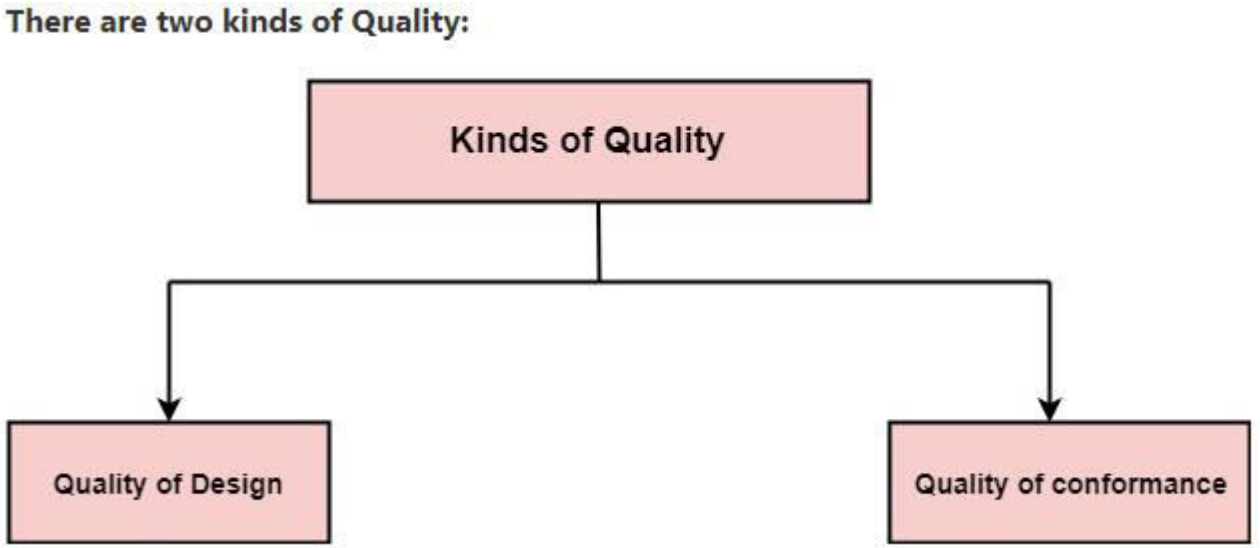
Software Quality Assurance

What is Quality?

- Quality defines to any measurable characteristics such as correctness, maintainability, portability, testability, usability, reliability, efficiency, integrity, reusability, and interoperability.



- **Quality of Design:** Quality of Design refers to the characteristics that designers specify for an item. The grade of materials, tolerances, and performance specifications that all contribute to the quality of design.
- **Quality of conformance:** Quality of conformance is the degree to which the design specifications are followed during manufacturing. Greater the degree of conformance, the higher is the level of quality of conformance.
- **Software Quality:** Software Quality is defined as the conformance to explicitly state functional and performance requirements, explicitly documented development standards, and inherent characteristics that are expected of all professionally developed software.

- **Quality Control:** Quality Control involves a series of inspections, reviews, and tests used throughout the software process to ensure each work product meets the requirements place upon it. Quality control includes a feedback loop to the process that created the work product.
- **Quality Assurance:** Quality Assurance is the preventive set of activities that provide greater confidence that the project will be completed successfully.
- **Quality Assurance** focuses on how the engineering and management activity will be done?
- As anyone is interested in the quality of the final product, it should be assured that we are building the right product.
- It can be assured only when we do inspection & review of intermediate products, if there are any bugs, then it is debugged. This quality can be enhanced

Importance of Quality

- We would expect the quality to be a concern of all producers of goods and services. However, the distinctive characteristics of software and in particular its intangibility and complexity, make special demands.
- **Increasing criticality of software:** The final customer or user is naturally concerned about the general quality of software, especially its reliability. This is increasing in the case as organizations become more dependent on their computer systems and software is used more and more in safety-critical areas. For example, to control aircraft.

- **The intangibility of software:** This makes it challenging to know that a particular task in a project has been completed satisfactorily. The results of these tasks can be made tangible by demanding that the developers produce 'deliverables' that can be examined for quality.
- **Accumulating errors during software development:** As computer system development is made up of several steps where the output from one level is input to the next, the errors in the earlier ?deliverables? will be added to those in the later stages leading to accumulated determinable effects. In general the later in a project that an error is found, the more expensive it will be to fix. In addition, because the number of errors in the system is unknown, the debugging phases of a project are particularly challenging to contro

Quality Management

Quality Concepts

- Variation control is the heart of quality control
- Form one project to another, we want to minimize the difference between the predicted resources needed to complete a project and the actual resources used, including staff, equipment, and calendar time
- Quality of design

  Refers to characteristics that designers specify for the end product

Quality Management

- Quality of conformance

  Degree to which design specifications are followed in manufacturing the product

- Quality control

  Series of inspections, reviews, and tests used to ensure conformance of a work product to its specifications

- Quality assurance

  Consists of a set of auditing and reporting functions that assess the effectiveness and completeness of quality control activities

Quality Management

- **Cost of Quality**
- Prevention costs

  Quality planning, formal technical reviews, test equipment, training
- Appraisal costs

  In-process and inter-process inspection, equipment calibration and maintenance, testing
- Failure costs

  rework, repair, failure mode analysis
- External failure costs

  Complaint resolution, product return and replacement, help line support, warranty work

Software Quality Assurance

- Software quality assurance (SQA) is the concern of
- every software engineer to reduce cost and improve
- product time-to-market.
- A Software Quality Assurance Plan is not merely
- another name for a test plan, though test plans are
- included in an SQA plan.
- SQA activities are performed on every software
- project.
- Use of metrics is an important part of developing a
- strategy to improve the quality of both software
- processes and work products.

Software Quality Assurance

- Software quality assurance is a planned and systematic plan of all actions necessary to provide adequate confidence that an item or product conforms to establish technical requirements.
- A set of activities designed to calculate the process by which the products are developed or manufactured.
- SQA Encompasses
  - A quality management approach
  - Effective Software engineering technology (methods and tools)
  - Formal technical reviews that are tested throughout the software process
  - A multitier testing strategy
  - Control of software documentation and the changes made to it.
  - A procedure to ensure compliances with software development standards
  - Measuring and reporting mechanisms.

SQA Activities

- Software quality assurance is composed of a variety of functions associated with two different constituencies ? the software engineers who do technical work and an SQA group that has responsibility for quality assurance planning, record keeping, analysis, and reporting.

- **Following activities are performed by an independent SQA group:**

1. **Prepares an SQA plan for a project:** The program is developed during project planning and is reviewed by all stakeholders. The plan governs quality assurance activities performed by the software engineering team and the SQA group. The plan identifies calculation to be performed, audits and reviews to be performed, standards that apply to the project, techniques for error reporting and tracking, documents to be produced by the SQA team, and amount of feedback provided to the software project team.
2. **Participates in the development of the project's software process description:** The software team selects a process for the work to be performed. The SQA group reviews the process description for compliance with organizational policy, internal software standards, externally imposed standards (e.g. ISO-9001), and other parts of the software project plan.
3. **Reviews software engineering activities to verify compliance with the defined software process:** The SQA group identifies, reports, and tracks deviations from the process and verifies that corrections have been made.
4. **Audits designated software work products to verify compliance with those defined as a part of the software process:** The SQA group reviews selected work products, identifies, documents and tracks deviations, verify that corrections have been made, and periodically reports the results of its work to the project manager.
5. **Ensures that deviations in software work and work products are documented and handled according to a documented procedure:** Deviations may be encountered in the project method, process description, applicable standards, or technical work products.
6. **Records any noncompliance and reports to senior management:** Non- compliance items are tracked until they are resolved.

Quality Assurance v/s Quality control

Quality Assurance	Quality Control
Quality Assurance (QA) is the set of actions including facilitation, training, measurement, and analysis needed to provide adequate confidence that processes are established and continuously improved to produce products or services that conform to specifications and are fit for use.	**Quality Control (QC)** is described as the processes and methods used to compare product quality to requirements and applicable standards, and the actions are taken when a nonconformance is detected.
QA is an activity that establishes and calculates the processes that produce the product. If there is no process, there is no role for QA.	**QC** is an activity that demonstrates whether or not the product produced met standards.
QA helps establish process	**QC** relates to a particular product or service
QA sets up a measurement program to evaluate processes	**QC** verified whether particular attributes exist, or do not exist, in a explicit product or service.
QA identifies weakness in processes and improves them	**QC** identifies defects for the primary goals of correcting errors.
Quality Assurance is a managerial tool.	Quality Control is a corrective tool.
Verification is an example of QA.	Validation is an example of QC.

Software Reviews

- Purpose is to find errors before they are
- passed on to another software engineering
- activity or released to the customer.
- Software engineers (and others) conduct
- formal technical reviews (FTRs) for software
- quality assurance.
- Using formal technical reviews (walkthroughs
- or inspections) is an effective means for
- improving software quality.

Formal Technical Review

- A FTR is a software quality control activity performed by software engineers and others.The objectives are:

1. To uncover errors in function, logic or implementation for any representation of the software.
2. To verify that the software under review meets its requirements.
3. To ensure that the software has been represented according to predefined standards.
4. To achieve software that is developed in a uniform manner and
5. To make projects more manageable.

Formal Technical Review

Review meeting in FTR

- The Review meeting in a FTR should abide to the following constraints

1. Review meeting members should be between three and five.
2. Every person should prepare for the meeting and should not require more than two hours of work for each person.
3. The duration of the review meeting should be less than two hours.

Formal Technical Review

- The focus of FTR is on a work product that is requirement specification, a detailed component design, a source code listing for a component.
- The individual who has developed the work product i.e, the producer informs the project leader that the work product is complete and that a review is required.
- The project leader contacts a review leader, who evaluates the product for readiness, generates copy of product material and distributes them to two or three review members for advance preparation .
- Each reviewer is expected to spend between one and two hours reviewing the product, making notes

Formal Technical Review

- The review leader also reviews the product and establish an agenda for the review meeting
- The review meeting is attended by review leader, all reviewers and the producer.
- One of the reviewer act as a recorder,who notes down all important points discussed in the meeting.
- The meeting(FTR) is started by introducing the agenda of meeting and then the producer introduces his product. Then the producer "walkthrough" the product, the reviewers raise issues which they have prepared in advance.
- If errors are found the recorder notes down

Review reporting and Record keeping

- During the FTR, a reviewer(recorder) records all issues that have been raised
- A review summary report answers three questions
  1. What was reviewed?
  2. Who reviewed it?
  3. What were the findings and conclusions?
- Review summary report is a single page form with possible attachments
- The review issues list serves two purposes
  1. To identify problem areas in the product
  2. To serve as an action item checklist that guides the producer as corrections are made

Review Guidelines

- Review the product, not the producer
- Set an agenda and maintain it
- Limit debate and rebuttal
- Enunciate problem areas, but don’t attempt to solve every problem noted
- Take return notes
- Limit the number of participants and insist upon advance preparation.
- Develop a checklist for each product i.e likely to be reviewed
- Allocate resources and schedule time for FTRS
- Conduct meaningful training for all reviewer • Review your early reviews

Software Defects

- Industry studies suggest that design activities
- introduce 50-65% of all defects or errors
- during the software process
- Review techniques have been shown to be up
- to 75% effective in uncovering design flaws
- which ultimately reduces the cost of • subsequent activities in the software process

Statistical Quality Assurance

- Information about software defects is collected
- and categorized
- Each defect is traced back to its cause
- Using the Pareto principle (80% of the defects
- can be traced to 20% of the causes) isolate
- the "vital few" defect causes •

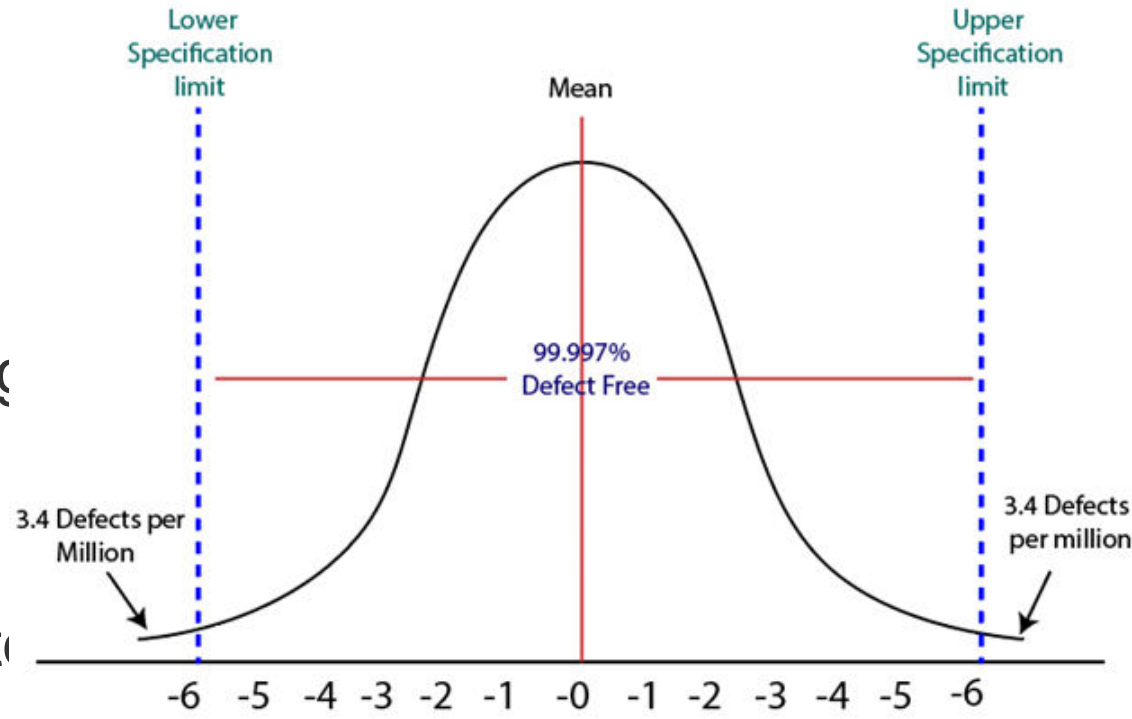
Move to correct the problems that caused the • defects in the "vital few”

Six Sigma for Software Engineering

- The most widely used strategy for statistical quality assurance
- Three core steps:
- 1. Define customer requirements, deliverables, and project goals via well-defined
- methods of customer communication.
- 2. Measure each existing process and its output to determine current quality
- performance (e.g., compute defect metrics)
- 3. Analyze defect metrics and determine vital few causes.
- For an existing process that needs improvement
- 1. Improve process by eliminating the root causes for defects
- 2. Control future work to ensure that future work does not reintroduce causes of
- defects
- If new processes are being developed
- 1. Design each new process to avoid root causes of defects and to meet
- customer requirements
- 2. Verify that the process model will avoid defects and meet customer
- requirements

Six Sigma

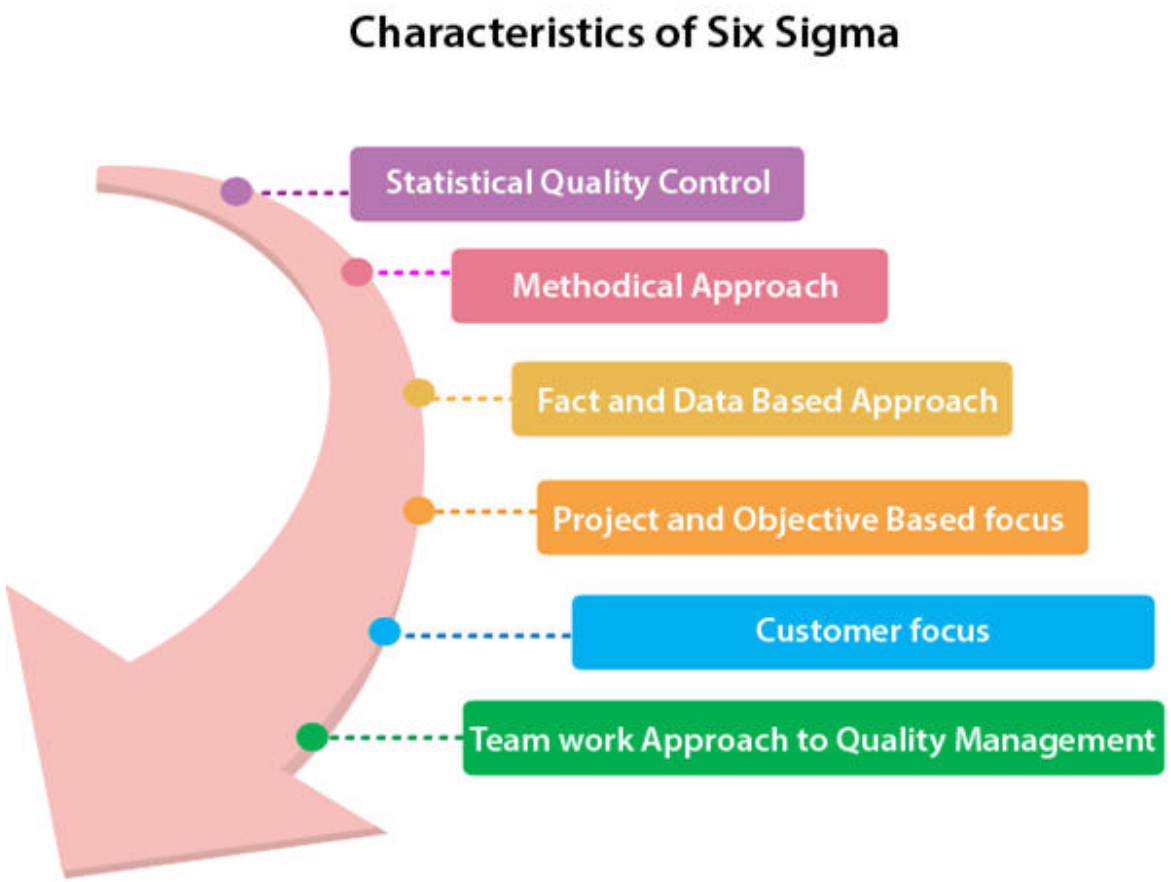
- Six Sigma is the process of improving the quality of the output by identifying and eliminating the cause of defects and reduce variability in manufacturing and business processes.
- The maturity of a manufacturing process can be defined by a sigma rating indicating its percentage of defect-free products it creates.
- A six sigma method is one in which **99.99966%** of all the opportunities t 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

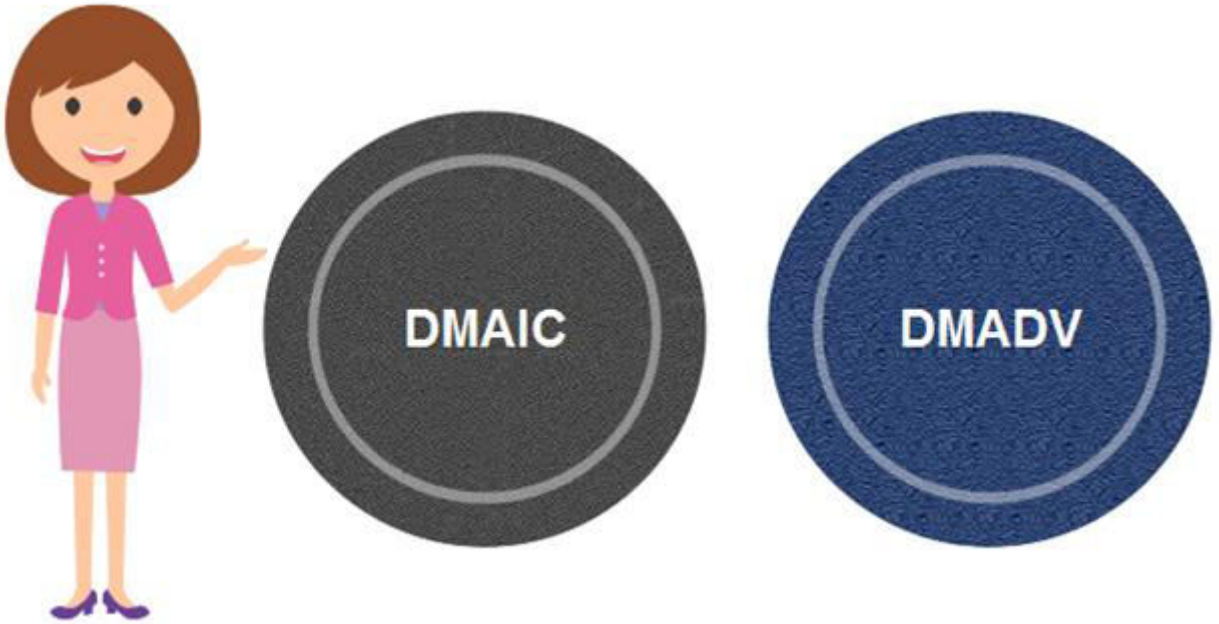
- Six-Sigma is a set of methods and tools for process improvement. It was introduced by Engineer **Sir Bill Smith** while working at **Motorola** in 1986. In the 1980s, **Motorola** was developing Quasar televisions which were famous, but the time there was lots of defects which came up on that due to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



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



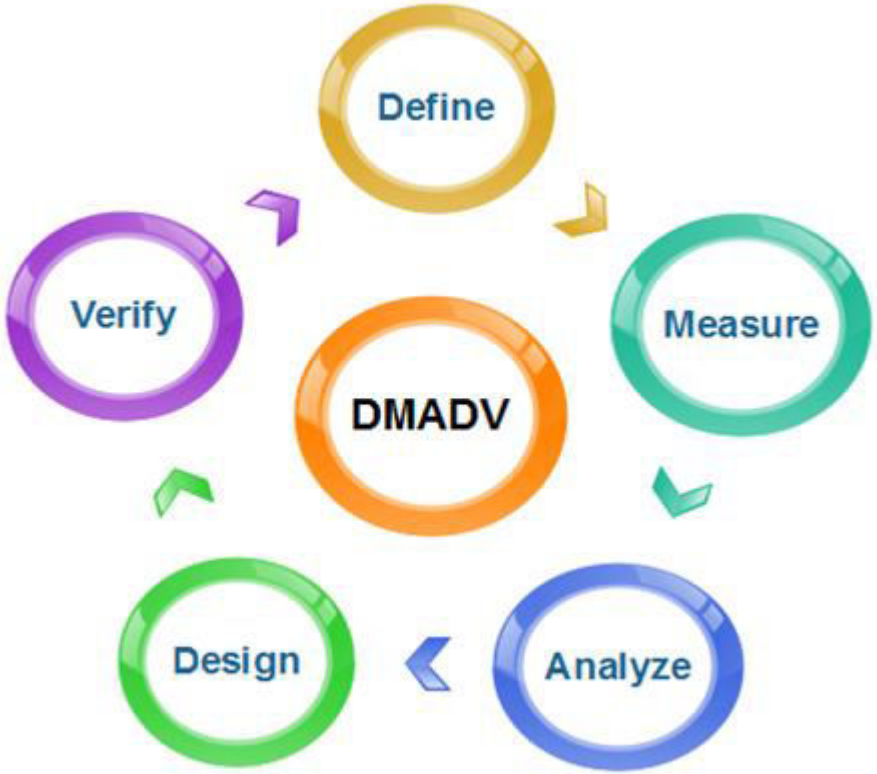
DMAIC

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

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 detect free performance.



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.

Software Reliability

- Defined as the probability of failure free operation of a
- computer program in a specified environment for a specified
- time period
- Can be measured directly and estimated using historical and
- developmental data
- Software reliability problems can usually be traced back to
- errors in design or implementation.
- Measures of Reliability
- Mean time between failure (MTBF) = MTTF + MTTR
- MTTF = mean time to failure
- MTTR = mean time to repair
- Availability = [MTTF / (MTTF + MTTR)] x 100%

ISO 9000 Quality Standards

- Quality assurance systems are defined as the
- organizational structure, responsibilities, procedures,
- processes, and resources for implementing quality
- management.
- ISO 9000 describes the quality elements that must
- be present for a quality assurance system to be
- compliant with the standard, but it does not describe
- how an organization should implement these
- elements.
- ISO 9001:2000 is the quality standard that contains
- 20 requirements that must be present in an effective
- software quality assurance system.

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

- 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:

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.