Abstract

Quality Assurance is a planned and systematic pattern of actions that are required to ensure high quality in software. In a more specific project context, it is about ensuring that project standards and procedures are adequate to provide the required degree of quality, and that they are adhered to throughout the project. It is an essential activity for any business that produces products to be used by others. Quality is a major concern in the development of Software projects because we get satisfied customers as a result of improved quality of the software. One can satisfy customers by delivering them compliant product with good quality and delivering within budget and schedule. Traditionally quality is defined as conformance to specification or requirements, and failures arise when the software does not meet the requirements. I have addressed quality assurance issues in component-based software development. The paper explores how organizations can assure good quality of software despite using reusable components. The paper focuses on brief introduction of Quality assurance and how good quality software is developed in MNC's. A study has been conducted in 2 MNC's namely 1) Infosys, Pune 2) R. M. Mednet, Gurgaon. Interview was conducted with the personnel of these companies that develop component based systems to ensure good quality software products thus reducing cost and time. These companies assure good quality before launching their software and introduce the concept of reusable components for their software. The paper also explores the quality assurance standards and metrics used at these organizations.

1. Introduction

1.1 Software Quality

As Software becomes more and more pervasive, there has been a growing concern in the academic community about software quality. This concern arises from the acknowledgement that the main
objective of software industries is to balance price and quality to stay ahead of competitors. Quality is a major concern in the development of software projects because we get satisfied customers as a result of improved quality of the software. One can satisfy customers by delivering them compliant product with good quality and delivering within budget and schedule. Traditionally quality is defined as conformance to specification or requirements, and failures arise when the software does not meet the requirements. Quality can be defined as a characteristic or attribute of an item. Quality refers to measurable characteristics to some extent as all characteristics cannot be measured. Software metrics and Quality models are required to measure Software Quality. Software metrics are the only mechanized tools for assessing the value of internal attributes of software. Metrics are defined as a standard of measurement used to judge the attributes like quality or complexity. Whereas a Quality model is a schema to better explain the view of quality. So, one can say that one of the major factors driving any production discipline is quality.

1.2 Software Quality Assurance

**Quality Assurance** is a planned and systematic pattern of actions that are required to ensure high quality in software. In a more specific project context, it is about ensuring that project standards and procedures are adequate to provide the required degree of quality, and that they are adhered to throughout the project. It is an essential activity for any business that produces products to be used by others. It consists of auditing and reporting functions of management. The goal of quality assurance is to provide management with the data necessary to be informed about product quality, thereby gaining insight and confidence that product quality is meeting its goals. Software quality assurance emphasizes on three important points which lets us know whether quality persists in the software or not:

I. Software requirements are the foundation from which quality is measured. Lack of conformance to requirements means lack of quality.

II. Some specified standards define a set of development criteria that guide the manner in which software is engineered. If the criteria are not followed lack of quality will result.

III. If software conforms to explicit requirements but fails to meet its implicit requirements it also means lack of quality.

Once we come to know the concept of Software quality, the major question arises is how to improve the quality of software. What effective methodology has to be used to increase quality manifold. Quality assurance systems are created to help organizations ensure their products and services satisfy customer expectations by meeting their specifications. These systems cover a wide variety of activities encompassing a product’s entire life cycle including planning, controlling, measuring, testing and reporting, and improving quality levels throughout the development and manufacturing process. Some organizations, such as ISO, IEEE and CMM try to standardize software quality by defining models combining and relating software quality characteristics.

1.3 Reusability

One of the main contributions that component based software has to this objective is the reuse of software components in multiple systems. In this way a software component is developed only once, and one can save the development effort number of times. Software reuse is the process whereby an organization defines a set of systematic operating procedures to specify, produce, classify, retrieve and adapt software facts for using them in the development activities.
Reuse based approaches emphasize cost reduction as a means of increasing productivity. Software reuse is of two kinds- Black box and White box. Black box reuse aims to integrate a unit of reuse into a target system without modification of original units. In white box reuse, a unit of reuse may be modified before integration into a large system. White box reuse is easier to realize, but yields a smaller benefit than black box reuse because more effort is required for understanding the unit and for redoing testing for the modified unit of reuse.

2. Component –Based Development at Mednet, Gurgaon

2.1 Introduction

Mednet is a company basically dealing in with medical support before getting into software development. Technology is backed by years of experience in the health care industry and has remained exclusively dedicated to the development, installation, conversion, and ongoing support of the healthcare information systems.

Technologies help our healthcare client’s business goals through custom software and application development and enable them to better interact with their employees, customers, and vendors, with customized web-based solutions. With our qualified team of developers and the attention to detail, we develop quality systems that are not only well architected and designed, but proven reliable and scalable for enterprise-wide deployment. Custom software development solution calls for a web-based application, our development team uses the latest .Net technology, specializing in creating user-friendly solutions, ensuring the applications are intuitive, visually impressive, and very easy to use. If you are a healthcare provider, R.M. Mednet Information Technology is the solution to your software application development, installation, conversion, and on-going support.

R.M. Mednet Information Technologies has experienced steady growth seeking to be a leading innovator of advanced software solutions for our healthcare providers. Now the company develops software using internally made reusable components thus making the software cost effective and releasing the software within schedule- thus saving time and cost.

2.2 The Development Process at Mednet Technology

The following activities are performed to develop software at Mednet.

Initially the requirements of the customers are listed. Two kinds of documents are prepared for specifying the requirement

a) **TSD’s** - Technical Specification Document.

b) **FSD’s** - Functional Specification Document.

To freeze the requirements a survey is made to collect market information. For instance –Mednet does development for their clients in USA. Unified modeling language is used in the process. Later then functional specification is made which deals with what would be the intended function the software will do. In case some team members making the document leaves the organization then this TSD and FSD are handled over to the new joinee of the organization. He makes a thorough study of these document and then proceeds ahead to the next phase.

Design and Analysis – Here professional designers are hired to make the best design. The concept of component based software development comes in to existence at this phase. Reusable components are designed using the phase. Reusable components are designed using the concept of OOPS i.e. Object Oriented Programming System.
2.2.1 Architecture- There are three types of client server Architecture

A. 2- Tier
B. 3- Tier
C. N- Tier

A. Simple client server architecture is referred to as 2 Tier client servers Architecture where there is a single server and number of clients receiving services from the server.

!Figure 2.2.1:2-Tier Architecture

In this Architecture number of requests from variety of clients reaches the server for processing and those requests are processed one by one. But when large number of requests arrives at the server – then all the requests are queued up and handled as there is a single server to process the requests. This situation leads to deadlock. So, 3 Tier Architecture became popular to avoid the deadlock problem.

B. 3- Tier Architecture- To resolve the problems encountered in 2- Tier architecture 3- Tier came with BL Server (Business Logic). In the client server architecture another server called business logic server was introduced to solve the deadlock. In this case some requests related to business are processed by BL server and rest are taken care by the other server.

!Figure 2.2.2: 3-tier architecture

C. N- Tier Architecture- Further improved architecture is now being used by Mednet. Here lies the heart of the project. This is done in ASP. Net where the web forms are designed. N- Tier architecture comprises of layers namely-

* End User
* Presentation Layer
* Façade
* Business Logic Layer
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* Service Access Layer

![N-tier Architecture Diagram]

**Presentation Layer** - This layer comprises of designing part. Here designers design the forms in ASP.net. This is layer is just to provide an interface for end users.

**Business Logic Layer** - In this layer the entire calculation is done classes are defined and the functions inside the classes. C#.Net is used in this layer. JavaScript is also used to save response time, thus speeding up the process.

**Service Access Layer Server** - This layer is used to access database. This SA server fetches the data from the DB server. Web services are also used for data access. It is highly used and the best part is that it doesn’t require platform. One of the major reasons for its popularity is that it is platform independent.

**Façade** - Façade is an object oriented design pattern. It’s an object that provides a simplified interface to a larger piece of functionality. When designing good programs, good designers tend to attempt to avoid excess coupling between modules, and the façade pattern is a popular structural pattern for doing the same. This is accomplished by creating a small collection of classes that have a single class that is used to access them. They tend to avoid unnecessary pointing directly to business logic layer, they make an intermediate layer that is called façade layer.

### 2.3 Testing

Here also testing is done at three levels that are component, integration and system testing. There is a test plan for each level of testing. The most important testing is the component testing level. In the component testing the component must always pass a so called basic test. Unit testing is conducted
by testers. Test cases are used to do the testing process. Tools like Win Runner and load Runner are used to test the system.

![Figure 2.3.1](image)

**Figure 2.3.1**

**2.3.1 Integration Testing**
Fault injection tests are made where the components are fed with faulty data and checked to see how they respond to it. On the second level of testing, the integration between the components is tested. The components are integrated and then tested. On the third level of testing, the whole system with components is tested. The system is tested to check if the requirements are fulfilled.

**2.4 Deployment**
Now the system deployment takes place, but before deployment bugs status is checked and same server setup environment is made at the place of installation. This activity is done in order to save unnecessary testing time at the installation site.

**2.5 Quality Assurance Standards And Metrics Used At R. Mednet**
From a document as per organization.
This is some part from the Excel file maintained for metrics as per their Project Manager

<table>
<thead>
<tr>
<th>Calculations Estimate Done By</th>
<th>Sreekumar</th>
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**2.5.1 Technology**
- Back End: SQL 2K
- Front End: ASP.Net / C#
- Operating System – Client: Windows 9.x/xp/2k

**2.5.2 Effort calculations**
- Total Unadjusted Function Points: 734
- Adjustment Factor: 23
- Total Adjusted Function Points: 646

**2.5.3 Static information**
Productivity per FP for .C# &-SQL 2K 0.5
Total Hours per month 176
Project Management %ge 22

2.5.4 Efforts calculation
Total Efforts in Person Months 1.84
PM/QA Effort 0.40
Total Project Efforts in Person Months 2.24

3. Component Based Development at Infosys, Pune

3.1 Introduction
The Infosys product engineering group provides product engineering and R & D services for product companies. The product R & D services cover the concept- to -market needs of the product and include product design and conceptualization, development, testing and automation. Another key service is the offshore extension of your engineering setup in a low-risk manner. Product engineering is an enterprise capability unit at Infosys that focuses on providing services and solutions to established and emerging product companies.

3.1.1 Product segments:
Infosys product R & D services are spread in several industry segments including networking and telecommunications products, mobile & handheld products, business and enterprise products, computing peripherals and office automation, storage services, scientific equipments and semiconductor testing products.

3.2 Development process at Infosys
The increasing competitive market environment and complexity of product requirements has made it critical for product development companies to seek help from partners. Infosys provides the right innovative product aware partner. Infosys leverages its product development expertise on a wide range of domains and platforms to deliver world-class products. The product development services include all the activities in product development.

- Product conceptualization
- Design
- Initial development for feature enhancement needs of a product

The process involves setting up joint engineering teams with well defined responsibilities and deliverables. Client’s can partner with us to set up off-shore development labs or work around project or activity based partnerships. They also devise optimum design and development strategies that include use of iterative development, modeling and prototyping techniques, use of 3rd party modules to aid in development process.

Infosys’s experience and expertise in this industry bring a number of advantages to clients:
• Reduced time to market: their ability to meet your needs of capacity and capability in a very short time drastically reduced the time to market.
• Reduced product cost: their ability to maximize on offshore in a low risk manner ensures reduced product development cost.
• Enhanced innovation: while Infosys focuses on sustaining the innovation and handling large parts of product modules, clients can focus on enhanced high-end innovation.

3.3 Testing and automation services
Infosys testing and automation services ensure that your product quality is enhanced, while reducing both times to market and cost of testing. Infosys testing services encompass test strategy design, test case creation, test bed design and regular activity of test execution, test replication and bug tracking. The testing includes functionality, system, load/stress, performance, scalability, security, installation and compatibility, usability etc.

Infosys automation services encompass automation strategy creation, automation framework design and development, the design, development and testing of automation scripts. Another key activity is the design, development and maintenance of in-house tools that aid in testing. Automation reduces the testing cycle time while enhancing the quality of testing. The testing and automation service can start at the product development stage itself and span until the end of life stage of the product.

Experts offer a smooth testing project with on-budget, on-time completion.

<table>
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<tr>
<th>Broadband</th>
<th>Infosys provides end to end services to telecommunication majors in areas</th>
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<td></td>
<td>• Design, development, testing, network management and maintenance of cable modem termination systems software</td>
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| Embedded systems           | Infosys services offering includes embedded solutions for product development, modeling a simulation, hardware design, safety critical software testing and validation and compliant testing. |

3.4 Quality assurance standards and metrics used at Infosys
An experienced team of quality professionals serves to ensure that our clients get defect free and highly reliable products.

Services provided by quality department include:
• Process definition
• Process deployment
• Audits
• Corporate services
• Certifications and training
  The metrics life cycle at Infosys
• Identifying the metrics
• Prioritizing the metrics
• Classifying metrics that may be project specific
3.5 Key Metrics used at Infosys for software testing

1) Test Progress tracking metrics
2) Defect Metrics
   a) Defects by action taken
   b) Defects by injection phase
   c) Defects by detection phase
   d) Defects by priority
   e) Defects by cause
   f) Defects by type

Test metrics are used as very powerful risk management tools at Infosys.

4. Results

Quality Assurance ensures high quality in software project. It is an essential activity for any business that produces products to be used by others. One of the main contributions of component based software is the reuse of software components in multiple systems. As a result productivity is increased as less code has to be developed which results in less testing efforts and also saves
analysis and design effort thereby reducing cost. In this way a software component is developed only once, and one can save the development effort number of times. Various quality standards are being enforced in the organizations mentioned above along with reusable components. A reused component yields higher quality than a component that is developed and used only once.

5. Discussion
Quality is a major concern in the development of Software projects because we get satisfied customers as a result of improved quality of the software. One can satisfy customers by delivering them compliant product with good quality and delivering within budget and schedule. Component based Development supports software reuse thereby reducing cost, effort, development time. Software reuse is a cost effective method to construct complicated software systems within a short span of time and delivering better performance. Software reuse has a positive impact on software quality, also on costs and productivity. Initially productivity may decrease due to increased learning effort and the need to develop reusable components. Time, effort and cost are associated with the development of a reusable component. A reusable component is not so easy to make and is also not free of cost. But, once developed reusable component provides reduction in redundant work thus saving effort and development time.

6. Conclusion
No particular Quality standard is being maintained in R.M.Mednet. But they do stress on quality metrics to enhance the quality of their components based systems. Mednet needs to maintain a standard like CMM level 5 so as to keep abreast of the market quality trends. Test metrics are used as very powerful risk management tools at Infosys. Software testing provides visibility into product and process quality. This helps to measure current performance. As today’s data becomes tomorrow’s historical data. This data is used to improve future work estimates and quality levels.

References