value that is returned in the form of process improvement, rating, benchmarking and the results of the appraisal.

Purpose of CMMI Appraisal

Appraisal – “An examination of one or more processes by a trained team of professionals using an appraisal model as a basis for determining strengths and weaknesses.” [2].

CMMI Appraisal models are used to identify the strengths and weaknesses of the processes examined during an appraisal. Appraisal results can be used in a number of ways:
• process improvement and planning strategy for the organization
• generation of maturity or capability level ratings
• decision-making guidance
• mitigation of risks for product acquisition, development, and monitoring

Scope of CMMI Appraisal

Appraisal is used as a diagnostic tool to measure the organization status and plan for the future process improvement strategies. It also helps an organization to prioritize its improvement plans, focus on process improvements that are most beneficial, and generate capability or maturity level ratings. Improvement in software development activities of R&D organization is the main motive of the study. The scope of the appraisal includes all process areas of CMMI level 3.

Benefits of CMMI Appraisal Methods

CMMI appraisals provide the facility to organizations that wish to appraise against multiple disciplines like software engineering and systems engineering. One appraisal method can provide separate or combined results for one or more disciplines. Appraisal methods can appraise a single discipline also [3].

3. Methodology Selection for CMMI Appraisal

In this chapter, different appraisal methods and techniques will be discussed. These methods and techniques have popularity because they add value in different ways. The difference between model-based process improvement efforts like CMMI and other approaches that are not based on a model will be explored. Similarities and differences between CMMI, Lean, Six Sigma, and ISO 9000 will be the major discussion point in this chapter and what will be the effect on appraisals. In the end, based on the discussion a technique will be selected for the appraisal of R&D organization.

3.1 SCAMPI CMMI Appraisal

The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) is designed to provide benchmark quality ratings relative to Capability Maturity Model Integration (CMMI) models. It is applicable to a wide range of appraisal usage modes, including both internal process improvement and external capability determinations. SCAMPI satisfies all of the Appraisal Requirements for CMMI ARC requirements for a Class A appraisal method and can support the conduct of ISO/IEC 15504 assessments.

SCAMPI appraisal is an appropriate tool for benchmarking. It is also widely used to compare an organization process improvement achievements with other organizations and in the determination of maturity levels. Organizational scope, CMMI model scope, appraisal method type, the identity of the Lead Appraiser and the team are items for which criteria is developed. Benchmarking can only be valid when there is a consistent criterion is established [6].

3.2 Lean

The Lean approach to process improvement was created to reduce the cost of products. Lean approach focuses on the elimination or reduction of waste to improve the flow of information and work products, and the efficient creation of value for the enterprise. A Lean approach can be applied across an entire organization, including manufacturing, finance, and virtually in any activity area. Mainly it is related to manufacturing, but Lean concepts can also be applied to product development processes and can be used in the delivery of services [7].
3.3 Six Sigma

Six Sigma is a popular improvement methodology developed and used by Motorola Corporation, Texas Instruments, and many other companies. It discusses how Six Sigma can be incorporated into a CMMI improvement and appraisal effort [8].

Six Sigma strengthens analysis capabilities and CMMI provides organizational structure. Six Sigma analysis techniques can be used to establish priorities for selecting individual process for improvement within CMMI continuous improvement model, or at every level of CMMI staged model. The process maturity model provides a strategic framework for continuous improvement, a perspective on industry best practices, and a systematic approach to benchmarking. This avoids excessive analysis, reinventing the wheel, and inadvertent sub optimization.

3.4 ISO 9000

ISO 9000 is a family of standards that represents good management practices to ensure an organization can consistently deliver products or services that meet its customers quality requirements. This is the same primary objective that CMMI addresses. CMMI is a set of best practices that ensures satisfactory performance when practiced at increasing levels of capability [10].

In general terms, an organization that satisfies CMMI will also satisfy ISO 9001:2000. The conservative approach is to ensure that the organization processes satisfy both ISO 9001:2000 requirements and CMMI goals by tracing the process elements to both. There is sufficient commonality between CMMI and ISO that interest is developing to explore whether a single appraisal could satisfy both CMMI and ISO 9001:2000.

3.5 Agile

Agile methods provide a means of streamlining development and manufacturing processes into their most fundamental and critical components. Organizations must balance their need for agility with the benefits of having standardized processes. Agile approach will be compared with model-based process improvement and process appraisals [11].

Both approaches are interested in delivering systems and software that meet the customer requirements. If the size and complexity of a project grows in terms of number of system requirements, major interfaces, operational scenarios, critical algorithms, and so on then Agile development becomes more challenging. In these cases a planned delivery development will be the preferred development approach. So CMMI is most effective. Figure 1 shows the flow of SCAMPI.

3.6 SCAMPI Methodology

![Flow of SCAMPI](Source Explanning SCAMPI from TeraQuest)
4. Planning and Preparation of SCAMPI Appraisal for R&D Organization

Planning and preparation steps for SCAMPI appraisal are identified. Activities like organization scope, appraisal team, distribution of maturity questionnaires, selection of projects and related staff is completed before conducting the appraisal.

4.1 Scope of the organization to be appraised

R&D Organization has a full functional Information Technology Department to fulfill the software needs of the organization and to participate as a commercial entity to provide software solutions.

Following major areas are in operation:

- Marketing
- Software Development
- Analysis and Design
- Configuration Management
- Quality Testing
- Quality Assurance

The Project Manager is primarily responsible for the planning of Software Development and Deployment. Planning is done on the basis of scope and size of the software projects, the effort requires completing it – measured in man-hours/days and the man-hours/days available. Project Manager plans for and assigns the available resources, with the consent of Department Head.

Numbers of software projects are being developed that will be included for appraisal. The other activities of the organization are not included for appraisal.

4.2 Responsibility for plan

The Lead Appraiser along with the site coordinator will be responsible for producing the SCAMPI Appraisal Plan in conjunction with the ATMs, sponsor, and others.

4.3 Confidentiality

Prior to a SCAMPI appraisal, the Lead Appraiser and all members of the appraisal team should sign a confidentiality agreement.

4.4 Sponsor’s Responsibility

In approving this plan, the sponsor accepts responsibility for:

- Committing the necessary resources for appraisal team members, project leaders, and functional area representatives and ensuring their full and unchallenged participation in this appraisal.
- Endorsing the principals of confidentiality and honesty during and after the appraisal.
- Attending the opening meeting, final findings presentation and accepts the appraisal results.

4.5 Scope of Appraisal

Appraisal goals

Appraisal is used as a diagnostic tool to measure the organization status and plan for the future process improvement strategies. It also helps an organization to prioritize its
improvement plans, focus on process improvements that are most beneficial, and generate capability or maturity level ratings. Improvement in software development activities of R&D organization is the main motive of the study. The scope of the appraisal includes all process areas of CMMI level 3.

**Process areas to be appraised**

All process areas of CMMI level 3 will be appraised during the appraisal.

### 4.6 Appraisal Team

**Leader of appraisal (LA)**

Name: Praful Sahoo

**Appraisal Team Members (ATMs).** Table 1 shows the team members.

**Table 1.** Appraisal team members

<table>
<thead>
<tr>
<th>Name</th>
<th>Role/Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sajid Rahim</td>
<td>ATM/eSolutions</td>
</tr>
<tr>
<td>Faraz Naqvi</td>
<td>ATM/eLink</td>
</tr>
</tbody>
</table>

### 4.7 Maturity Questionnaire

Table 2 identifies the distribution of the Maturity Questionnaires:

**Table 2.** Names of Project Managers who filled the maturity questionnaire

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashutosh</td>
<td>Project Manager</td>
</tr>
<tr>
<td>Harman</td>
<td>Project Manager</td>
</tr>
<tr>
<td>Mallik</td>
<td>Project Manager</td>
</tr>
</tbody>
</table>

### 4.8 Participation Selection Matrix

Table 3 shows project manager’s name and staff working in different groups.

**Table 3.** Names of project managers and staff working in different groups

<table>
<thead>
<tr>
<th>Projects/Business Areas</th>
<th>Individuals and Groups to Be Interviewed</th>
<th>Project Managers</th>
<th>Software Managers</th>
<th>System Managers</th>
<th>Group 1 Team Leads (System and Software)</th>
<th>Group 2 Requirements (System and Software)</th>
<th>Group 3 Architects</th>
<th>Group 4 Detailed Design (System and S/W Engineers)</th>
<th>Group 5 Implementation</th>
<th>Group 6 Testing (System, Software, Integration, and Acceptance Test Engineers)</th>
<th>Group 7 Configuration Management (System and Software)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Institute Online</td>
<td>eProcurement</td>
<td>Electronic Commitment</td>
<td>Satyaki</td>
<td>Sarman</td>
<td>Odishi</td>
<td>Anwesha</td>
<td>Sheikh</td>
<td>Mishra</td>
<td>Deenkar</td>
<td>Dayanana</td>
</tr>
</tbody>
</table>
4.9 Project Selection Matrix

Table 4 shows the selected projects for appraisal and their information.

<table>
<thead>
<tr>
<th>All Projects in Organization</th>
<th>Institute Online</th>
<th>eProcurement</th>
<th>Electronic Commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Areas</td>
<td>Educational / Electronic University</td>
<td>Electronic purchase for every purchase dept</td>
<td>Finance related activities</td>
</tr>
<tr>
<td>Age and Duration of Project</td>
<td>2 yrs</td>
<td>1 yr/6 mos</td>
<td>1 yr</td>
</tr>
<tr>
<td>Present Life Cycle and Life-Cycle Phase</td>
<td>This project is in the designing phase. Two modules of this system is in the coding phase as well.</td>
<td>Designing of this project is nearly completed. Coding team has started to develop the system.</td>
<td>This project has been developed and currently is in the testing phase. Some change requirements from the user are also coming.</td>
</tr>
<tr>
<td>Current Business Value</td>
<td>H</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>(determined by sponsor) High, Medium, or Low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future Business Value</td>
<td>H</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>(determined by sponsor) High, Medium, or Low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Team Size</td>
<td>Team of this project is about 10 persons working full time. The distribution is like 6 are working as Project Staff, 2 Software Engineers, and 2 Test Engineer</td>
<td>Team of this project is about 8 persons working full time. The distribution is like 4 are working as Project Staff, 2 Software Engineers, and 2 Test Engineer</td>
<td>Team of this project is about 7 persons working full time. The distribution is like 3 are working as Project Staff, 2 Software Engineers, and 2 Test Engineer</td>
</tr>
<tr>
<td>Size and Language of Product</td>
<td>PL / SQL and ASP</td>
<td>PL / SQL and ASP</td>
<td>PL / SQL and ASP</td>
</tr>
</tbody>
</table>

Figure 2. Process area findings of CMMI level 2 (Source Author’s evaluation based on appraisal)
5. Conducting Appraisal and Reporting Results

Based on interview with the Project Managers and Project Teams, the following are the process areas and their related strengths and weaknesses that have observed during the appraisal of R&D organization. Figure 2 shows process area findings of CMMI level 2.

5.1 Process Area Findings of CMMI Level 2

The complete findings after conducting the CMMI appraisal is shown in the following diagram. This bar chart has developed based on the questionnaire and interviews with the project managers and technical staff selected in the planning and preparation phase of R&D organization.

The details of a process area of CMMI level 2 is also shown with the help of bar chart. Purpose, strengths and weaknesses of particular process area implementation in R&D organization are also discussed.

5.2 Project Planning Process Area

<table>
<thead>
<tr>
<th>Purpose</th>
<th>The purpose of Project Planning is to establish and maintain plans that define project activities.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image" alt="Project Planning PA" /></td>
</tr>
<tr>
<td></td>
<td><strong>Figure 3. Process area findings of Project Planning PA</strong></td>
</tr>
<tr>
<td></td>
<td><em>(Source Author’s evaluation based on appraisal)</em></td>
</tr>
<tr>
<td>Strengths</td>
<td>In almost every project necessary planning, organizing, staffing, coordinating, reporting, and budgeting activities are done well.</td>
</tr>
<tr>
<td></td>
<td>Most of the Project Plans cover project life cycle phases and consistency with other plans.</td>
</tr>
<tr>
<td>Weaknesses</td>
<td>It is observed that the interaction among all relevant stakeholders both internal and external to the project is not executing often. So the re-costing, rescheduling will create some problems.</td>
</tr>
</tbody>
</table>

5.2 Process Area Findings of CMMI Level 3

The complete findings after conducting the CMMI appraisal is shown in the following diagram. This bar chart has developed based on the questionnaire and interviews with the project managers and technical staff selected in the planning and preparation phase of R&D organization. Figure 4 shows the process area findings of CMMI level 3.
Figure 4. Process area findings of CMMI level 3 (Source Author’s evaluation based on appraisal)

The details of a process area of CMMI level 3 is also shown with the help of bar chart. Purpose, strengths and weaknesses of particular process area implementation in R&D organization are also discussed.

Requirements Development Process Area

<table>
<thead>
<tr>
<th>Purpose</th>
<th>The purpose of Requirements Development is to produce and analyze customer, product, and product-component requirements.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strengths</td>
<td>Product architecture design team is proficient in identifying interface requirements between product and product components. Because of this practice the alternative solutions are also easily identified to them. Most of the technical team very well know about the Use Case modeling so they are capable to group the functions and their association with the requirements</td>
</tr>
<tr>
<td>Weaknesses</td>
<td>Requirement allocation sheet is not properly filled and sometimes overlooked the derived requirements.</td>
</tr>
</tbody>
</table>

Appraisal Results

Appraisal results in the form of diagram is developed based on the generation of the final findings from the level 2 and level 3 of CMMI process areas, interviews from technical staff, and the document verification during the appraisal. These appraisal results reflects the strength and weaknesses of R&D organization. Figure 6 shows appraisal results.
These appraisal results are useful to the R&D organization in supporting decision making, business process improvement and process monitoring.

5.4 Organizational Level Findings and Recommendation

Strengths

There is an overall sense that process improvement activities undertaken over the last year have benefited the R&D organization.

- Quality of the software products has improved.
- Development errors have been reduced.
- Quality reviews have been positively received.
- Relationship with customers has increased
- Procedures have made life easier.
- Project Management procedures are strength and being used.
- It is easier to participate in projects across different sites.
- It is seen as a benefit that all technical staff must follow the same procedures and document what they have done

Figure 6. Appraisal Results (Source Author’s evaluation based on appraisal).
Weaknesses

- Management is not taking process improvement as important as project work.
- Most technical staff do not know the number of defects found before test, during test, and in development.
- The different process improvement initiatives are not coordinated and controlled centrally.
- Development methodologies are not captured at the organizational level, and in some cases, different methodologies are used on the same project.

Recommendations

- The organization should implement the regular inspections to detect, measure and fix defects. It saves the time, improve quality and lower project cost.
- Process Improvement program should be restructured to ensure the evaluation and implementation of process improvement in the whole organization.
- Educational and technical trainings should be provided to staff for better development.
- Reporting procedures with technical staff need improvement and management should do monthly project reviews.

5. Conclusion

Overall this study can be divided into four parts; first study the purpose, scope, benefits, and class of CMMI appraisal, secondly methodology and technique is selected for CMMI appraisal, thirdly plan and prepare the activities for appraisal in R&D organization and lastly conduct the appraisal, report the results and provide recommendation.

There are number of software organizations claimed that they are CMMI level 3 compliant. This research will provide the guidelines to prepare and conduct the appraisal with CMMI SCAMPI and identify the current implementation of process areas in the organization. It also provides the strengths, weaknesses, and recommendation.

References


