ADOPTION AND UP GRADATION OF CMMI: PROSPECT OF SOFTWARE INDUSTRY OF BANGLADESH

A Thesis

Submitted to the Department of Computer Science and Engineering

of

BRAC University

by

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In Partial Fulfillment of the Requirements for the Degree

of

Bachelor of Science in Computer Science

Department of Computer Science and Engineering

BRAC University

May 2005

DECLARATION

I hereby declare that this thesis is based on the results found by myself. Materials of work found by other researcher are mentioned by reference. This thesis, neither in whole nor in part, has been previously submitted for any degree.

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Signature of Supervisor

Signature of Author

ACKNOWLEDGMENTS

First of all I thank Allah for His blessings. Special thanks to Mr. Moinul Islam Zaber, lecturer, BRAC University for introducing and encouraging me with this contemporary topic and guided me through out the thesis semester and accepting the difficult task of overseeing this work to completion. Mr Monjur Ashraf, Mr. Sumon Shahriar, lecturers, BRAC University for taking time out of their busy schedules to help me on doing my survey by providing information and recommendation to several software firms. Mention less, my gratitude to all those personnel who provided me with information about their organizations to extract the current scenario of our software firms. Whole hearted thanks to Ms. Rizwana Choudhry to scrutinize the thesis draft.

ABSTRACT

Software industry of Bangladesh is still a way beyond the international standard and recognition because of its infrastructure. To consolidate its structural integrity, the constituent firms should be encouraged for transcending their individual's standard. This paper puts up CMMI (Capability Maturity Model Integration); a de facto standard for assessing and improving software processes, in font to introduce the capabilities of enhancing firms' productivity, maturity and competitiveness. Basically these organizations are product developers that need a way to manage an integrated approach to their software and systems engineering as part of reaching their business objectives. Unlike other available improvement approaches, CMMI does not only take care of any specific part of the business but provides a systematic approach to the problems that most of the organizations are facing in several disciplines. This thesis is an effort to give an overview of how software firm(s) can get international and domestic recognition by tailoring CMMI.

TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

1.1 What Is CMMI (Capability Maturity Model Integration)?

The Capability Maturity Model Integration (CMMI) is one of the models for judging the maturity and the capability of the processes and the products of an organization. CMMI provides enough documents of the key practices that are required to increase the maturity and the capability of these processes. This maturity model measures that how well the organization is managed (systematization). [2]

1.1.1 History of CMMI

The software engineering research Institute (SEI) of Carnegie Mellon University in the United States developed the capability of the Maturity Model process sponsored by The Office of the Secretary of Defense (OSD) and the National Defense Industrial Association. [2]

CMMI capitalizes on the similarities of other process improvement models; eliminates differences that increase effort and expense of “stovepiping” models.

- The project CMMI began with the following source models:
  - SEI’s Capability Maturity Model for Software (SW-CMM®)
  - Electronic Industries Alliance (EIA) Systems Engineering Capability Model, Interim Standard (EIA/IS 731)—the result of the merger of the SE-CMM, created by the Enterprise Process Improvement Collaboration (EPIC), and the SECAM, created by INCOSE
  - A draft model covering Integrated Product and Process Development (IPPD), the IPD-CMM, previously released in draft form by EPIC

1.2 Structure of CMMI

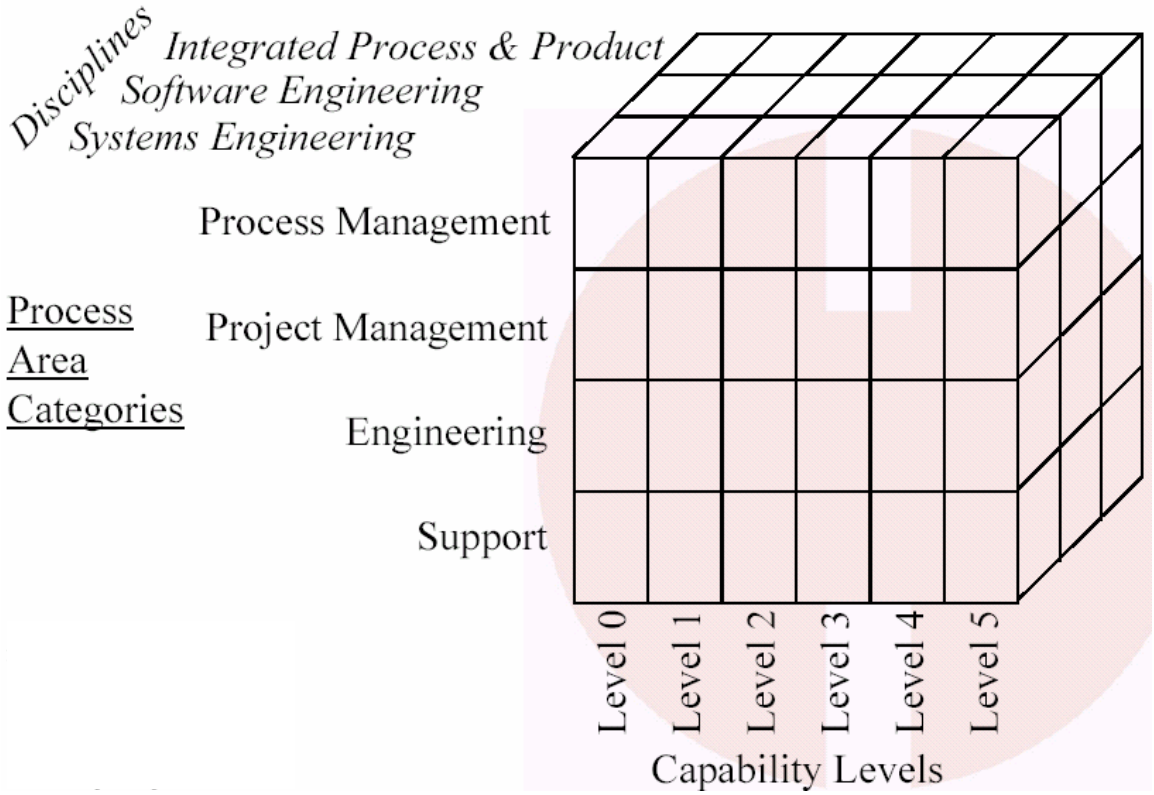

Figure 1.1: Structure of CMMI

CMMI structure is consisting of those components that give the brief idea about them in the subsequent sections. [2]

1.2.1 Components of CMMI structure

The constituents of CMMI are

1.2.1.1 Disciplines

1. Integrated Process and Product Development
2. Software Engineering
3. System Engineering

4. Supplier Sourcing

1.2.1.2 Process Area Categories

1. Process Management (PRO)
2. Project Management (MAN)
3. Engineering (ENG)
4. Support (SUP)

Table 1.1

Key Process Areas

Area Categories		Maturity levels	KPA
ENG	REQM	2	Requirements Management
MAN	PP	2	Project Planning
MAN	PMC	2	Project Monitoring And Control
MAN	SAM	2	Supplier Agreement Management
SUP	MA	2	Measurement And Analysis
SUP	PPQA	2	Process And Product Quality Assurance
SUP	CM	2	Configuration Management
PRO	OPF	3	Organizational Process Focus
PRO	OPD	3	Organizational Process Definition
PRO	OT	3	Organizational Training
SUP	OEI	3	Organizational Environment For Integration
MAN	IPM	3	Integrated Project Management For IPPD
MAN	ISM	3	Integrated Supplier Management
MAN	IT	3	Integrated Teaming
MAN	RSKM	3	Risk Management
ENG	RD	3	Requirements Development
ENG	TS	3	Technical Solution
ENG	PI	3	Product Integration
ENG	VER	3	Verification
ENG	VAL	3	Validation
SUP	DAR	3	Decision Analysis And Resolution
PRO	OPP	4	Organizational Process Performance
MAN	QPM	4	Quantitative Project Management
PRO	OID	5	Organizational Innovation And Deployment
SUP	CAR	5	Causal Analysis And Resolution

1.2.1.3 Capability Levels

1. Level 0: Incomplete
2. Level 1: Performed
3. Level 2: Managed
4. Level 3: Defined
5. Level 4: Quantitatively Managed
6. Level 5: Optimizing

1.2.1.4 Maturity Levels

1. Level 1:Initial
2. Level 2:Managed
3. Level 3:Defined
4. Level 4:Quantitatively Managed
5. Level 5:Optimizing

1.3 CMMI and Business Objectives

Every organization has some business objectives in common and most of them are concern of their product and processes' improvement. Based on CMMI process content and concern with processes improvement, an organization could expect from CMMI to meet the following objectives that have been listed within the range of this section. [2]

1.3.1 Produce quality products or services

The process-improvement concept in CMMI models evolved out of the Deming, Juran, and Crosby quality paradigm: Quality products are a result of

quality processes. CMMI has a strong focus on quality-related activities including requirements management, quality assurance, verification, and validation. [2]

1.3.2 Create value for the stakeholders

Mature organizations are more likely to make better cost and revenue estimates than those with less maturity, and then perform in line with those estimates. CMMI supports quality products, predictable schedules, and effective measurement to support management in making accurate and defensible forecasts. This process maturity can guard against project performance problems that could weaken the value of the organization in the eyes of investors. [2]

1.3.3 Be an employer of choice

Watts Humphrey has said, “Quality work is not done by accident; it is done only by skilled and motivated people.” CMMI emphasizes training, both in disciplines and in process. Experience has shown that organizations with mature processes have far less turnover than immature organizations. Engineers in particular are more comfortable in an organization where there is a sense of cohesion and competence. [2]

1.3.4 Enhance customer satisfaction

Meeting cost and schedule targets with high-quality products that are validated against customer needs is a good formula for customer satisfaction. CMMI addresses all of these ingredients through its emphasis on planning, monitoring, and measuring, and the improved predictability that comes with more capable processes. [2]

1.3.5 Increase market share

Market share is a result of a number of factors including quality products and services, name identification, pricing, and image or goodwill. Clearly, customer satisfaction is a central factor, and in a marketplace, having satisfied customers can be contagious. Customers like to deal with suppliers who have a reputation for meeting their commitments. CMMI improves estimation and lowers

process variability to enable better, more accurate bids that are demonstrably achievable. It also contributes in meeting essential quality goals. [2]

1.3.6 Implement cost savings and best practices.

Processes that are documented, measured, and continuously improved are perfect candidates for becoming best practices, resulting in cost savings for the organization. CMMI encourages measurement as a managerial tool. Using the historical data, collected to support schedule estimation, an organization can identify and widely deploy practices that work, and eliminate those that do not. [2]

1.3.7 Gain an industry-wide recognition for excellence

The best way to develop a reputation for excellence is to consistently perform well on projects, delivering quality products and services within cost and schedule parameters. Having processes that conform to CMMI requirements can enhance that reputation. The results of CMMI appraisals can be compared across a company, a corporation, or an industry. Many organizations proudly advertise their CMMI-defined maturity rating alongside their ISO 9000 registration. [2]

It is obvious that CMMI comprises information that can make a significant impact on organizations and on the achievement of their business objectives. Section 1.4 discusses a different set of objectives, those that led to the development of CMMI itself. [2]

1.4 CMMI Objectives

While CMMI has many business-related benefits, the project as defined by its sponsors was directed toward the development of more efficient and effective process-improvement models. The CMMI project had both initial and longer-term objectives. The initial objective was to integrate three specific process-

improvement models: software, systems engineering, and integrated product development. [2]

This integration was intended to reduce the cost of implementing multidisciplinary model-based process improvement by:

- Eliminating inconsistencies
- Reducing duplication
- Increasing clarity and understanding
- Providing common terminology
- Providing consistent style
- Establishing uniform construction rules
- Maintaining common components
- Assuring consistency with ISO/*IEC* 15504
- Being sensitive to the implications for legacy efforts

CHAPTER II

CMMI MODELS AND REPRESENTATIONS

2.1 CMMI Models

A model is a presentable structured view; comprise of the components or building blocks within it. CMMI models are not an exception. They contain the essential elements of effective processes for one or more disciplines and describe an evolutionary improvement path from ad hoc, immature processes to disciplined, mature processes with improved quality and effectiveness. Currently there are four disciplines available. Section 2.1.1 has some of the familiar names.

2.1.1 How are CMMI models named?

Each CMMI model is given a name consisting of “CMMI-“ followed by the abbreviation of the disciplines covered in that model. Where more than one discipline is covered, the discipline abbreviations are listed with a slash (/) between them. [2]

- *CMMI-SW* is the name of the software engineering model.
- *CMMI-SE/SW* is the name of the systems engineering and software engineering model.
- *CMMI-SE/SW/IPPD* is the name of the systems engineering, software engineering, and integrated product and process development model.
- *CMMI-SE/SW/IPPD/SS* is the name of the systems engineering, software engineering, integrated product and process development, and supplier-sourcing model.

2.1.2 Selecting a model

There are multiple CMMI models available as generated from the CMMI framework. An organization that wants to adopt CMMI has to select among the models, which best fits for the organization's process-improvement needs. [2]

To get started the organization has to select which disciplines (IPPD, SE, SW, SS) it wants to include in the process improvement program and should select a model representation (staged or continuous). [2]

2.2 Model Representation

A representation allows an organization to pursue different improvement objectives and presents model components differently. The content is nearly identical in both representations. [2]

The continuous representation uses capability levels to measure process improvement, while the staged representation uses maturity levels. The main difference between maturity levels and capability levels is the representation they belong to and how they are applied. [2]

2.2.1 Continuous representation

Capability levels, which belong to the continuous representation, apply to an organization's process-improvement achievement for each process area. There are six capability levels, numbered 0 through 5. Each capability level corresponds to a generic goal and a set of generic and specific practices. [1]

Table 2.1

Capability Levels

Continuous Representation	
Capability Level	**Capability Levels**
0	Incomplete
1	Performed
2	Managed
3	Defined
4	Quantitatively Managed
5	Optimizing

If continuous representation is chosen by an organization, it is expected that the model will do the following:

- ☑ Allows selecting the order of improvement that best meets the organization's business objectives and mitigates the organization's areas of risk
- ☑ Enables comparisons across and among organizations on a process area by process area basis or by comparing results through the use of equivalent staging [2]
- ☑ Provides an easy migration from Electronic Industries Alliance Interim Standard (EIA/IS) 731 to CMMI [2]
- ☑ Affords an easy comparison of process improvement to International Organization for Standardization and International Electro-technical Commission (ISO/IEC) 15504, because the organization of process areas is similar to ISO/IEC 15504 [2]

2.2.2 Staged representations

Maturity levels, which belong to the staged representation, apply to an organization's overall maturity. There are five maturity levels, numbered 1 through 5. Each maturity level comprises a predefined set of process areas. [2]

Table2.2

Maturity Levels

Staged Representation	
Maturity Level	**Maturity Levels**
1	Initial
2	Managed
3	Defined
4	Quantitatively Managed
5	Optimizing

If the staged representation is chosen by an organization, it is expected that the model will do the following: [2]

- Provide a proven sequence of improvements, beginning with basic management practices and progressing through a predefined and proven path of successive levels, each serving as a foundation for the next
- Permit comparisons across and among organizations by the use of maturity levels
- Provide an easy migration from the SW-CMM to CMMI
- Provide a single rating that summarizes appraisal results and allows comparisons among organizations

2.2.3 Comparison: goals and practices

The continuous representation has more specific practices than the staged representation because the continuous representation has two types of specific practices. Those are

- Base: All the specific practices with a capability level of 1
- Advanced: All the specific practices with a capability level of 2 or higher

On the other hand, the staged representation has only one type of specific practice. In the continuous representation, generic practices exist for capability levels 1-5, whereas, in the staged representation, only the generic practices from capability levels 2 and 3 appear; there are no generic practices from capability levels 1, 4, and 5. [2]

Equivalent staging enables the results of appraisals using the continuous representation to be translated into maturity levels.

2.2.3.1 Advantages of each representation

Table 2.3

Comparative advantages of the two representations

Continuous Representation	Staged Representation
Grants explicit freedom to select the order of improvement that best meets the organization's business objectives and mitigates the organization's areas of risk	Enables organizations to have a predefined and proved improvement path
Enables increased visibility of the capability achieved in each individual process area	Focuses on a set of processes that provide an organization with a specific capability that is characterized by each maturity level

Provides a capability-level rating that is used primarily for improvement in an organization and is rarely communicated externally.	Provides a maturity-level rating that is often used in internal management communication, statements external to the organization, and during acquisitions as a means to qualify bidders.
Allows improvements of different processes to be performed at different rates.	Summarizes process-improvement results in a simple form—a single maturity-level number.
Reflects a newer approach that does not yet have the data to demonstrate its ties to return on investment.	Builds on a relatively long history of use that includes case studies and data that demonstrate proved return on investment.
Provides an easy migration from the SECM to the CMMI.	Provides an easy migration from the Software CMM to CMMI.
Affords an easy comparison of process improvement to ISO/IEC 15504 because the organization of process areas is derived from 15504.	Allows comparison to 15504, but the organization of process areas does not correspond to the organization used in ISO/IEC 15504.

Whether used for process improvement or appraisals, both representations are designed to offer essentially equivalent results. Details about each of the representations are placed in the following chapters. [2]

CHAPTER III

CONTINUOUS REPRESENTATION

3.1 Components

The components of both the staged and continuous representations are process areas, specific goals, specific practices, generic goals, generic practices, typical work products, sub-practices, notes, discipline amplifications, generic practice elaborations, and references. [1]

The continuous representation uses six capability levels, capability profiles, target staging, and equivalent staging as organizing principles for the model components. The continuous representation groups the process areas by affinity categories and designates capability levels for process improvement within each process area. [1]

Equivalent staging is used to relate the process areas' capability levels to the staged representation's maturity levels. [1]

Within each process area, the specific goals and specific practices are listed first, followed by the generic goals and generic practices. The continuous representation uses the generic goals to organize the generic practices. [1]

In this chapter, each component of the continuous representation, the relationships between the components, and the relationships between the two representations will be described. [1]

Note: Many of the components described here are also components of CMMI models with a staged representation.

3.1.1 Structural overview

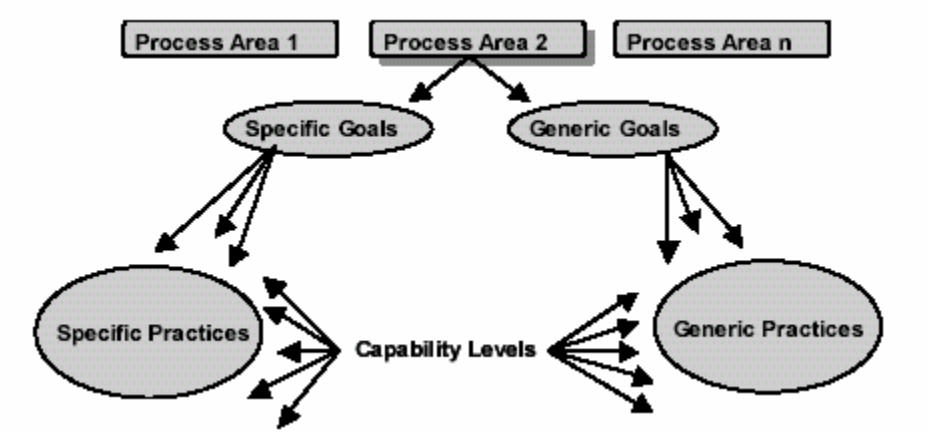

Figure3.1: CMMI Model Components

As illustrated in Figure 3.1, specific goals organize specific practices and generic goals organize generic practices. Each specific and generic practice corresponds to a capability level. Specific goals and specific practices apply to individual process areas. [1]

Generic goals and generic practices apply to multiple process areas. Generic goals and generic practices define a sequence of capability levels that represent improvements in the implementation and effectiveness of all the processes you choose to improve. [1]

CMMI models are designed to describe discrete levels of process improvement. In continuous representation, capability levels provide a recommended order for approaching process improvement within each process area. At the same time, continuous representation allows some flexibility for the order in which the process areas are addressed. [1]

3.2 Capability levels

In continuous representation first thing to do is to select a process area category (Process Management, Project Management, Support, Engineering or All). A capability level consists of related specific and generic practices for a process area that can improve the organization's processes associated with that process area. As satisfying the generic and specific goals for a process area at a particular capability level leads an organization achieving that capability level. [1]

Capability levels focus on growing the organization's ability to perform, control, and improve its performance in a process area. Capability levels enable to track, evaluate, and demonstrate the organization's progress as it improves its processes associated with a process area. Capability levels build on each other, providing a recommended order for approaching process improvement. [1]

3.2.1 Capability Level 0: Incomplete

An incomplete process is a process that is either not performed or partially performed. One or more of the specific goals of the process area are not satisfied. [1]

3.2.2 Capability Level 1: Performed

A capability level 1 process is characterized as a "performed process."

A performed process is a process that satisfies the specific goals of the process area. It supports and enables the work needed to produce identified output work products using identified input work products. [1]

A critical distinction between an incomplete process and a performed process is that a performed process satisfies all of the specific goals of the process area. [1]

3.2.2.1 Level 1: Generic Goals

GG 1 Achieve Specific Goals

The description of GG1 is given in the glossary.

3.2.2.2 Level 1: Generic Practices

GP 1.1 Perform Base Practices

To perform the base practices of the process area to develop work products and provide services to achieve the specific goals of the process area.

The purpose of this generic practice is to produce the work products and deliver the services that are expected by performing the process. These practices may be done informally, without following a documented process description or plan. The rigor with which these practices are performed depends on the individual's capability of managing and performing the work and may vary considerably. [1]

When using the continuous representation of CMMI, the base practices of a process area refer to all of the capability level 1 specific practices for the process area. [1]

3.2.3 Capability Level 2: Managed

A capability level 2 process is characterized as a "managed process."

A managed process is a performed (capability level 1) process that is also planned and executed in accordance with policy, employs skilled people having

adequate resources to produce controlled outputs, involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description. The process may be instantiated by an individual project, group, or organizational function. Management of the process is concerned with the institutionalization of the process area and the achievement of other specific objectives established for the process, such as cost, schedule, and quality objectives. [1]

A critical distinction between a performed process and a managed process is the extent to which the process is managed. A managed process is planned (the plan may be part of a more encompassing plan) and the performance of the process is managed against the plan. [1]

Corrective actions are taken when the actual results and performance deviate significantly from the plan. A managed process achieves the objectives of the plan and is institutionalized for consistent performance (generic practices are mentioned below). [1]

The objectives for the process are determined based on an understanding of the project or organization’s particular needs. Objectives may be quantitative or qualitative. [1]

The objectives for the process may be specific objectives for the individual process or they may be defined for a broader scope (i.e., for a set of processes), with the individual processes contributing to achieving these objectives. These objectives may be revised as part of the corrective actions taken for the process.

The control provided by a managed process helps to ensure that the established process is retained during times of stress. [1]

The requirements and objectives for the process are established. The status of the work products and delivery of the services are visible to management at defined points (e.g., at major milestones and completion of major tasks). Commitments are established among those performing the work and relevant stakeholders. Commitments are revised as necessary. Work products

are reviewed with relevant stakeholders and are controlled. The work products and services satisfy their specified requirements. [1]

As each of the process areas, Requirements Managements process area also consists of specific and generic goals and practices. Table 3.1 and followed by figure 3.1 they have been illustrated. [1]

Table 3.1

Example Specific Goal and Specific Practices

SG 1 Manage Requirements Requirements are managed and inconsistencies with project plans and work products are identified.
SP 1.1-1 Obtain an Understanding of Requirements Develop an understanding with the requirements providers on the meaning of the requirements. SP 1.2-2 Obtain Commitment to Requirements Obtain commitment to the requirements from the project participants. SP 1.3-1 Manage Requirements Changes Manage changes to the requirements as they evolve during the project. SP 1.4-2 Maintain Bidirectional Traceability of Requirements Maintain bidirectional traceability among the requirements and the project plans and work products. SP 1.5-1 Identify Inconsistencies between Project Work and Requirements Identify inconsistencies between the project plans and work products and the requirements.

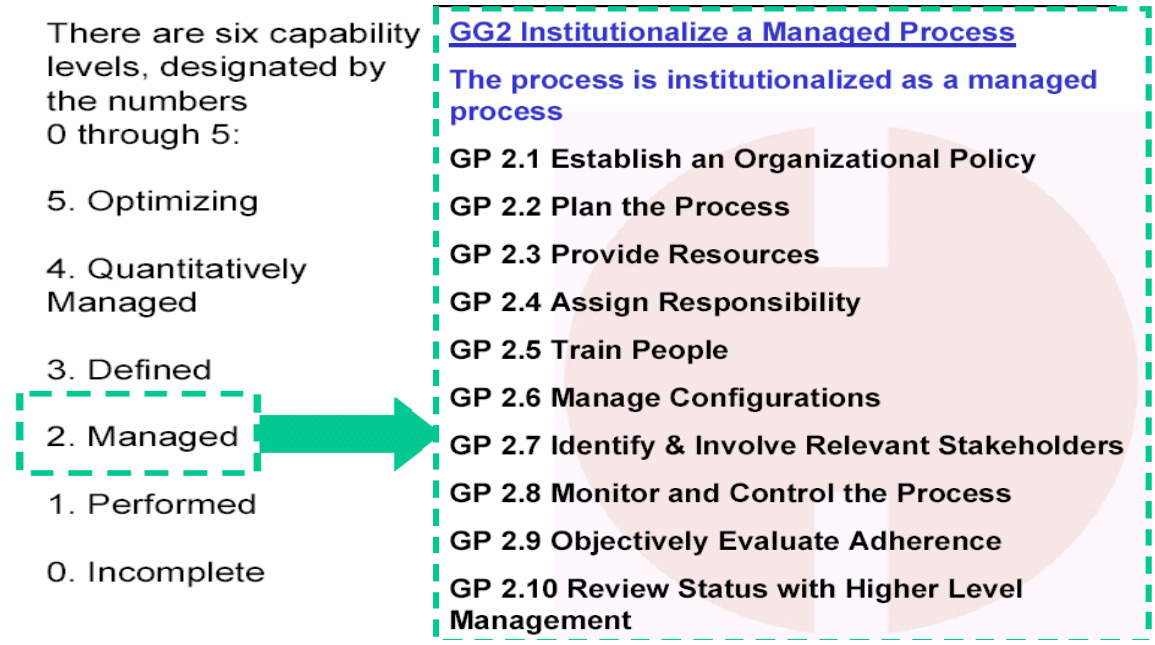

Figure 3.2: A Capability Level Corresponds to a Generic Goal (GG), which organizes Generic Practices (GP)

A managed process is institutionalized by doing the following: [2]

- ☑ Adhering to organizational policies
- ☑ Following established plans and process descriptions
- ☑ Providing adequate resources (including funding, people, and tools)
- ☑ Assigning responsibility and authority for performing the process
- ☑ Training the people performing and supporting the process
- ☑ Placing designated work products under appropriate levels of configuration management
- ☑ Identifying and involving relevant stakeholders
- ☑ Monitoring and controlling the performance of the process against the plans for performing the process and taking corrective actions

- Objectively evaluating the process, its work products, and its services for adherence to the process descriptions, standards, and procedures, and addressing noncompliance
- Reviewing the activities, status, and results of the process with higher level management, and taking corrective action Institutionalization also implies that the breadth and depth of the implementation of the process and the length of time the process has been in place are appropriate to ensure that the process is ingrained in the way the work is performed.

3.2.3.1 Level 2: Generic Goals

GG 2 Institutionalize a Managed Process

The description of GG1 is given in the glossary.

3.2.3.2 Level 2: Generic Practices

GP 2.1 Establish an Organizational Policy

Establish and maintain an organizational policy for planning and performing the process. [1]

The purpose of this generic practice is to define the organizational expectations for the process and make these expectations visible to those in the organization who are affected. In general, senior management is responsible for establishing and communicating guiding principles, direction, and expectations for the organization.

Not all direction from senior management will bear the label “policy.” The existence of appropriate organizational direction is the expectation of this generic practice, regardless of what it is called or how it is imparted. [1]

GP 2.2 Plan the Process

Establish and maintain the plan for performing the process. [1]

The purpose of this generic practice is to determine what is needed to perform the process and achieve the established objectives, to prepare a plan for performing the process, to prepare a process description, and to get agreement on the plan from relevant stakeholders. [1]

GP 2.3 Provide Resources

Provide adequate resources for performing the process, developing the work products, and providing the services of the process. [1]

The purpose of this generic practice is to ensure that the resources necessary to perform the process as defined by the plan are available when they are needed. Resources include adequate funding, appropriate physical facilities, skilled people, and appropriate tools. [1]

GP 2.4 Assign Responsibility

Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process. [1]

The purpose of this generic practice is to ensure that there is accountability throughout the life of the process for performing the process and achieving the specified results. The people assigned must have the appropriate authority to perform the assigned responsibilities. [1]

GP 2.5 Train People

Train the people performing or supporting the process as needed. [1]

GP 2.6 Manage Configurations

Place designated work products of the process under appropriate levels of configuration management. [1]

GP 2.7 Identify and Involve Relevant Stakeholders

Identify and involve the relevant stakeholders as planned. [1]

GP 2.8 Monitor and Control the Process

Monitor and control the process against the plan for performing the process and take appropriate corrective action.

GP 2.9 Objectively Evaluate Adherence

Objectively evaluate adherence of the process against its process description, standards, and procedures, and address noncompliance. [1]

GP 2.10 Review Status with Higher Level Management

Review the activities, status, and results of the process with higher-level management and resolve issues. [1]

Table 3.2

An example showing conformance

Problem Domain		Solution Domain	
Generic Goal	Specific Goal	Specific/Generic Practice	Example Implementation
Level 2 GG2 Institutionalize a Managed Process The Process is Institutionalized as a managed process	SP1 Manage Requirements Requirements are managed and inconsistencies with project plan and work products are identified	SP1.1-1 Obtain an Understanding of requirements	At a Requirements Elicitation workshop all attendees will discuss, model, and document requirements develop an understanding of the requirements. The commitment to the requirements documented at the workshop will be obtained and documented through acceptance of the requirements at reviews during the workshop.
		SP1.2-2 Obtain commitment to requirements	
		GP2.1 Establish an organizational policy	The Project Member responsible for Requirements Elicitation must Invite all parties to the Requirements Elicitation Workshops Invitations must be sent between 2 and 4 weeks before the planned start of the workshop. A person with a grade xyz qualification may only lead the Workshop.

3.2.4 Capability Level 3: Defined

A capability level 3 process is characterized as a “defined process.”

A defined process is a managed (capability level 2) process that is tailored from the organization's set of standard processes according to the organization’s tailoring guidelines, and contributes work products, measures, and other process-improvement information to the organizational process assets. [1]

The organization’s set of standard processes, which are the basis of the defined process, are established and improved over time. Standard processes describe the fundamental process elements that are expected in the defined processes. Standard processes also describe the relationships (e.g., the ordering and interfaces) between these process elements. The organization-level infrastructure to support current and future use of the organization's set of standard processes is established and improved over time. [1]

A defined process clearly states the following:

1. Purpose
2. Inputs
3. Entry criteria
4. Activities
5. Roles
6. Measures
7. Verification steps
8. Outputs
9. Exit criteria

A defined process is institutionalized by doing the following:

1. Addressing the items that institutionalize a managed process
2. Following a plan that incorporates a defined process
3. Collecting work products, measures, and improvement information for supporting the use and improvement of the organizational process assets

A critical distinction between a managed process and a defined process is the scope of application of the process descriptions, standards, and procedures. For a managed process, the process descriptions, standards, and procedures are applicable to a particular project, group, or organizational function. As a result, the managed processes for two projects within the same organization may be very different. [1]

At the defined capability level, the organization is interested in deploying standard processes that are proven and that therefore take less time and money than continually writing and deploying new processes. Because the process descriptions, standards, and procedures are tailored from the organization's set of standard processes and related organizational process assets, defined processes are appropriately consistent across the organization. Another critical distinction is that a defined process is described in more detail and performed more rigorously than a managed process. This means that improvement information is easier to understand, analyze, and use. Finally, management of the defined process is based on the additional insight provided by an understanding of the interrelationships of the process activities and detailed measures of the process, its work products, and its services. [1]

3.2.3.1 Level 3: Generic Goals

GG 3 Institutionalize a Defined Process

The description of GG1 is given in the glossary

3.2.3.2 Level 3: Generic Practices

GP 3.1 Establish a Defined Process

Establish and maintain the description of a defined process. [1]

GP 3.2 Collect Improvement Information

Collect work products, measures, measurement results, and improvement information derived from planning and performing the process to support the future use and improvement of the organization's processes and process assets.

3.2.4 Capability Level 4: Quantitatively Managed

A capability level 4 process is characterized as a "quantitatively managed process."

A quantitatively managed process is a defined (capability level 3) process that is controlled using statistical and other quantitative techniques. Quantitative objectives for quality and process performance are established and used as criteria in managing the process. The quality and process performance are understood in statistical terms and are managed throughout the life of the process. [1]

The quantitative objectives are based on the capability of the organization's set of standard processes, the organization's business objectives, and the needs of the customer, end users, organization, and process implementers, subject to available resources. [1]

Quantitative management is performed on the overall set of processes that produces a product or provides a service. The sub-processes that are significant contributors to overall process performance are statistically managed. For these selected sub-processes, detailed measures of the process performance are collected and statistically analyzed. Special causes of process variation are identified and, where appropriate, the source of the special cause is addressed to prevent future occurrences. [1]

A quantitatively managed process is institutionalized by doing the following:

1. Addressing the items that institutionalize a defined process
2. Establishing and maintaining quantitative objectives for quality and process performance
3. Stabilizing the performance of sub-processes critical to the performance of the process
4. Establishing and maintaining an understanding of the ability of the process to achieve the established quantitative objectives for quality and process performance

3.2.4.1 Level 4: Generic Goals

GG 4 Institutionalize a Quantitatively Managed Process

The description of GG1 is given in the glossary

3.2.4.2 Level 4: Generic Practices

GP 4.1 Establish Quantitative Objectives for the Process

Establish and maintain quantitative objectives for the process that address quality and process performance based on customer needs and business objectives. [1]

GP 4.2 Stabilize Sub-process Performance

Stabilize the performance of one or more sub-processes to determine the ability of the process to achieve the established quantitative quality and process-performance objectives. [1]

3.2.5 Capability Level 5: Optimizing

A capability level 5 process is characterized as an “optimizing process.”

An optimizing process is a quantitatively managed (capability level 4) process that is changed and adapted to meet relevant current and projected business objectives. An optimizing process focuses on continually improving the process performance through both incremental and innovative technological improvements. Process improvements that would address root causes of process variation and measurably improve the organization's processes are identified, evaluated, and deployed as appropriate. These improvements are selected based on a quantitative understanding of their expected contribution to achieving the organization's process-improvement objectives versus the cost and impact to the organization. The process performance of the organization's processes is continually improved. [1]

An optimizing process is institutionalized by doing the following:

1. Satisfying the items that institutionalize a quantitatively managed process
2. Establishing and maintaining quantitative process-improvement objectives
3. Identifying and deploying both incremental and innovative technological improvements that continually improve the range of process performance

A critical distinction between a quantitatively managed process and an optimizing process is that the optimizing process is continuously improved by addressing common causes of process variation. A quantitatively managed process is concerned with addressing special causes of process variation and providing statistical predictability for the results. Though the process may produce predictable results, the results may be insufficient to achieve the established objectives. In a process that is optimized, common causes of process variation are addressed by changing that process in a manner that will lead to a shift in the mean or a decrease in variation when it is brought back to stability. These changes are intended to improve process performance and achieve the organization's established process-improvement objectives. [1]

3.2.5.1 Level 5: Generic Goals

GG 5 Institutionalize an Optimizing Process

The description of GG1 is given in the glossary

3.2.5.2 Level 5: Generic Practices

GP 5.1 Ensure Continuous Process Improvement

Ensure continuous improvement of the process in fulfilling the relevant business objectives of the organization. [1]

Optimizing processes that are agile and innovative depends on the participation of an empowered workforce aligned with the business values and objectives of the organization. The organization's ability to rapidly respond to changes and opportunities is enhanced by finding ways to accelerate and share learning. Improvement of the processes is inherently part of everybody's role, resulting in a cycle of continual improvement. [1]

CHAPTER IV

STAGED REPRESENTATION

4.1 Structural Overview

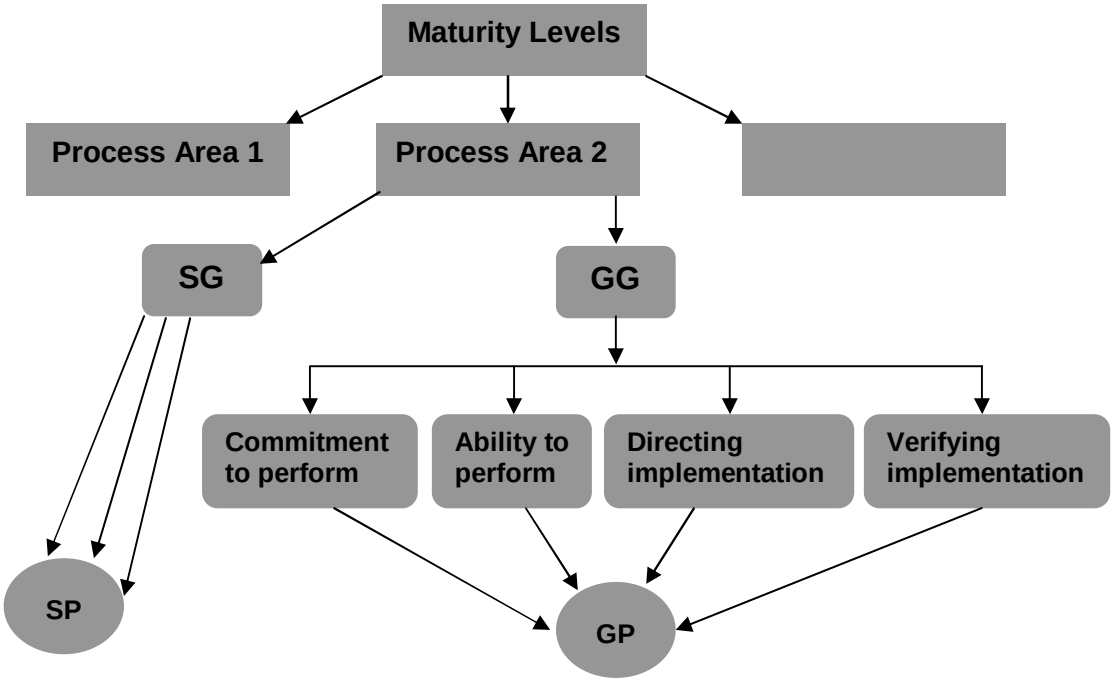

Figure 4.1: Structure of the Staged Representation

4.2 Maturity Levels

To get started with staged representation the following two steps are mandatory. [2]

- At staged representation, the desired maturity levels that are Initial, Managed, Defined, Quantitatively Managed and Optimizing need to be chosen.
- Select a process area.

4.2.1 Maturity level 1: Initial

At maturity level 1, processes are usually ad hoc and chaotic. The organization usually does not provide a stable environment. Success in these organizations depends on the competence and heroics of the people in the organization and not on the use of proven processes. In spite of this ad hoc, chaotic environment, maturity level 1 organizations often produce products and services that work; however, they frequently exceed the budget and schedule of their projects. [1]

Maturity level 1 organizations are characterized by a tendency to over commit, abandon processes in the time of crisis, and not be able to repeat their past successes. [1]

4.2.2 Maturity level 2: Managed

At maturity level 2, represents process maturity characterized by repeatable project performance that is, the key process focus is on project-level activities and practices. [1]

At maturity level 2, an organization has achieved all the specific and generic goals of the maturity level 2 process areas. In other words, the projects of the organization have ensured that requirements are managed and that processes are planned, performed, measured, and controlled. [2]

The process discipline reflected by maturity level 2 helps to ensure that existing practices are retained during times of stress. When these practices are in place, projects are performed and managed according to their documented plans. [2]

At maturity level 2, requirements, processes, work products, and services are managed. The status of the work products and the delivery of services are

visible to management at defined points (for example, at major milestones and at the completion of major tasks). [2]

Commitments are established among relevant stakeholders and are revised as needed. Work products are reviewed with stakeholders and are controlled. The work products and services satisfy their specified requirements, standards, and objectives. [2]

An example of level 2 process is given bellow where the related specific and generic goals and practices are mentioned and highlighted.

Example:

Figure 4.2: Goals and practices for Requirement Management

Process Area: Requirements Management

Purpose

> The purpose of Requirements Management is to manage the requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products. [1]

Requirements management processes manage all requirements received or generated by the project, including both technical and non-technical requirements. In particular, if the Requirements Development process area is implemented, its processes will generate product and product-component requirements that will also be managed by the requirements management processes. When the Requirements Management, Requirements Development,

and Technical Solution process areas are all implemented, their associated processes may be closely tied and be performed concurrently. [2]

The project takes appropriate steps to ensure that the agreed-upon set of requirements is managed to support the planning and execution needs of the project. When a project receives requirements from an approved requirements provider, the requirements are reviewed with the requirements provider to resolve issues and prevent misunderstanding before the requirements are incorporated into the project's plans. Once the requirements provider and the requirements receiver reach an agreement, commitment to the requirements is obtained from the project participants. The project manages changes to the requirements as they evolve and identifies any inconsistencies that occur among the plans, work products, and requirements. [2]

Part of the management of requirements is to document requirements changes and rationale and maintain bi-directional traceability between source requirements and all product and product-component requirements. [2]

4.2.3 Maturity level 3: Defined

Level 3 represents a process maturity characterized by improving project performance within an organization. Consistent, cross-project disciplines for Level 2 key process areas are emphasized to establish organization-level activities and practices. [1]

At maturity level 3, an organization has achieved all the specific and generic goals of the process areas assigned to maturity levels 2 and 3. At maturity level 3, processes are well characterized and understood, and are described in standards, procedures, tools, and methods. [2]

The organization's set of standard processes, which is the basis for maturity level 3, is established and improved over time. These standard processes are used to establish consistency across the organization. Projects

establish their defined processes by tailoring the organization's set of standard processes according to tailoring guidelines. [2]

The organization's management establishes process objectives based on the organization's set of standard processes and ensures that these objectives are appropriately addressed. [2]

A critical distinction between maturity level 2 and maturity level 3 is the scope of standards, process descriptions, and procedures. At maturity level 2, the standards, process descriptions, and procedures may be quite different in each specific instance of the process (for example, on a particular project). At maturity level 3, the standards, process descriptions, and procedures for a project are tailored from the organization's set of standard processes to suit a particular project or organizational unit. The organization's set of standard processes includes the processes addressed at maturity level 2 and maturity level 3. As a result, the processes that are performed across the organization are consistent except for the differences allowed by the tailoring guidelines. [2]

Another critical distinction is that at maturity level 3, processes are typically described in more detail and more rigorously than at maturity level 2. At maturity level 3, processes are managed more proactively using an understanding of the interrelationships of the process activities and detailed measures of the process, its work products, and its services. [2]

An example of level 3 process is given in the following page where the related specific and generic goals and practices are mentioned and highlighted.

Example:

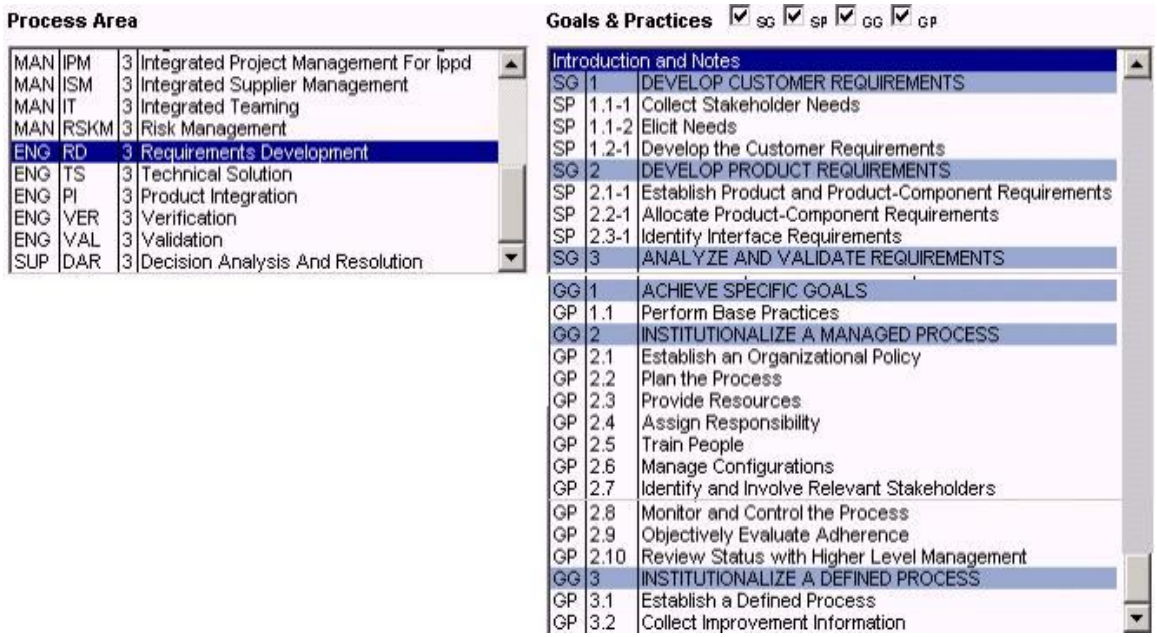

Figure 4.3: Goals and practices for Requirement Development

Process Area: Requirements Development

Purpose

The purpose of Requirements Development is to produce and analyze customer, product, and product-component requirements. [1]

This process area describes three types of requirements: customer requirements, product requirements, and product-component requirements. Taken together, these requirements address the needs of relevant stakeholders, including those pertinent to various product life-cycle phases (e.g., acceptance, testing criteria) and product attributes (e.g., safety, reliability, maintainability). Requirements also address constraints caused by the selection of design solutions (e.g., integration of commercial off-the-shelf products). [2]

Requirements are the basis for design. The development of requirements includes the following activities: [1]

- Elicitation, analysis, validation, and communication of customer needs, expectations, and constraints to obtain customer requirements that constitute an understanding of what will satisfy stakeholders
- Collection and coordination of stakeholder needs
- Development of the life-cycle requirements of the product
- Establishment of the customer requirements
- Establishment of initial product and product-component requirements consistent with customer requirements

This process area addresses all customer requirements rather than only product-level requirements because the customer may also provide specific design requirements. [2]

Customer requirements are further refined into product and product-component requirements. In addition to customer requirements, product and product-component requirements are derived from the selected design solutions.

Requirements are identified and refined throughout the phases of the product life cycle. Design decisions, subsequent corrective actions, and feedback during each phase of the product's life cycle are analyzed for impact on derived and allocated requirements. [2]

The Requirements Development process area includes three specific goals.

1. Develop Customer Requirements specific goal addresses defining a set of customer requirements to use in the development of product requirements. [2]
2. Develop Product Requirements specific goal addresses defining a set of product or product-component requirements to use in the design of products and product components. [2]

3. Analyze and Validate Requirements specific goal addresses the necessary analysis of customer, product, and product-component requirements to define, derive, and understand the requirements. [2]

The specific practices of the third specific goal are intended to assist the specific practices in the first two specific goals. The processes associated with Requirements Development process area and those associated with Technical Solution process area may interact recursively with one another. [2]

Analyses are used to understand, define, and select the requirements at all levels from competing alternatives. These analyses include the following:

- Analysis of needs and requirements for each product life-cycle phase, including needs of relevant stakeholders, the operational environment, and factors that reflect overall customer and end-user expectations and satisfaction, such as safety, security, and affordability [2]
- Development of an operational concept [2]
- Definition of the required functionality [2]

The definition of functionality, also referred to as “functional analysis,” is not the same as structured analysis in software development and does not presume a functionally oriented software design. In object-oriented software design, it relates to defining the services. The definition of functions, their logical groupings, and their association with requirements is referred to as a “functional architecture.” [2]

Analyses occur recursively at successively more detailed layers of a product’s architecture until sufficient detail is available to enable detailed design, acquisition, and testing of the product to proceed. As a result of the analysis of requirements and the operational concept (including functionality, support, maintenance, and disposal), the manufacturing or production concept produces more derived requirements, including consideration of the following:

- Constraints of various types
- Technological limitations

- Cost and cost drivers
- Time constraints and schedule drivers
- Risks
- Consideration of issues implied but not explicitly stated by the customer or end user
- Factors introduced by the developer's unique business considerations, regulations, and laws

A hierarchy of logical entities (functions and sub-functions, object classes and subclasses) is established through iteration with the evolving operational concept. Requirements are refined, derived, and allocated to these logical entities. Requirements and logical entities are allocated to products, product components, people, associated processes, or services. [2]

Involvement of relevant stakeholders in both requirements development and analysis gives them visibility into the evolution of requirements. This activity continually assures them that the requirements are being properly defined.

4.2.4 Maturity level 4: Quantitatively Managed

Level 4 represents a process maturity characterized by improving organizational performance. Historical results for Level 3 projects can be exploited to make trade offs, with predictable results, among competing dimensions of business performance (cost, quality, timeliness). [2]

At maturity level 4, an organization has achieved all the specific goals of the process areas assigned to maturity levels 2, 3, and 4 and the generic goals assigned to maturity levels 2 and 3. Sub-processes are selected so that they significantly contribute to overall process performance. These selected sub-processes are controlled using statistical and other quantitative techniques. [2]

Quantitative objectives for quality and process performance are established and used as criteria in managing processes. Quantitative objectives

are based on the needs of the customer, end users, organization, and process implementers. Quality and process-performance are understood in statistical terms and are managed throughout the life of the processes. [2]

For these processes, detailed measures of process performance are collected and statistically analyzed. Special causes of process variation 2 are identified and, where appropriate, the sources of special causes are corrected to prevent future occurrences. [2]

Quality and process performance measures are incorporated into the organization’s measurement repository to support fact-based decision making in the future. [2]

A critical distinction between maturity level 3 and maturity level 4 is the predictability of process performance. At maturity level 4, the performance of processes is controlled using statistical and other quantitative techniques, and is quantitatively predictable. At maturity level 3, processes are only qualitatively predictable. [2]

An example of level 4 process is given at the following page where the related specific and generic goals and practices are mentioned and highlighted.

Example:

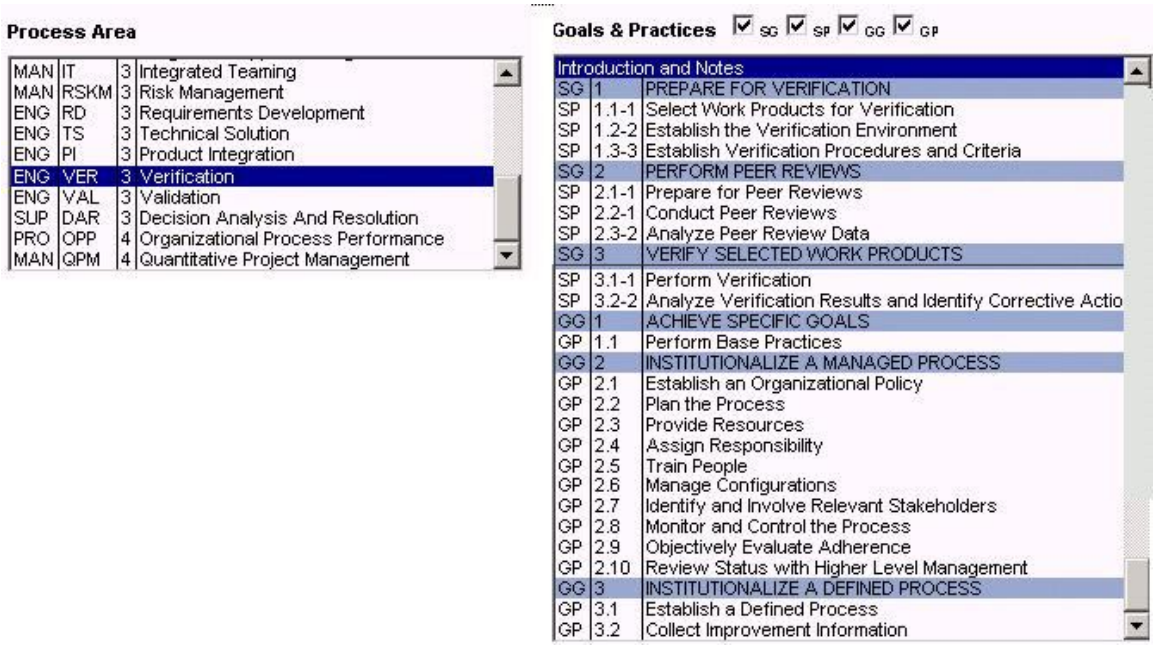

Figure 4.4: Goals and practices for Verification

Process Area: Verification

Purpose

The purpose of Verification is to ensure that selected work products meet their specified requirements. [1]

The Verification process area involves the following: verification preparation, verification performance, and identification of corrective action. [2]

Verification includes verification of the product and intermediate work products against all selected requirements, including customer, product, and product-component requirements. [2]

Verification is inherently an incremental process because it occurs throughout the development of the product and work products, beginning with verification of the requirements, progressing through the verification of the evolving work products, and culminating in the verification of the completed product. [2]

The specific practices of this process area build upon each other in the following way:

- The *Select Work Products for Verification* specific practice enables the identification of the work products to be verified, the methods to be used to perform the verification, and the requirements to be satisfied by each selected work product. [2]
- The *Establish the Verification Environment* specific practice enables the determination of the environment that will be used to carry out the verification. [2]
- The *Establish Verification Procedures and Criteria* specific practice then enables the development of verification procedures and criteria that are aligned with the selected work products, requirements, methods, and characteristics of the verification environment. [2]
- The *Perform Verification* specific practice conducts the verification according to the available methods, procedures, and criteria. [2]

Verification of work products substantially increases the likelihood that the product will meet the customer, product, and product-component requirements.

The Verification and Validation process areas are similar, but they address different issues. Validation demonstrates that the product, as provided (or as it will be provided), will fulfill its intended use, whereas verification addresses whether the work product properly reflects the specified requirements. In other words, verification ensures that “you built it right;” whereas, validation ensures that “you built the right thing.” [2]

Peer reviews are an important part of verification and are a proven mechanism for effective defect removal. An important corollary is to develop a better understanding of the work products and the processes that produced them so defects can be prevented and process-improvement opportunities can be identified. [2]

Peer reviews involve a methodical examination of work products by the producers' peers to identify defects and other changes that are needed. [2]

Examples of peer review methods include the following:

- Inspections
- Structured walkthroughs

4.2.5 Maturity level 5: Optimizing

Level 5 represents a process maturity characterized by rapidly re-configurable organizational performance as well as quantitative, continuous process improvement.

At maturity level 5 an organization has achieved all the specific goals of the process areas assigned to maturity levels 2, 3, 4, and 5 and the generic goals assigned to maturity levels 2 and 3. Processes are continually improved based on a quantitative understanding of the common causes of variation 3. [2]

Maturity level 5 focuses on continually improving process performance through both incremental and innovative technological improvements. Quantitative process-improvement objectives for the organization are established, continually revised to reflect changing business objectives, and used as criteria in managing process improvement. The effects of deployed process improvements are measured and evaluated against the quantitative process-improvement objectives. Both the defined processes and the organization’s set of standard processes are targets of measurable improvement activities. Process improvements to address common causes of process variation and measurably improve the organization’s processes are identified, evaluated, and deployed. Improvements are selected based on a quantitative understanding of their expected contribution for achieving the organization’s process-improvement objectives versus the cost and impact to the organization. The performance of the organization’s processes is continually improved. [2]

Optimizing processes that are agile and innovative depends on the participation of an empowered workforce aligned with the business values and objectives of the organization. The organization's ability to rapidly respond to changes and opportunities is enhanced by finding ways to accelerate and share learning. Improvement of the processes is inherently part of everybody's role, resulting in a cycle of continual improvement. [2]

A critical distinction between maturity level 4 and maturity level 5 is the type of process variation addressed. At maturity level 4, processes are concerned with addressing special causes of process variation and providing statistical predictability of the results. Though processes may produce predictable results, the results may be insufficient to achieve the established objectives. At maturity level 5, processes are concerned with addressing common causes of process variation and changing the process (that is, shifting the mean of the process performance) to improve process performance (while maintaining statistical predictability) to achieve the established quantitative process-improvement objectives. [2]

An example of level 5 process is given in the following page where the related specific and generic goals and practices are mentioned.

Example:

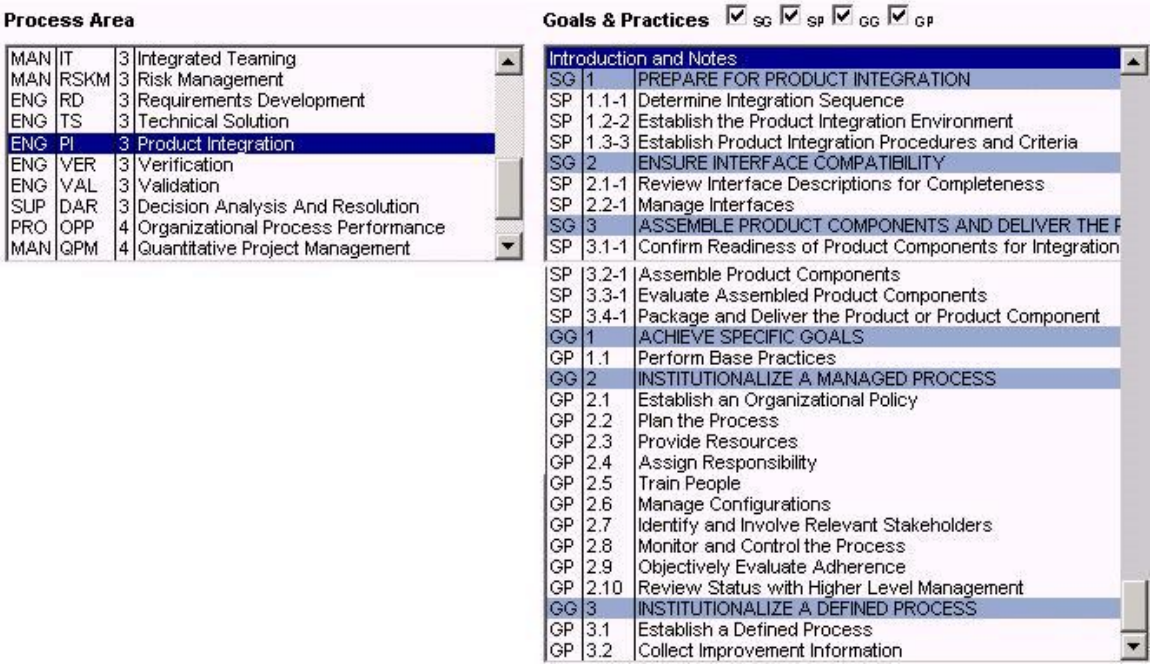

Figure 4.5: Goals and practices for Product Integration

Process Area: Product Integration

Purpose

> The purpose of Product Integration is to assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product. [1]

This process area addresses the integration of product components into more complex product components or into complete products. The term “integration” is used in this sense throughout this process area and is not to be confused with integration of people or activities that may be described elsewhere in the model. [2]

The scope of this process area is to achieve complete product integration through progressive assembly of product components, in one stage or in incremental stages, according to a defined integration sequence and procedures.

A critical aspect of product integration is the management of internal and external interfaces of the products and product components to ensure compatibility among the interfaces. Attention should be paid to interface management throughout the project. [2]

Product integration is more than just a one-time assembly of the product components at the conclusion of design and fabrication. Product integration can be conducted incrementally, using an iterative process of assembling product components, evaluating them, and then assembling more product components. This process may begin with analysis and simulations (e.g., threads, rapid prototypes, virtual prototypes, and physical prototypes) and steadily progress through increasingly more realistic incremental functionality until the final product is achieved. In each successive build, prototypes (virtual, rapid, or physical) are constructed, evaluated, improved, and reconstructed based upon knowledge gained in the evaluation process. The degree of virtual vs. physical prototyping required depends on the functionality of the design tools; the complexity of the product, and its associated risk. There is a high probability that the product, integrated in this manner, will pass product verification and validation. For some products, the last integration phase will occur when the product is deployed at its intended operational site. [2]

CHAPTER V

SCENARIO: GLOBAL AND DOMESTIC

5.1 Organizations New to CMM-Type Models

Organizations without experience either in SW-CMM or EIA/IS 731 are assumed to be in one of two categories. [2]

- They may have undertaken process-improvement efforts under other quality initiatives such as ISO 9000 or Malcolm Baldrige, or
- They may be considering such efforts because of the mounting evidence of business value resulting from such a commitment.

Both categories of organizations will find familiar relationships to other quality efforts in the CMMI Product Suite. They also gain reference models of effective practices that can be applied—across the value chain—to enhance the quality of products and their associated processes. [2]

These organizations may approach improvement by using either a continuous or staged representation. Each approach is complementary to the other. Neither is mutually exclusive, but the choice will affect the schedule and needs of the organization for training and appraisal. [2]

5.2 Global Scenario

SCAMPI appraisals conducted since 1999 and reported to the SEI by February 2003:73 appraisals [2]

- 40 participating companies
- 30% organizations upgrading
- 70% organizations new to CMM-type
- 52% offshore organizations

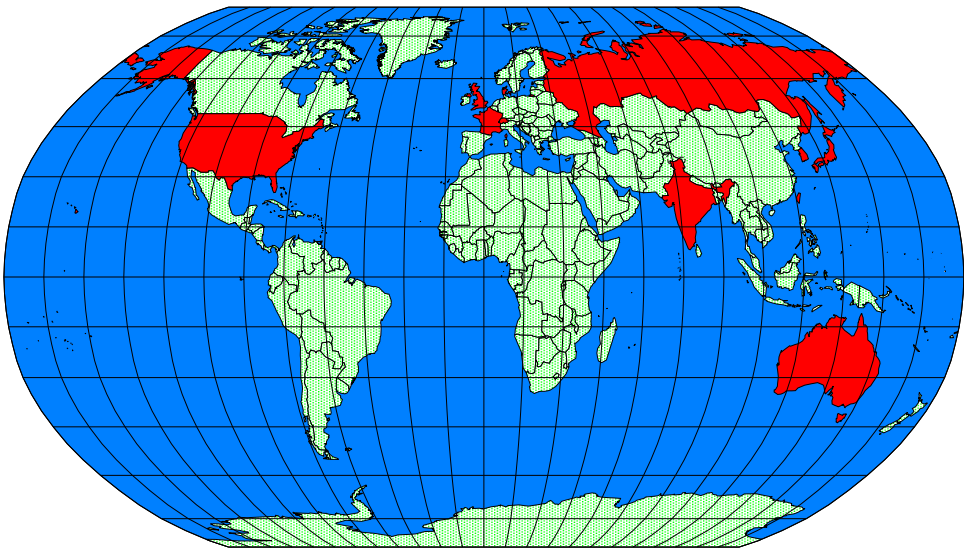

Figure 5.1: Dark portions indicates the adopter's region

CMMI is being adopted worldwide. Appraisals of organizations using CMMI were conducted in the following countries:

Argentina, Australia, Belarus, Canada, Chile, China, Columbia, Denmark, Finland, France, Germany, India, Israel, Japan, Korea, Republic of Malaysia, Philippines, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom, United States. [2]

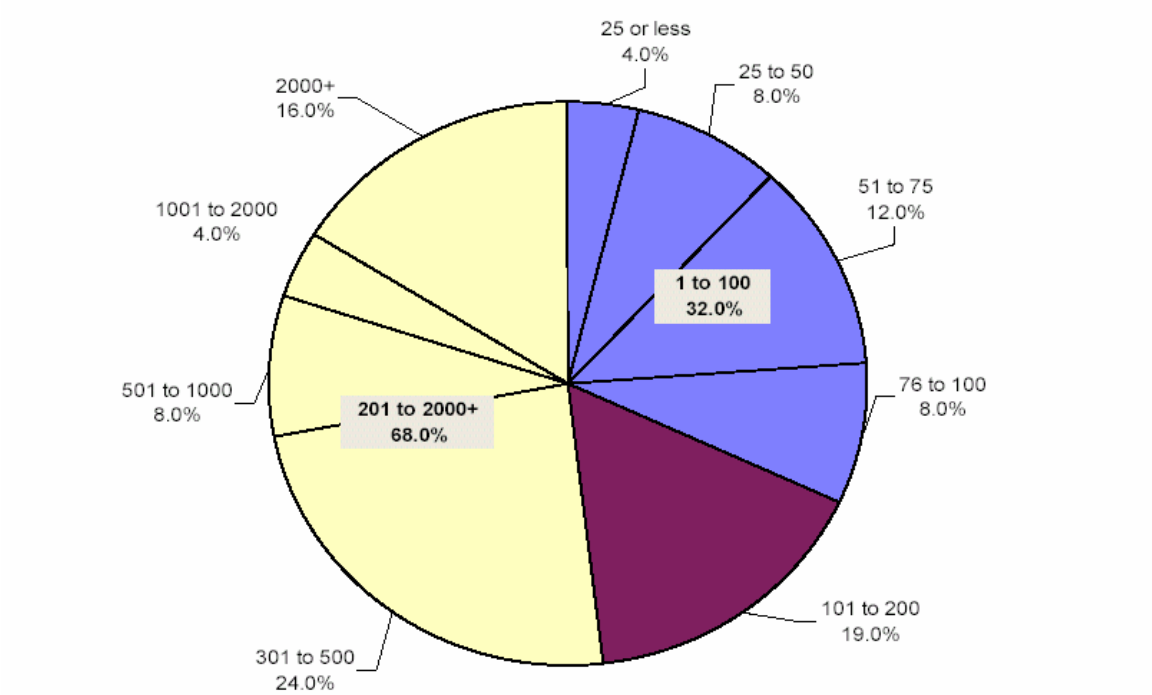

Figure 5.2: Appraised organizations (based on total no. of employees)

5.2.1 Some optimistic examples in domain B

TCS (Tata Consultancy Service), Wipro, Infosys Technology Limited are the top 3 companies in software and service exporter. All of them are CMMI certified. There are two figures given in section 5.4 that indicates quite clearly that how good these companies are doing business.

5.3 Domestic Scenario

Human resources for the IT industry in Bangladesh have been growing rapidly since the government declared this industry as a thrust sector and has embarked on a mission to make the industry a substantial part of the USD 36 Billion economy. The vital statistics for this sector are given in the next page.

- More than 300,000 IT professionals are engaged in the industry.
- 26 universities offer undergraduate and graduate degrees in computer science and engineering.
- More than 1000 private and public sector computer training institutes offer IT skill development of various levels.

However, as in section 5.2, it is obvious that what ever the size of the organization is or wherever it locates in the globe the adoption of CMMI is possible. Not only that CMMI promise to make organization wide improvement, which will earn more revenue and reputation. As the software industry in Bangladesh is not yet been structured to satisfy any international standards and since we have enough resources (manpower, low labor cost), it is time to adopt standardized model(s) to strengthen the infrastructure and the structural integrity to climb above the surface as if we can prove to the world that we exist.

May be with the same spirit, some of the Bangladeshi organizations has been practicing some of the standards like ISO. As the goal of this thesis is to identify their standard and find the potentialities whether CMMI can be adopted or not, the interview report is given bellow.

5.3.1 Interview with reputed organizations

The participatory organizations are Southtech Limited, Therap Services, Millennium Information Solution Limited and Soft-Ed.

5.3.2 Interview And Analysis

5.3.2.1 Southtech Limited

This organization has already procured good name in software market. It has achieved ISO 9001-2000 certification. They are also familiar with CMMI and

have their own on going process enhancement program. This program seeks for upgrading in house processes if it finds any drawback.

Southtech Limited is always very keen about customer satisfaction from requirement collection to after sales services. The steps of their development cycle are:

1. Collect information or requirements
2. Integrate requirements
3. Thorough technical documentation using different templates including use-case modeling.
4. Feedback from the client
5. If the requirements change then, software configuration management processes are followed.
6. Design the system and detailed technical documentation is maintained.
7. Testing
8. Delivered
9. Implementing the system

Southtech Limited is proud to state that they always manage to meet project deadline. To avoid deadline failure they adjust their schedule with clients concerns. In case of urgency of the clients what they do is

1. Collect the requirements
2. Identify the fundamental features with the agreement of the clients
3. Clarification
4. Documentation
5. Impact analysis
6. Design
7. Implementation

Since they maintain in details documentation and work as a team in every phase of SDLC (System Development Life Cycle) they do not encounter any problem to upgrade any version of the delivered product even if any of the developer who developed that particular product is no more there.

When they receive request from any of the clients they carryout the following tasks:

1. Collect requested requirements
2. Post implementation
   - 2.1 Integrate new requirements
   - 2.2 Document the changes and enhancements
   - 2.3 Impact analysis both business and technical
   - 2.4 Enhance the product's maturity by implementing new features

Questionnaire for Southtech Limited

Table 5.1:

Process areas that you are currently operating in

Key Process Area	**T**otally/**P**artially conceived	**A**djustments
Requirements Management	T	A
Project Planning	T	A
Project Monitoring & Control	T	A
Supplier Agreement Management	P	A
Measurement & Analysis	P	A
Process & Product Quality Assurance	P	A
Configuration Management	T	A
Requirements Development	T	A
Technical Solution	P	A
Product Integration	T	A
Verification	P	A

Validation	P	A
Organizational Process Focus	P	A
Organizational Process Definition	P	A
Organizational Training	T	A
Integrated Project Management	P	A
Risk Management	T	A
Integrated Teaming	P	A
Integrated Supplier Management	P	A
Decision Analysis & Resolution	P	A
Organizational Environment for Integration	P	A
Organizational Process Performance	P	A
Quantitative Project Management	P	A
Organizational Innovation & Deployment	P	A
Causal Analysis & Resolution	P	A

Q 1: Identify the process(s) from the above list that you are currently targeting to adopt?

Answer: We are currently targeting to adopt process areas 5, 6, 7 and adjust a few others.

Table 5.2:

Requirement collection method for past 4 projects

Methods	Answer: **Y**es / **N**o / To some **E**xtend			
	P-1	P-2	P-3	P-4

1. Interview	Y	Y	Y	Y
2. Questionnaire	E	E	E	E
3. Documents study	Y	Y	Y	Y
4. Observation	Y	Y	Y	Y
5. JAD session	E	E	E	E
6. Any other (Please mention)				

Table 5.3:

At what extend did the developers follow the recommended practices of the company for past 4 projects?

	Answer: **Y**es / **N**o / To some **E**xtend			
Recommended practices	P-1	P-2	P-3	P-4
How to plan a project?	Y	Y	Y	Y
How to perform technical review?	Y	Y	Y	Y
How to manage requirements?	Y	Y	Y	Y
How to assure quality?	Y	Y	Y	Y
How to design?	Y	Y	Y	Y
How to code?	Y	Y	Y	Y
How to test?	Y	Y	Y	Y
How to adopt new technology?	E	E	E	E

Table 5.4:

What are the sections you used to care about when planning a project?

Product specification	Answer
Detailed user interface prototype	We care about all the listed above sections and also others as required by our procedures and standards.
Realistic schedule	
Explicit priorities	
Active risk management	
Quality assurance plan	
Detailed activity lists	
Software configuration management	
Software architecture	
An integration plan	
Any other	

Q 3: How do you judge whether your project's plan is sound?

Answer: A project plan is judged to be sound based on requirement, technical, and impact analysis; existing development work if any, development experience, customer interaction, project scheduling and risk mitigation.

Q 4: How you predict the size of the project?

Answer: Requirement analysis, Request for changes, enhancement requests and the corresponding technical and business impacts.

Table 5.5:

At what extend did you experience following problems due to departure of past 5 employees?

Problems	Answer: **Y**es / **N**o / To some **E**xtend				
	E-1	E-2	E-3	E-4	E-5
Loss of technical soundness	E	E	N	N	E
It was difficult to continue the work done due to lack of documentation	N	N	N	N	N
It was difficult to serve post implementation	N	N	N	N	N
Other problems (Please mention)					

Table 5.6:

Do you have following designations (or equivalent) in your organization?

Designation	**# of personnel**	**Dual designation**
System engineer/analyst	8	Varies according to project nature and expertise
Requirement engineer	6	Varies according to project nature and expertise
Software architect	4	Varies according to project nature and expertise
Software designer	6	Varies according to project nature and expertise
Software test designer	5	Varies according to project nature and expertise
Coder	20	Varies according to project nature and expertise
Tester	6	Varies according to project nature and expertise
Technical writer	4	Varies according to project nature and expertise

System integrator	7	Varies according to project nature and expertise
Project manager	4	Varies according to project nature and expertise

Table 5.7:

How do new recruits know about how to perform what?

Means of learning	Answer: **Y**es / **N**o / To some **E**xtend
By asking fellow workers	Y
By getting direction from Boss	Y
By consulting organization's manual (if any)	Y
By observing others	Y
By studying code and documents produced in other projects	Y
By getting formal training	Y (in-house)
Other ways (Please mention) Answer: Professional training is also arranged as required.	

Table 5.8:

At what frequency the requirements change during past 5 projects?

	Answer: **Y**es / **N**o				
When changes	P-1	P-2	P-3	P-4	P-5
Requirements changes before significant amount of work has done	N	N	N	N	N
Requirements changes after significant amount of work has been done	Y	N	N	Y	N

Change request after delivering the project	Y	Y	N	Y	N
Too many calls from client seeking helps in using the software	N	N	N	N	N

Q 6: How to manage the changes in the middle of the project?

- ✓ Project plan
- ✓ Changes are invited as enhancement requests once the initial requirement analysis is signed off by the customers.

Q 7: What are the promises that CMMI is capable of: Cross which one you think CMMI is incapable of?

- o Supporting process integration and product improvement
- o Integrating multiple disciplines into one process
- o Improving framework that eliminates inconsistencies and reduces duplication
- o Providing a framework for introducing new disciplines as needs arise and therefore reduces the cost of implementing model-based improvement
- o Setting goals and practices for every process area
- o Encouraging to perform own processes with some adjustments
- o Providing information what goals to achieve
- o Providing information how goals can be achieved
- o ~~Designing to minimize the impact on legacy process improvement efforts and investment~~

Q 8: Does it make sense from the following why any organization should adopt CMMI?

- Improve delivery of *performance, cost, and schedule*
- Collaborate with *relevant stakeholders* and integrate their expectations into day-to-day activities
- Provide *competitive* world-class products and services
- Implement an *integrated* enterprise business and engineering perspective
- Use common, integrated, and *improving processes* for systems and software

Answer: It does.

In terms of Requirement Management process this organization's generic and specific goals are extracted from the interview. On behalf of Southtech Limited Quality Assurance Analyst and Auditor participated in the interview. By analyzing the report the analysis is tabulated as shown bellow.

Table 5.9

Level-2 analysis on interview report

Requirement Management		Analysis
Specific Goals: Manage Requirements	Obtain an understanding of requirements	Yes. Both the clients and project team work together to understand the requirements. In many cases project team asks for clarification what the requirements really meant to them.
	Obtain commitment to requirements	No. The notion exists in the process but not actually performed.
	Manage requirement changes	Yes. Every time the requirements change, the project team documents the changes according to the template.

	Maintain bi-directional traceability of requirements	Yes very strongly. From the customer needs the project team identifies the requirements, track down the changes until its final form, and trace the relationship with the changes. The traceability across these two work groups enables the work groups to see when and how a change in a requirement for one of the components may affect the other component. Thus, bi-directional traceability enables the project to understand the requirements and to anticipate potential problems
	Identify inconsistencies between project work and requirements	Yes. As the work progresses the project team often finds the inconsistencies. Eventually they sort out what and where the lacks are by their gap analysis and followed by impact analysis.
Generic Goal	Achieve specific goals	Yes
	Institutionalized managed process	They are practicing for a long time and achieved ISO 9001-2000.

Table 5.10

Level-3 analysis on interview report

Requirement Development process		**Analysis**
Specific Goals: 1.Requirements	Collect stakeholders needs	No

Development 2.Develop Product Requirements 3. Achieve Specific goals	Elicit needs	Yes. By bi-directional traceability
	Develop customer requirements	No
	Establish product and product-component requirements	No.
	Allocate product-component requirements	Yes. As they are working for a long time they have managed to allocate familiar product components that can be demanded by the clients.
	Identify interface requirements	Yes. By the organization's post implementation process, it identifies what would be the interface and where and how it should be placed.
Generic Goal	1.Achieve specific goals 2.Institutionalized a managed process 3. Institutionalized a defined process	Partially. They have managed to achieve some of the specific goals but they did not yet institutionalized all the existing processes as defined or managed processes. They audit the existing processes in regular intervals to identify the maturity of the processes and the room for improvement.

Though they are not CMMI certified but their on-going processes certainly have the maturity and capability to comply CMMI level 2,3. Southtech Limited can be a potential candidate to be appraised as CMMI adopter. It has been assessed by several foreign organizations and conveyed their willingness to work

with. So for software outsourcing Southtech Limited can be considered as a promising figure.

5.3.2.2 Therap Services

Therap Services is working for mentally retarded individuals. It has already working in 6 states of US and has been planned to cover not all 52 states but beyond the boundary of US.

Therap Services provides online applications along with the following features

- Incident Reports
- Medication Error Reports
- Behavior Tracking and
- Emergency Individual Data

Therap's reporting tools are faster, easier, and more accurate to manage. To give the users a better service (i.e. less access time to queries) it adopted the latest technologies (i.e. hardware, software) and its business analysts are always very keen and responsive to customers/ users demands.

Since the requirements deviated very frequently Therap adopted Agile/Extreme programming method. It practices everyday meeting to set up daily task(s) and finishes that before being engaged in something new.

Therap's stuffs are recruited according to its specified qualities. After recruitment Therap provides exclusive in-house training. It also provides a homely environment to extract the best output from its stuffs by providing room to be entertained.

Ultimately Therap is planned to promote its product as a robust, matured one with in 2007, and then want to go for CMMI certification.

5.3.2.3 Millennium Information Solution Limited

Questionnaire for MISL

Table 5.11:

Where CMMI helps you out to improve your own process areas?

Key process area	**T**otally/ **P**artially conceived	**A**djustments
Requirements Management	T	
Project Planning	T	
Project Monitoring & Control	T	
Supplier Agreement Management		
Measurement & Analysis	T	
Process & Product Quality Assurance	T	
Configuration Management	T	
Requirements Development	T	
Technical Solution	T	
Product Integration	T	
Verification	T	
Validation	T	
Organizational Process Focus	T	
Organizational Process Definition	T	
Organizational Training	T	
Integrated Project Management	T	

Risk Management	T	
Integrated Teaming	T	
Integrated Supplier Management		
Decision Analysis & Resolution	T	
Organizational Environment for Integration		
Organizational Process Performance		
Quantitative Project Management		
Organizational Innovation & Deployment		
Causal Analysis & Resolution		

Q 1:Identify the process(s) from the above list that you are currently targeting to adopt?

Answer: we have all the level 3 processes. So unless we are going for level 4 or 5 assessment we do not have any target process(s) to adopt.

Table 5.12:

Requirement collection method for past 4 projects

Methods	Answer: **Y**es / **N**o / To some **E**xtend			
	P-1	P-2	P-3	P-4
1. Interview	Y	Y	Y	Y
2. Questionnaire	Y	Y	Y	Y
3. Documents study	Y	Y	Y	Y
4. Observation	E	E	E	E

5. e-JAD session	Y	Y	E	E
6. Any other (Please mention) Online chat: Especially for the foreign clients for collecting and clarifying the requirements. Online software: We host 1st version of the software in the internet so that the user can use and directly interact with us about their queries. Domain expertise: We hire domain experts to help our developer team to integrate requirements.				

Table 5.13:

At what extend did the developers follow the recommended practices of the company for past 4 projects?

Answer: **Y**es / **N**o / To some **E**xtend				
	P-1	P-2	P-3	P-4
How to plan a project?	Y	Y	Y	Y
How to perform technical review?	Y	Y	Y	Y
How to manage requirements? Answer: Documentation is done according to the format	Y	Y	Y	Y
How to assure quality? Answer: Quality assurance department	Y	Y	Y	Y
How to design? Answer: Object oriented design	Y	Y	Y	Y
How to code?	Y	Y	Y	Y
How to test? Answer: Tester team	Y	Y	Y	Y
How to adopt new technology? Answer: Switch to new technology for better	Y	Y	Y	Y

business and performance				

Q 2: What are the sections you used to care about when planning a project?

- Product specification **(√)**
- Detailed user interface prototype **(√)**
- Realistic schedule **(√)** *around 80 percent accuracy has been achieved in an average so far.*
- Explicit priorities **(√)**
- Active risk management **(√)** *mainly requirements changes and departure of employee(s) are common risks. Change Control Board and Change Management Process departments handle requirements changes and by engaging our idle resource (back up employees) we manage the latter.*
- Quality assurance plan **(√)** *is taken care of by a separate department*
- Detailed activity lists **(√)** *we mainly maintain the iterative list*
- Software configuration management **(√)** *we use CVS (Concurrent Versioning System)*
- Software architecture **(√)**
- An integration plan **(√)** *for last two criterions we use STRUTS Application Development framework.*

Q 3: How you judge whether your project's plan is sound?

Answer: We arrange a meeting with the stakeholders where the project plan is widely discussed. Those meetings last unless all the sections of the plan meet the interest best of everyone.

Q 4: How you predict the size of the project?

Answer: we used to use use-case points, function points and we rely mostly on Wide Band Delphi methodology (2% - 10%).

Table 5.14:

At what extend did you experience following problems due to departure of past 5 employees?

Problems	Answer: **Y**es / **N**o / To some **E**xtend				
	E-1	E-2	E-3	E-4	E-5
Loss of technical soundness	N	N	N	N	N
It was difficult to continue the work done due to lack of documentation	N	N	N	N	N
It was difficult to serve post implementation	N	N	N	N	N
Other problems (Please mention) Project delay					

We used to do at least two set of documents by two different technical writers so that at least one of them is present to help the team when post implementation requests come.

Table 5.16:

How do new recruits know about how to perform what?

Designation	**# of personnel**	**Dual designation**
System Engineer/Analyst	Total of 40	They have all or equivalent designations. All of their employees more or less can code. Highly experienced personnel carry out the responsibilities like of Software Architect, Software Designer, System Analyst and Project Manager.
Requirement Engineer		
Software Architect		
Software Designer		
Software Test Designer		
Coder		

Tester		
Technical Writer		
System Integrator		
Project Manager		

Table 5.16:

How do new recruits know about how to perform what?

Means of learning	Answer: **Y**es / **N**o / To some **E**xtend
By asking fellow workers	
By getting direction from Boss	
By consulting organization's manual (if any)	
By observing others	
By studying code and documents produced in other projects	
By getting formal training Answer: Not less than 6 months	Y
Other ways (Please mention)	

Table 5.17:

At what frequency the requirements change during past 5 projects?

					Answer: **Y**es / **N**o
When changes	P-1	P-2	P-3	P-4	P-5

Requirements changes before significant amount of work has done	N	N	N	N	N
Requirements changes after significant amount of work has been done	N	N	N	N	N
Change request after delivering the project	N	N	N	N	N
Too many calls from client seeking helps in using the software	N	N	N	N	N

Q 6: How to manage the changes in the middle of the project?

Answer: We have Change Management Process and Change Control Board. These bodies take care of change requests. Project Manager and 2 users (inside or outside of the project) form these bodies.

Q 7: What are the promises that CMMI is capable of: Cross which one you think CMMI is incapable of

- Supporting process integration and product improvement **(√)**
- Integrating multiple disciplines into one process **(√)** *SW/SE*
- Improving framework that eliminates inconsistencies and reduces duplication **(√)** *replicate CMMI framework*
- Providing a framework for introducing new disciplines as needs arise and therefore reduces the cost of implementing model-based improvement **(x)**
- Setting goals and practices for every process area **(√)** *we have our own set of goals and policies but we perform the usual practices set by CMMI*
- Encouraging to perform own processes with some adjustments **(√)**

- Providing information what goals to achieve **(√)** *each Process Area has a policy that sets the goals*
- Providing information how goals can be achieved **(√)** *inside the procedure we manage information about how to achieve the goals*
- Designing to minimize the impact on legacy process improvement efforts and investment **(x)** *we do not have any legacy process. From the day of our foundation we adopted the CMMI supported processes.*

Q 8: does it make sense from the following why any organization should adopt CMMI?

- Improve delivery of *performance, cost, and schedule* **(√)**
- Collaborate with *relevant stakeholders* and integrate their expectations into day-to-day activities **(√)**
- Provide *competitive* world-class products and services **(x)**
- Implement an *integrated* enterprise business and engineering perspective **(x)**
- Use common, integrated, and *improving processes* for systems and software **(√)**

Q 9: When did you decide to adopt CMMI?

Answer: In 2000.

Table 5.18:

Why you decide to adopt CMMI?

Reasons	Answer: **Y**es / **N**o
Mature your processes	Y
More revenue	N
Confirm ROI (Return On Investment)	Y
Stakeholders satisfaction	Y
To make your project plan more accurate	Y
To manage risks	Y
Any other (please mention) Answer: To maintain professional attitude inside the organization we practice PSP (Professional Software Personnel).	

Q 10: What makes you think that you will be able to achieve Level 3 straight?

Answer: We have technical people from top to bottom in our organogram. We have adopted CMMI since 2000 with the view to achieve the standard. So its gave us the confidence to go for level 3 straight.

Q 11: Who is your appraiser?

Answer: Two high-ranked member of SCAMPI () from India. In December, 2003 QP and in 2004 QAI.

Q 12: What part of the company will be tested?

Answer: Every part.

Q 13: When the appraisal process will to be done according to your hope?

Answer: With in December, 2005.

Q 14: How long does it take the company to move from one level to another?

Answer: It depends on which level the organization is targeting to achieve and how they take the preparation.

Q 15: How does the company train new people to be CMMI compliant?

Answer: By organizational training facilities.

5.3.2.4 Soft-Ed

Questionnaire for Soft-Ed

Table 5.19:

Where CMMI helps you out to improve your own process areas?

Key process area	**T**otally/ **P**artially conceived	**A**djustments
Requirements Management	P	A
Project Planning	P	A
Project Monitoring & Control	P	A
Supplier Agreement Management		

Measurement & Analysis		
Process & Product Quality Assurance	P	A
Configuration Management	P	A
Requirements Development		
Technical Solution		
Product Integration		
Verification		
Validation		
Organizational Process Focus		
Organizational Process Definition		
Organizational Training		
Integrated Project Management		
Risk Management	P	A
Integrated Teaming		
Integrated Supplier Management		
Decision Analysis & Resolution		
Organizational Environment for Integration		
Organizational Process Performance		
Quantitative Project Management		
Organizational Innovation & Deployment		
Causal Analysis & Resolution	P	A

Table 5.20:

Requirement collection method for past 4 projects

Methods	Answer: **Y**es / **N**o / To some **E**xtend			
	P-1	P-2	P-3	P-4
1. Interview	Y	Y	Y	Y
2. Questionnaire	Y	Y	Y	Y
3. Documents study	Y	Y	Y	Y
4. Observation	E	E	E	E
5. JAD session	N	N	Y	N
6. Any other (Please mention)				

Table 5.21:

At what extend did the developers follow the recommended practices of the company for past 4 projects?

	Answer: **Y**es / **N**o / To some **E**xtend			
	P-1	P-2	P-3	P-4
How to plan a project?	Y	Y	Y	Y
How to perform technical review?	Y	Y	Y	Y
How to manage requirements? Answer: Documentation is done before the design phase according to the format	E	E	E	E
How to assure quality?	E	E	E	E
How to design?	Y	Y	Y	Y
How to code?	Y	Y	Y	Y

How to test?	Y	Y	Y	Y
How to adopt new technology?	E	E	E	E

Q 2: What are the sections you used to care about when planning a project?

- Product specification **(√)**
- Detailed user interface prototype **(√)**
- Realistic schedule **(√)**
- Explicit priorities **(x)**
- Active risk management **(√)**
- Quality assurance plan **(√)**
- Detailed activity lists **(√)**
- Software configuration management **(√)**
- Software architecture **(√)**
- An integration plan **(√)**

Q 3: How you judge whether your project's plan is sound?

Answer: By the benefits of the user and whether the project can participate in the business.

Q 4: How you predict the size of the project?

Answer: Number of outputs the project need to produce. Form the experience it has been seen that the output increases from 250% - 300% from the AS-IS system.

Table 5.22:

At what extend did you experience following problems due to departure of past 5 employees?

Problems	Answer: **Y**es / **N**o / To some **E**xtend				
	E-1	E-2	E-3	E-4	E-5
Loss of technical soundness	N	N	N	N	N
It was difficult to continue the work done due to lack of documentation	N	N	N	N	N
It was difficult to serve post implementation	Y	Y	Y	Y	Y
Other problems (Please mention)					

Due to the insufficient documentation post implementation seemed to be a problem but now we are giving emphasis on proper documentation.

Table 5.23:

Do you have following designations (or equivalent) in your organization? Please strikethrough if you don't have

Designation	**# of personnel**	**Dual designation**
Business Analyst	1	
System Engineer/Analyst	2	Designer
Requirement Engineer	2	
Software Architect	1	Technical Writer, System Integrator, Project Manager
Software Designer	1	Database Administrator
Software Test Designer	1	
Coder	6	

Tester	1	
Technical Writer	1	
System Integrator	1	
Project Manager	1	

Table 5.24:

How do new recruits know about how to perform what?

Means of learning	Answer: **Y**es/ **N**o/To some **E**xtend
By asking fellow workers	E
By getting direction from Boss	Y
By consulting organization's manual (if any)	E
By observing others	E
By studying code and documents produced in other projects (current project)	Y
By getting formal training	N
Other ways (Please mention)	

Table 5.25:

At what frequency the requirements change during past 5 projects?

					Answer: **Y**es / **N**o
When changes	P-1	P-2	P-3	P-4	P-5
Requirements changes before significant amount of work has done	N	N	N	N	N

Requirements changes after significant amount of work has been done	N	N	N	N	N
Change request after delivering the project	N	N	N	N	N
Too many calls from client seeking helps in using the software	N	N	N	N	N

Q 6: How to manage the changes in the middle of the project?

Answer: We have Change Management Process, which takes care of change requests.

5.4 Software Export: India vs. Bangladesh

The IT industry is represented by two industry bodies, namely Bangladesh Association of Software and Information Services (BASIS) and Bangladesh Computer Samity (BCS). BASIS, established in 1998, is a relatively new industry association whose membership count stands at 34 today and is growing steadily. All major software development and data processing firms of the country are its members. BCS on the other hand was formed in 1988 and represents computer business firms in general; its membership stands at more than 100 today.

5.4.1 Bangladesh software industry

The market size of the Total ICT industry in the country excluding the Telecom Sector is around Tk. 1100 crore out of which size of the Software sector is Tk. 170 crore.[1]

[1] Source: BASIS Software and ITES Directory

At present, more than fifty (50) software and IT service companies are exporting their services to 30 countries in the world including USA, Canada, European Countries, Middle East, Japan, Australia, South Africa and some of the South East Asian countries.

Table 5.26:

Growth of Software Export During Last Four Years (In Millions)

	2000-2001	2001- 2002	2002-2003	2003-2004	2004-2005 (till Dec 2004 – first five months)
Export in US$	2.24	2.8	4.2	7.2	5.29
Yearly Growth		25.00%	51.00%	71.00%	122% (over same period last year)

5.4.2 Indian software industry

Currently, the software industry in India is worth US $ 1.75 billion. If in-house development of the large commercial/corporate end-users is added, then the total software industry is close to US $ 2.2 billion, whereas ten years back the software industry in India was not more than US $10 million. [10]

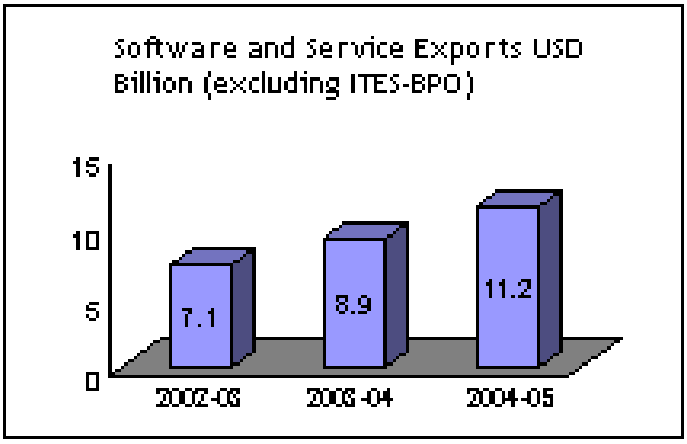

Figure 5.3: Indian software and service export

The Indian software and services exports industry has recorded growth of 30.5% growth clocking revenues of USD 12.5 billion in FY 2003-04 over export revenues of USD 9.6 billion in 2002-03. Of the total software and services exports in FY 2003-04, IT Services, Products and Technology Services grew by 25%, registering revenues of USD 8.9 billion. [9]

Indian IT Software and Services: Export Revenue Ranking (2003-04)

Rank	Company	Rs. Crore	US $ mn
1	Tata Consultancy Services	5503	1198.9
2	Infosys Technologies Ltd	4709	1026.0
3	Wipro Technologies	3920	854.1
4	Satyam Computer Services Ltd	2472	538.6
5	HCL Technologies Ltd	1895	412.9
6	Patni Computer Systems Ltd	1223	266.4
7	iFlex Solutions	773	168.4
8	Mahindra British Telecom Ltd	727	158.5
9	Polaris Software	579	126.1
10	Perot Systems TSI (HCL Perot Systems Ltd)	544	118.6
11	Digital Globalsoft Ltd	541	117.9
12	NIIT Ltd	538	117.2
13	iGate Global Solutions Limited (Mascot Systems Ltd)	488	106.4
14	Birlasoft Ltd	427	93.1
15	Mphasis BFL Ltd	393	85.5
16	Mastek Ltd	379	82.5
17	Hexaware Technologies Ltd	378	82.4
18	Larsen & Toubro Infotech Ltd	352	76.6
19	Tata Infotech Ltd	345	75.1
20	Hughes Software Systems	321	70

Source: NASSCOM

**Note: This list does not include companies, such as Cognizant, which are US listed companies but have significant offshore operations in India. In 2003-04, Cognizant recorded revenues of Rs 1,893 crore, which would have placed them 6th on this list were they to be ranked. In addition, Syntel, Covansys, Intelligroup - all with an India-centric global delivery model - are excluded from this list.*

5.4.3 Potential and drawbacks of Bangladesh

It is clear from the above statistics that Indian software industry came across a long way with a bunch of positive approaches that helped them to build a strong infrastructure and they are rapidly improving. Bangladesh has also some positive potential over India such as

Table 5.27:

Advantage over India and USA

	Bangladesh	India	U.S.A.
Programmers Average Salary per month (per month)	US$ 400 to 800	US$ 1,200	US$ 4,500
Data Entry (Per 10,000 key strokes)	US$ 3 to 5	US$ 10	US$ 30 to 50

We have also some identified problems and barriers hindering the growth of export-oriented Software and Data Processing Services Industry, and classified those under the following major functional areas:

Fiscal

1. The user base of computer is extremely low because of high cost of computers and peripherals, due mainly to high incidence of import duty and VAT.
2. In the absence of any incentive scheme, the exporters do not feel encouraged to explore potential markets.
3. Interest rates on loans, charged by the Commercial Banks (currently between 15% to 17% p.a.) are too prohibitive for entrepreneurs to investment in IT field.
4. The existing banking procedures are too complicated to induce exporters to bring their export remittances through banking channel.

Human Resource Development

1. Course curricula for computer-related education followed in the Universities do not fully reflect the requirements of the IT industry.

2. The number of graduates in computer-related subjects produced by the Universities each year is far less than the actual requirement.
3. Substantial number of such graduates leaves the country for overseas employment.
4. Private IT training institutions lack the required quality of trainers.
5. Private IT training institutions do not follow any standard course curricula and examination system.
6. There is no planned scheme to increase computer literacy.

Infrastructure

1. Absence of necessary laws protecting the Intellectual Property Rights discourages prospective overseas customers from using Bangladesh as a source of supply.
2. The facility of high-speed data (both nationally and internationally) is very limited.
3. Present cost of data communication is very high.
4. High Speed Video Conferencing facility is not available.
5. ISDN Telecommunication line with Fibre Optic backbone does not exist.
6. Resource materials on Information Technology, such as books, magazines, software etc. are scanty and scattered.
7. Whatever little hardware, software and communication resources are available, cannot be found under 'one roof.
8. Custom formalities for handling equipment / documents for export purpose are too time consuming to encourage export.

Marketing

1. Bangladesh is not known to be a potential offshore source of software and Data Processing Services.
2. Information on prospective overseas customers is not available.
3. Not all software in use are Licensed.
4. The use of Customized Application Software is virtually non-existent; therefore, domestic Software market has not developed at all.
5. It is not possible to enter into the export market without having a strong domestic market base.

So if we can get rid of these problems and barriers, our software industry will hopefully become a familiar name to the world. To do so we need to build our infrastructure as per internationally recognized standard and CMMI is especially would be the right model to adopt.

CHAPTER VI

CMMI ADOPTION

6.1 CMMI Adoption

Process improvement has proven to increase product and service quality as organizations apply it to achieve their business objectives.

There are multiple CMMI models available. Consequently, organization needs to be prepared to decide which CMMI model best fits the organization's process improvement needs. To get started the organization is to select which disciplines (IPPD,SE,SW) it wants to include in the process improvement program and should select a model representation (staged or continuous). [2]

6.1.1 Adoption process

Following actions will lead an organization to get prepare for CMMI-based process improvement.

1. **Identification of the model:** Identify the model that is going to be followed and figure out the differences between the model that has been used or followed so far. [2]
2. **Selection of the model:** Select a model for the process improvement program. To select a model, the organization must determine which disciplines are relevant to its business goals. [2]
3. **Training:** Sign up for some Introduction to CMMI training to learn more about CMMI. Key people involved in the organization's process improvement efforts should attend Introduction to CMMI training. Sign up

for either the course that teaches about CMMI models with a staged representation or the one about the continuous representation. Any of the representations that probably the best fit for the organization can be chosen. [2]

[A CMMI course can be taken from the SEI or from one of the many members of the SEI Partner Network (listed on the SEI Web site and in the SEI Partner Network Directory and Guide to Services. SEI partners are organizations licensed to employ those who are authorized by the SEI to help other organizations adopt new and improved technologies, typically training courses or appraisal services.)]

4. **Management sponsorship:** Ensure that the process improvement program has a senior management sponsorship. Such sponsorship is critical to ensuring the program's success. [2]
5. **Determination of the scope:** Determine the scope of initial process improvement program. One or more departments, divisions, programs, or projects can be selected. Or, the entire organization can also be selected. However, for those who are new to process improvement, it is wise to begin with a smaller scope. [2]
6. **Mapping:** The organization should map the processes to the CMMI model that has been chosen. By mapping the existing processes to CMMI best practices, the gaps will be identified. [2]
7. **Developing a process improvement plan:** This is to fill the gaps found when while mapping the organization's processes to CMMI best practices. Re-evaluation of mapping needs to be done regularly to see if the org. is meeting its process improvement goals. [2]
8. **Appraisal:** Engage a SCAMPI Lead Appraiser to conduct an appraisal of the organization. An appraisal will provide an objective evaluation of the organization using the SCAMPI method and a CMMI model. If the organization chooses to use the staged representation or the continuous

representation with equivalent staging, it will also earn a maturity level. To conduct an appraisal using SCAMPI, the org. must employ an SEI-authorized SCAMPI Lead Appraiser. SEI-authorized lead appraisers are required to provide the SEI with reports of the appraisals they conduct. The time and expense required for such an appraisal depends on multiple factors and it is best to ask potential lead appraisers to estimate time and expense. [2]

After the appraisal, the org. would return to step 7 above to implement further improvements based on the feedback in the appraisal results.

CHAPTER VII

CONCLUSION

7.1 How CMMI Helps

CMMI model provides a structured view of process improvement across an organization. It can help to

- Set process improvement goals and priorities
- Provide guidance for quality processes
- Provide a yardstick for appraising current practice

7.2 Why To Adopt

CMMI promises an organization to …

- Improve delivery of performance, cost, and schedule
- Collaborate with relevant stakeholders and integrate their expectations into day-to-day activities
- Provide competitive world-class products and services
- Implement an integrated enterprise business and engineering perspective
- Use common, integrated, and improving processes for systems and software

7.3 Barriers To Expect

As an executive, one can identify these barriers and help the organization get past them:

- “This doesn’t apply to me”-- syndrome
- Resources drained from process improvement by other “more important” work
- Resistance to change of any kind

CMMI is being worldwide adopted and let the adopters do their business successfully then there should be no doubt that CMMI can change the fate of our software industry. What we only need is to step forward to it increase the awareness and grab the knowledge about CMMI. The early adopters of CMMI will show the path to the rest.

LIST OF REFERENCES

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APPENDICES

A. MODEL TERMINOLOGY

Some of the terms used in CMMI models have meanings attached to them that differ from their everyday use.

Adequate, Appropriate, As Needed

These words are used so that you can interpret goals and practices in light of your organization's business objectives. When using any CMMI model, you must interpret the practices so that they work for your organization. These terms are used in goals and practices where certain activities may not be done all of the time.

Stakeholder

A "stakeholder" is a group or individual that is affected by or in some way accountable for the outcome of an undertaking. Stakeholders may include project members, suppliers, customers, end users, and others.

Relevant Stakeholder

The term "relevant stakeholder" is used to designate a stakeholder that is identified for involvement in specified activities and is included in an appropriate plan.

Project Manager

In the CMMI Product Suite, a "project manager" is the person responsible for planning, directing, controlling, structuring, and motivating the project. The project manager is responsible for satisfying the customer.

Shared Vision

In the CMMI Product Suite, a “shared vision” is a common understanding of guiding principles including mission, objectives, expected behavior, values, and final outcomes, which are developed and used by a group, such as an organization, project, or team. Creating a shared vision requires that all people in the group have an opportunity to speak and be heard about what really matters to them.

Organization

An organization is typically an administrative structure in which people collectively manage one or more projects as a whole, and whose projects share a senior manager and operates under the same policies.

Enterprise

When CMMI models refer to an “enterprise,” they illustrate the larger entity not always reached by the word “organization.” Companies may consist of many organizations in many different locations with different customers. The word “enterprise” refers to the full composition of companies.

Development

The word “development,” when used in the CMMI Product Suite implies not only development activities, but also maintenance activities.

Discipline

The word “discipline” when used in the CMMI Product Suite refers to the bodies of knowledge available when selecting a CMMI model (e.g., systems engineering).

Project

In CMMI models, a “project” is a managed set of interrelated resources that delivers one or more products to a customer or end user. This set of resources has a definite beginning and end and typically operates according to a plan. Such a plan is frequently documented and specifies the product to be delivered or implemented, the resources and funds used, the work to be done, and a schedule for doing the work. A project can be composed of projects.

Product

The word “product” is used throughout the CMMI Product Suite to mean any tangible output or service that is a result of a process and that is intended for delivery to a customer or end user. A product is a work product that is delivered to the customer.

Work Product

The term “work product” is used throughout the CMMI Product Suite to mean any artifact produced by a process. These artifacts can include files, documents, parts of the product, services, processes, specifications, and invoices.

Product Component

The term “product component” is used as a relative term in CMMI models. In CMMI, product components are lower level components of the product; product components are integrated to “build” the product. There may be multiple levels of product components. A product component is any work product that must be engineered (requirements defined and designs developed and implemented) to achieve the intended use of the product throughout its life.

Appraisal

In the CMMI Product Suite, an “appraisal” is an examination of one or more processes by a trained team of professionals using an appraisal reference model as the basis for determining strengths and weaknesses.

Assessment

In the CMMI Product Suite, an “assessment” is an appraisal that an organization does to and for itself for the purposes of process improvement. The word “assessment” is also used in the CMMI Product Suite in an everyday English sense (e.g., risk assessment).

Tailoring Guidelines

“Tailoring guidelines” are used in CMMI models to enable organizations to implement standard processes appropriately in their projects. It aids those who establish the defined processes for projects. Tailoring guidelines cover

(1) Selecting a standard process

(2) Selecting an approved life-cycle model and

(3) Tailoring the selected standard process and life-cycle model to fit project needs. Tailoring guidelines describe what can and cannot be modified and identify process components that are candidates for modification.

Traceability:

Vertical traceability identifies the origin of items (e.g., customer needs) and follows these same items as they travel through the hierarchy of the Work Breakdown Structure to the project teams and eventually to the customer. Effective vertical traceability assures that a requirement can be followed from its inception through any and all changes until it takes its final form at all levels of the system and its subsystems. Horizontal trace ability, in contrast, identifies the

relationships among related items across work groups or product components for the purpose of avoiding potential conflicts. For example, horizontal traceability would follow related requirements across two work groups working on two associated components of a product. The traceability across these two work groups enables the work groups to see when and how a change in a requirement for one of the components may affect the other component. Thus, horizontal trace ability enables the project to anticipate potential problems (and mitigate or solve them) before integration testing.

Verification

Although “verification” and “validation” at first seem quite similar in CMMI models, on closer inspection you can see that each addresses different issues. Verification confirms that work products properly reflect the requirements specified for them. In other words, verification ensures that “you built it right.”

Validation

Validation confirms that the product, as provided, will fulfill its intended use. In other words, validation ensures that “you built the right thing.”

Goal

A “goal” is a required CMMI component that can be either a generic goal or a specific goal. When you see the word “goal” in a CMMI model, it always refers to model components (for example, generic goal, specific goal). (In Appendix A, the definitions of “specific goal” and “generic goal” and descriptions of how these terms are used in the CMMI Product Suite are given.)

Standard

The word “standard” used as a noun in a CMMI model. It refers to the formal mandatory requirements developed and used to prescribe consistent approaches to development (for example, ISO standards, IEEE standards, organizational standards).

CMMI Product Suite

The “CMMI Product Suite” is the complete set of products developed around the CMMI concept. These products include the framework itself, models, appraisal methods, appraisal materials, and various types of training that are produced from the CMMI Framework.

CMMI Framework

The “CMMI Framework” is the basic structure that organizes CMMI components, including common elements of the current CMMI models as well as rules and methods for generating models, their appraisal methods (including associated artifacts), and their training materials.

Peer Review

The term “peer review” is used in the CMMI Product Suite instead of the term “work product inspection.”

Process

A “process,” as used in the CMMI Product Suite, consists of activities that can be recognized as implementations of practices in a CMMI model.

Managed Process

A “managed process” is a performed process that is planned and executed in accordance with policy; employs skilled people having adequate resources to produce controlled outputs; involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description.

Defined Process

A “defined process” is a managed process that is tailored from the organization’s set of standard processes according to the organization’s tailoring

guidelines. A project's defined process provides a basis for planning, performing, and improving the project's tasks and activities. A project may have more than one defined process (for example, one for developing the product and another for testing the product).

Organizational Process Assets

"Organizational process assets" are artifacts that relate to describing, implementing, and improving processes (e.g., policies, measurements, process descriptions, and process implementation support tools).

Process Architectures

"Process architecture" describes the ordering, interfaces, interdependencies, and other relationships among the process elements in a standard process. Process architecture also describes the interfaces, interdependencies, and other relationships between process elements and external processes (for example, contract management).

Product Life Cycle

A "product life cycle" is the period of time, consisting of phases, that begins when a product is conceived and ends when the product is no longer available for use. A product life cycle could consist of the following phases: (1) concept/vision, (2) feasibility, (3) design/development, (4) production, and (5) phase out.

Document

A "document" is a collection of data, regardless of the medium on which it is recorded, that generally has permanence and can be read by humans or machines. So, documents include both paper and electronic documents.

B. ACCRONYMS

CMMI	Capability Maturity Model Integration
CMMI-SE/SW	Capability Maturity Model Integration for Systems Engineering and Software Engineering
DAR	Decision Analysis and Resolution (process area)
EIA/IS	Electronic Industries Alliance Interim Standard
GG	generic goal
GP	generic practice
IPPD	Integrated Product and Process Development
ISO/IEC	International Organization for Standardization and International Electrotechnical Commission
IT	Integrated Teaming (process area)
MA	Measurement and Analysis (process area)
PA	process area
PAIS	Process Appraisal Information System
PERT	Program Evaluation and Review Technique
SCAMPI	Standard CMMI Appraisal Method for Process Improvement
SG	specific goal
SP	specific practice
SS	Supplier Sourcing

C. PROCESS AREA: GOALS AND PRACTICES

Specific Goals

Specific goals apply to a process area and address the unique characteristics of which describe what must be implemented to satisfy the process area. Specific goals are required model components and are used in appraisals to help determine whether a process area is satisfied. There can be specific practices at different capability levels mapped to the same goal. However, every goal has at least one capability level 1 practice mapped to it.

SG 1 Develop Customer Requirements

Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.

SG 2 Develop Product Requirements

Customer requirements are refined and elaborated to develop product and product-component requirements.

SG 3 Analyze and Validate Requirements

The requirements are analyzed and validated, and a definition of required functionality is developed.

Specific Practices

A specific practice is an activity that is considered important in achieving the associated specific goal. The specific practices describe the activities expected to result in achievement of the specific goals of a process area. Every specific practice is associated with a capability level. Specific practices are expected model components.

Generic Goals

Each capability level (1-5) has only one generic goal that describes the institutionalization that the organization must achieve at that capability level. Thus, there are five generic goals; each appears in every process area. Achievement of a generic goal in a process area that signifies improved control in planning and implementing the processes associated with that process area, thus indicating whether these processes are likely to be effective, repeatable, and lasting. Generic goals are required model components and are used in appraisals to determine whether a process area is satisfied.

GG 1 Achieve Specific Goals

The process supports and enables achievement of the specific goals of the process area by transforming identifiable input work products to produce identifiable output work products.

GG 2 Institutionalize a Managed Process

The process is institutionalized as a managed process.

GG 3 Institutionalize a Defined Process

The process is institutionalized as a defined process.

GG 4 Institutionalize a Quantitatively Managed Process

The process is institutionalized as a quantitatively managed process.

GG 5 Institutionalize an Optimizing Process

The process is institutionalized as an optimizing process.