

# Assembling Total Quality Management in Information Technology Processes and Products

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**Abstract - Software quality implies that a product conforms to the explicit as well as implicit requirements laid down by the customer. In addition to this, the customer must be satisfied with the budget and schedule of the software product. Software Quality Management is the process of managing quality of a product throughout its Software Development Life Cycle (SDLC), by providing certain standards and procedures which are required to be followed. To empower the efficacy of quality management the term Total Quality Management was coined. TQM provides standards and procedures not only for quality management but also for Quality Assurance (QA) and Quality Control (QC), as it is very important to ensure whether the quality management standards have been followed appropriately or not and simultaneously provide assurance for the same. This research seeks to highlight the importance of TQM in the development of software as well as its hardware products. The first phase of this paper defines the process of Total Quality Management and the existing standards for QA and QC in various fields. In the next phase, present literature has been reviewed to highlight the achievements in the field of quality management. This study has discovered TQM as a standard practice not only in the sector of information technology but in other sectors as well. Various techniques for defining a standardized set of quality management procedures have also been described in this paper. Furthermore, comparative analysis has been performed among various techniques implemented in this area. This research paper pinpoints the increase in efficiency and throughput of software products, when TQM practices were induced in SDLC process.**

## I. INTRODUCTION

Information Technology (IT) is a broad term that is used to refer to the use of computers and related technology for day to day activities. It consists of computer hardware, software and related devices. Every time one downloads a song, streams a movie, checks email or performs a web search, they access IT services. Areas of study that fall within IT include database development, computer networking, software engineering, data analysis and many more. The developments in this field are continuously emerging and are reaching new landmarks. An important aspect of IT is Total Quality Management (TQM) as it defines various procedures for managing quality of information systems.

TQM describes a set of standards and procedures to be followed for Quality Control and Quality Assurance. TQM serves to improve overall quality in all phases of software development life cycle (SDLC) process. The number of quality cycles is greater than the development cycles in the lifespan of overall development of a product since it begins long before the requirement gathering phase. Some frameworks have been standardized for TQM in order to provide effective quality checks including ISO 9001, ISO 14000, ISO 13485, ISO 10911 and ISO/TS 16949.

ISO 9001, 2015 version is the most widely used standard by world famous organizations. It mentions the design and review checks that must be incorporated in the quality assurance policies of an organization. Apart from these, TQM has also introduced various other frameworks which consist of the rest of the ISO 9000 family (including ISO 9000 and ISO 9004), the ISO 14000 family which is related to environmental management systems. ISO 13485 defines quality management systems for medical devices. ISO 19011 is the core of audit management systems and ISO/TS 16949 define Quality Management Systems (QMS) for automotive related products.

Along with TQM, an important aspect which comes into play is QMS. Paul F. and Davies [1] argued on the techniques of implementing a QMS- The core steps that form the building block of a QMS have been listed as follows:

Step 1: Design and Build aims for the development of the fundamental design of a QMS with key focus on its plans and procedures that define its implementation. Senior members of the organization must make sure that it is implemented in an efficient manner as the needs of a customer is the driving force behind the development of every project.

Step 2: Deployment is best implemented by breaking down processes into modules and by training the staff on proper knowhow of documentation, education, training tools and metrics. Local networks of companies are help organizations in implementing QMS.

Step 3: Control and Measurement is concerned with the quality checks at regular intervals in the form of audits and reviews. Quality assurance checks are dependent on many factors, the major ones being the size of the project, the potential risk involved and the impact on environment.

Step 4: Review and Improvementportion deals with how well the feedback from review and audit phase has been received and implemented in the corresponding deliverables of the project. The ultimate goal is to measure the overall output of each process based on its pre- defined goals.

Although various number of implementations of TQM have been defined so far, yet the key elements of each approach can be penned down as: Captive Customer Base, Process Development, Human aspect of Quality, Measurement strategiesand Analysis.

Customer focusrelies upon the needs and wants of customers and their requirements. The key areas consist ofdedication of top level management towards the quality assurance and control phases, increased effective participation of employees, employee empowerment and otherphysiological, social, psychological and human factors.

Measurement and Analysis elementprovides continuous improvement in all phases of SDLC based on a Goal Oriented System.

## II. LITERATURE REVIEW

Saraph V., Bensen P.G. and Schroeder R.G.[2]outlined the essential procedures that are mandatory to know the effectiveness of an organization's quality policies. These practices portray a comprehensive picture of the goal setting process withdue importance given to other short term goals and efficient quality assurance and control. All such practices require information and analysis before they can be put into effective use. Therefore, it is obvious that IT is required in order to complement the aspects which help in the working of its key practices. In context of the Deming's theory [3] about TQM, being a management based philosophy, it defines certain standards and rules to help an organization expand in size and increase its Returns on Investment.Witcher claims that it can be used to increase productivity by avoiding rejections, reworks, wastes, customer complaints and high costs ultimately leading to increased market shares. According to Deming, TQM consists of three terms: Total, Quality and Management. Total means the involvement of all the stakeholders. Quality implies that customer requirements are met judiciously. Management refers to the commitment of senior members in the continual improvement of every individual process by approaching the problems participating in quality compromise through a data driven approach by ensuring commitment of top level management authorities along with empowerment of employee groups.

Tenner A.R.stated that the principles of TQM, including all its practices and procedures, are applicable to all the departments within an organization such as R&D, testing, business, database management and many more[4].

Kon, Basil and Shapiro [5] examined the meaning of software quality and observed TQM as a management philosophy and analysed its core elements:customer centric approach, process improvement and quality and its relevance in software development, by depicting the software specific topics in the TQM framework. Various forms of structured experience and quality models have been described to aid in the practical software engineering. A systematic engineering approach must be taken to improve the numerous elements of software engineering and bring TQM in software development.

According to Godfrey A.B., TQM serves as an asset for customer centric practices in order to deliver quality assured product[6]. Pearson and McCahon observed thatestablishing a quality management system along with its effective implementation helps organizations increase their throughput as well as efficiency[7]. Prior to establishing a QMS, the organization must identify and manage the connections and links between various process modules to enhance customer satisfaction as it's a major target to be achieved by an organization.Numerous things must be taken into consideration before establishing a QMS. It must be a tactical decision that is focused on the constantly varying objectives, services, requirements and products required. The foundation of this structure stands solely on the Plan-Do-Check-Act (PDCA) cycle that authorizes regular and consistent improvements to the module breakdown structure and the QMS.

Miller noticed how specific IT applications might impact the TQM process [8]. In order to satisfy the clients,the management must be aware of the implicit as well as explicit requirements of the customer, that is, the Software Requirement Specification process. The article points out that many a times, in order to access the quality of an organization, the customer reaches a conclusion based upon the quality of services offered by systems. For an instance, customers may reject theservices being offered by an organization if the technology used in the services are not up to date with the current trends in technology and ultimately fail to meet the customer requirements. This

further classifies the role of IT in improvement of quality standards as: increasing awareness amongst its employees about quality standards adopted by companies on a worldwide basis; making online portals for various quality controls being adopted by the organization; and reducing quality costs.

Rogers D.S., Daughtery P.J. and Ellinger A.E. studied the association between utilization of IT and the performance of various firms in the warehouse industry and statistical evidence was provided to support the factual information that firm performance in the warehouse industry is greatly dominated by the IT sector[9]. The role of IT in supporting quality management capabilities builds a strong foundation which says that in order to gain an upper hand over other firms and increase the barriers to entry, an organization must focus on acquiring resources, funds and capital that seek to provide a strong positive impact on the TQM chart. Working on similar lines, McQueen K. noticed TQM process is impacted by specific IT applications[10].

Li E.Y., Chen H. and Cheung W. explained the Deming's quality management concept of fourteen points of management methods[11]. The study provided details about how Deming's TQM method could be incorporated in software development process and provided suggestions for TQM prospects to ensure success during its implementation. It has been argued that improved quality will lead to decrease in costs due to reduced mistakes and delays resulting in better use of resources. Consequently, productivity can be enhanced with improved chances of staying in business by capturing the market with better quality and lower price leading to generation of employment. It has been claimed that improving quality can benefit not only the company but also the society as a whole.

Wielle T., Dale B. and Williams R. analysed the concept of TQM through the help of "fad, fashion and fit theory" to investigate whether TQM can "survive and become fit" [12]. For this to happen, TQM must be defined in a crystal clear way, one that is quantifiable and must have no direct links to the extensive losses occurred over short periods of time". Devaraj S. and Kohli R. believed that the global competition has led to the enhancement of the role of quality in business by adding pressure to the organizations through increased levels of competitors[13]. These challenges and pressures in the professional world have shifted the focus of organization towards quality management and its long-term sustainability in the competitive market.

Pearson M., McCahon C.S. and Hightower R.T. considered TQM as a significant element in the implementation of an information-intensive management system which transformed into a tool to quantify the effect of IT on quality management[14]. It has been observed collaborating IT with quality management has been a huge success as far as quality of the products and quality costs are concerned. It has been found that TQM and IT play vital and supportive roles in enhancing the overall system performance. Top management initiatives can find new implementations of TQM if IT is used as an instrument for performing several tasks faster and if economical technology works as a supportive mechanism resulting in quality jobs and increased employee satisfaction.

McManus J. and Wood H.T. studied the concept of quality with regards to software development using the ISO, Tick IT and CMM frameworks and reached the conclusion that varying approaches involved in software development will greatly determine the techniques for observing quality[15]. It had been found that while the various frameworks of TQM define different set of rules and procedures, a lot of similarity can be found among these approaches. In a nutshell, the underlying philosophy of ISO (International Quality of Standardisation) and CMM (Capability Maturity Model) is similar.

Talib F., Rahman Z. and Qureshi M.N. concluded that TQM has affected the perception of the manager in such a way that their daily day to day activities are focused upon an increased quality throughput[16]. This effect seems to have been generated from their familiarity with the concepts of TQM. This study further showcased that the managers consider TQM as a valuable asset through its major practices such as: commitment of the top order management, quality information and performance, human resource management, zero defects and communication amongst all stakeholders.

### III. COMPARATIVE ANALYSIS OF TQM METHODOLOGIES

S.No.	Approach	Focus	Tools & techniques used
1	[2] Management Decision Science	This article throws light on the mutual relationship between quality and product.	SDLC, ANOVA, retest, pilot test
2	[3] The Quarterly Review of Marketing Winter	This paper provides a keen insight into the conceptual aspects of TQM.	Likert Scale, Conceptual framework
3	[4] Research Technology Management	Empirical statistics have been used to display the importance of TQM in the IT industry.	Entity diagram, DFD, parcto chart, control chart

4	[5] IBM Systems Journal	Utilizing the results of survey based research, different variations of TQM have been shown.	300 Michigan auto parts
5	[6] Executive Excellence	This paper shows how work flow can be controlled in the IT sector by the use of TQM.	Simulation Tools
6	[7] Information and Management	The fact that TQM and IT go hand in hand was supported by strong empirical evidence.	Data collection by mail survey, factor analysis
7	[8] Information Systems Management	The eight dimensions of TQM have been explored in detail.	SPSS, SERVQUAL method
8	[9] Logistics and Transportation Review	The impact of TQM on various industries has been studied in great detail.	CRUT model, ITEC
9	[10] Information Systems Management	This article shows how reliable IIR and CSF are in practice.	CRM core system
10	[11] The Journal of Quality Assurance Institute	A practical implementation of the different frameworks of TQM has been shown.	SPSS feedback people, pilot test
11	[12] Management Decision	A relationship has been established between customer focus and quality centric practices.	ANOVA, statistical method
12	[1] International Journal of Quality and Reliability management	This basically shows to what extent TQM has been used in the IT sector.	FRP, SPSS packages
13	[13] A Journal of institute for operational research and the management science	The role of TQM as a systematic management approach was discussed.	EDI, CAD/CAM, ERP
14	[14] Information and Management	An insight into the organizational hierarchy by taking TQM control into account has been given.	Statistical analysis, confirmatory factor analysis
15	[15] Asian Journal on Quality	This papers shows how today's organizational culture affects the implementation of TQM.	EDI, CAD, JIT
16	[16] Quality Management	This article sets a standard for the various implementations of TQM.	Mail questionnaire survey, seven point Likert scale

#### IV. CONCLUSION

TQM (Total Quality Management) plays a vital role in IT sector for producing quality efficient products. Due to the everincreasing competition, the organization with better quality management outperforms others. TQM has a defined set of practices and procedures which must be enforced during each phase of SDLC. It guides an organization towards an efficient path focused on increased quality and reduced costs. Timely reviews must also be conducted for proper Software Quality Assurance. Besides, audits must also be conducted by external third party sources for an effective quality control mechanism. TQM greatly reduces the effort, rework, testing time, error fixing time and increase the efficiency and quality of a software product greatly. A large number of frameworks have been developed for quality checks such as ISO, CMM and Tick. These define certain quality standards that must be followed by various organizations. An organization must have various policies to ensure quality assurance and control. TQM has great scope in the future considering the fact that quality defines the brand value of an organization. Research has been conducted to a great extent for introducing more effective TQM procedures as there

is still some ambiguity in some procedures and the way in which to enforce them. In a nutshell, in order to deliver quality efficient products, TQM is a must to be adopted by every organization.

#### V. REFERENCE

- [1] Davies M. and Paul N.F., "Measures to assess the impact of Quality management". International Journal of Quality and Reliability management, vol.17 pp.42-66. 2000
- [2] Saraph V., Bensen P.G. and Schroeder R.G., "An instrument for measuring the critical factors of quality", Management Decision Science, vol. 20, pp.810-829, 1989
- [3] Witche B.J., "Total Marketing: Total quality and Marketing Concept", The Quarterly Review of Marketing Winter, 1990
- [4] Tenner A.R., "Quality Management Beyond Manufacturing", Research Technology Management, vol. 34, pp. 27-32, 1991
- [5] KanS.H., Basili V.R. and Shapiro L.N., "Software Quality: An overview from the perspective of total quality management", IBM Systems Journal, vol. 33 no. 1, 1994
- [6] Godfrey A.B., "10 Quality Trends", Executive Excellence, vol. 12, p 10-11, 1994
- [7] Pearson J.M. and McCahon C.S., "Total Quality Management; Are information systems managers ready?", Information and Management, vol.29, pp.252-163,1995
- [8] Miller, H. "The multiple dimensions of information quality", Information Systems Management, Spring, vol. 13, pp. 79-82, 1996
- [9] Rogers D.S., Daughtery P.J. and Ellinger A.E., "The relationship between information technology and warehousing performance ", Logistics and Transportation Review, vol. 32, pp. 404-421, 1996
- [10] Kock N.F.J. and McQueen R.J., "Using groupware in quality management programs", Information Systems Management, vol. 14, pp. 56-62, 1997
- [11] Li E.Y., Chen H. and Cheung W. "Total Quality Management in Software Development Process". The Journal of Quality Assurance Institute, vol. 14 no.1, pp. 35-4, January 2000
- [12] Wiele D.T., Dale B. and Williams R., "Business improvement through quality management system", Management Decision, vol. 38, pp. 19-23, 2000
- [13] Devaraj S. and Kohli R., "Performance impacts of Information Technology: IS Actual usage the missing Link", A Journal of institute for operational research and the management science, vol. 49, pp. 273-289, 2003
- [14] Pearson M, McCahon C.S. and Hightower R.T., Total Quality Management:" Are information system managers ready?", Information and Management, vol. 29, pp. 252-263, 2004
- [15] McManus J. and Wood H.T., Software Engineering: "A Quality Management Perspective to the TQM magazine", Quality Management vol. 19 No. 4,2007, pp. 315-327, Emerald Group Publishing Limited
- [16] Talib F., Rahman Z. and Qureshi M.N., "Assessing the awareness of total quality management in Indian service industries: An empirical investigation", Asian Journal on Quality, vol.1 2, pp. 228-243, 2011