

PROCESS CAPABILITY MODELS

Key Process Areas (KPA)

Each of these KPA (Key Process Areas) defines the basic requirements that should be met by a software process to satisfy the KPA and achieve that level of maturity.

Conceptually, key process areas form the basis for management control of the software project and establish a context in which technical methods are applied, work products like models, documents, data, reports, etc. are produced, milestones are established, quality is ensured and change is properly managed.

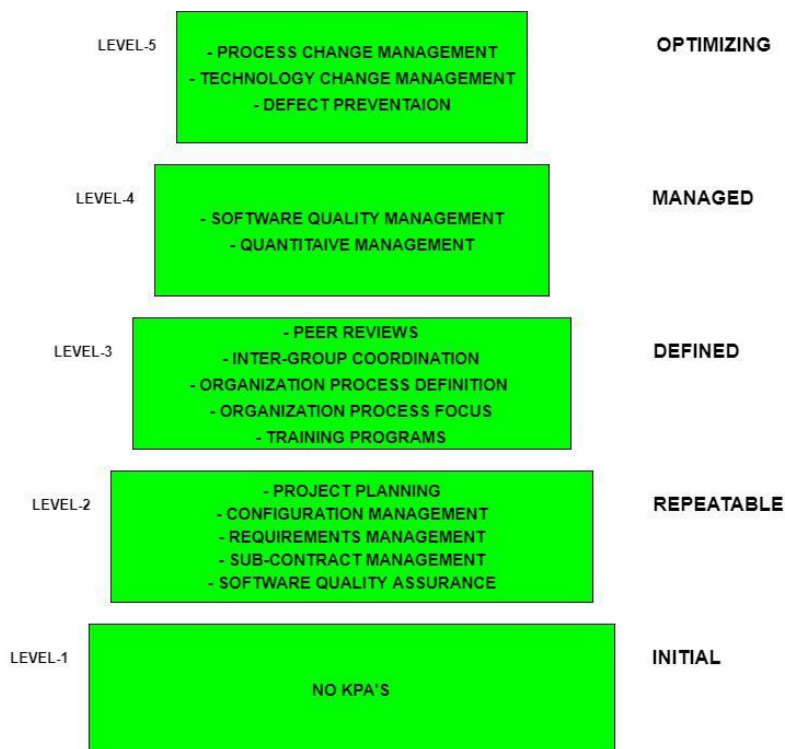
Capability Maturity Model (CMM)

Capability Maturity Model (CMM) was developed by the Software Engineering Institute (SEI). It is a framework that is used to analyze the approach and techniques followed by any organization to develop software products.

The Capability Maturity Model (CMM) is a tool used to improve and refine software development processes. It provides a structured way for organizations to assess their current practices and identify areas for improvement.

CMM consists of five maturity levels: **initial, repeatable, defined, managed, and optimizing**. Each level of maturity shows a process capability level.

By following the CMM, organizations can systematically improve their software development processes, leading to higher-quality products and more efficient project management.



Level-1: Initial

- No KPIs defined.
- Processes followed are Adhoc and immature and are not well defined.
- Unstable environment for software development.
- No basis for predicting product quality, time for completion, etc.
- Limited project management capabilities, such as no systematic tracking of schedules, budgets, or progress.
- We have limited communication and coordination among team members and stakeholders.
- Little or no use of software development tools or automation.
- Highly dependent on individual skills and knowledge rather than standardized processes.
- High risk of project failure or delays due to a lack of process control and stability.

Level-2: Repeatable

- Focuses on establishing basic project management policies.
- Experience with earlier projects is used for managing new similar-natured projects.
- **Project Planning**- It includes defining resources required, goals, constraints, etc. for the project. It presents a detailed plan to be followed systematically for the successful completion of good-quality software.
- **Configuration Management**- The focus is on maintaining the performance of the software product, including all its components, for the entire lifecycle.
- **Requirements Management**- It includes the management of customer reviews and feedback which result in some changes in the requirement set. It also consists of accommodation of those modified requirements.
- **Subcontract Management**- It focuses on the effective management of qualified software contractors i.e. it manages the parts of the software developed by third parties.
- **Software Quality Assurance**- It guarantees a good quality software product by following certain rules and quality standard guidelines while developing.

Level-3: Defined

- At this level, documentation of the standard guidelines and procedures takes place.
- It is a well-defined integrated set of project-specific software engineering and management processes.
- **Peer Reviews**: In this method, defects are removed by using several review methods like walkthroughs, inspections, buddy checks, etc.
- **Intergroup Coordination**: It consists of planned interactions between different development teams to ensure efficient and proper fulfillment of customer needs.
- **Organization Process Definition**: Its key focus is on the development and maintenance of standard development processes.
- **Organization Process Focus**: It includes activities and practices that should be followed to improve the process capabilities of an organization.

- **Training Programs:** It focuses on the enhancement of knowledge and skills of the team members including the developers and ensuring an increase in work efficiency.

Level-4: Managed

- At this stage, quantitative quality goals are set for the organization for software products as well as software processes.
- The measurements made help the organization to predict the product and process quality within some limits defined quantitatively.
- **Software Quality Management:** It includes the establishment of plans and strategies to develop quantitative analysis and understanding of the product's quality.
- **Quantitative Management:** It focuses on controlling the project performance quantitatively.

Level-5: Optimizing

- This is the highest level of process maturity in CMM and focuses on continuous process improvement in the organization using quantitative feedback.
- The use of new tools, techniques, and evaluation of software processes is done to prevent the recurrence of known defects.
- **Process Change Management:** Its focus is on the continuous improvement of the organization's software processes to improve productivity, quality, and cycle time for the software product.
- **Technology Change Management:** It consists of the identification and use of new technologies to improve product quality and decrease product development time.
- **Defect Prevention:** It focuses on the identification of causes of defects and prevents them from recurring in future projects by improving project-defined processes.

Capability Maturity Model Integration (CMMI)

Capability Maturity Model Integration (CMMI) builds upon its predecessor CMM by integrating the best elements from individual disciplines such as Software CMM, Systems Engineering CMM, and People CMM. Unlike CMM, which focuses on mature practices within specific disciplines, integrating these disciplines to meet requirements can be challenging. Therefore, CMMI is preferred because it enables the integration of multiple disciplines as needed.

Objectives of CMMI:

- Fulfilling customer needs and expectations.
- Value creation for investors/stockholders.
- Market growth is increased.
- Improved quality of products and services.
- Enhanced reputation in Industry.

CMMI Representation – Staged and Continuous:

A representation allows an organization to pursue a different set of improvement objectives. There are two representations for CMMI:

Staged Representation:

1. uses a pre-defined set of process areas to define improvement path.
2. provides a sequence of improvements, where each part in the sequence serves as a foundation for the next.
3. an improved path is defined by maturity level.
4. maturity level describes the maturity of processes in organization.
5. Staged CMMI representation allows comparison between different organizations for multiple maturity levels.

Continuous Representation:

1. allows selection of specific process areas.
2. uses capability levels that measures improvement of an individual process area.
3. Continuous CMMI representation allows comparison between different organizations on a process-area-by-process-area basis.
4. allows organizations to select processes which require more improvement.
5. In this representation, order of improvement of various processes can be selected which allows the organizations to meet their objectives and eliminate risks.

Maturity levels In CMMI with staged representation, there are five maturity levels described as follows:

Maturity level 1: Initial

1. processes are poorly managed or controlled.
2. unpredictable outcomes of processes involved.
3. ad hoc and chaotic approach used.
4. No KPAs (Key Process Areas) defined.
5. Lowest quality and highest risk.

Maturity level 2: Managed

1. requirements are managed.
2. processes are planned and controlled.
3. projects are managed and implemented according to their documented plans.
4. This risk involved is lower than Initial level, but still exists.
5. Quality is better than Initial level.

Maturity level 3: Defined

1. processes are well characterized and described using standards, proper procedures, and methods, tools, etc.
2. Medium quality and medium risk involved.
3. Focus is process standardization.

Maturity level 4: Quantitatively managed

1. quantitative objectives for process performance and quality are set.
2. quantitative objectives are based on customer requirements, organization needs, etc.
3. process performance measures are analysed quantitatively.
4. higher quality of processes is achieved.
5. lower risk

Maturity level 5: Optimizing

1. continuous improvement in processes and their performance.
2. improvement has to be both incremental and innovative.
3. highest quality of processes.
4. lowest risk in processes and their performance.

ISO 15504 Process assessment

ISO 15504, also known as SPICE (Software Process Improvement and Capability dEtermination), is a standard for assessing and improving the processes used in the development, maintenance, and operation of software systems. It provides a framework and a set of guidelines for evaluating the capability of software processes based on a defined maturity model. The standard helps organizations understand their current capabilities, identify areas for improvement, and establish a roadmap for achieving higher levels of process maturity and quality in software development.

The maturity levels in ISO 15504 (SPICE) represent different stages of process capability and organizational maturity in software development and management. These levels provide a framework for organizations to assess and improve their processes systematically. Here's an elaboration on each maturity level:

1. **Level 0 - Incomplete Process:** At this level, processes are either not performed or are only partially performed. There is typically no systematic approach, and results are unpredictable and inconsistent. Organizations at this level may not have defined processes, leading to ad-hoc practices and high variability in outcomes.
2. **Level 1 - Performed Process: (Attribute- Process performance)**
Processes at this level are characterized by being performed in a basic manner. There might be informal practices in place, but they are not consistently applied across projects or the organization. Results may still vary significantly due to the lack of standardized processes.
3. **Level 2 - Managed Process: (Attribute- Performance management, work product management)**
At this level, processes are planned, executed, monitored, and controlled. There is a basic level of management oversight, and processes are documented to some extent. Organizations begin to establish a more structured approach, aiming for consistency in process execution and better predictability in outcomes.
4. **Level 3 - Established Process: (Attribute- Process definition and deployment)** Processes at this level are institutionalized and well-defined throughout the organization. They are

consistently applied across projects and are supported by documented procedures and standards. There is a focus on process improvement based on quantitative analysis of process performance data.

5. Level 4 - Predictable Process: (Attribute: Process measurement and control)

At this level, processes are quantitatively managed. Detailed metrics and measures are collected to understand process performance and variability. Processes are continually monitored and adjusted based on statistical analysis to ensure predictability and control.

6. Level 5 - Optimizing Process: (Attribute: Process innovation and Optimization)

This is the highest level of maturity, where processes are continuously improved based on quantitative understanding and innovation. Organizations at this level focus on continuous process improvement and innovation to achieve higher levels of efficiency, effectiveness, and agility.