Software Quality

There is no one universal definition of software quality. This is because of the complexity caused by the three or more participants affected by the quality of software, namely, customer, developer and stakeholders. The issue is whose views, expectations and aspirations are to be considered supreme. The majority hold that customer satisfaction should be the goal for measuring software quality. The customer may be satisfied though with software, the quality of which cannot be considered the best by other standards.

The software quality definition is based on the following:

- Customer focus and customer satisfaction
- Functional and performance requirement
- Ease of learning, use and maintainability
- Adherence to development standards

Customer satisfaction largely depends on meeting functional and performance requirements and ease of operations. Adhering to development standards ensures to a great extent the achievement of these goals.

Software quality is defined as the quality that ensures customer satisfaction by offering all the customer deliverables on performance, standards and ease of operations. The definition is applicable for software as well as for a generic software product.

Software Quality Assurance (SQA)

Software quality assurance is a planned effort to ensure that a software product fulfills these criteria and has additional attributes specific to the project, e.g., portability, efficiency, reusability, and flexibility. It is the collection of activities and functions used to monitor and control a software project so that specific objectives are achieved with the desired level of confidence. It is not the sole responsibility of the software quality assurance group but is determined by the consensus of the project manager, project leader, project personnel, and users.

A formal definition of software quality assurance is that is ‘the systematic activities providing evidence of the fitness for use of the total software product.” Software quality assurance is achieved through the use of established guidelines

for quality control to ensure the Integrity and prolonged life of software. The relationships between quality assurance, quality control, the auditing function, and software testing are often confused.

Quality assurance is the set of support activities needed to provide adequate confidence that processes are established and continuously improved in order to products that meet specifications and are fit for use. Quality control is the process by which product quality is compared with applicable standards and the action taken when nonconformance is detected. Auditing is the inspection/ assessment activity that verifies compliance with plans, policies, and procedures.

SQA Activities

SQA is ensured through a Quality Management System (QMS), QMS is made of several components; it is a system integrated in the bigger system of software development, which comprises project, process and product management systems.

The Software Engineering Institute (SEI) recommends a set of activities, which, when implemented effectively, assures the designed quality. These activities include:

• Quality assurance planning
• Data gathering on key quality defining parameters
• Data analysis and reporting
• Quality control mechanisms

The first and foremost requirement in SQA is that it is a separate group responsible for quality in the organization. They set the goals, standards and mechanisms (systems) for SQA. The role of the SQA group is to assist the software development team in managing the quality requirements of the software. Every software has certain quality goals specified by the customer. These quality goals are to be achieved by the development team by introducing a set of activities or ensuring the delivery of quality to the customer.

SQA activities operate on the normal activities of quality management. These activities play the role of monitoring, tracking, evaluations, auditing and reviews to ensure that the quality policy of the organization is implemented. These activities are independently carried out, and feedback is given to the development team.

The responsibility of delivering the required quality to the customer rests with the

development team. The development team has an obligation to implement quality policy in terms of goals, objectives, procedures, checks and controls, documentation and feedback to management. For example, the quality policy stipulates preparation of a test plan for stages for development as well as at the end of the development process. SQA has a variety of tools to implement the policy.

They are

• Auditing
• Inspection

Verify compliance with those norms and practices specified in QA policy; deviations are set right. Ensure that deviations are documented and reported and put into the QA database for guidance. Design and architecture is reviewed to ensure that standards are met and customer quality is assured. Implement change management. Collect data on various observations in the process of auditing, inspection and reviews to build QA database and to improve various standards.

Software Defects

The causes for not meeting the quality commonly are

• Imprecise requirement and software specifications
• Lack of understanding of customer requirements
• International deviations
• Violation of standards (Design, Programming)
• Erroneous data representation
• Improper interface
• Faulty logic in rules and processes
• Erroneous testing
• Incomplete and defective documentation
• H&S platforms not coping up to required standards
• Lack of domain knowledge

Statistical analysis of errors or defects helps to focus and concentrate on probable areas where SQA efforts are necessary.

SQA is also concerned with two other aspects namely, software reliability and software safety. Software reliability is defined as the probability of failure free operation of a computer program in a specified environment for a specified time.

The nature of failure may be such that one error may require only a few repair, and other may need hours. SQA collects data on these failures and examines why these failures could not be prevented through earlier SQA activities.

A simple measure of reliability is Mean Time between Failure (MTBF).

MTBF = MTTF + MTTR

Where MTTF is Mean Time to Failure and MTTR is Mean Time to Repair.

Software safety deals with identification and assessment of potential hazards of software failing, and its impact on the system or in the environment in which it operates. Software safety needs are more crucial in process control systems, health care systems, defense and so on. SQA activities concentrate on such areas of software where failure affects the customer system adversely.

In short, SQA efforts assure software quality, reliability, availability and safety.

Components of Quality Assurance

Most software quality assurance activities can be categorized into software testing, i.e., verification and validation, software configuration management, and quality control. But the success of a software quality assurance program also depends on a coherent collection of standards, practices, conventions, and specifications.

Software Quality Assurance Plan

The software quality assurance (SQA) plan is an outline of quality measures to ensure quality levels within a software development effort. The plan is used as a baseline to compare the levels of quality during development with the planned levels of quality. If the levels of quality are not within the planned quality levels management will respond appropriately as documented within the plan.

The plan provides the framework and guidelines for development of understandable and maintainable code. These Ingredients help ensure the quality sought in a software project, A SQA plan also provides the procedures for ensuring that quality software will be produced or maintained in house or under contract. These procedures affect planning. Designing, writing, testing, documenting, strong, and maintaining computer software. It should be organized in this way because the plan ensures the quality of the software rather than describing specific

procedures for developing and maintaining the software.

In the management approval process, management relinquishes tight control over software quality to the SQA plan administrator in exchange for improved software quality. Software quality is often left to software developers. Quality is desirable. But management may express concern as to the cost of a formal SQA plan. Staff should be aware that management views the program as a means of ensuring software quality, and not as an end in itself.

To address management concerns, software life cycle costs should be formally estimated for projects implemented both with and without a formal SQA plan. In general, implementing a formal SQA plan makes economic and management sense.

The SQA Plan helps to lay down the steps towards the quality goals of the organization. A standard for SQA plan gives details and templates on all activities, which have become part of the standard and which ensure quality standards implementation.

The documentation of SQA plan includes

• Project plan
• Models of data, classes and objects, processes, design, architecture
• Software Requirement Specifications (SRS)
• Test plans for testing SRS
• Users help documentation, manuals, online help, etc.
• Reviews and audits

The SQA process is made up of several activities. Some are organization specific, some are software specific and some are customer specific. It helps effective application of methods, tools, test plans and standards towards the goal of software quality. It also include measures, measurement and metric for building a quality in the organization.

Software Testing

Software testing is a popular risk management strategy .It is used to verify that functional requirements were met. Responsibility for Inspections is stated in the stated in the software quality assurance plan. For small projects, the project leader or the department's quality coordinator can perform the Inspections. For large projects, a member of the software quality assurance group may lead an Inspection performed by an audit team. Which is similar to the configuration control board

mentioned previously. Following the inspection, project personnel are assigned to correct the problems on a specific schedule.

Testing Techniques for SQA

To test a code once it has been declared as complete is critical to achieving the quality assured to the customer. This testing is expected to discover and, more importantly, to correct errors before the software is demonstrated and delivered. The goal is therefore to discover and correct so that the customer does not encounter any error later. This is achieved through Test cases designed specifically to detect errors in the code. The test cases are designed and written using testing techniques. Reviews and SQA activities alone are not sufficient to detect errors. In order to find the highest number of errors, test cases must also be designed and systematically executed. Test cases are designed to test internal logic (white box tests) and software requirements (back box tests). The test cases are executed and if errors are detected they are corrected and proper documentation is prepared.

Testing Objectives and Principles

The testing objective is to test the code, whereby there is a high probability of discovering all errors. This objective also demonstrates that the software functions are working according to software requirement specifications (SRS) with regard to functionality, features, facilities and performance. It should be another certification is given by ISO, which also specifies the quality management infrastructure required to achieve the best quality performance.

ISO 9000 Quality System

The ISO 9000 standards are a collection of formal International Standards, technical reports, handbooks and web based documents on quality management and quality assurance. ISO technical committee and web based documents on quality management and quality assurance. ISO technical committee and its sub committees are responsible for the development of the standards. The work is conducted on the basis of “consensus” among quality and industry experts nominated by the national standards bodies, representing a wide range of interested parties.

The ISO 9000 series of standards are generic rather than industry specific. It can be applied to any organization, large or small, whether its product, and whether it is a business enterprise, a public administration, or a government department.

ISO 9000 is a family of standards for quality management systems. ISO 9000 is maintained by ISO, the International Organization for Standardization and is administered by accreditation and certification bodies. The rules are updated, the time and changes in the requirements for quality, motive change. Recently, on

November 15, 2008, has made changes to the requirements of ISO 9001.

Some of the requirements in 9001 9 which is one of the standards in the ISO 9000 family) include

• A set of procedures that cover all key processes in the business;
• Monitoring processes to ensure they are effective;
• Keeping adequate records;
• Checking output for defects, with appropriate and corrective action where necessary;
• Regularly reviewing individual processes and the quality system itself for effectiveness; and
• Facilitating continual improvement

A company or organization that has been independently audited and certified to be in conference with ISO 9001 may publicly state that it is "ISO 9001 registered." Certification to an ISO 9001 standard does not guarantee any quality of end products and services; rather, it certifies that formalized business processes are being applied.

Although the standards originated in manufacturing, they are now employed across several types of organizations. A "product", in ISO vocabulary, can mean a physical object, services, or software.

ISO 9000 Standards

• **ISO 9001: 2008 Quality management systems —** Requirements is intended for use in any organization regardless of size, type or product (including service). It provides a number of requirements which an organization needs to fulfill to achieve customer satisfaction through consistent products and services which meet customer expectations. It includes a requirement for continual (i.e., planned) improvement of the Quality Management System, for which ISO 9004:2004 provides many hints.

This is the only implementation for which third party auditors can grant certification. It should be noted that certification is not described as any of the 'needs' of an organization as a driver for using ISO 9001 but does recognize that it may be used for such a purpose.

• **ISO 9004:2000 Quality management systems -** Guidelines for performance improvements covers continual improvement. This gives you advice on what you could do to enhance a mature system. This document very specifically states that it is not intended as a guide to implementation.

There are many more standards in the ISO 9001 series, many of them not even

carrying “ISO 9000” numbers. For example, some standards in the 10,000 range are considered part of the 9000 group: ISO 10007: 1995 discusses configuration management, which for most organizations is just one element of a complete management system. The emphasis on certification tends to overshadow the fact that there is an entire family of ISO 9000 standards… Organizations stand to obtain the greatest value when the standards in the new core series are used in an integrated manner, both with each other and with the other standards making up the ISO 9000 family as a whole.

Note that the previous members of the ISO 9000 series 9002 and 9003 have been integrated into 9001. In most cases, an organization claiming to be “ISO 9000 registered” is referring to ISO 9001.

ISO 9001 Scope of Software Quality

The ISO 9001 standard has 20 clauses (4.1 to 4.20) that lay down guidelines for the development of quality assurance systems. These guidelines define the essential features of the software quality management system and suggest controls and methods that allow the software to meet customer needs.

The steps that have to be taken to set up the ISO 9001 standard are :

1. A commitment to quality by the highest level of management of the organization and necessary resource allocation. Understanding quality requirements for organizing the work.

2. Identifying procedures to develop the software and to test whether it can meet customer needs in a defined time.

3. Acceptance of software by customer.

4. Delivery and installation.

5. Maintenance.

6. Support activities, namely, documentation control, maintenance of detailed records , and training.

7. Non-conformity control and corrective action these steps when implemented through a set of procedures will make the company eligible for ISO 9001. ISO 9001 gives a detailed explanation for each clause, which requires compliance for a company to become eligible for ISO 9001 certification. If all the above steps are fully executed, then clauses 4.1 to 4.20 of 4.20 of ISO 9001 are taken care of.

ISO 9001 does not recommend standard formats but demands execution of these steps

ISO 9001 Checklist

Quality Policy (4.0 of ISO 9001)

The management shall define the quality policy and ensure all concerned understand this policy. The policy document should be signed by the CEO and be displayed at prominent places.

Management Review (4.1 to ISO 9001)

The quality system adopted to satisfy the requirements for this information standard shall be reviewed periodically to ensure continuity, suitability, and effectiveness. The company shall appoint a management representative with the responsibility to ensure that ISO guidelines are implemented.

Quality System Procedure (QSP) (4.2 of ISO 9001)

The company shall establish a OSP and maintain a documented quality system as a means of ensuring that it confirms to the specified requirements of ISO.

(a) Preparation of documented quality system procedures and instructions.

(b) Effective implementation of these procedures.

Broadly, QAS includes the following:

• QA manual
• Management procedures
• Technical work instructions

Contract Review (4.3 of ISO 9001)

The company shall establish a procedure for contract review and coordination of activities:

• Contractual requirements are adequately defined and documented
• Procedure to resolve any deviation
• Ensure capability to meet contractual requirement
• Records of contract review are maintained

Design control (4.4 of/ so 9001)

Establish and maintain procedures to control and verify the design to ensure that specified requirements are met. The points to be covered are

• Identification of design consideration
• Design methodology
• Use of past design experience
• Inclusion of design experience
• Inclusion of design Inputs requirements
• Design verification
• Design changes

Documnt control (4.5 0f ISO 9001)

• Design documents
• Planning documents
• Procedural documents
• Reference documents
• Document master list and its revision log
• The organization for documentation

Purchasing (4.6 of ISO 9001)

• Hardware, software, tools
• Assessment of sub-contractors
• Verification of supplies

Software Identification and Tracing (4.7 of ISO 9001)

Establish a procedure whereby software can be drilled down to all documentation to trace any information needed. Appropriate numbering, coding and version control numbers should be introduced.

Purchase supplied Product (4.7 of ISO 9001)

The company shall establish a procedure to receive, verify, store and maintain client supplied software/ tools etc. These items are part of the deliverables of the company. If software is found unsuitable it should be returned with resource for rejection.

Process control (4.9 of ISO 9001)

A procedure to ensure that from development to implementation all activities are carried out to meet the quality requirements. The procedure should have following aspects covered through documents:

• Work Instruction
• Monitoring and control of activities
• Approval of processes and hardware and software/ tools etc.
• Workmanship standards

Inspection and testing (4.10 ISO 9001)

Establish a procedure to ensure that resources are as per the required standards. It should cover

• In process inspection and testing
• Final inspection and testing
• Records of testing

Inspection, measuring and testing equipment (4.11 of ISO 9001)

• Establish a procedure to ensure that rules, practices, conventions, tools and techniques agreed upon between the company and customer are adhered to and used in the development

• Software tools, e.g., compilers, editors, database software, steps, communication software internet and Web tools are evaluated earlier for purchase and installation

• Ensure that test plans are evolved for all stages of development

Test status (4.12 of ISO 9001)

Set a procedure to ensure that only tested and quality assured products are dispatched, used or installed.

Control of Non- conforming Products (4.13 0f ISO 9001)

Set up a procedure to ensure that the software not conforming to specified requirements is not dispatched, installed or used by mistake.

Corrective Action (4.14 of ISO 9001)

Set up a procedure to ensure that corrective action is taken to set right non-conforming software.

Handling, Storage and delivery (4.15 ISO 9001)

Ensure that unauthorized persons do not tamper with the software during development and after completion, and as a result, deliver software that has quality problems. Strict controls on access and us of media are necessary to control the quality of outgoing software.

Quality Records (4.16 of ISO 9001)

A procedure should be set to identify and maintain quality records with a clear and unique relation to the software for which it is maintained. There should be a set of guidelines for retention of quality records for future reference in case a dispute arises. The retention period is of mutual convenience and as per contract terms, if any.

Internal quality Audits (4.17 of IO 9001)

A procedure should be in place to audit whether the quality procedures have been complied with. The audit will be scheduled and results reported and corrective action taken as laid down.

Training (4.18 of ISO 9001)

The company will maintain a procedure to identify the training needs of people responsible for quality assurance. The training records will justify the inclusion of personnel in the testing team.

Software Maintenance Service (4.19 0f ISO 9001)

If software includes support and service needs of the customer, then a support procedure should be in place that ensures that this service is effectively carried out.

Statistical Techniques (4.20 of ISO 9001)

A procedure should be in place be in place to verify the needs for statistical techniques that will in turn verify process capability and characteristics. This would be more applicable in process control software.

Advantages of ISO 9000

It is widely acknowledged that proper quality management improves business, often having a positive effect on investment, market share, sales growth, sales margins, competitive advantage, and avoidance of Litigation. The quality principles in ISO 9000: 2000 are also sound, according to Wade, and Barnes, who says “ISO 9000 guidelines provide a comprehensive model for quality management systems that can make any company competitive.” Barnes also cites a survey by LIoyd’s Register Quality Assurance which indicated that ISO 9000 increased net profit, and another by Deloitte Touche which reported that the costs of registration were recovered in three years. According to the Providence Business News, implementing ISO often gives the following advantages:

1. Create a more efficient , effective operation
2. Increase customer satisfaction and retention
3. Reduce audits
4. Enhance marketing
5. Improve employee motivation, awareness, and morale
6. Promote international trade
7. Increase profit
8. Reduce waste and increases productivity

However, a broad statistical study of 800 Spanish companies found that ISO 9000 registration in itself creates little improvement because companies interested in it have usually already made some type of commitment to quality management and were performing just as well before registration.

In today’s service sector driven economy, more and more companies are using ISO 9000 as a business tool. Through the use of properly stated quality objectives, customer satisfaction surveys and a well-defined continual improvement program companies are using IO 9000 processes to increase their efficiency and profitability.

Problems of ISO 9001

A common criticism of ISO 9001 is the amount of money, time and paperwork required for registration. According to Barnes, “Opponents claim that it is only for documentation. Proponents believe that if a company has documented its quality systems, then most of the paperwork has already been completed.”

According to Seddon, ISO promotes specification, control, and procedures rather than understanding and improvement. Ade argues that IO 9000 is effective as a guideline, but that is promoting it as a standard “helps to mislead companies into thinking that certification means better quality, [undermining] the need for an organization to set its own quality standards“. Reliance on the specifications of ISO 9001 does not guarantee a successful quality system.

The standard is seen as especially prone to failure when a company is interested in certification before quality. Certifications are in fact often based on customer contractual requirements rather than a desire to actually improve quality. “ If you just want the certificate on the wall, chances are, you will create a paper system that doesn’t have much to do with the way you actually run your business,’” said ISO’s Roger Frost. Certification by an independent auditor is often seen as the problem area, and according to Barnes, “has become a vehicle to increase consulting services.” In fact, ISO itself, advises that ISO 9001 can be implemented without certification, simply for the quality benefits that can be achieved.

Another problem reported is the competition among the numerous certifying bodies, leading to a softer approach to the defects noticed in the operation of the Quality system of a firm.

Capability Maturity Model Integration (CMMI)

CMMI is a collection of best practices that met the needs of organizations in different areas of interest. A collection of best practices that cover a particular area of interest is called a CMMI model.

Capability maturity model Integration (CMMI) in software engineering and organizational development is a process improvement approach that provides organizations with the essential elements for effective process improvement. It can

be used to guide process improvement across a project, a division, or an entire organization. CMMI helps integrate traditionally separate organizational functions. Set process improvement goals and priorities, provide guidance for quality processes, and provide a point of reference for appraising current processes.

CMMI currently addresses three areas of interest:

(1) Product and service development --- CMMI for development (CMMI DEV),
(2) Service establishment, management, and delivery --- CMMI for Services (CMMI SVC), and
(3) Product and service acquisition ---- CMMI for Acquisition (CMMI ACQ).

CMMI was developed by a group of experts from industry, government, and the Software Engineering Institute (SEI) at carnage Mellon University. CMMI models provide guidance for developing or improving processes that meet the business goals of an organization. A CMMI model may also be used as a framework for appraising the process maturity of the organization.

Depending on the CMMI constellation (acquisition, services, development), you use, the process areas it contains will vary. Key process areas are the areas that will be covered by covered by the organization's processes. The table below lists the process areas that are present in all CMMI constellations. This collection of sixteen process areas is called the CMMI Model framework, or CMF.

CMMI Model Framework (CMF)

Capability Maturity model Integration (CMMI) Model framework (CMF)

Abbreviation	Name	Area	Maturity Level
REQM	Requirements Management	Engineering	2
PMC	Project Monitoring and Control	Project Management	2
PP	Project Monitoring and Control	Project Management	2
CM	Configuration Management	Support	2
MA	Measurement and Analysis	Support	2
PPQA	Process and product Quality Assurance	Support	2

OPD	Organizational Process Definition	Process Management	3
OPF	Organizational Process Focus	Process Management	3
OT	Organizational Training	Process Management	3
IPM	Integrated Project Management	Project Management	3
RSKM	Risk Management	Project Management	3
DAR	Decision analysis and resolution	Support	3
OPP	Organizational Process Performance	Process Management	4
QPM	Quantitative Project Management	Project Management	4
OID	Organizational Innovation and Deployment	Process Management	5
CAR	Casual Analysis and Resolution	Support	5

CMMI Representation

CMMI enables you to approach process improvement because it provides the latest best practices for product and service development and maintenance. The CMMI best practices enable organizations to do the following:

• More explicitly link management and engineering activities to their business objectives

• Expand the scope of and visibility into the product lifecycle and engineering activities to ensure that the producer or service meets customer expectations

• Incorporate lessons learned from additional areas of best practice (e.g., measurement, risk management, and supplier management)

• Implement more robust high maturity practices

• Address additional organizational functions critical to their products and services

• More fully comply with relevant ISO standards

Levels of the Capability Maturity model

There are five levels defined along the continuum of the CMM, and, according to the SEI: “Predictability, effectiveness, and control of an organization’s processes are believed to improve as the organization moves up these five levels. While not rigorous, the empirical evidence to date supports this belief.”

Level 1 Initial

It is characteristic of processes at this level that they are (typically) undocumented and in a state of dynamic change, tending to be driven in an ad hoc, uncontrolled and reactive manner by users or events. This provides a chaotic or unstable environment for the processes.

Level 2 – Managed

It is characteristic of processes at this level that some processes are repeatable, possibly with consistent results. Process discipline is unlikely to be rigorous, but where it exists it may help to ensure that existing processes are maintained during times of stress.

Level 3 – Defined

It is characteristic of processes at this level that there are sets of defined and documented standard processes established and subject to some degree of improvement over time. These standard processes are in place (i.e., they are the AS-IS processes) and used to establish consistency of process performance across the organization.

Level 4- Quantitatively Managed

It is characteristic of processes at this level that, using process metrics, management can effectively control the AS IS process (e.g., for software development). In particular, management can identify way to adjust and adapt the process to particular projects without measurable losses of quality or deviations from specifications. Process capability is established from this level.

Level 5- Optimizing

It is a characteristic of processes at this level that the focus is on continually

improving process performance through both incremental and innovative technological changes/ improvements.

At maturity level 5, processes are concerned with addressing statistical common causes of process (for example, shifting the mean of the process performance) to improve process performance. This would be done at the same time as maintaining the likelihood of achieving the established quantitative process improvement objectives.

Six Sigma

Six Sigma is one of the most popular quality methods lately. It is the rating that signifies “best in class,” with only 3.4 defects per million units or operations (DPMO). Its concept works and results in remarkable and tangible quality improvements when implemented wisely. Today, Six Sigma processes are being executed in a vast array of organization and in a wide variety of functions.

Fueled by its success at large companies such as Motorola, General electric, Sony, and Allied Signal, the methodology is proving to be much than just a quality initiative. Why are these large companies embracing Six Sigma? What makes this methodology different from the others?

The goal of Six Sigma is not to achieve six sigma levels of quality, but to improve profitability. Prior to Six Sigma, improvements brought about by quality programs, such as Total Quality Management (TOM) and ISO 9000, usually had no visible impact on a company’s net income. In general, the consequences of immeasurable improvement and invisible impact caused these quality programs gradually to be.

Six Sigma was originally developed as a set of practices designed to improve manufacturing processes and eliminate defects, but its application was subsequently extended to other types of business processes as well In Six Sigma, a defect is defined as anything that lead to customer dissatisfaction.

• Six Sigma stands for six standard deviation from mean (sigma is thee Greek letter used to represent standard deviation in statistics).

• Six Sigma methodologies provide the techniques and tools to improve the capability and reduce the defects in any process.

• Six Sigma strives for perfection. It allows for only 3.4 defects per million opportunities (or 99.999666 percent accuracy)

• Six Sigma improves the process performance decrease variation and maintains consistent quality of the process output. This leads to defect reduction and improvements in profits, product quality and customer satisfaction.

• Six Sigma incorporates the basic principles and techniques used in business, statistics and engineering.

• The objective of Six Sigma principle is to achieve zero defects products/ process. It allows and engineering.

• The objective of Six Sigma principle is to achieve zero defects products/ process. It allows 4.4 defects per million opportunities.

Features that St Six Sigma

Apart from previous quality improvement initiatives include—

• A clear focus on achieving measurable and quantifiable financial returns from any Six Sigma project.

• An increased emphasis on strong and passionate management leadership and support.

• A special infrastructure of " Champions, " " Master black Belts, " "black Belts, " etc. to lead and implement the Six Sigma approach.

• A clear commitment to making decisions on the basis of verifiable data, rather than assumptions and guesswork.

Sigma Levels

• 1 sigma = 690, 000 DPMO= 31% efficiency
• 2 sigma = 308,000 DPMO= 69.2% efficiency
• 3 sigma = 66,800 DPMO= 93.32% efficiency
• 4 sigma= 6,210 DPMO = 99.379 % efficiency
• 5 sigma = 230 DPMO = 99.977 % efficiency
• 6 sigma = 3.4 DPMO = 99.9997 % efficiency

Note:
I willingly confess the liberal use of Excerpts from: https://www.tutorialspoint.com/ in compiling this material.