**SOFTWARE QUALITY ASSURANCE (SQA)**

**Role of SQA**

Software quality assurance is the process of ensuring the quality of software that it meets the required it meet the desired quality measures. Software Quality Assurance is implemented in various types of software models. SQA is used to test the software, rather than checking the quality after completion. SQA processes, test for quality in each phase of development until the software is complete. With the SQA the software development moves to the next phase if the current phase of software is compiled with required quality standards. SQA works on one more standards that help in building software quality guidelines and implementation strategies. These include ISO 9000 and capability maturity model CMM.

**Different activities of SQA are as follows**

* Maintaining the quality of the system as per the specification and business requirements.
* Defect prevention and formal methods for other defect prevention technique.
* Defect Reduction
* Direct fault detection and removal without executing the project scenario.
* Testing the project for Failure observation and bug removal.
* Risk identification
* Defect tracking techniques and methods. Software fault tolerance. Concluding remarks and maintaining reports.

Software quality can be quantified into two major groups

**Software function quality:**it basically shows how well a software product conforms to the basic design, based on functional requirements.

**Software structural quality:** It reflects on how well the project meets the non functional requirement such as usability, accessibility and security that helps in proper the delivery of the requirement.

Software tester faces a great deal of pressure to get their product during the released under budget and time. So the developers and testers need to take every opportunity to effectively manage the quality of their products or risks. To maintain the quality of the software the QA managers need to able to gauge the effectiveness of their organization.

**SQA Benefits**

SQA has a host of benefits. It ensures that that software built as per SQA procedures are of specified quality. SOA helps to

1. Eliminate errors when they are still inexpensive to correct
2. Improves the quality of the software
3. Improving the process of creating software
4. Create a mature software process

### Software Quality Assurance Plan

**Abbreviated as SQAP, the software quality assurance plan comprises of the procedures, techniques, and tools that are employed to make sure that a product or service aligns with the requirements defined in the SRS(software requirement specification).**

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**The plan identifies the SQA responsibilities of a team, lists the areas that need to be reviewed and audited. It also identifies the SQA work products.**

**The SQA plan document consists of the below sections:**

1. **Purpose section**
2. **Reference section**
3. **Software configuration management section**
4. **Problem reporting and corrective action section**
5. **Tools, technologies and methodologies section**
6. **Code control section**
7. **Records: Collection, maintenance and retention section**
8. **Testing methodology**

**Software Quality Management**

Basically, a three-level structure of management exists in software development organizations −

* Top management
* Department management
* Project management

## Top Management Responsibilities in Software Quality

Following are the responsibilities of the top management in ensuring Software Quality −

* Assure the quality of the company’s software products and software maintenance services
* Communicate the importance of the product and service quality in addition to customer satisfaction to employees at all levels
* Assure satisfactory functioning and full compliance with customer requirements
* Ensure that quality objectives are established for the organization’s SQA system and that its objectives are accomplished
* Initiate planning and oversee implementation of changes necessary to adapt the SQA system to major internal as well as external changes related to the organization’s clientele, competition, and technology
* Intervene directly to support resolution of crisis situations and minimize damages
* Ensure the availability of resources required by SQA systems

The following steps can be taken by the top management to fulfill its responsibilities −

* Establishing and updating the organization’s software quality policy.
* Assigning one of the executives such as Vice President for SQA to be in charge of software quality issues
* Conducting regular management reviews of performance with respect to software quality issues

### The Executive In-charge of Software Quality

The responsibilities of the executive in-charge of software quality issues may be classified as −

* Responsibility for preparation of an annual SQA activities program and budget
* Responsibility for preparation of SQA system development plans
* Overall control of implementation of the annual SQA regular activities program and planned SQA development projects
* Presentation and advocacy of SQA issues to executive management

### Responsibility for Preparation of Annual SQA Activities Program

This requires the executive to −

* Establish the system’s SQA objectives for the coming year
* Review proposals prepared by the SQA unit for the annual activities program and verify the proposal's potential to fulfil the objectives set for the SQA system
* Determine whether the activities program is adequate to the characteristics and scope of subcontractor services and software purchases planned for the coming year
* Determine the adequacy of the manpower and other resources planned for implementation of the SQA program
* Approve the final version of the annual SQA activities program and budget

### Responsibility for Preparation of SQA System Development Plans

These plans must be adaptable to the changes in technological as well as customer demands and competition. The responsibilities include −

* Review of trends that are expected to affect the organization’s software quality in the near future
* Review proposals for SQA adaptations such as preparation of new procedures appropriate to the new tools and SQA standards
* Preparation of training programs for veteran software development teams and newly recruited team members
* Development of software quality metrics appropriate for evaluating the new tools and standards as well as the success of the training programs
* Approval of the final version of the planned SQA development projects, including their schedules and budgets

### Overall Control of Implementation of the Annual SQA Program

The executive in-charge is responsible for −

* General supervision of the annual activities program
* Review of the progress of the SQA adaptation projects
* General supervision of the actions taken to realize the quality achievements dictated by the teams’ objectives (based on periodic reports)
* Review of compliance with SQA procedures and standards based on internal quality audits
* General follow-up of compliance to software development project schedules and budgets
* General follow-up of provision of quality maintenance services to external and internal customers

### Presentation and Advocacy of SQA Issues to Executive Management

In order to promote quality and resolve SQA system difficulties it requires −

* Presentation for final approval of the proposed annual activities program and budget
* Presentation for final approval of planned SQA adaptation projects together with the corresponding budgets
* Initiation and leadership of periodic management review meetings dedicated to the organization’s software quality
* Initiation of management-level discussions dedicated to special software quality events, such as severe quality failures, threats to the successful completion of projects due to severe professional staff shortages, managerial crises in the SQA unit, and so on

### Department Management Responsibilities for SQA

Middle management’s quality assurance responsibilities include −

* Management of the software quality management system (quality system-related tasks)
* Management of tasks related to the projects and services performed by units or teams under the specific manager’s authority (project-related tasks)

### Quality system-related responsibilities

These include SQA activities to be performed on the department level −

* Preparation of the department’s annual SQA activities program and budget, based on the recommended program prepared by the SQA unit
* Preparation of the department’s SQA systems development plans, based on the recommended plan prepared by the SQA unit
* Control of performance of the department’s annual SQA activities program and development projects
* Presentation of the department’s SQA issues to top management

### Project-related Responsibilities

These vary according to the organization’s procedures and distribution of authority; they usually involve −

* Control of compliance to quality assurance procedures in the department’s units, including CAB, SCM and SCCA bodies
* Detailed follow-up of contract review results and proposal approvals
* Review of unit performance of planned review activities; approval of project documents and project phase completion
* Follow-up of software tests and test results; approval of project’s software products
* Follow-up of progress of software development project schedules and budget deviations
* Advice and support to project managers in resolving schedule, budget and customer relations difficulties
* Follow-up of quality of maintenance services provision
* Detailed follow-up of the project risks and their solutions
* Follow-up of project’s compliance with customer requirements and customer’s satisfaction
* Approval of large software change orders and significant deviations from project specifications

## SQA Considerations

* Create a Robust Testing Environment
* Select release criteria carefully
* Apply automated testing to high-risk areas to save money. It helps to fasten the entire process.
* Allocate Time Appropriately for each process
* It is important to prioritize bugs fixes based on software usage
* Form dedicated security and performance testing team
* Simulate customer accounts similar to a production environment

## Quality Assurance Functions:

There are 5 primary Quality Assurance Functions:

1. **Technology transfer:** This function involves getting a product design document as well as trial and error data and its evaluation. The documents are distributed, checked and approved
2. **Validation:** Here validation master plan for the entire system is prepared. Approval of test criteria for validating product and process is set. Resource planning for execution of a validation plan is done.
3. **Documentation:** This function controls the distribution and archiving of documents. Any change in a document is made by adopting the proper change control procedure. Approval of all types of documents.
4. **Assuring Quality of products**
5. **Quality improvement plans**

## Quality Assurance Certifications:

There are several certifications available in the industry to ensure that Organizations follow Standards Quality Processes. Customers make this as qualifying criteria while selecting a software vendor.

### ****ISO 9000****

This standard was first established in 1987, and it is related to Quality Management Systems. This helps the organization ensure quality to their customers and other stakeholders. An organization who wishes to be certified as ISO 9000 is audited based on their functions, products, services and their processes. The main objective is to review and verify whether the organization is following the process as expected and check whether existing processes need improvement.

This certification helps -

* Increase the profit of the organization
* Improves Domestic and International trade
* Reduces waste and increase the productivity of the employees
* Provide Excellent customer satisfaction

## CMMI level

The **Capability Maturity Model Integrated (CMMI)** is a process improvement approach developed specially for software process improvement. It is based on the process maturity framework and used as a general aid in business processes in the Software Industry. This model is highly regarded and widely used in Software Development Organizations.

CMMI has 5 levels. An organization is certified at CMMI level 1 to 5 based on the maturity of their Quality Assurance Mechanisms.

* Level 1 - **Initial:** In this stage the quality environment is unstable. Simply, no processes have been followed or documented
* Level 2 - **Repeatable:** Some processes are followed which are repeatable. This level ensures processes are followed at the project level.
* Level 3 - **Defined:**Set of processes are defined and documented at the organizational level. Those defined processes are subject to some degree of improvement.
* Level 4 - **Managed:** This level uses process metrics and effectively controls the processes that are followed.
* Level 5 - **Optimizing:** This level focuses on the continuous improvements of the processes through learning &  innovation.

**Software Configuration Management**

Configuration Management helps organizations to systematically manage, organize, and control the changes in the documents, codes, and other entities during the Software Development Life Cycle. It is abbreviated as the

SCM process. It aims to control cost and work effort involved in making changes to the software system. The primary goal is to increase productivity with minimal mistakes.

**Why do we need Configuration management?**

The primary reasons for Implementing Software Configuration Management System are**:**

* There are multiple people working on software which is continually updating
* It may be a case where multiple version, branches, authors are involved in a software project, and the team is geographically distributed and works concurrently
* Changes in user requirement, policy, budget, schedule need to be accommodated.
* Software should able to run on various machines and Operating Systems
* Helps to develop coordination among stakeholders
* SCM process is also beneficial to control the costs involved in making changes to a system

**Tasks in SCM process**

Configuration Identification

Baselines

Change Control

Configuration Status Accounting

Configuration Audits and Reviews

**Configuration Identification:**

Configuration identification is a method of determining the scope of the software system. With the help of this step, you can manage or control something even if you don't know what it is. It is a description that contains the CSCI type (Computer Software Configuration Item), a project identifier and version information.

**Activities during this process:**

* Identification of configuration Items like source code modules, test case, and requirements specification.
* Identification of each CSCI in the SCM repository, by using an object-oriented approach
* The process starts with basic objects which are grouped into aggregate objects. Details of what, why, when and by whom changes in the test are made
* Every object has its own features that identify its name that is explicit to all other objects
* List of resources required such as the document, the file, tools, etc.

Example:

Instead of naming a File login.php its should be named login\_v1.2.php where v1.2 stands for the version number of the file

Instead of naming folder "Code" it should be named "Code\_D" where D represents code should be backed up daily.

**Baseline:**

A baseline is a formally accepted version of a software configuration item. It is designated and fixed at a specific time while conducting the SCM process. It can only be changed through formal change control procedures.

**Activities during this process:**

* Facilitate construction of various versions of an application
* Defining and determining mechanisms for managing various versions of these work products
* The functional baseline corresponds to the reviewed system requirements
* Widely used baselines include functional, developmental, and product baselines

In simple words, baseline means ready for release.

**Change Control:**

Change control is a procedural method which ensures quality and consistency when changes are made in the configuration object. In this step, the change request is submitted to software configuration manager.

Activities during this process:

* Control ad-hoc change to build stable software development environment. Changes are committed to the repository
* The request will be checked based on the technical merit, possible side effects and overall impact on other configuration objects.
* It manages changes and making configuration items available during the software lifecycle

**Configuration Status Accounting:**

Configuration status accounting tracks each release during the SCM process. This stage involves tracking what each version has and the changes that lead to this version.

**Activities during this process:**

* Keeps a record of all the changes made to the previous baseline to reach a new baseline
* Identify all items to define the software configuration
* Monitor status of change requests
* Complete listing of all changes since the last baseline
* Allows tracking of progress to next baseline
* Allows to check previous releases/versions to be extracted for testing

**Configuration Audits and Reviews:**

Software Configuration audits verify that all the software product satisfies the baseline needs. It ensures that what is built is what is delivered.

**Activities during this process:**

* Configuration auditing is conducted by auditors by checking that defined processes are being followed and ensuring that the SCM goals are satisfied.
* To verify compliance with configuration control standards. auditing and reporting the changes made
* SCM audits also ensure that traceability is maintained during the process.
* Ensures that changes made to a baseline comply with the configuration status reports
* Validation of completeness and consistency

**Participant of SCM process:**

Following are the key participants in SCM



**1. Configuration Manager**

* Configuration Manager is the head who is Responsible for identifying configuration items.
* CM ensures team follows the SCM process
* He/She needs to approve or reject change requests

**2. Developer**

* The developer needs to change the code as per standard development activities or change requests. He is responsible for maintaining configuration of code.
* The developer should check the changes and resolves conflicts

**3. Auditor**

* The auditor is responsible for SCM audits and reviews.
* Need to ensure the consistency and completeness of release.

**4. Project Manager:**

* Ensure that the product is developed within a certain time frame
* Monitors the progress of development and recognizes issues in the SCM process
* Generate reports about the status of the software system
* Make sure that processes and policies are followed for creating, changing, and testing

**5. User**

The end user should understand the key SCM terms to ensure he has the latest version of the software

**Software Configuration Management Plan**

The SCMP (Software Configuration management planning) process planning begins at the early phases of a project. The outcome of the planning phase is the SCM plan which might be stretched or revised during the project.

* The SCMP can follow a public standard like the IEEE 828 or organization specific standard
* It defines the types of documents to be management and a document naming. Example Test\_v1
* SCMP defines the person who will be responsible for the entire SCM process and creation of baselines.
* Fix policies for version management & change control
* Define tools which can be used during the SCM process
* Configuration management database for recording configuration information.