

Software Quality

Software quality product is defined in term of its fitness of purpose. That is, a quality product does precisely what the users want it to do. For software products, the fitness of use is generally explained in terms of satisfaction of the requirements laid down in the SRS document. Although "fitness of purpose" is a satisfactory interpretation of quality for many devices such as a car, a table fan, a grinding machine, etc. for software products, "fitness of purpose" is not a wholly satisfactory definition of quality.

Example: Consider a functionally correct software product. That is, it performs all tasks as specified in the SRS document. But, has an almost unusable user interface. Even though it may be functionally right, we cannot consider it to be a quality product.

The modern view of a quality associated with a software product several quality methods such as the following:

Portability: A software device is said to be portable, if it can be freely made to work in various operating system environments, in multiple machines, with other software products, etc.

Usability: A software product has better usability if various categories of users can easily invoke the functions of the product.

Reusability: A software product has excellent reusability if different modules of the product can quickly be reused to develop new products.

Correctness: A software product is correct if various requirements as specified in the SRS document have been correctly implemented.

Maintainability: A software product is maintainable if bugs can be easily corrected as and when they show up, new tasks can be easily added to the product, and the functionalities of the product can be easily modified, etc.

Software Quality Management System

A quality management system is the principal methods used by organizations to provide that the products they develop have the desired quality.

A quality system subsists of the following:

Managerial Structure and Individual Responsibilities: A quality system is the responsibility of the organization as a whole. However, every organization has a separate quality department to perform various quality system activities. The quality system of an arrangement should have the support of the top management. Without help for

the quality system at a high level in a company, some members of staff will take the quality system seriously.

Quality System Activities: The quality system activities encompass the following:

Auditing of projects

Review of the quality system

Development of standards, methods, and guidelines, etc.

Production of documents for the top management summarizing the effectiveness of the quality system in the organization.

Evolution of Quality Management System

Quality systems have increasingly evolved over the last five decades. Before World War II, the usual function to produce quality products was to inspect the finished products to remove defective devices. Since that time, quality systems of organizations have undergone through four steps of evolution, as shown in the fig. The first product inspection task gave method to quality control (QC).

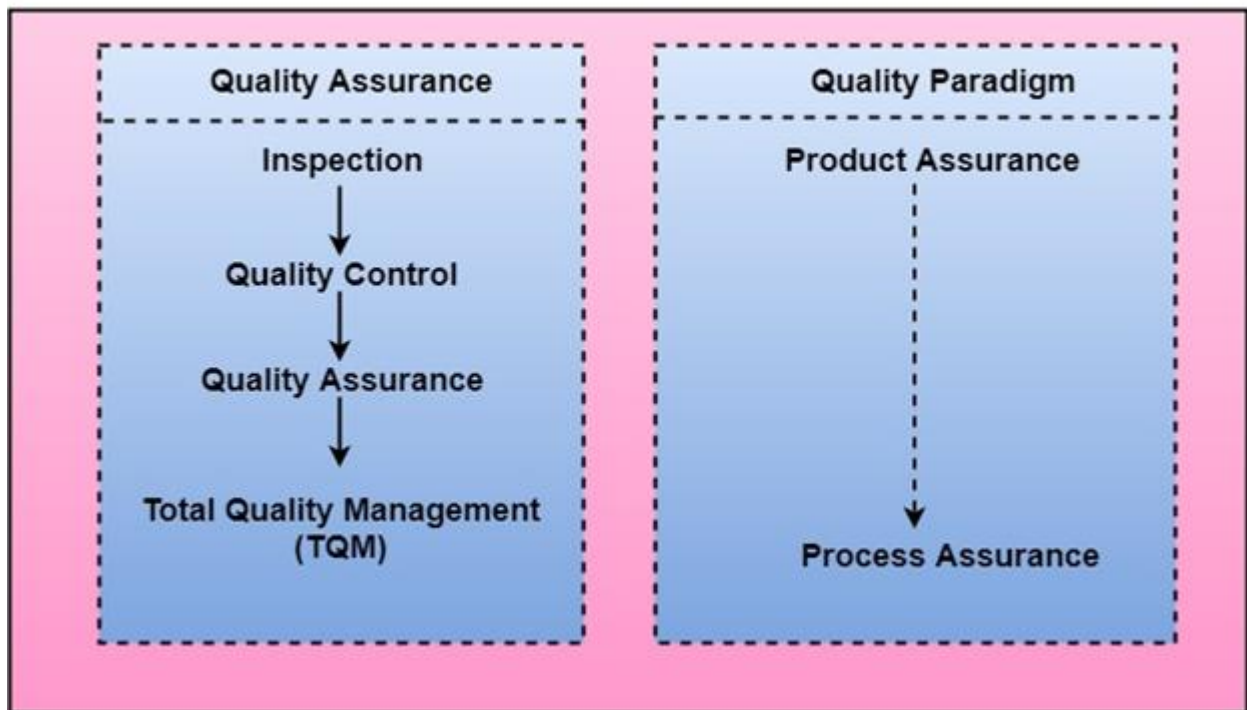
Quality control target not only on detecting the defective devices and removes them but also on determining the causes behind the defects. Thus, quality control aims at correcting the reasons for bugs and not just rejecting the products. The next breakthrough in quality methods was the development of quality assurance methods.

The primary premise of modern quality assurance is that if an organization's processes are proper and are followed rigorously, then the products are obligated to be of good quality. The new quality functions include guidance for recognizing, defining, analyzing, and improving the production process.

Total quality management (TQM) advocates that the procedure followed by an organization must be continuously improved through process measurements. TQM goes stages further than quality assurance and aims at frequently process improvement. TQM goes beyond documenting steps to optimizing them through a redesign. A term linked to TQM is Business Process Reengineering (BPR).

BPR aims at reengineering the method business is carried out in an organization. From the above conversation, it can be stated that over the years, the quality paradigm has changed from product assurance to process assurance, as shown in fig.

Evolution of quality system and corresponding shift in the quality paradigm



ISO 9000 Certification

ISO (International Standards Organization) is a group or consortium of 63 countries established to plan and fosters standardization. ISO declared its 9000 series of standards in 1987. It serves as a reference for the contract between independent parties. The ISO 9000 standard determines the guidelines for maintaining a quality system. The ISO standard mainly addresses operational methods and organizational methods such as responsibilities, reporting, etc. ISO 9000 defines a set of guidelines for the production process and is not directly concerned about the product itself.

Types of ISO 9000 Quality Standards

ISO 9000 is a series of three standards:



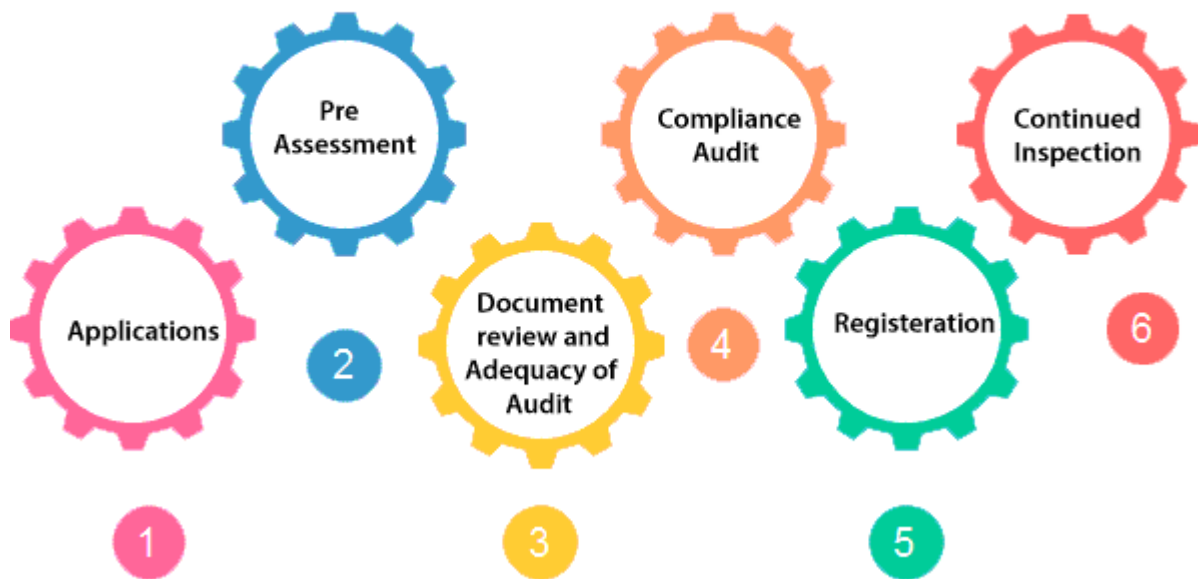
The ISO 9000 series of standards is based on the assumption that if a proper stage is followed for production, then good quality products are bound to follow automatically. The types of industries to which the various ISO standards apply are as follows.

1. **ISO 9001:** This standard applies to the organizations engaged in design, development, production, and servicing of goods. This is the standard that applies to most software development organizations.
2. **ISO 9002:** This standard applies to those organizations which do not design products but are only involved in the production. Examples of these category industries contain steel and car manufacturing industries that buy the product and plants designs from external sources and are engaged in only manufacturing those products. Therefore, ISO 9002 does not apply to software development organizations.
3. **ISO 9003:** This standard applies to organizations that are involved only in the installation and testing of the products. For example, Gas companies.

How to get ISO 9000 Certification?

An organization determines to obtain ISO 9000 certification applies to ISO registrar office for registration. The process consists of the following stages:

ISO 9000 Certification



1. **Application:** Once an organization decided to go for ISO certification, it applies to the registrar for registration.
2. **Pre-Assessment:** During this stage, the registrar makes a rough assessment of the organization.
3. **Document review and Adequacy of Audit:** During this stage, the registrar reviews the document submitted by the organization and suggest an improvement.
4. **Compliance Audit:** During this stage, the registrar checks whether the organization has compiled the suggestion made by it during the review or not.
5. **Registration:** The Registrar awards the ISO certification after the successful completion of all the phases.
6. **Continued Inspection:** The registrar continued to monitor the organization time by time.

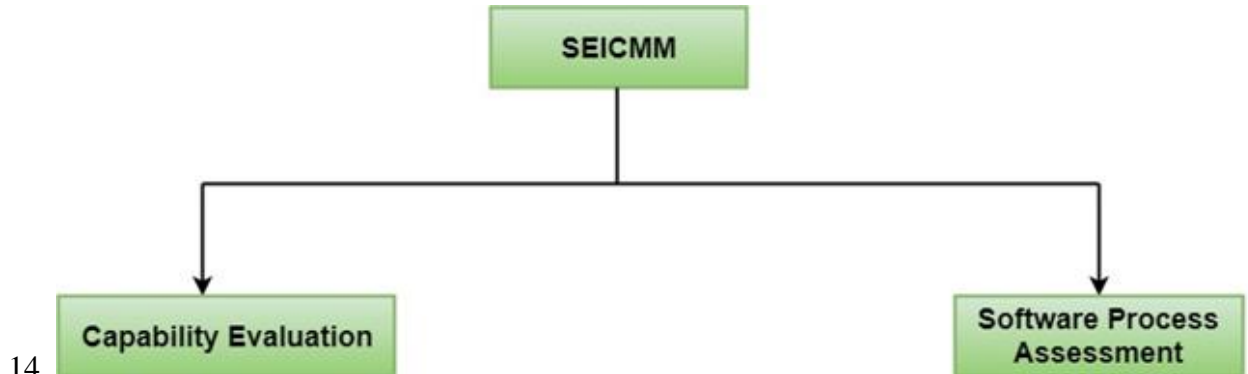
7. Software Engineering Institute Capability Maturity Model (SEICMM)

8. The Capability Maturity Model (CMM) is a procedure used to develop and refine an organization's software development process.
9. The model defines a five-level evolutionary stage of increasingly organized and consistently more mature processes.

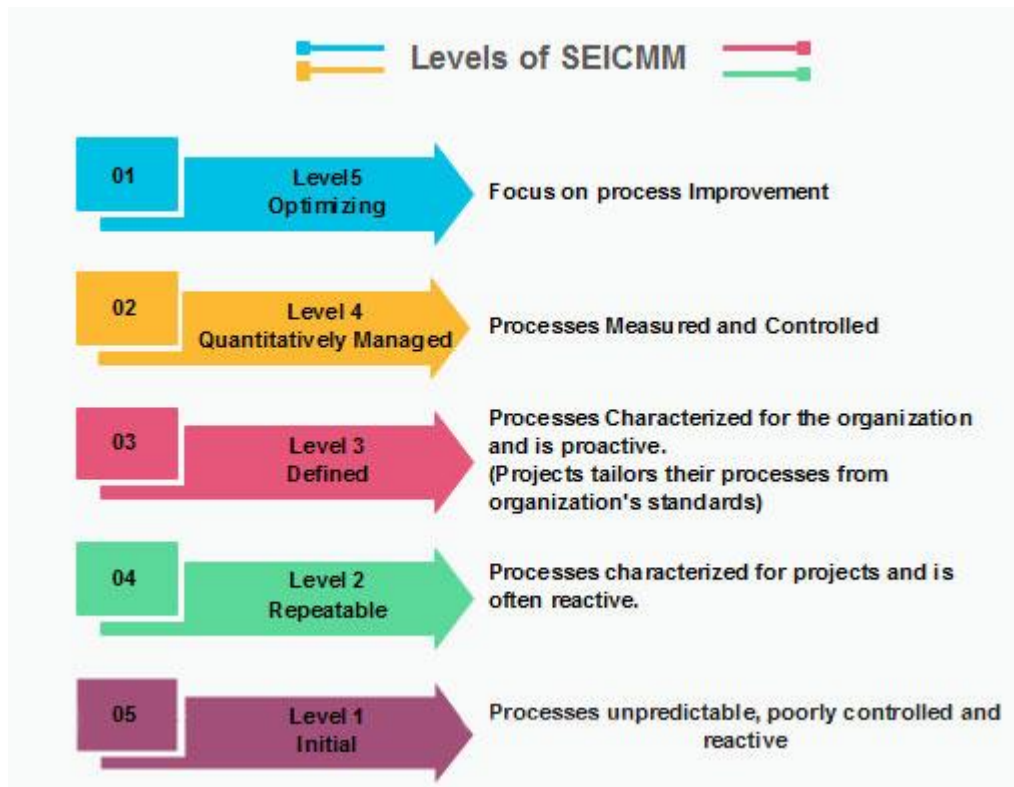
10. CMM was developed and is promoted by the Software Engineering Institute (SEI), a research and development center promote by the U.S. Department of Defense (DOD).
11. Capability Maturity Model is used as a benchmark to measure the maturity of an organization's software process.

12. Methods of SEICMM

13. There are two methods of SEICMM:



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15. **Capability Evaluation:** Capability evaluation provides a way to assess the software process capability of an organization. The results of capability evaluation indicate the likely contractor performance if the contractor is awarded a work. Therefore, the results of the software process capability assessment can be used to select a contractor.
16. **Software Process Assessment:** Software process assessment is used by an organization to improve its process capability. Thus, this type of evaluation is for purely internal use.
17. SEI CMM categorized software development industries into the following five maturity levels. The various levels of SEI CMM have been designed so that it is easy for an organization to build its quality system starting from scratch slowly.



18.

19. Level 1: Initial

20. Ad hoc activities characterize a software development organization at this level. Very few or no processes are described and followed. Since software production processes are not limited, different engineers follow their process and as a result, development efforts become chaotic. Therefore, it is also called a chaotic level.

21. Level 2: Repeatable

22. At this level, the fundamental project management practices like tracking cost and schedule are established. Size and cost estimation methods, like function point analysis, COCOMO, etc. are used.

23. Level 3: Defined

24. At this level, the methods for both management and development activities are defined and documented. There is a common organization-wide understanding of operations, roles, and responsibilities. The ways through defined, the process and product qualities are not measured. ISO 9000 goals at achieving this level.

25. Level 4: Managed

26. At this level, the focus is on software metrics. Two kinds of metrics are composed.

27. **Product metrics** measure the features of the product being developed, such as its size, reliability, time complexity, understandability, etc.

28. **Process metrics** follow the effectiveness of the process being used, such as average defect correction time, productivity, the average number of defects found per hour inspection, the average number of failures detected during testing per LOC, etc. The software process and product quality are measured,

and quantitative quality requirements for the product are met. Various tools like Pareto charts, fishbone diagrams, etc. are used to measure the product and process quality. The process metrics are used to analyze if a project performed satisfactorily. Thus, the outcome of process measurements is used to calculate project performance rather than improve the process.

29. Level 5: Optimizing

30. At this phase, process and product metrics are collected. Process and product measurement data are evaluated for continuous process improvement.

31. Key Process Areas (KPA) of a software organization

32. Except for SEI CMM level 1, each maturity level is featured by several Key Process Areas (KPAs) that contains the areas an organization should focus on improving its software process to the next level. The focus of each level and the corresponding key process areas are shown in the fig.

CMM Level	Focus	Key Process Areas
1. Initial	Competent People	NO KPA'S
2. Repeatable	Project Management	Software Project Planning software Configuration Management
3. Defined	Definition of Processes	Process definition Training Program Peer reviews
4. Managed	Product and Process quality	Quantitative Process Metrics Software Quality Management
5. Optimizing	Continuous Process improvement	Defect Prevention Process change management Technology change management

The focus of each SEI CMM level and the Corresponding Key process areas.

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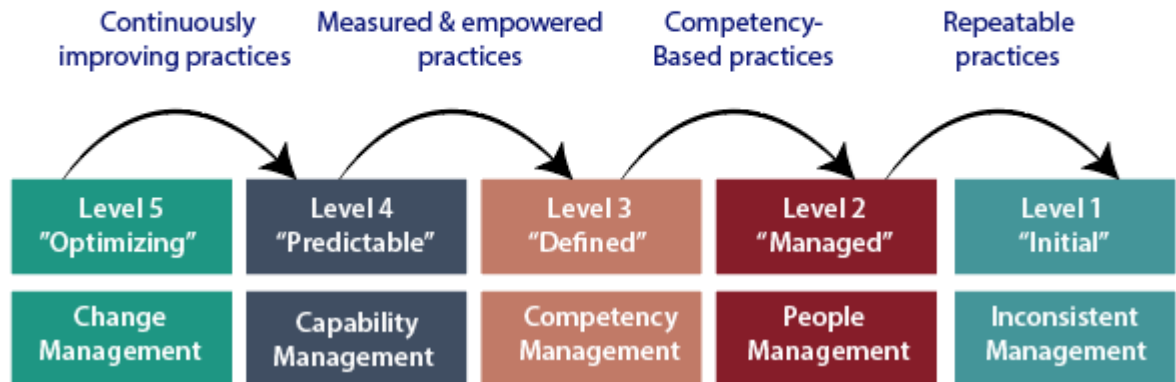
34. SEI CMM provides a series of key areas on which to focus to take an organization from one level of maturity to the next. Thus, it provides a method for gradual quality improvement over various stages. Each step has been carefully designed such that one step enhances the capability already built up.

35. People Capability Maturity Model (PCMM)

36. PCMM is a maturity structure that focuses on continuously improving the management and development of the human assets of an organization.

37. It defines an evolutionary improvement path from Adhoc, inconsistently performed practices, to a mature, disciplined, and continuously improving the development of the knowledge, skills, and motivation of the workforce that enhances strategic business performance.
38. The People Capability Maturity Model (PCMM) is a framework that helps the organization successfully address their critical people issues. Based on the best current study in fields such as human resources, knowledge management, and organizational development, the PCMM guides organizations in improving their steps for managing and developing their workforces.
39. The People CMM defines an evolutionary improvement path from Adhoc, inconsistently performed workforce practices, to a mature infrastructure of practices for continuously elevating workforce capability.
40. The PCMM subsists of five maturity levels that lay successive foundations for continuously improving talent, developing effective methods, and successfully directing the people assets of the organization. Each maturity level is a well-defined evolutionary plateau that institutionalizes a level of capability for developing the talent within the organization
41. **The five steps of the People CMM framework are:**

People CMM Maturity Levels



- 42.
43. **Initial Level: Maturity Level 1**
44. The Initial Level of maturity includes no process areas. Although workforce practices implement in Maturity Level, 1 organization tend to be inconsistent or ritualistic, virtually all of these organizations perform processes that are defined in the Maturity Level 2 process areas.
45. **Managed Level: Maturity Level 2**
46. To achieve the Managed Level, Maturity Level 2, managers starts to perform necessary people management practices such as staffing, operating performance, and adjusting compensation as a repeatable management discipline. The organization establishes a culture focused at the unit level for ensuring that person can meet their work commitments. In achieving Maturity Level 2, the organization develops the capability to handle skills and

performance at the unit level. The process areas at Maturity Level 2 are Staffing, Communication and Coordination, Work Environment, Performance Management, Training and Development, and Compensation.

47. Defined Level: Maturity Level 3

48. The fundamental objective of the defined level is to help an organization gain a competitive benefit from developing the different competencies that must be combined in its workforce to accomplish its business activities. These workforce competencies represent critical pillars supporting the strategic workforce competencies to current and future business objectives; the improved workforce practices for implemented at Maturity Level 3 become crucial enablers of business strategy.

49. Predictable Level: Maturity Level 4

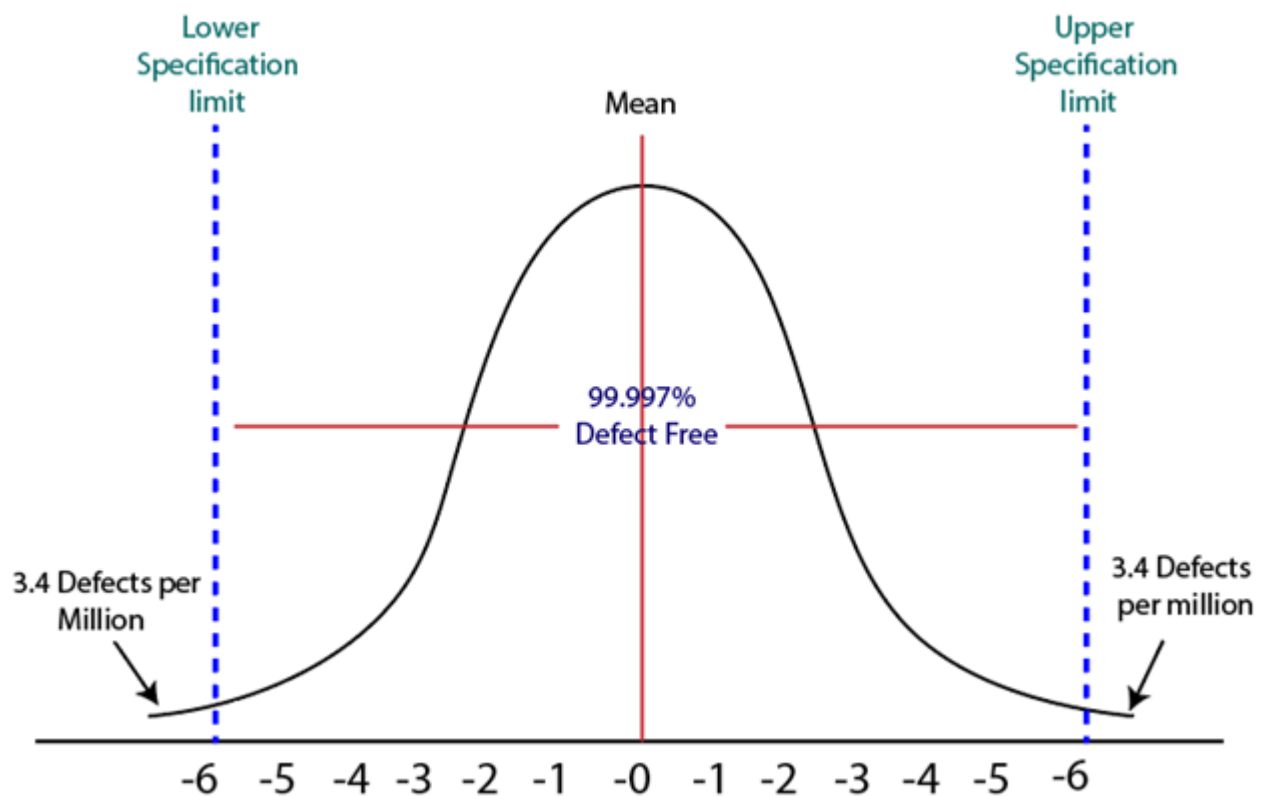
50. At the Predictable Level, the organization handles and exploits the capability developed by its framework of workforce competencies. The organization is now able to handle its capacity and performance quantitatively. The organization can predict its capability for performing work because it can quantify the ability of its workforce and of the competency-based methods they use performing in their assignments.

51. Optimizing Level: Maturity Level 5

52. At the Optimizing Level, the integrated organization is focused on continual improvement. These improvements are made to the efficiency of individuals and workgroups, to the act of competency-based processes, and workforce practices and activities.

Six Sigma

Six Sigma is the process of improving the quality of the output by identifying and eliminating the cause of defects and reduce variability in manufacturing and business processes. The maturity of a manufacturing process can be defined by a sigma rating indicating its percentage of defect-free products it creates. A six sigma method is one in which **99.99966%** of all the opportunities to produce some features of a component are statistically expected to be free of defects (**3.4 defective features per million opportunities**).



History of Six Sigma

Six-Sigma is a set of methods and tools for process improvement. It was introduced by Engineer **Sir Bill Smith** while working at **Motorola** in 1986. In the 1980s, **Motorola** was developing Quasar televisions which were famous, but the time there was lots of defects which came up on that due to picture quality and sound variations.

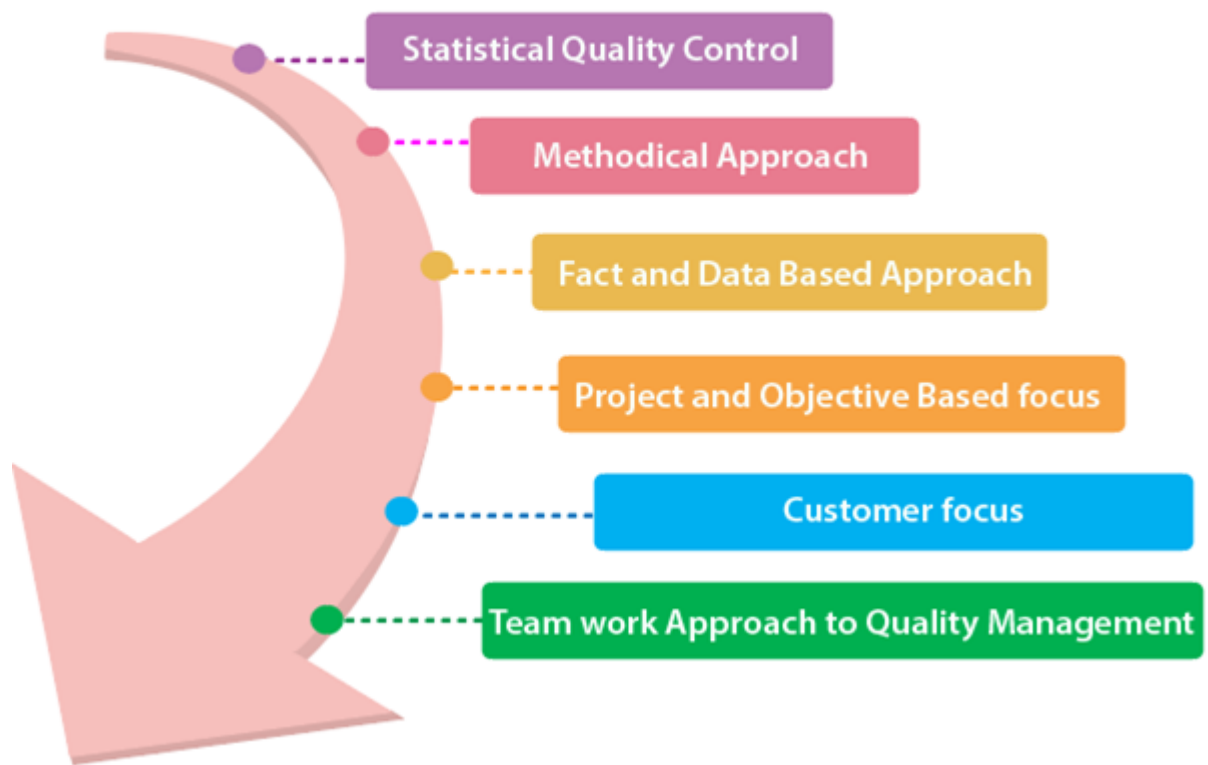
By using the same raw material, machinery and workforce a Japanese firm took over Quasar television production, and within a few months, they produce Quasar TV's sets which have fewer errors. This was obtained by improving management techniques.

Six Sigma was adopted by Bob Galvin, the CEO of Motorola in 1986 and registered as a Motorola Trademark on December 28, 1993, then it became a quality leader.

Characteristics of Six Sigma

The Characteristics of Six Sigma are as follows:

Characteristics of Six Sigma



1. **Statistical Quality Control:** Six Sigma is derived from the Greek Letter σ (Sigma) from the Greek alphabet, which is used to denote Standard Deviation in statistics. Standard Deviation is used to measure variance, which is an essential tool for measuring non-conformance as far as the quality of output is concerned.
2. **Methodical Approach:** The Six Sigma is not a merely quality improvement strategy in theory, as it features a well defined systematic approach of application in DMAIC and DMADV which can be used to improve the quality of production. DMAIC is an acronym for Design-Measure- Analyze-Improve- Control. The alternative method DMADV stands for Design-Measure- Analyze- Design-Verify.
3. **Fact and Data-Based Approach:** The statistical and methodical aspect of Six Sigma shows the scientific basis of the technique. This accentuates essential elements of the Six Sigma that is a fact and data-based.
4. **Project and Objective-Based Focus:** The Six Sigma process is implemented for an organization's project tailored to its specification and requirements. The

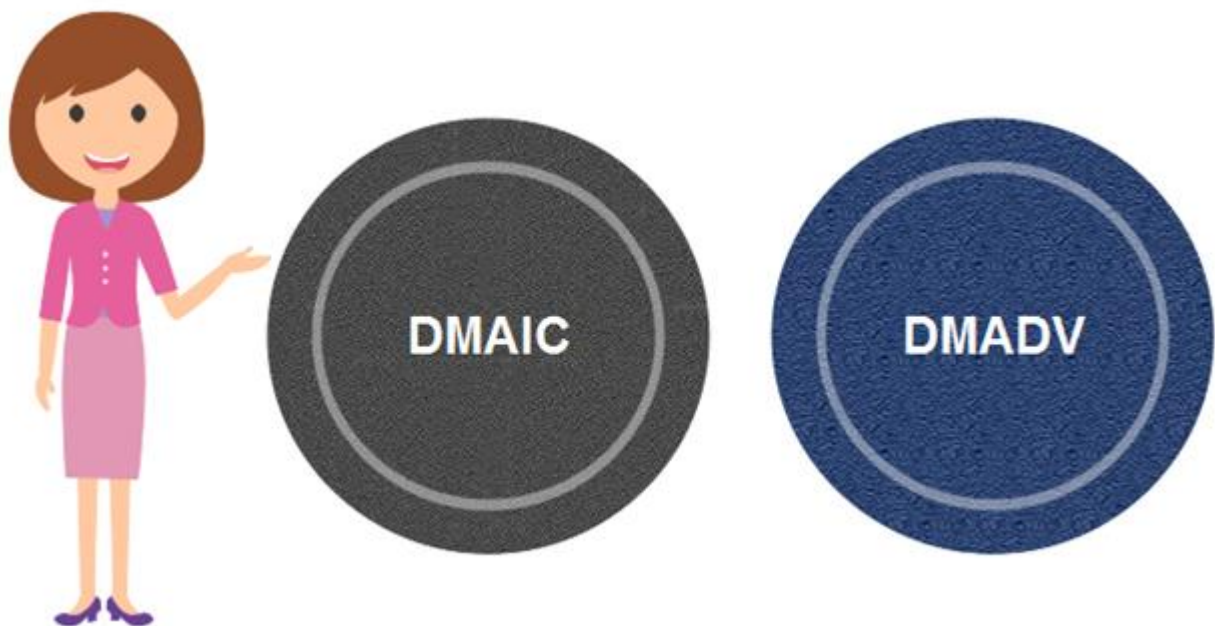
process is flexed to suits the requirements and conditions in which the projects are operating to get the best results.

5. **Customer Focus:** The customer focus is fundamental to the Six Sigma approach. The quality improvement and control standards are based on specific customer requirements.
6. **Teamwork Approach to Quality Management:** The Six Sigma process requires organizations to get organized when it comes to controlling and improving quality. Six Sigma involving a lot of training depending on the role of an individual in the Quality Management team.

Six Sigma Methodologies

Six Sigma projects follow two project methodologies:

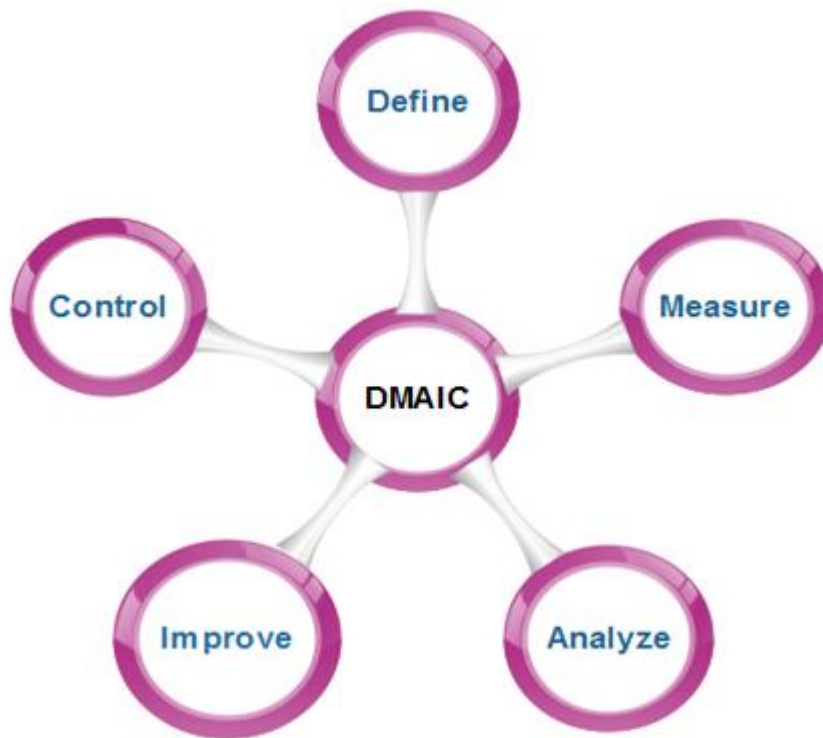
1. DMAIC
2. DMADV



DMAIC

It specifies a data-driven quality strategy for improving processes. This methodology is used to enhance an existing business process.

The DMAIC project methodology has five phases:

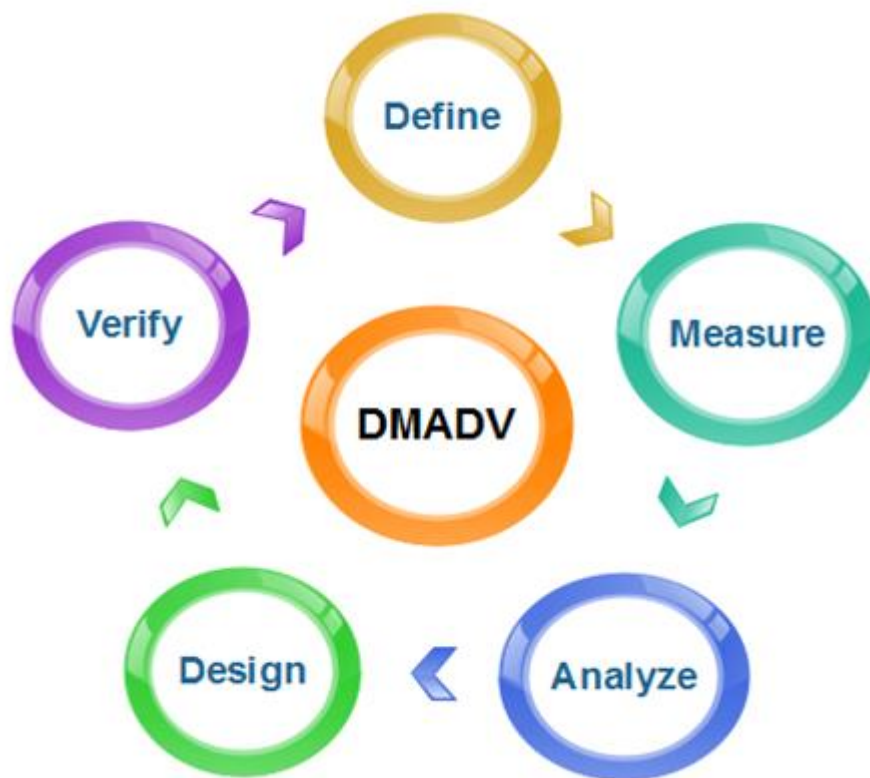


1. **Define:** It covers the process mapping and flow-charting, project charter development, problem-solving tools, and so-called 7-M tools.
2. **Measure:** It includes the principles of measurement, continuous and discrete data, and scales of measurement, an overview of the principle of variations and repeatability and reproducibility (RR) studies for continuous and discrete data.
3. **Analyze:** It covers establishing a process baseline, how to determine process improvement goals, knowledge discovery, including descriptive and exploratory data analysis and data mining tools, the basic principle of Statistical Process Control (SPC), specialized control charts, process capability analysis, correlation and regression analysis, analysis of categorical data, and non-parametric statistical methods.
4. **Improve:** It covers project management, risk assessment, process simulation, and design of experiments (DOE), robust design concepts, and process optimization.
5. **Control:** It covers process control planning, using SPC for operational control and PRE-Control.

DMADV

It specifies a data-driven quality strategy for designing products and processes. This method is used to create new product designs or process designs in such a way that it results in a more predictable, mature, and defect free performance.

The DMADV project methodology has five phases:



1. **Define:** It defines the problem or project goal that needs to be addressed.
2. **Measure:** It measures and determines the customer's needs and specifications.
3. **Analyze:** It analyzes the process to meet customer needs.
4. **Design:** It can design a process that will meet customer needs.
5. **Verify:** It can verify the design performance and ability to meet customer needs.