Developing CMMI in IT Projects with Considering other Development Models

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Abstract

This paper is aimed to explain the benefits of implementing the Capability Maturity Model Integration (CMMI) for IT organization widely , and then describes a case study based on a BPM project which has performed in International systems engineering and automation company (IRISA).

To make The CMMI implementing project more productive and efficient, in our case study we have merged PMBOK and CMMI for project management area and RUP methodology with CMMI in process management area as well.

Keywords: Capability Maturity Model, Project Management, PMBOK, RUP, Organizational Process.

Background on Capability Maturity Model Integration

The Capability Maturity Model Integration (CMMI) evolved from the Capability Maturity Model (CMM).The concept of the CMM started at late 1980s and appeared to the public when Watts Humphrey published his book "Managing the Software Process" that was based on the earlier work of Phil Crosby [1].

However, before the book was published, funded by US Air Force, the Software Engineering Institute (SEI) at Carnegie Mellon University has actively worked on the model in 1986. The SEI published the SW-CMM V0.2 in 1990 for software development, and released the V1.0 and its assessment method in late 1991. Since then, the CMM model has gained its popularity through contractors of Us Department of Defense (US DoD) and other software development organizations around the world. The trend of adopting SW-CMM into organizational software processes is driven by primary two reasons: (1) The lack of good process practices/guidelines for software development organization, and (2) the mandatory requirement of CMM level-2 certification and above to acquire US DoD contracts. [2]

The Software CMM was followed by other capability maturity models, including the People Capability Maturity Model (P- CMM) [2].

Organizations from industry, government, and the Software Engineering Institute (SEI) joined together to develop the CMMI Framework, a set of integrated CMMI models.

The CMMI model was formally introduced in 2002 when the V1.1 version was published. The revised CMMI V1.2 released in 2006 co-exists with the SW-CMM until the phased out of the CMM model in August 2007.

Two kinds of materials are contained in the CMMI model [3]:

1. Materials to help you evaluate the contents of your processes- information that is essential to your technical, support and managerial activities.

2. Materials to help you improve process performance-information that is used to increase the capability of your organization's activities.

Through the process of adopting CMMI, we aim to attain the following objectives: (1) to improve project management capability; (2) to enhance product quality; (3) to increase productivity and cost down; (4) to improve the capability of predicting the project budget and schedule; (5) to increase customer satisfaction [4].

With the adoption of CMMI comes the reward of software process improvement as well as product quality enhancement. It also defines a common language and a uniform standard for staff members to carry out daily tasks, and provides quantitative indicators for work performance and thereby further consolidates management [4].

CMMI model is quite comprehensive. It covers several bodies of knowledge and defined numerous process areas, specific and generic goals, specific and generic practices, as well as a lot of typical work products. It should be used to improve processes, increase productivity and raise competitiveness of an organization [5].

Overview of the CMMI

The CMMI is composed of five maturity levels. Levels of CMMI are supposed to describe an evolutionary path recommended for an organization that wants to improve the processes and develop and maintain products and services. The five capability maturity levels, designated by the numbers 1 through 5, are as follows [6]:

1 → Initial: Processes unpredictable, poorly controlled and reactive.

2 → Managed: Processes characterized for projects and is often reactive. This level covers 7 process areas for repeatable success of project implementation: Requirement management, project planning, project monitoring and control, supplier agreement management, measurement and analysis, process and product quality assurance, and configuration management.

3 → Defined: Processes characterized for the organization and is proactive (Projects tailor their process from the organization's standard). this level covers 11 process areas for organization processes standardization.

4 → Quantitatively Managed: Processes measured and controlled. This level covers 2 processes areas: Organizational process performance and quantitative project management.

5 → Optimizing: Focus on process improvement. This level covers 2 process areas: Organizational innovation and deployment and causal analysis and resolution.

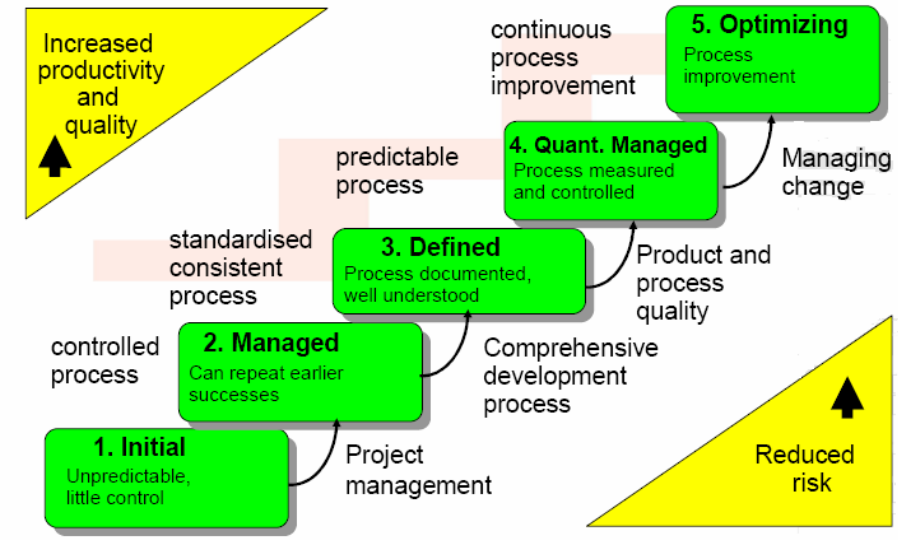

Figure 1. Maturity Level

There are 22 process areas in CMMI V1.2. A process area is a cluster of related practices in an area that, when implemented collectively, satisfies a set of goals considered important for making improvement in that area. Process areas can be grouped into four categories:

- Process Management
- Project Management
- Engineering
- Support

Process Management process areas contain the cross-project activities related to defining, planning, deploying, implementing, monitoring, controlling, appraising, measuring, and improving processes.

Project Management process areas cover the project management activities related to planning, monitoring, and controlling the project.

Engineering process areas cover the development and maintenance activities that are shared across engineering disciplines. The Engineering process areas were written using general engineering terminology so that any technical discipline involved in the product Development process can use them for process improvement. The Engineering process areas also integrate the processes associated with different engineering disciplines into a single product development process, supporting a product-oriented process improvement strategy.

Support process areas cover the activities that support product development and maintenance. The Support process areas address processes that are used in the context of performing other processes. In general, the Support process areas address processes that are targeted toward the project and may address processes that apply more generally to the organization. For example, Process and Product Quality Assurance can be used with all the process areas to provide an Objective evaluation of the processes and work products described in all the process areas.[7]

	Process Mgmt.	Project Mgmt.	Engineering	Support
2		Project Planning (PP) Project Monitoring and Control (PMC) Supplier Agreement Management (SAM)	Requirements Management (REQM)	Configuration Management (CM) Process & Product Quality Assurance Measurement and Analysis (MA)
3	Organizational Process Focus (OPF) Organizational Process Definition (OPD) Organizational Training (OT)	Integrated Project Management (IPM) Risk Management (RSKM)	Requirements Development (RD) Technical Solution (TS) Product Integration (PI) Verification (VER) Validation (VAL)	Decision Analysis and Resolution (DAR)
4	Organizational Process Performance (OPP)	Quantitative Project Management (QPM)		
5	Organizational Innovation and Deployment (OID)			Causal Analysis and Resolution (CAR)

Figure 2. Process areas in CMMI V1.2

In CMMI within each process area, there are one or more specific goals with specific practices and generic goals with generic practices. Generic goals are associated with the institutionalization of good practice, called "generic" because the same goal statement appears in multiple process areas. A specific goal applies to a process area and addresses the unique characteristics that describe what must be implemented to satisfy the process area. A specific practice is an activity that is considered important in achieving the associated specific goal [8].

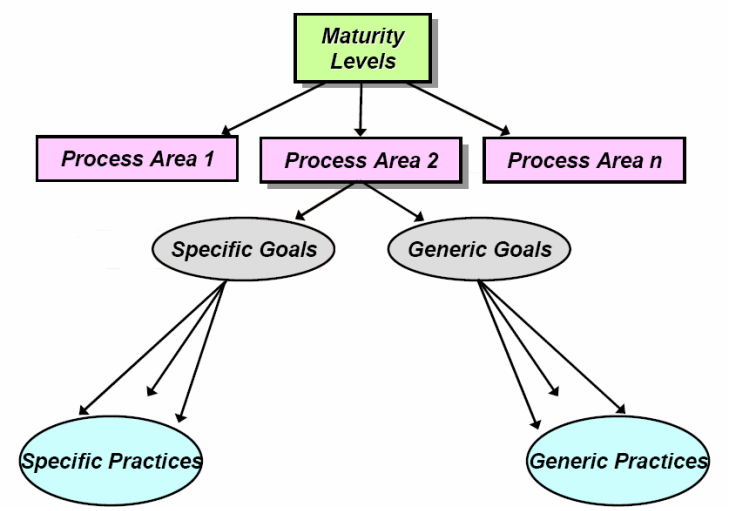

Figure 3. Specific and generic goals

CMMI supports two improvement paths: continuous and staged. The continuous path enables organizations to incrementally improve processes corresponding to an individual process area (or process areas) selected by the organization. The staged path enables organizations to improve a set of related processes by incrementally addressing successive sets of process areas. These two improvement paths are associated with the two types of levels that correspond to the two representations. For the continuous representation, we use the term "capability level." For the staged representation, we use the term "maturity level."[6]

The SEI also defined the Standard CMMI Appraisal Method for Process Improvement (SCAMPI) for CMMI level-2 to level-5 certification. The CMMI level 1 is actually a pseudo level referring to any organizations that have no sound standard development processes. The SCAMPI defines three appraisal approaches: A, B, and C. SCAMPI A is utilized for capability maturity level certification that requires an appraisal team and a lead appraiser. SCAMPI C is for organization internal assessment and does not require a lead appraiser. SCAMPI B is most likely being used as a mock appraisal prior to SCAMPI A.[6]

The CMMI model provides a very good guideline for organizations that are seeking process management and improvement. The activity-based pattern at the CMMI level-2 and level-3 presents a clear path and easy implementation for organizations to establish the standard processes starting from scratch and to keep them intact. At the CMMI level- 4 and level-5, the centralized process group within an organization concentrates on process

improvement effort and assures the process reflecting the organization's business change.[9]

CMMI Case Study in IRISA Company

International Systems Engineering & Automation Company (IRISA) is a prominent company in the field of consulting, design and implementation of industrial automation ,information systems, and design & implementation of network and infrastructure based on the most recent and advanced technologies. IRISA was founded in 1992 and now it has over 600 specialists who are experienced with many projects in several organizations and industries. The central office of IRISA is located in Isfahan and it has representative offices in Tehran and Ahvaz.

Background

Before establishing CMMI, we had performed BPM project to manage our organizational processes and we had meted requirements of ISO 9001; 2004 and Tick IT certificate as well.

The Capability Maturity Model project initiated in 2010. Our first goal was reaching level 3 of the maturity levels. As far as we have informed IRISA is one of the first companies which has targeted to implement CMMI model for its organizational processes.

IRISA Mission for CMMI Project

IRISA mission for establishing this project is to achieve excellent customer satisfaction and program performance and Improve, grow, and diversify of its business. These are our goals to reach for next 1years, at the end of CMMI project.

The Initiating Phase

The first critical step to adopting CMMI is the efficient involvement of management. Then we determine the scope of the effort, estimation of cost and time, which all are in project charter. Schedules were established and planning was conducted to obtain commitments, resources, tools, personnel, and training. Internal meetings were held to select projects from 3 different business units and to identify and assign project members to tasks. The team member divided in 2 groups, one is core of the team and the second is other projects' members which are involved in CMMI project.

The Diagnosing Phase

Each department and business units of company is audited and the problems and improvement solutions is identified, moreover for each department we draw a radar chart based on 11 KPIs. After completing all the audits, team extract required and expected CMMI components (i.e., goals and practices). The informative material, while helpful to understand the specific and generic practices, was explicitly reviewed for compliance as a part of this activity.

The CMMI team identified where the processes met or did not meet practices. A process was determined to meet the practices of the model if it was sufficiently institutionalized means it is followed consistently and repeatedly, is used throughout the project, is known and understood by constituents, and is documented. The team members set appointment to establish related processes in different projects and departments.

CMMI implementing project Results:

The following section demonstrates how IRISA processes match with CMMI process areas.

Project Management Process Areas:

IRISA has project support office (PSO), which controls and monitors all of the projects from beginning to the end and that department also uses PMBOK to standardize all of the project management processes.

The PMBOK is process-based approach. This approach is consistent with other management standards such as ISO 9000 and the CMMI. Processes overlap and interact throughout a project or its various phases. Processes are described in terms of Inputs (documents, plans, designs, etc.), Tools and Techniques and Outputs (documents, products, etc.). The Guide recognizes 42 processes that fall into five basic process groups and nine knowledge areas that are typical of almost all projects. The five process groups are Initiating, Planning, Executing, Monitoring and controlling and Closing. The nine knowledge areas are Project Integration Management, Project Scope Management, Project Time Management, Project Cost Management, Project Quality Management, Project Human Resource Management, Project Communications Management, Project Risk Management and Project Procurement Management.

Each of the nine knowledge areas contains the processes that need to be accomplished within its discipline in order to achieve an effective project management program. Each of these processes also falls into one of the five basic process groups, creating a matrix structure such that every process can be related to one knowledge area and one process group.

PMBOK has a lot in common with project management area of CMMI which is explained below widely.

Project Planning

All the Project estimates like time and budget are done in charter document and project plan of the project. Needed equipments and resources to support all project activities are estimated and budget is allocated there the risk management is considered too. Work product and task attribute are placed in project WBS (work breakdown structure) as well. It must be mentioned that all these templates are standard and based on PMBOK and completed with CMMI specific goals.

Relevant stakeholders participate in initiating through the closing phase. Participation of relevant stakeholders is also defined in the process documents for each phase of the development cycle.

Project Monitoring and Control

Performance progress monitors in PSO too. The earned-value method provides timely insight into the completion of project milestones.

Parameters developed during planning (specifically, effort to accomplish specific deliverables and milestones) are entered and are tracked closely for variances. The program-level schedules include different phases at which project accomplishments are to

be reviewed. Issues that require special corrective action normally result in development of unique plans with special schedules for issue resolution.

Integrated Project Management

IRISA project processes are patterned after two previous processes and are tailored to meet the specific requirements of the project. The project processes and the integration of these processes are described in the Project Management Plan. The Software Development Management Plan further defines the software processes and how they are integrated. The integration of these processes is implemented through the Integrated Management Plan.

Supplier Agreement Management

The supplier is required to describe its management approach, technical approach, past performance on similar programs, and pricing. Detailed evaluation criteria are applied to the bids received and the contract is awarded to the supplier with the highest score. The selection process, evaluation criteria and rationale for candidate selection are reviewed at multiple management levels.

The selected subcontractor provides a rough order of magnitude cost based on procurement department's initial estimate. The subcontractor revises the estimate by applying an appropriate estimation to the revised Software Requirements Specification.

The subcontractor typically participates in the project's requirements processes to obtain an understanding and make a commitment to the software requirements. The software includes compliance with government regulations, acquisition strategies, source selection, and management of subcontractors' performance.

Risk Management

Project risk management employs a collective set of activities for identifying, assessing, monitoring, and mitigating risks. Proactive risk management is designed to uncover potential issues before they can disrupt normal operations.

When a risk assessment is performed, multiple options for handling the risk are usually presented. Actions can fall into three categories: accept, mitigate, or prevent.

Risks are "accepted" when the action is totally outside of control or the risk is low priority. Management is aware that the risk condition exists, but no further action will be taken. Risks are "mitigated" when control measures have been put in place to reduce the consequence if the event were to occur. Risks are "prevented" when some form of action has been taken to reduce the likelihood of an undesirable event.

Quantitative Project Management

The financial measurements are conducted and monitored throughout project different lifecycle to determine if the actual results support achievement of the established objectives. The process owners are involved, as needed, to make changes to the process based on feedback from the statistical process control analysis (e.g., data collection changes).

Engineering Process Areas

For establishing engineering process area, a pilot project was selected. The CMMI engineering processes merged with RUP (Rational Unified Process) methodology and it was a new concept in our company

RUP is a software engineering method that describes who does what, when and how in a software development and deployment project. It has the characteristics of being use-case driven, architecture-centric, risk-driven and iterative approach.[10]

Requirements Management and Requirements Development

Team members work closely together for requirements elicitation, development, and management. All the customer requirements are recognized via requirement list and Software Requirements Specification. The highest-level requirements document is the Architecture Requirements Specification and R&D Result for Architecture. The lowest level of software requirements is documented in the Software Requirements Specification. Use cases are created to analyze and validate above documents.

The project uses a tool to track the traceability from the Software Requirements Specification to the other System Specification Documents. This tool will also be used during code, design, and test to document traceability to the requirements.

Technical Solution

Operational concepts, alternative solutions, and architectures are developed, and make/buy/reuse decisions are performed in technical solution. Software Architecture Requirement, General Design, Source Code and Technical Risk are described in the Technical Solution process area. However, projects develop designs, code, and end-use documentation using defined standards, guidelines, and processes are done here.

Product Integration

Detailed procedures are used for integrating software components as part of the project's build process. The build function is a highly tooled process that is controlled by the overall configuration management system. Product Integration plan, System Installation Guide, Install the system and Component Diagram is described in this process.

Verification and Validation

The objective of software system verification and validation is to perform tests, analysis, and evaluation of the software to ensure full conformity to specification and satisfaction of operational needs. There are several levels of testing here. Initial Test Plan first prepared and Business Test, Unit Test, Integration test and FAT is directed to validate and verify the project as well.

Support Process Area

Support process areas cover the activities that support development and maintenance of the projects. The Support process areas address processes that are used in the context of performing other processes. The Support process areas address processes that are targeted toward the project and may address processes that apply more generally to the organization.

Process Management Process Areas

Many of the Process Management Process Area practices apply to organization-level, not project-level and activities. The organization represents the IRISA Company and all the processes in this area are described in organization.

Conclusion

This paper presents a CMMI model and approach for managing the IT projects. CMMI is divided the organization in five maturity level. This model has 22 processes which help the organization to improve to upper steps. We have merged this model, which is based on process improvement, with some other models, since all of these models are consistent with each other as well. We merge PMBOK with CMMI in project management area, they approve each other and we insist on some processes like risk management and supply agreement management more. Of course in engineering process area of CMMI, RUP methodology helps a lot for organizing the processes based on chronological order.

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