# Development and Validation of Quality Management Constructs For Software Industries

**THESIS**

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**of the requirements for the degree of**

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**by**


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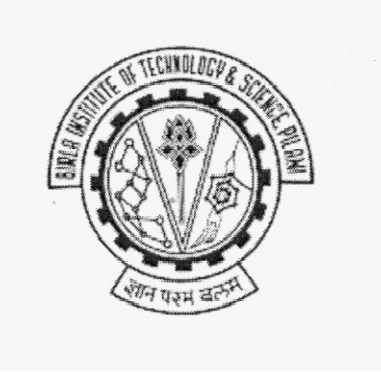



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**PILANI (RAJASTHAN) INDIA**

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# CERTIFICATE

This is to certify that the thesis entitled "Development and Validation of Quality Management Constructs for Software Industries" which is submitted by P.Haridas, ID No: 2002PHXF019 for award of Ph.D Degree of the Institute embodies original work done by him under my supervision.

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## LIST OF SYMBOLS AND ABBREVIATIONS

| | | |
|---|---|---|
| QM | : | Quality Management |
| CFs | : | Critical Factors |
| QWL | : | Quality of Work Life |
| DA | : | Dimensional Analysis |
| DS | : | Dimensional Similarity |
| TMCL | : | Top Management Commitment and Leadership |
| QP | : | Quality Policy |
| TE | : | Training to Employee |
| PDOP | : | Product Design and Operating Procedure |
| QIS | : | Quality Information System |
| EPE | : | Employee Participation and Empowerment |
| HRM | : | Human Resources Management |
| CFS | : | Customer Focus and Satisfaction |
| CI | : | Continuous Improvement |
| OC | : | Organizational Culture |
| IF | : | Infrastructure and Facilities |
| FG | : | Financial Growth |
| CIMTC | : | Corrected item minus Total co-related items |
| EFQM | : | European Foundation for Quality Management |
| MBNQA | : | Malcolm Baldrige National Quality Award |

# ABSTRACT

Global competition, which has now become fierce because of advancements in technology and changing equations in the global economy, has made its impact on the software industry as well; various studies have been done in the manufacturing and service sectors to find out the relation between quality management practices and operational performance. This study in the software industry is to develop and validate the quality management constructs. Literature survey is done to find out the work done in quality management area in the manufacturing and service sectors.

The critical factors of quality management implementation were identified from this and from personal contact from the people working in the software area. Data was collected from software companies with regard to their quality management practices and its effect on the different organizational parameters. Dimensional analysis of top performing companies are done to do the clustering of dimensions in the response collected. The coefficient of range and coefficient of variation of quality management factors are done to find out their consistency in the response collected data.. Quality management can be achieved only with continuous improvement. The main aim of this study is to develop and validate a performance measure and their items/variables .in the practice of quality management. After a through synthesis of the quality management literature and discussions held with software practioners and academicians twelve performance measures are developed; top management commitment and

leadership, quality policy, employee training, software product design, quality information system ,employee participation, human resources management, continuous improvement, organization culture, infra- structure and facilities and financial growth. A survey instrument is developed to collect the data by using snowball sampling from the real software practitioners .The data obtained from the survey is subjected to statistical analysis using statistical computing package SPSS® 11.5 for MS Windows®. The correlation matrix, internal consistency analysis and item analysis indicate that the developed performance measures are reliable. The content validity and construct validity analysis indicate that the developed performance measures are valid measures for quality management. Finally a performance measures framework for quality management is proposed.

The proposed framework can be used by the practitioners to assess the current performance, assign responsibilities and resources and monitor the progress for the implementation of quality management. Measurement of the performance measures permit the project/team leaders in the software companies to obtain a better understanding of the quality management practices and allow the researchers to proceed with the task of developing and testing theories of quality management.

# CHAPTER 1

## INTRODUCTION

In the present day of globalisation and liberalisation, ability to export successfully is becoming crucial to the economic well-being of any country. It was not long ago that USA and UK were dominant in the world market and goods made in Japan were synonymous with a poor quality image. Today it cannot be disputed that the Japanese have achieved a position of superiority in the world market. This is achieved by the Japanese companies by producing universally acceptable quality products. This reputation for quality has enabled Japanese companies to increase their market share at a rapid and incredible rate. For example, in the UK motor cycle market, the Japanese "invasion" succeeded to the tune of an incredible 94% by the mid of 1980's. The performance in the motor car market was even more impressive, where, during the period, the market share rose from less that of 0.5 % to the tariff constrained 11% of the mid 1980's. These achievements are remarkable and it is essential to understand the reasons for the Japanese success in the world market - a success based on the application of Quality Management (Spenley 1992). It is a fact that companies are increasingly forced to achieve world-class manufacturing capability in order to compete and in many cases to survive. The ability to respond to these domestic and world class challengers is the differentiator between survival and extinction. Quality Management is a way to establish that differentiation in any company.

In this context, Indian Companies have a lot of challenges ahead and the picture is not very encouraging. An analysis of the Global Competitive Report of 1996 has revealed that the image of Indian organizations is rated at $30^{th}$ in a ranking of 49 countries. In terms of customer orientation, India ranked $43^{rd}$ out of 49 countries. In

terms of orientation towards quality management, India occupied 42nd position out of 49 countries. Before the era of liberalization, it was perhaps a luxury to talk about quality of products, quality management, systems and procedures, and customer focus – etc. But after the liberalization process during early 90's, these processes have become imperative for the survival of many organizations. In the last few years India has seen world leaders such as IBM, Siemens, Sony, Coco-Cola, Pepsi etc. entering the market with different focus and agenda. So it is a fact that the Business units in India are ever increasingly forced to achieve world class manufacturing capabilities in order to compete and in many cases to survive. The world class manufacturing capability can be achieved through the practice of Quality Management (QM).

A Survey conducted by National Productivity Council (Singh 1991)revealed that quality improvement was considered vital to strengthen the competitiveness of Indian business and industry. Yet many survey responses showed that a majority of senior managers were unaware of the elements of QM. For example, a majority of senior managers are unaware of the benefits of quality costing, an integral element of QM; most financial managers have little idea of how much non-conformance of quality costs them each year. Out of the companies that responded, 57.8% indicated the practice of QM and only 42.2% had implemented qualitycircle type programmes. From the survey one could conclude that the function of quality assurance is well accepted in manufacturing organizations in India. However there seems to be some erroneous understanding since many organizations consider quality assurance to be same as QM(Singh, 1991).

Many surveys and studies conducted in this decade in many of the Indian organization shows that they have already geared to accept changes and adaptation to bring about new management thinking based on QM. However there have been

differences in the approaches to QM(Singh 1991, Business Today, 1995). Although experts claim numerous benefits to implementation of QM, there exist no sources that outline the specific operating system element of QM in India. Introduction to quality assurance through ISO 9000 is the most popular approach towards QM in Indian Companies.

Also in the past decade, managerial concept for quality reached unprecedented levels. Today, an increasing number of managers in many organizations than before view due to "quality as of bedrock strategic importance" rather than an abstract to be pulled out of the platitudes file and given lip service at the annual general meeting. Research has confirmed the strategic benefits of quality. Quality has been shown to contribute to greater market shares and return on investments as well as lower manufacturing costs in the long run and improved productivity.

Although instilling higher quality characteristics in a product may result in higher manufacturing costs in the short-run and thereby result in higher prices for a product, this will not necessarily have a negative impact on consumer demand. When confronted with substitutes for products, consumers would prefer to pay moderately higher prices to ensure the purchase of a quality product.

For a company or country to compete effectively in a global economy, its products must meet a certain standard of quality. Distribution of inferior products may harm firms and nations, both at home and abroad and can have severe implications for balance of payments.In India, too, industrial and service organizations are becoming concerned with the need to upgrade the quality of their products and services in order to keep pace with competition within and outside the country.

In QM the main focus is on continuous improvement. Performance measurement should therefore activate continuous improvement. When the organization adopts total

quality management practices, they need new methods of performance measurement to check for the continuous improvement. The traditional notion of productivity,which has been considered as a good indicator of theperformance and progress of an organization,also has many limitations.

## 1.1 BRIEF BACKGROUND OF QM DEVELOPMENT

Only a limited literature is available on the performance measures of QM (Adam, 2001; Agus, 2000; Johail, 2003). The importance of quality has been acknowledged since the times of the earliest craft societies.Sheward, in 1920, developed quality control charts for process control using statistical methods. Immediately after the Second World War, Japanese goods had the notoriety for shoddiness and cheapness that kept their competitive position in the bottom half of the world trade. In the early 1950's, Taylor's management principles were the fundamental tools in the manufacturing industry world-wide and helped USA to rapidly meet the huge post-war demand for the goods such as cars and television. The Japanese recognized that they could not compete using the same Taylor management principles and began to develop alternative principles (Spenley1992).

In the early 1950's Japanese study tours became a feature in many western companies, whereby the most successful companies were scrutinized in detail to define the "industrial best practice". At the same time, two well-known quality gurus from the USA, Deming and Juran, were invited by the Japanese to help them to understand the principles of quality control and their application to Japanese industries. This work formed the basis of a national drive, co-ordinated by the Japanese Union of Scientists and Engineers (JUSE), to improve the functioning of quality control in Japanese Companies which achieved a cultural change in methods and attitudes that were then prevalent in Japanese Industrial Society.

Over the last 40 years, the fundamental principles proposed by Juran and Deming have been adapted with an increasing success by Japanese Companies. Deming, Juranand Ishikawa were recognized world-wide as the intellectual god fathers of Japanese industrial miracle. Further developments in quality systems, quality information and costing system, along with the theory of these quality gurus form the basis of what is known as "Quality Management" (QM).

The quality movement development is described in terms of a four phase model consisting of quality inspection, quality control, quality assurance and (total) Quality Management. There are two schools of thought called the Deterministic School of thought and the Continuous Improvement School of thought. "The deterministic School of thought is specified as evolving around a deterministic view of reality with a belief in the existence of one best way". This means that conformance to standards is the best way to meet customer requirements. On the other hand, "The Continuous School of thought is specified as being founded as a reality full of variation, with an awareness of improvement potential in every aspect of work". Continuous improvements are used to reduce the impact of environmental changes and other variations. The deterministic School has its origin in Taylorism and was developed roughly via Philip Crosby by the ISO 9000 series of standards. The Continuous Improvement School was Walter A Shewhart, Armand Feigenbaum and Edward W Deming as some of its figure heads. According to Bergman and Klefsjo (2003), the two schools are currently converging.

**ISO 9000**

This is also one of the quality management systems, which help the firms to better organize and co-ordinate their operations by documenting their processes, defining responsibilities of employees and by putting in preventive measures to prevent errors.

This was first introduced in 1987 by the International Organization for Standardization based on the BS 5750 series. A major revision to their ISO 9000 standards was made in the year 2000 and is known as ISO 9000:2000. With this revision, the importance placed on documentation procedure was reduced while customer satisfaction and leadership by top management began to play a much bigger role (Heizer& Render 2008).

**Six Sigma**

This concept was introduces by Motorola Company in 1980s. This was on a systematic variance reduction technique. It was an idea of inserting hard-nosed statistics into the blurred philosophy of quality. This program was inspired by Japanese work, but also strongly influenced by Juran's thoughts. Due to this technique, Motorola managed to reduce their cost and variation in many processes and were an inaugural winner of America's Malcolm Baldrige National Quality Award in 1988.

An important part of Six Sigma is the DMAIC procedure: Define – Measure – Analyze – Improve – Control. Conceptually DMAIC is a highly structured and rigorous problem-solving approach, but are that offers a good deal of freedom within each step so long as the six sigma team holds true to the intent of each step and the goals of each step are accomplished. In many aspects DMAIC is simply a more polished version of a more "ancient" and very familiar improvement cycle: Plan – Do – Study – Act or PDSA. This PDSA cycle which was popularized by Deming was adapted by him from the earlier version developed by his mentor Walter AShewhert.

Six-sigma emphasizes the importance of linking financial gains to projects undertaken. The financial aspect attracts top managers to this method. The popularity of this is mainly because of the published success stories. Six-sigma focuses on reducing defects as a top priority for quality improvements. The large savings obtained from this effect are the savings from reducing the costs of poor quality.

According to Snee (2004), there are four aspects of six-sigma that are not emphasized sufficiently in QM. First, Six Sigma places a clear focus on bottom line financial results. No Six Sigma project is approved under the bottom line impact has been identified. Next, Six Sigma builds on improvement methods that have been shown to be effective and integrated the human and process elements of improvement. The third characteristic of Six Sigma is that it sequences and links the important tools into an overall approach – that is, DMAIC sequences and links key tools process to be effective in improving processes. The fourth point is that Six Sigma creates an infrastructure of champions, Master Black Belts, Black Belts, and Green Belts that lead, deploy and implement the approach. Champions are responsible for keeping the six sigma programme focused within their business area, they select black belts, approve projects, set improvement targets and provide the resources needed to conduct the projects (Watson, 2003).

**Business Process Re-engineering (BPR)**

Business Process Re-engineering (BPR) is described as "a conceptually new business model and an associated set of techniques" used to reinvent competing organizations. It is defined as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service and speed.

Re-engineering is proclaimed to achieve fast, immediate, massive breakthrough change by integrating and enlarging the scale of existing business improvement disciplines to a company-wide level, instead of applying improvement techniques to individual functions and isolated processes that may not be critical to a company's success. Companies are told to completely revamp their functional approaches to process, to redesign outdated processes and to enhance competitive potential.

At the heart of re-engineering is the notion of discontinuous thinking of recognizing and challenging the traditional approach to management, the outdated rules of work design and fundamental, but invalid, assumptions about technology, people and organizational goals. Quality, innovation and service are now more important than cost, growth and control. Re-engineering cannot be planned meticulously or accomplished in small and caution steps. It is all-or-nothing proposition with an uncertain result. Unlike the traditional process improvement, BPR aims for 60, 80 or 100 % improvements in process performance.

## Seven Principles of Business Re-engineering

Re-engineering can be defined in terms of the following seven principles.

1. Job Design – Management should organize and design a person's job around an objective or outcome instead of a single task. Management should compress the responsibility for the various steps of the task and assign it to one person to perform.
2. Work Process – Management should allow those who use the output result of the process to perform the process so that there is little need for the overhead associated with managing it. For example, departments can make their own purchase using modern technologies such as expert systems and shared databases without sacrificing the benefits of specialized purchases.

   Interfaces, liaisons and the mechanisms that are used to coordinate the performers and benefactors of the process can be eliminated.
3. Information Processing – Management should attempt to include information processing work into the real work that produces the information. In other words, managers should reorganize the work so that an organization that produces the information also processes it.

4. Network technology – Management should treat geographically dispersed resources as though they were centralized by using database, telecommunication networks and standards and coordination while maintaining the benefits of flexibility and service.
5. Parallel Processing – Managers should link parallel activities instead of integrating their results. Product development typically operated in parallel processes; ie., separate units perform the same function, or separate units perform different activities that must be integrated. There is a need to forge links between parallel functions and to coordinate them while their activities are in process rather than after they are completed, using means such as communication networks, shared databases and teleconferencing.
6. Decision making – This should be delegated to the person who performs the work, and management should build control into the process. In most organizations, the workers are distinguished from their supervisors and the decision maker.

   Re-engineering suggest that the performer should make the decisions and that the process itself can have built in controls, resulting in self-managing and self controlling employees.
7. Information storing – Information should be captured once and at the source. Bar coding, relational database and electronic data interchange (EDI) help organizations to collect, store and transmit information more easily and quickly

## 1.2 A BRIEF STUDY ON THE STUDIES ON QM

An analysis on the studies of QM revealed that QM is a company-wide function and that QM practices varied from organization to organization. But there is a common thread of continuous improvement of quality in all QM practices. Different sets of organizational requirements for an effective practice of company-wide quality management were prescribed by quality management gurus and practitioners (eg. Juran 1974, Crosby 1979, Deming 1982, Garvin 1984 , Imai 1986, Spenley 1992, Collard 1993 Crosby 1995 and Juran 1995). These requirements for an effective quality management were based on judgment and experience of these gurus in working with different organizations as consultants, researchers and or managers. These requirements were not formulated on the basis of a systematic empirical research.

A lot of personal prescriptions are available in the literature for the effective practice of QM. There is no unique and empirically based theory of QM. Dotchin and Oakland (1992) pointed out the lack of fundamental research in QM, particularly with respect to the development of theory and empirical evidence to support the discipline. A total of 199 QM related articles were identified from 44 referred journals published from 1970 to 1993 by Ahire, Landeros and Golhen (1995). There were only 29 articles based an empirical studies in the literature and a few articles addressed the issue of operating-system elements of QM.

Since QM is an organization-wide function, organization factors such as organisation culture, top management commitment and communication could be used to improve the implementation and practice of QM. Organisational factors create an environment in which QM is rewarded. So research on organizational factors could contribute significantly to the practice of QM and, in turn, improve quality performance and business performance. Powel (1995) observed that most features generally

associated with QM, such as employee training, process improvement and benchmarking, need not necessarily produce the competitive advantage, but tacit, behavioral imperfectly imitable factors such as open culture, employee empowerment and execution commitment, could produce competitive edge. Powel further argued that such tacit factors and not tools and techniques, could drive QM success, and that organizations would need to acquire these factors to stay successful with a competitive advantage.

The QM authorities (Eg: Crosby 1979 and Deming 1986) have also strongly argued that a favorableorganizational environment would be essential for the effective practice of QM. However, they could not offer any empirical evidence to support their claims. It is therefore clear that organizational factors play a very crucial role in implementing QM in any organization. There seems to be no empirical study cited in the literature that could establish a relation between QM and organizational factors. Also no study has been conducted so far to study the impact of QM on the organizational performance of the service sectors and software area.

It is therefore evident that there exists a need for fundamental research to understand the key elements and critical factors of QM and the relation between QM and its impact on the organizational effectiveness/productivity.

**1.3 QUALITY JOURNEY IN INDIA**

For more than four decades after independence the companies in India enjoyed a protected market with virtually no competition,and some of them even monopolized the market, with consumers having little or no choice. As a result, complacency set in and no pressure existed for improvement or change. However, the policy of economic liberalization adopted by the Indian Government since late 1980s,has thrown open new avenues and challenges to companies in India. The new policy has resulted in open doors

through which global corporate players have entered the Indian markets, and are threatening the domestic manufacturers and suppliers,using quality as aweapon.This has compelled the managements of domestic companies to look for those tools and techniques,proven and tested,which would help them to maintain and improve their strategies and positions in the market.One such policy or philosophy that has captured the attention of industry and business community is QM. Particularly,in the recent years QM is even regarded as absolutely essential for growth,stability and prosperity.

However,the post-independent era did not witness any spectacular improvement regarding the quality of goods and services produced in the country.According to Agrawal(1993) due to protected business environment many positive attributes of the Indian industry have been lost and weakness has surfaced.These weaknesses based on the study are:lack of trust and credibility in the working system,lack of clarity/seriousness for achieving target,lack of precise observance of rules and norms,low quality of supplies and components,lack of consciousness of time as money,viewing only short term benefits ahead of long term goals,politicalisation of labour unions,lack of accountability for actions,lack of management commitment, lack of national quality policy,inadequate economic resources,lack of indigenous technology,inadequate infrastructure, preferring quantity to quality,lack of teamspirit, cartel formation and sellers' market.Besides,lack of consumerism, Government control on everything,bureaucratic delays, quick profit making attitude by companies. All resulted in quality getting low priority and consequently Indian products were constrained to serve only the domestic market being not able to compete in the international markets.Further, the factors mentioned before,clearlyproved to be obstacles in the path to progress,and India in spite of possessing good resources and rich and

scientific and technical manpower,could not produce world-class products acceptable in the international markets.

### 1.3.1 QM Implementations in Indian Organizations

ManyQM activities in Asia were started in private companies as Total Quality Control(TQC).These were mainly Japanese companies with investments in manufacturing plants throughout Asia.The principle of TQC were expounded by Feigenbaum(1961)who suggested that high quality products are more likely to be produced by total quality control rather than manufacturing workers alone. These principles gave way to Quality Management when management of companies realized that responsibilities for quality are company-wide, and rest with the management hierarchy.

Chan and Quazi(2000)have conducted a comparative study of quality management practices at a national level in nine Asian countries including India,from 1960 onwards.Quality Control circles(QCCs),which worked well in Japan,were first adopted as a quality improvement practice.Between 1970s and 1980s,these countries had very active QCC activities.As more complete quality management systems were developed,QM and ISO 9000 were widely accepted in these countries.The development and adoption of a comprehensive quality management system were slower in certain countries.Singapore and South Korea were ahead in the implementation of quality management practices with the adoption of global and world class standards.Malaysia was quite close behind.Philippines had a few years of experience withits national quality award and were moving towards world-class very soon.Indonesia and India have yet to move on to world-class quality standards.

India also had National Productivity Councils early as 1958 and the country has one of the oldest standards institute in Asia.Although product quality was important,QCC was not a major quality initiative in India.

Misra(2003), had another study on the effectiveness of QM initiatives in Indian organizations with attention to Agfa-Gevaert company's success in total quality.The company recognizes total quality as a major component of its worldwide strategy. Dedication to customer,wide ranging know-how, innovation and quality are hallmarks of Agfa. Quality at Agfa is total, covering products, service and administration.

There are only a few Indian companies successfully implementing QM.Nath, et al. (2003) has conducted a study regarding the Cost of Quality(COQ) and QM implementation among Indian industries. The analysis showed that cost of quality implementation in Indian industries is a recent and growing phenomenon. There is a lack of awareness among companies about the use of COQ in other companies in the national level.

Iyer and Seshadri(2004),illustrate quality improvement by focusing on one Indian company,Rane Brake Linings(RBL). RBL is a division of Rane group,an automotive component company with a sales turnover of $ 131 million and 4600 employees. In 2002,RBL won the prestigious Deming prize.The Deming prize awarded by the Japan Union of Scientists and Engineers (JUSE),was a culmination of a three year journey for RBL,which began with a visit by Professor Tsuda from Japan.RBL's QMJourney began with the choice of Professor Tsuda as their coach in1999.

QM implementation created tangible and intangible benefits for RBL.Intangible benefits included role clarity so that each person understands their role in the organization,their suppliers and customers and their metrics.

Plant in process rejections at RBL decreased from 2.1 percent of total pieces to 0.85 percent of total pieces produced. Sales per employee went up from $22000 to $40000.Number of employee suggestions went from 280 to 7500 during this period.Thus QM represented a dramatic and measurable improvement across many specific metrics that would impact the company.

Quality management self assessment is now of great interest to Indian companies. This is largely because of the introduction of quality award models,starting with the MalcolmBaldrige National quality Award(MBNQA) introduced in 1987 and the European Quality Award introduced in 1991.More recently,a number of other national quality awards such as Rajiv Gandhi National Quality Award in 1991,the CII-EXIM Business Excellence Quality Award (1999),the Gold Peacock National Quality Award(1991)and the Ramakrishna Bajaj National Quality Award(1995)were introduced. Then awards were based on the methodologies of the MBNQAandEQA. These award models,the criteria and the guidelines for application are helpful in defining quality management in a way which enables management to more easily understand the concept.

## 1.4 SCOPE AND OBJECTIVE OF PRESENT STUDY

So far the literature says that there is a great scope for implementing QM in production sectors. Like heavy vehicles, electronics, machine tools, steel companies, tyre units, pump units, Earth movingequipment'setc (Arumugam et al, 2008; Brah et al, 2002; Jaideep et al, 1994). The review of the literature indicates sufficient scope for an empirical research on QM that can remove some of the existing deficiencies. The present study aims the problems related to the identification of operating-system elements and critical factors of QM, and an instrument for measuring the levels of QM in software which and its impact on the organizational performance.

Following specific objectives have been developed for the present study:

1) To identify the operating system elements and critical factors of QM in software units
2) To develop an instrument for measuring the level of QM
3) To finalize the measurement instrument of conducting validity and reliability tests.

## 1.5 DESCRIPTION OF THE PRESENT WORK

In order to accomplish the stated objectives of this research work, this study was divided into two distinct phases as outlined below:

1. An instrument development phase in which a questionnaire was developed to measure the top management's perception of current practice of QM in their software business units and to identify the critical factors of QM.
2. To find out the similarity co-efficient of different companies in their critical factors and also to find out the co-relation coefficient of the QM measure and its performance .Also to develop and validate the quality management constructs for the software industries.

### Methodology used

The objectives defined in the previous section are achieved through the accomplishment of the following tasks.

- A thorough review of literature related to QM.
- Development of theoretical framework for performance measurement based on the literature review.
- Development and testing of a survey instrument.
- Data collection from software companies.
- Internal consistency anddetailed item analysis for reliability assessment.

- ❖ Construct and content validity analysis.
- ❖ Development of a frame work for the performance measures of Quality Management.

## 1.6 OVERVIEW OF THE PRESENT STUDY

The next chapter of this work presents a critical and comprehensive review of the available and related literature and the quality management and the organizational factors. The review also seeks to establish the scope and objectives of the present study.

The process of development for measuring the level of quality management is described in Chapter 3.

Chapter 4 presents the different types of analyses using the data availed from the survey. Analysis includes dimensional similarity, coefficient of variation and analysis of co-relation between variables.The validity and reliability tests are conducted on the quality management performance measures.

Chapter 5 presents reliability and validity assessment for the validation of performance measures. A frame work of performance measures of quality management is proposed in this chapter. In Chapter 6, conclusion of the research work with limitation and scope for the future work is given.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 OVERVIEW OF THE CHAPTER

This chapter presents a detailed review of work reported in the literature on Quality and Quality Management. This review leads to a summary of findings of empirical studies in the area of QM. A review is also carried out on the work related to the study of the organizational productivity factors such as financial, human resource, customer focus and organizational effectiveness. A same review of the work on QM in some of the Indian software companies is also presented. The scope and objectives of the present study are identified and presented.

## 2.2 DEFINITIONS OF QUALITY

It is perhaps difficult and problematic to define "quality". In colloquial speech, 'quality' can be interpreted differently, depending on the context. To compound the problem, a host of 'quality' definitions was suggested by quality gurus and experts. These definitions are briefly discussed below;

Crosby (1979) defined quality as "conformance to requirements." He believed that any product or service that consistently reproduced its designs specifications was a high quality. Juran (1980) defined quality as "fitness for use" measuring that the users of a product or service should be able to count down it for what they needed or wanted to do with it. Juran was one of the first quality gurus to show the details of quality. "Fitness for use" consists of five dimensions: quality of design, quality of conformance, availability, safety and field use (Juran and Gryne 1980).

Quality may be interpreted through product and service characteristics as offered by design, marketing, manufacturing, maintenance and service that meet customer expectations.

Oakland (1995) suggests quality as a perceivable (and measurable) move from mere satisfaction by a customer to "delight and reputation for excellence." Customer expectations are to be consistently met with an after-glow of well being.

Unlike other gurus and consultants, Deming never defined quality precisely. According to him, a product or service possesses quality if it helps somebody and enjoys a good and sustainable market (Deming 1993). Garvin (1988) identified five approaches to define quality:

1. The transcendent approach of philosophy;
2. The product based approach of economics;
3. The user-based approach of economics, marketing and operations management.
4. The manufacturing based and
5. Value based approaches of operations management.

Quality experts fail to agree on a single definition of quality that satisfying everyone. Freund (1982) believed that the confusion about the meaning of the word "quality" is one possible reason that quality slipped as management priority. So there is no unique definition for quality.

## 2.3 EVOLUTION OF QUALITY MANAGEMENT

The advancement of quality has taken place over centuries. In the beginning of the previous century quality was being treated as an art but at present it is accepted as a result of concerted effort. Many organizations of different countries have contributed to the development of quality. A brief detail of the evolution is presented below.

**1**. **Prior to Twentieth Century**

- Quality as an art
- Demands overcome potential production
- An era of workmanship

**2. Beginning of Twentieth century** F.W Taylor–The Scientific approach to management: Rationalization of work, splitting the work for standardization, inspection and supervision.

**3. 1930s - Shewart:** Beginning of application of statistics, study of quality control

R.A.Fisher: Studies on Experimental Design; Beginning of Control Charts.

**4. Late 1930s**:

- Quality standards and approaches introduced(France and Japan)
- Beginning of SQC, Reliability and Maintenance Engineering

**5.1942:**

- Decisive work by Deming at the Ministry of War, United States
- Contribution of Juran and Dodge in SQC in U.S.Army
- Emergence of concept of Acceptance Sampling.

**6.1944:** Seminal research, Dodge and Deming on Acceptance Sampling.

**7.1945:** Formation of Japan Standards Association.

**8.1946:** Founding of American Society for Quality Control (ASQC).

**9.1950:** Deming visited Japan being invited by K.Ishikawa.

**10.1951:** Quality Assurance increasingly accepted.

**11.1954:** Total Quality Control (TQC) became very popular (Feigenbaum and Juran); Book published in 1956.

**12.1957:** Founding of European organization for the control of quality (France:AFCIQ, Also in Germany, Italy, Holland, England)

**13.1961:** The "Zero defect approach" introduced while developing and producing Persing Missiles (Crosby). Company Martin (Marietta) Co., USA. Quality motivation started in US followed by integrated programmes.

**14.1962:** Quality Circle (QC) started in Japan.

**15.1964:** Book on Quality Management published. (Ishikawa)

**16.1970:** Book on basics of Quality Circle, concept of Total Quality published by Ishikawa (in the context of Japanese industries)

**17.1970-80:** Quality and Just in Time (JIT) appeared as crucial for competitiveness.

- Large number of US companies and European companies started appreciating the advancement of industries of Japan.
- Taguchi popularized the use of designing robust systems and products.

**18. 1980 onwards:**

- Companies started facing the "rising sun" challenges in regard to quality.
- Development and introduction of Flexible Manufacturing System(FMS)
- Dependence on supplier's contract intensified
- Growth of economy based 'quality control', information software packages.

**19.1990-99:**

- Management of quality considered inescapable.
- Emphasis laid on off-line quality management for the manufacture of robust systems and products.
- Growth of process optimization.
- Standards (ISO 9000, 9001, 9002, 9003, 9004) Quality Management System released in 1987.
- Standards first time revised in 1994.

- Standards second time revised in 2000.(ISO9001,9002 and 9003 merged)

**20.2000:**

- Revision of standards Quality Management System making them more user-friendly and applicable for manufacturing and service industries, withdrawal of ISO9002: and ISO9003: 1994.
- Launching of ISO 9000:2000,ISO9004:2000

## 2.4 DEFINITIONS OF QUALITY MANAGEMENT

QM has been defined as a broad approach to quality, including product/service quality, extending well beyond to virtually everything done by an organization for "external" as well as "internal" customer within the same organization. Continuous improvement is sought towards measurable and even more difficult quality targets (Electronic Business, 1999).

Ishikawa's (1985) approach advocates a company - wide quality control system which requires not only the involvement of all functions, but also the involvement of all levels of an organization. He suggested that "through total quality control with the participation of all the employees, including the President, any company could create better products/services at lower cost, increase sales, improve profits and make the company into a better organization.

One definition of QM endorsed by the Total Quality Forum is defined as a people focused management system that aims at a continuous increase in customer satisfaction at a continually lower cost. QM is a total system approach, and is an integral part of high level strategy. It works horizontally across functions and departments, involving all employees, top to bottom and extends backwards and forwards to include the supply chain and customer chain.

The extended user-oriented definition of quality is an integral element of QM. Quality as well as price is what could sell today and quality is what ensures repeat business (Feigenbaum1983). Feigenbaum (1990) has defined QM as a management approach that encourages everyone in the organization to focus exclusively upon serving the customer. In short, there is no unique definition for QM, but there is a common thread of customer satisfaction and continuous improvement in almost all definitions of QM.

## 2.5 LITERATURE ON TOTAL QUALITY MANAGEMEMT

The literature available on QM can be classified into three categories: one related to various quality management theorists; another related to various processes of quality management; and the last one dealing with QM research and contribution to quality management.

### 2.5.1 Quality Management Theorists

The major theorists in this area are Deming, Crosby, Feigenbaum, Taguchi, Ishikawa, and Juran. Although each theory is unique in the kind of processes and procedures advocated, the common thread is the concept of continuous improvement.

Deming, the American consultant, is generally regarded as the father of the QM revolution. Japan's reputation for producing quality products is now legendary and the Japanese themselves are the first to acknowledge Deming's contribution to this success. This acknowledgement was first reflected in the initiation in Japan in 1951of Deming application prize. The essential message to management from Deming is that variations need to be minimized (Deming 1986). Deming advocated that the key to quality management is Statistical Process Control. In his renowned paper, Deming (1992) pointed out that random or common causes of variation are inherent in the processes

which managers themselves have designed and established. He estimated that as much as 84% of problems arose through system deficiencies rather than the fault of operators of these systems. To improve the system itself, common causes have to be removed. Indeed, processes in control could produce a high proportion of defects. Concentrated and integrated efforts of sales, manufacturing and other departments are essential to narrow the range of variations and hence to improve the system. Deming's view was that management often blamed employees for things that were beyond their control and that what was really required would be a "Total transformation of the master style of management". He believed in encouraging the employee participation and in enabling them to contribute the continuous improvement through their understanding of the process.

Deming (1986) viewed production as a system, with the consumer as the most important part of a production line, and believed quality should be aimed at the needs of the customer. In this system framework, quality improvements can only be achieved by focusing on the entire process, from incoming materials to the consumer, and redesign of product and service of the future.

Some of the key thoughts of Deming (1986) were embodied in the following distillations of his thinking:

a. Deming's fourteen points,
b. The seven deadly diseases,
c. The sixteen obstacles,
d. The new climate, and
e. A system of profound knowledge.

Deming opined that higher quality would lead to higher productivity, which in turn would lead to long-term competitive strength. Deming (1993) developed a

statement called “A system of profound knowledge” providing the underlying foundations behind the 14 points. It included (1) Appreciation for system, (2) Understanding variation, (3) Theory of knowledge, and (4) Psychology.

A system is a set of functions or activities within an organization that work together for achieving the objectives of the organization. Any system is composed of many smaller, interacting subsystems. Deming believed that the aim of any system was for every one-stockholders, employees, customers, community, and the environment – to gain over the long term. The second part of profound knowledge is a basic understanding of statistical theory and variation. The third part of profound knowledge is theory of knowledge. Deming emphasized that there was no knowledge without theory, and experience alone would not establish theory. Experience only describes; it cannot be tested or validated. Theory shows the cause-and-effect relationship that can be used for prediction. The last component of theory of profound knowledge is psychology. Psychology helps us to understand people, interaction between people and circumstance, interaction between leaders and employees, and any system of management. Much of Deming’s philosophy is based on understanding human behavior and treating people fairly. If people cannot enjoy work, they will not be productive and focused on quality principles. Psychology helps us to nurture and preserve these positive innate attributes of people.

Crosby (1979) addressed the top management for quality management and improvement. Crosby speaks of quality as “conformance to requirements”. He believed that if quality should improve, total cost would inevitable fall, allowing companies to increase profitability. This reasoning led to Crosby’s sensational claim that quality is “free” (Crosby 1979). The goal of quality improvement would be “zero defects” to be achieved through prevention rather than the after-the-fact-inspection.

Crosby argued that the key to quality improvement would be to change the thinking of top management. If management expects imperfection and defects, it would get them, for workers will bring similar expectations to their jobs. But if management could establish a higher standard of performance, and communicate it thoroughly to all levels of the company, zero defects would be possible. In other words, "Zero defects" is a management standard and not simply a motivation program for employees.

Crosby introduced the four absolutes of his quality management philosophy as follows.

1. The definition of quality as conformance to requirements.
2. The system of quality being the prevention of problems.
3. The performance standard of quality being zero defects.
4. The measurement of quality being the price of conformance, or the cost of quality.

Like Deming, Crosby had been critical of the Malcolm Baldrige Quality Award. He departed from the other gurus in his emphasis on performance standards instead of statistical data to achieve zero defects. He believed that the identification of goals to be achieved, setting of standards for the final product, removal of error-causing situations, and the complete organizational commitment would comprise the foundation for excellence.

Feigenbaum (1983) advocated that the workforce ought to have a clear understanding of the management objectives and goals, and that everyone should participate in improvement processes. However, he cautioned that quality must not simply be based on short-term motivational strategies: leadership from top towards achieving the objectives of quality was essential, and managers must develop the clear long-term and customer-oriented quality management processes which every employee could understand and commit to.

Feigenbaum suggested that there were two requirements to establishing quality as a business strategy: establishing customer satisfaction must be central and quality/cost objectives must drive the total quality system. His systems theory of total quality control included the following four fundamental principles:

1. Total quality being a continuous work process, starting with customer requirements and ending with customer satisfaction.
2. Documentation allowing the visualization and communication of work assignments.
3. The quality system providing for greater flexibility because of greater use of alternatives provided.
4. Systematic reengineering of major quality activities leading to greater levels of continuous improvement.

Like Deming, Feigenbaum used a visual concept to capture the idea of waste and rework-the so called “Hidden Plant”. Based upon studies, he taught that this “Hidden Plant” could account for between 15 and 40% of the production capacity of a company. He used the concept of the “9 M’s” to describe the factors which affect quality: (1) Markets, (2) Money, (3) Management, (4) Men, (5) Motivation, (6) Materials, (7) Machines and Mechanization, (8) Modern information methods, and (9) Mounting product requirements.

Ishikawa (1985) was instrumental in the development of Japanese attitude to and practices in quality. He was acknowledged as the father of quality circles of the journal of Quality Circles for foremen. He proposed the introduction of QC circles in which foremen and their workers could study and try-out the statistical techniques. Ishikawa stressed the importance of internal customer, education at all levels, and a respect of humanity within the management culture and philosophy. When the management should

decide company-wide quality control, it must standardize all processes and procedures, and then boldly delegate authority to subordinates (Ishikawa 1985).

Like Deming, Juran made a significant contribution to the quality revolution in the post second world war reconstruction of Japan. At the heart of Juran's thinking about managing quality was the need to present his ideas to senior managers in an easily understood form. To achieve this, he conceptualized his thoughts in a trilogy of management process: quality planning, quality control and quality improvement (Juran 1986), each of which was interrelated with the other. Juran proposed the following:

1. Quality planning consisted of a series of steps:

Determination of the customers and the needs of the customers; development of product features to respond to customer needs and process to produce these features; and the transfer of the resulting plans to the operating forces.

2. The quality control process consisted of the following three steps:

- Evaluation of actual operating performance,
- comparison of the actual performances with goals, and
- actions on the difference

3. The quality improvement process was perhaps the most significant of Juran's contributions to the QM movement. Quality control processes are more concerned with maintenance of a level of quality either through the prevention of errors or the correction of errors when they occur. The improvement process is at the heart of QM. The search for never-ending or continuous improvement is what it is all about, not just in the quality of the product or service provided but also in the process employed. Juran emphasized on improvements of both products or service and processes being applied to all customers and he was one of the first to recognize that customers were both internal to the organization as well as external.

Juran and Gryna (1980) advocated that the cost of quality accounting system was not only to provide management with a dollar cost for defective products but also to establish the goal of quality programs. Juran was most commonly associated with the concept of "Management Breakthroughs". Juran (1989) stated that an understanding of the human situations associated with the job would go quite far to solve the technical problems.

Shingo is considered as one of the Japanese quality management gurus. He developed mistake-proofing (Poka-yoke) system to facilitate quality products. Poka-yaka system improves process efficiency, save waste and reduces cost Shingo also developed a system known as "Single-Minute Exchange of Dies", or SMED. The purpose of SMED is to minimize the amount of time taken when making changeovers in jobs. It reduces downtime and increases production flexibility, obviating the need for long production runs and large batches.

Moller was a Danish business economist who developed ways to measure personal quality and saw it as the basis for all other types of quality. Moller has developed a series of grids and tables to allow individuals to measure and monitor their personal quality performance. He believed that to improve departmental quality, product quality, service quality and company quality; it would be necessary to improve personal quality.

Taguchi, a Japanese quality guru, contributed tremendously to Japan's post-war turn-round. Taguchi's methods build quality into processes and products right at the design stage. Within a process, the number of factors that contribute to quality and consistency of the product can be many. For example, which factors are the important ones, and how important are they? Are they always important or only under certain

conditions? To test out and measure the effect of all of the possible combinations of variables and at different levels would be an impossible task.

But Taguchi's method suggested the use of statistical methods for minimizing the number of trials or test that need to be carried out in order to arrive a satisfactory design. This method used a standard set of table to optimize the number of experimental trials to be carried out initially. The above mentioned authors have emphasized somewhat different sets of organizational requirements for an effective quality management based on their judgment and experience in working with different organization as consultants, researchers and / or managers. For example, Collard (1993) strongly believed that people are at the heart of a successful QM programme.

### 2.5.2 Quality Management Process

Quality Management Processes are the means by which quality is achieved. A lot of personal prescriptions are available in the literature. But the existing work has considered only that Quality Management Process, which is recommended by QM gurus and experts for the effective implementation and practice of company-wide quality management. Quality Management Process includes the following.

#### 2.5.2.1 Statistical Tools

The importance of statistical is often stressed in the literature (e.g. Deming 1982, Ishikawa 1985 and Juran 1989). Imai (1986) distinguished between the "old seven tools" and the "new seven tools". Rank and file employees are taught to use the "old seven tools" in analyzing production system quality. Managers are trained to use the new "seven" in the processes of strategic analysis. These tools enable to take decision on the basis of data or facts instead of the traditional method of intuition or hunches. There are two different approaches to problem solving. The first approach is used when data are

available and the job is to analyse the data to solve a particular problem. Most problems that occur in production – related areas fall into the category.

The seven statistical tools used for such analytical problem solving are as follows.

1. Paraeto diagrams: These diagrams classify problems according to cause and phenomenon. The problems are diagrammed according to priority, using bar-graph format.
2. Cause-and-effect diagrams (Fishbone graphs): These diagrams are used to analyze the characteristics of a process or situation and the factors that contribute to them.
3. Histograms: Histograms are mainly used to determine problems by checking the dispersion shape, central value, and nature of dispersion.
4. Control charts: There are two types of variations: the inevitable variations that occur under normal conditions and those that can be traced to a cause. The later are referred to as abnormal. Control charts serve to detect abnormal trends with the help of graphs. Sample data are plotted on the graph to evaluate process situations and trends.
5. Scatter diagrams: Two pieces of corresponding data are plotted in a scatter diagram. The relation between these plotting illustrates the relation between the corresponding data.
6. Graphs: There are many kinds of graphs employed, depending upon the shape desired and the purpose of analysis. Bar graphs compare values via parallel bars, while line graphs are used to illustrate variations over a period of time. Circle graphs indicate categorical breakdown of values.
7. Check sheets: These are designed to tabulate the results through routine checking of the situation.

In many management situations, not all the data needed for problem solving are available. New product development is illustrative. The ideal way to develop a new product would be to identify the customer requirements, translate these requirements into engineering requirements, and then translate the engineering requirements into production requirements. Similar is the development of a new manufacturing method. In both cases, the necessary data are not available – and what data are available are often available only in the minds of the people concerned, and expressed in language and not in mathematical figures. Such verbal data must be arranged into a meaningful form so that a reasonable decision can be made.

Many problem-solving situations in management call for collaboration among people from different departments and functional areas. Here too, hard data are scarce, and the available data are likely to be highly subjective.

In all these situations, it is necessary to go beyond the analytical approach and to use a design approach to problem solving. The seven new tools used for this design approach have proved useful in such areas as product quality improvement, cost reduction, new product development and policy deployment. The new seven are among the most effective tools for today's managers, staff people and engineers (see Imai 1986).

The design approach is a comprehensive systems approach to problem solving characterized by attention to details. Another feature of the design approach is its involvement of people from different backgrounds, which makes it effective in solving inter-departmental or cross-functional problems.

The new seven tools are as follows.

1. **Relationship diagram**: This diagram clarifies the interrelations in a complex situation involving many inter-related factors, and serves to clarify the cause and effect relationships among factors.
2. **Affinity diagram**: This is essentially a brain-storming method. It is based on group work in which every participant writes down his ideas, and the ideas are then grouped and realigned by subject matter.
3. **Tree diagram**: This is extension of the value engineering concept of functional analysis. It is applied to show the interrelations among goals and measures.
4. **Matrix diagram**: This format is used to clarify the relations between two different factors. The matrix diagram is often used in deploying quality requirements into counterpart characteristics and then into production requirements.
5. **Matrix data-analysis diagram**: This diagram is used then the matrix chart does not provide sufficiently detailed information. This is the only method within the new seven tools that is based on data analysis and gives numerical results.
6. **Process decision program chart (PDPC)**: This is an application of the process decision program chart used in Operations Research. Because implementation programs to achieve specific goals do not always go according to plan, and because unexpected developments are likely to have serious consequences, PDPC has been developed not only to arrive at the best conclusions but also to avoid surprises.
7. **Arrow diagram**: This is often used in PERT and CPM. It uses a net work representation to show the steps necessary to implement a plan.

#### 2.5.2.2 Customer Orientation

A QM organization defines a customer as someone who receives the product or service, whether he/she is internal or external to the organization (Deming 1986).

Focusing on value by knowing what the customer wants, and successfully translating that to operating requirements is integral to a customer orientation.

Deming (1986) believed that the main purpose of consumer research should be to feed consumer reactions back into the design of the product. This process enables management to anticipate the changing demands and requirements.

#### 2.5.2.3 Competitive Benchmarking

In the planning process, benchmarks are used to compare company's performance against the world's best. Companies employ criteria for selecting quality-related competitive comparisons and world-class benchmarks to support their strategic quality planning.

Benchmarking sets new directions and establishes effective goals and objectives, ensuring that the best, feasible, and proven practices are incorporated into business operations. Benchmarking is a rational way of ensuring the organisation in satisfying the customer requirements and will continue so long as customer requirements change over time (Camp 1989).

Benchmarks ensure the development of effective business plans by proving an increased awareness of products, cost, markets and processes. The benchmarking process challenges the current practices by introducing new ideas and practices from the external environment. These new practices are used to build the efficient functional strategies and business plans (Camp 1989).

#### 2.5.2.4 Employee Involvement

Employee involvement is advocated by a number of quality theorists and it denotes harnessing the talent, creativity experience and knowledge of every one in an organization  Although the employee involvement has been existing for quite some time, only in recent years it has emerged as a management tool for securing the management

commitment and identification with organizational success. Thus QM makes all employees responsible for quality. For such a change to become meaningful, employee also must be given responsibility commensurating with authority, to take actions when quality problems are confronted. Here QM initiates some form of employee empowerment. Proponents of high performance and high commitment maintain that high levels of employee empowerment may be used successfully to transform organizations.

To reward the employee initiatives, QM interventions frequently include employee recognition programs (Smith 1990). Japanese firms utilize elaborate recognition programs to foster quality consciousness among employees.

#### 2.5.2.5 Education and Training

The advocates of QM highlight the importance of education and training (Ishikawa 1985 and Juran 1989). Training is something to be applied to both the customer and supplier in the quality chain. Japanese companies believe that everyone in an organization must understand QM, and that this can be achieved only by education and training, and tend to have a master training schedule and curriculum to develop the skills of their employees. Employees need to be presented with the right level of education and training to ensure that their general awareness of quality management concepts, skills and attitude is appropriated and suited to the continuous improvement philosophy. An outline of the training given at supervisory level by a typical mechanical engineering company includes self development; effective use of time; education of subordinates; labour and personnel management; safety and health management; productivity; quality cost; process control; maintenance and environmental control (see Dale and Cooper 1992).

The structure of the training may incorporate some updating of basic educational skills in numeric and literacy, but it must also promote the continuing education and self

development. In this way, the latent potential of many employees will be realized, and the best use is made of each individual's ability. In Japan many companies provided at least one year of training for employees before they could be given sole responsibility for a job.

#### 2.5.2.6 Top Management Commitment

Quality management experts strongly argue for top management commitment and support for the successful implementation and practice of QM. This has been well supported empirically. Garvin (1986) reported that high levels of quality performance were always accompanied by an organizational commitment to that goal; high quality products would not exist without strong top management commitment. The study by Saraph, Benson and Schroeder (1989) suggested consideration of operating elements of QM/items which examined management responsibility for, commitment to, and participation in the quality improvement process.

#### 2.5.2.7 Quality Circles

Quality Circles (QC) have their origin in Japan. The idea has grown from a suggestion from Ishikawa to the foremen, who have pioneered book-reading circles which have been essentially study groups. Quality circles are a form of employee involvement, and foster quality attitudes and behaviour. The major difference between QC and quality management is that QC are voluntary, whereas quality management is not. QC are usually oriented towards specific problems rather than towards an overall improvement. A common reason for QC's possible failure is that suggestions are blocked by top management. Bradley and Hill (1987) observed that QCs have only limited value in changing organizational culture and promoting employee involvement.

### 2.5.2.8 Team Work

Team work is another important behavioral tool associated with quality management. Many quality problems originate when the work flow crosses the functional lines. QM proponents recommend the establishment of cross functional teams comprising of managers and workers (Imai 1986). Hill (1991) stressed on the cross-functional teams to develop plans to improve cross-functional quality, and these teams have jurisdiction over cross-functional problems that arise. Team work can also be used to reduce the organizational resistance to change and inflexible attitudes among managers.

### 2.5.2.9 Attitude Surveys

Attitude surveys have long been associated with the implementation of quality initiatives. They provide an important means of assessing changes in behaviour and attitude among employees, and monitoring progress towards a shared vision of quality improvement. Walters (1990) observed that attitude surveys can be used to measure resistance to change, identify employment problems and focus the resources on particular behavioural problems.

### 2.5.2.10 Technology Utilization

Technology, when utilized fully and focused to support business objectives, can be a competitive advantage. For example, it is startling fact that in the period from the mid-1950s to the mid-1980s, UK scientists won 26 Nobel prizes for scientific innovation, while the Japanese won only four. This is an enlightening statistic since the period is the exact time that Japanese industry successfully took major world markets. If technical edge was available to the West before Japan, why didn't Western companies take greater advantage? The Japanese were not misleading by the exhortation to "Automate or Die" which was the clarion call in the early 1980s. Unfortunately this

became “Automate and Die” for many companies who, through poor implementation, failed to realize the benefits of their investments in automation.

Industrial leaders are rarely the champions of FMS, CIM, IT or other technology “buzz words”. Industrial leaders are the only people who can really make technology work, since successful application involves all the people in the organization. QM provides the management methodology for industrial leaders to harness the benefit of appropriate technology in line with, and as a key part of, implementing the business strategy (Spenley 1992).

#### 2.5.2.11 Quality System

ISO 8402 defines a quality system as the organizational structure, responsibilities, procedures, processes and resources for implementing quality management. The UMIST QM research experience indicates that in most companies it is not easy to involve every function and person in taking responsibility for their own quality assurance and making quality improvements in their processes (see Laselles and Dale 1992). ISO 9000 makes such things happen. In general, ISO 9000 series tends to measure the effectiveness of documentation, paper work and procedures. ISO 9000 series registration is often misinterpreted as a guide to QM. ISO 9000 does not deal with attitudes or generation of commitment, and enthusiasm from the bottom level of the organization.

Crosby (1995) reiterated that quality would not come from a system; it would come from the understanding and application of management concepts, education and examples. Juran (1995) reaffirmed that the certification from ISO 9000 did not mean that a company has actually become a world class company. It has merits, but what it tries to do is to define a system for control, not for improvement. Those are two different things, and the organization needs both. One is control that avoids the adverse changes and the

other is improvement that creates the beneficial changes. ISO certification is therefore a marketing requirement.

#### 2.5.2.12 Human Resource Management

According to Gitlow and Gitlow (1987), people are the organization's most valuable long-term resource. Human resource management is a key linkage in QM and can be responsible for significant differences between the performances of organization with similar technical capabilities. In this category, the Malcolm Baldrige Award (1993) evaluates the process through which the workforce develops its potential for pursuing the organization's quality and operational performance objectives. The organization's efforts to build an environment conducive to full participation and personal and organizational growth are also examined. Accordingly, QM demands that all aspects of human resource management (manpower planning, recruitment and staffing, training and development, performance appraisal, and reward system management) assume strategic roles.

Indeed, as technology and business strategies become more and more easily available to companies world-wide, the only differentiating factor will be the people.

#### 2.5.2.13 Industrial Relations

The study on QM involving industrial relations is somewhat over loaded by the literature (Wilkinson 1993). This could be so because managers tend to be more concerned with the "hard" quantifiable aspects of quality such as cost and productivity, than with "sift" qualitative aspects such as employ commitment (Seddon 1989). Generally, quality managers do not see the aspect of IR as important to establish to union agreement, prior to a quality management programme.

### 2.5.2.14 Quality Information

Feedback to employees about quality performance provides a means of learning and maintaining quality-oriented bahaviour (Flynn, Schroeder and Sakakibara 1994). An important component of quality information is the provision of timely and accurate information about the manufacturing operation of the manufacturing process. Juran advocates the determination of cost of quality for all process components and wide dissemination of this information within the organization. The Malcolm Baldrige Award (1993) recognizes the importance of making timely, adequate, and relevant quality data available to concerned departments and employees.

## 2.6 RESEARCH ON QUALITY MANAGEMENT

### 2.6.1 State of the Art in the Developed Countries

The QM research is replete with practitioner-oriented "do-everything-right" articles and case studies (Ahire, Landeros and Goihar 1995). A total of 200 QM related articles are identified from 44 referred journals published from 1970 to 1993 by Ahire *et al* (1995). Then they classified these articles into 5 groups by their orientation. These orientations include overview, conceptual, case study, empirical, analytical and simulation. Some articles present a holistic treatment of all aspects of QM; these articles are grouped as overview. Conceptual articles include topic such as prescriptive models and methods for implementing QM, and opinions of researchers on various aspects of QM. When an article presents a detailed study of a few organizations (less than 10), it is classified as a case study. An article based on field study of large number of organizations is classified as empirical. If the focus of the article is on analytical modeling of various aspects of QM (e.g. cost models), it comes under "analytical" category. Finally, articles with simulated experiments are classified as "simulation".

Table No:2.1 show the summary result of the QM literature classification made by Ahire *et al* (1995).

It may be noted that some of the articles have focused on more than one area. It is seen that the major emphasis of QM research has been on conceptual articles (107), followed by case studies (56). Only 29 articles can be classified as empirical. The least number of articles is published on analytical modeling of the QM process. So, one can conclude that much of the research on QM has concentrated on conceptual articles and less on empirical research. Dotchin and Oakland (1992) and Hackman and Wagman (1995) also lend support to this observation.

**Table No: 2.1 Frequency of reviewed articles by orientation and focus**

| Articles reviewed | | Article foci | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Orientation | Frequency | L | I & A | SQP | HRM | MPQ | QOR | CFS | Total |
| Conceptual | 107 | 17 | 20 | 13 | 26 | 52 | 6 | 19 | 153 |
| Case study | 56 | 15 | 9 | 14 | 22 | 34 | 9 | 9 | 112 |
| Empirical | 29 | 5 | 1 | 2 | 11 | 19 | 0 | 4 | 42 |
| Analytical | 6 | 0 | 1 | 1 | 1 | 4 | 0 | 1 | 8 |
| Simulation | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| Total | 199 | 38 | 31 | 31 | 60 | 109 | 15 | 33 | 317 |

L – Leadership; I&A- Information and Analysis; SQP- Strategic Quality Planning; HRM-Human Resources Management; MPO-Management of Process Quality; QOR- Quality and Operational Results; CFS- Customer Focus and Satisfaction. (Source: Ahire *et al*. 1995)

Out of these 29 articles on empirical studies, only one article (Saraph *et al* 1989) addressed the issue of operating – system elements of QM. Subsequently, there have been a few attempts on the empirical research reported in the literature (Flynn, Schroeder and Sakakibara 1994, Ahire, Golhar, and Waller 1996, and Black and Porter 1996).

Until a study conducted by Saraph *et al* (1989), no comprehensive measure of quality management was found in the literature that could systematically measure the extent of quality management in business units. This study developed measures of quality management, and identified 76 operating-system elements of quality management program. Using a sample of 162 managers, the authors validated scales for the identified constructs.

Further testing and refinement of the Saraph *et al* (1989) instrument is required to understand quality management practice better, and to develop theories and models that relate the critical factors of QM program to an organisation's performance. Saraph *et al*. (1989) considered their study to be preliminary, and they called for follow up studies to further develop the systematic measurement of quality management practice in industry. Saraph *et al*. identified the following eight critical factors of quality management that were synthesized from the literature on quality management at the business unit level:

1. Divisional top management leadership for quality
2. Role of quality department
3. Training
4. Product design
5. Supplier quality management
6. Process management
7. Quality data and reporting
8. Employee relations

The instrument contained operational measures (items) for each of the factors. The measures could be used in combination to produce a profile of quality management within a business unit as a whole, or with respect to individual factors. The measures proposed by authors were empirically based and shown to be reliable and valid.

The contribution of Saraph *et al* (1989) study was the development of a set of critical factors of quality management, and the development of an instrument that can be used to measure the extent of quality management in organizations.

Flynn *et al* (1994) developed dimensions of quality management. A study of 42 manufacturing plants from three industries, which sought multiple responses from managers and workers from various functions, formed the basis for empirical validation and refinement of these constructs. Based on the seven dimensions of quality management identified, a set of 14 perceptual scales was developed. The scales consisted of Quality leadership, Quality improvement rewards, Process control, Feedback, Maintenance, Cleanliness and organization, New Product Quality, Product Design Simplicity, Inter-functional Design Process, Labour Skills, Selection for team work potential, Team work, Supplier relationship, and Customer interaction.

Black and Porter (1996) proposed an empirical frame work for QM implementation. The research extracted a series of items from the Malcolm Baldrige model and the established literature. These items formed the basis of a questionnaire sent to over 200 managers. Data was examined using several well established analytical techniques that identified 10 critical factors of QM. The factors included Corporate Quality Culture, Strategic Quality Management, Performance Measurement System, Human Resource Management, Operational Quality Planning, Corporate Image, Supplier Partnership, and Infrastructure for Process Improvement, Customer Satisfaction Orientation and Improvement Assessment. These factors were shown to be reliable and valid.

Ahire *et al* (1996) conducted a similar study and suggested an empirical framework for QM implementation. Through a detailed analysis of the literature, they identified 12 constructs of integrated quality management strategies. Using a survey of

371 manufacturing firms and the constructs were then validated. Finally, a framework to examine the effects of integrated quality management strategies on a firm's product quality was suggested. The integrated quality management constructs included Top Management Commitment, Customer Focus, Supplier Quality Management, Design Quality Management, Benchmarking, SPC usage, and Internal Quality Information usage, Employee Empowerment, Employee Involvement, Employee Training, Product Quality, Supplier and Performance.

Based on literature review Seetharaman *et al.* (2006) generalized 6 key success factors on the execution of QM activities: high-rank manager's support, employee's active involvement in the execution, methods to measure the performance, culture of continuous improvement, value on customer's needs, education and employment training. Ismail and Ebrahimpour (2003) selected 76 literatures related to QM activities from 1989 to 2000 and recognized the key success factors of effective QM activities execution, including leadership, strategic planning, customer and market orientation, data analysis, human resource management and process management. Antony *et al*. (2002) suggested 11 key success factors of the execution of QM activities, including educational training, quality data and figure analysis, the manager's commitment, customer satisfaction orientation, role of quality control department, communication for quality improvement, continuous improvement, product and service design, the supplier's quality management, manufacturing management and employee relationship. Motwani (2001) generalized 7 constructs of the execution of QM activities high rank manager's support, quality measurement and benchmarking, manufacturing management, product design, employee training and empowerment, supplier quality management and customer participation and satisfaction. Yi-Chan-Chung *et al*. (2010) has in their study divided the implementation of QM activities into 5 constructs:

Leadership, data analysis, human resource management, process management and market orientation. Prajogo and Sohal (2001) suggested that the implementation strategies of QM activities included differentiation strategy and cost leadership strategy. QM activities upon differentiation strategy aimed to provide better products or services to satisfy the customer's needs. Cost leadership strategy aimed to reduce the cost and avoid the flaws and wastes. Reed *et al.* (1996) suggested that cost leadership and differentiation strategy in the companies would enhance the execution effect of QM activities.

According to Sohail and Teo (2003) some researchers have pointed out the opinion that the ISO 9000 certification is the first step towards the implementation of QM while some researchers still prefer to maintain focus on QM only. They indicated that even though some authors praise the ISO 9000 concept, others view it as a ritualized form of quality management that should not be used in isolation from QM principles. One study by Sun (2000) found that ISO 9000 standards are partially related to the implementation of QM and the improvement of business performance and therefore it is recommended by the study that ISO 9000 should be incorporated with the philosophy and methods of QM.

A study by Ankur Jain and S.L.Guptha(2011) indicates that quality certifications help the implementation of quality management programmers based on QM principles and that the quality certification has an impact on performance and helps the organizations to achieve business excellence. Also among the quality certified organisations, CMM certified software organizations have better QM practices and business excellence as compared to ISO certified organisations. Because ISO 9000provides general guidelines for all the organizations ,which can be used for QM purposes ,whereas CMM stresses on process improvement and provides guidance for

stable, capable and mature processes by identifying the key processing areas in software development.

Parzinger and Nath (2000)examined the link between QM and software quality and found that QM implementation improves software quality and performance and thus increases customer satisfaction. Hasen and Kerr (2003) studied the relationship between QM practice and organizational performance in service organizations and discovered that QM practices like top-management commitment; employee involvement; training; supplier quality; service design; quality techniques; bench marking; and customer satisfaction leads to higher productivity and quality performance.

The following table shows the various practices that have been proposed by different authors.

**Table No. 2.2: Various types of QM practices proposed**

| Author (Year) | Number of Practices Used | Practices |
|---|---|---|
| Saraph, Benson, Schroeder (1989) | Eight (8) Critical Success Factors (CSFs) for QM implementation | Top management leadership, role of the quality department, training, product design, supplier quality management, process management, quality data reporting and employee relations. |
| Ahire, Golhar and Walker (1996) | Twelve (12) implementation constructs of QM | Top Management commitment, employee training, design quality management, supplier quality management, internal quality information usage, employee involvement, employee empowerment, customer focus, benchmarking, and SPC usage. |
| Black and Porter (1996) | Ten (10) major QM practices | People and customer management, supplier partnerships, communication of improvement information, customer satisfaction orientation external interface management, teamwork structures for improvement, operational quality planning, quality improvement measurement systems, and corporate quality culture. |

| | | |
|---|---|---|
| Yusoff and Aspinwal (1999) | Ten (10) QM factors | Management leadership, continuous improvement systems, education and training, supplier quality management, systems and processes, measurement and feedback, human resources management, improvement tools and techniques, resources, and work environment and culture. |
| Brasin *et al.* (2000) | Eleven (11) constructs of QM implementation | Top Management support, customer focus, employee involvement, employee training, employee empowerment, supply quality management, process improvement, service design, quality improvement rewards, benchmarking, and cleanliness and organization. |
| Agus and Abdullah (2000) | Eight (8) QM factors | Top management commitment, customer focus, supplier relationship, training, employee focus, quality process, measurement, and zero defect. |
| Agus, Krishna, and Syed (2000) | Five (5) QM factors | Top management commitment, supplier relationship, training, employee focus, customer focus |
| Antony *et al.* (2002) | Eleven (11) QM practices | Management commitment, role of quality department, training and education, employee involvement, continuous improvement, supplier partnership, product/service design, quality policies, quality data and reporting, communication to improve quality, and customer satisfaction orientation. |
| Sureshchandar *et al.* (2002) | Twelve (12) major practices | Top management commitment and visionary leadership, human resource management, technical system, information and analysis system, benchmarking, continuous improvement, customer focus, employee satisfaction, union intervention, social responsibility, services capes, and service culture. |
| Temtime Solomon (2002) | Eight (8) critical QM factors | Managerial leadership and commitment, customer satisfaction, continuous improvement, employee empowerment and involvement, supplier partnership, quality culture and philosophy, resources and working environment, and measurement and feedback. |
| Ooi, Arumugam and Teo (2005) | Nine (9) QM Practices | Top management, education and training, employee participation, customer focus, organizational culture, teamwork, job involvement, career satisfaction, commitment. |

### 2.6.2 Quality in International Context

Currently developed and developing countries are in different stages of the quality movement especially in automobile industries. Here in this industry, most quality

practices research has focused on developed countries since the early 1990's such as United States and Japan. Studies on the implementation of quality practices in developed countries are found to be very common and thus most quality practices nowadays is based on the experiences of developed companies such as Toyota, GM, and Ford. Benito and Dale (2001) have reported some empirical observation of the way in which Spanish auto components industry is implementing supplier quality practices. They pointed out that suppliers which are more advanced in the use of quality practices are achieving better operational performance in terms of quality, reliability, cost, flexibility and design. A recent study by Iwaarden *et al.* (2006) in a European automotive manufacturer showed that the application of management control model in the field of quality management practices is found to be useful in explaining what changes are necessary to maintain high quality levels.

Quality practices research has been extended beyond developed countries to other countries around the world such as China and India. A study was conducted to investigate the status of quality practices and its perception among Chinese small manufacturing companies. It was pointed out that by adapting certain quality management practices, it can help Chinese small manufacturers to achieve competitive advantage in both domestic and international markets. Lin *et al.* (2004) showed that Taiwanese and American firms can benchmark the efficient practices of Japanese firms in order to be the best-in-class. The study found that the efficiency of quality management practices for Japanese owned firms is the highest, even though almost all their employees are Taiwanese; also American-owned firm's efficiency is highest than that of Taiwanese-owned firms.

Parast *et al.* (2006) conducted a comparative analysis of quality management practices between USA and Mexican manufacturing companies, using Malcolm Baldrige

National Quality Award (MBNQA) criteria as a framework. The results show that there are differences between the critical success factors of quality management practices within USA and Mexico. In both countries, social responsibilities and supplier quality were significant in explaining variability of quality results.

Brah and Tee (2002) examined the relationship between QM constructs and organizational performance by measuring quality performance of Singapore companies. They found the implementation of QM leads to quality performance and have positive correlations. In another study based on the comparative analysis of QM practices and quality performance between manufacturing and service firms in Australia, Prajogo (2005) reported that there exists no significant difference in the level of most of the QM practices and quality performance between two sectors. In another study conducted by Arumugam *et al* (2008), explored the relationship between QM practices and quality performance on ISO9001:2000 certified manufacturing organizations in Malaysia. Findings revealed that QM practices were found to be partially correlated with quality performance. It was also emphasized that customer focus and continuous improvement were perceived as dominant QM practices in quality performance. Prajogo and Brown (2004) conducted an empirical study within Australian organizations to investigate the relationship between QM practices and quality performance and the result indicated a strong positive linkage. Another study on ISO 9000certified organizations of Taiwan performed by Jeng (1998) examined the linkage between six QM practices and quality performance. He found customer focus as the most powerful discriminated practice of quality performance while remaining five practices showed low discriminating powers.

Schniederjans *et al.* (2006) conducted a study on quality management practices in manufacturing companies between these countries – India, Mexico and USA; stated

that cross comparison study may be helpful in understanding the similarities and differences in quality management practices in various countries.

Some of the past related researches on comparative study in quality practices implementation between countries from the year 2000 to 2007 are summarized in the following table.

**Table No. 2.3: Research on comparative study in quality practices implementation between countries from the 2000 to 2007 (Zakuan and Yusof, 2007)**

| Year | Author | Focus area | Sector | Countries |
|---|---|---|---|---|
| 2000 | Aziz *et al.* | Quality Practices | Manufacturing | UK, Malaysia |
| 2002 | Ahmad and Schroeder | QM | Automotive | US, Germany, Italy, Japan |
| 2003 | Noronha | QM | Manufacturing | China, Hong Kong, Taiwan |
| 2003 | Khoo and Tan | QM | Manufacturing | US, Japan |
| 2005 | Jabnoun | QM | Manufacturing | Saudi Arabia, Australia, Canada |
| 2005 | Rothenberg *et al.* | Benchmarking | Automotive | US, Japan, Europe |
| 2006 | Schniederjans *et al*. | MBNQA | Manufacturing | India, Mexico, US |
| 2006 | Iwaarden *et al.* | Quality practices | Automotive | European |
| 2006 | Yoo *et al.* | Quality practices | Manufacturing | Korea, USA, Mexico, Taiwan |
| 2006 | Parast *et al.* | Quality practices | Manufacturing | USA, Mexico |
| 2006 | Hermann *et al.* | Quality tools | Automotive | Germany, France, England, Italy |
| 2006 | Feng *et al.* | QM | Manufacturing | Australia, Singapore |
| 2007 | Tari *et al.* | QM | Manufacturing | Spain, US, Korea |

The following table gives a comparison of quality management constructs across different studies.

**Table No: 2.4Comparison of quality management constructs across different studies**

| No. | Saraph *et al.*, 1989 | Flynn *et al.*, 1994 | Ahire *et al.*, 1996 | Rao *et al.*, 1999 | Yusof and Aspinwall, 2000 | Parast *et al.*, 2006 | Sila, 2007 |
|---|---|---|---|---|---|---|---|
| 1 | The role of top management leadership | Top management Support | Top management commitment | Top management commitment Quality citizenship | Management leadership | Quality leadership | Leadership |
| 2 | The role of quality department | Customer involvement | Customer focus | Customer orientation | - | Customer focus and satisfaction | Customer focus |
| 3 | Quality data and reporting | Quality information | Internal quality information usage Benchmarking | Quality information availability | Measurement and feedback | Quality information and analysis | Information and analysis |
| 4 | Training | Workforce management | Employee training | Employee training | Education and training Human resource development | Support for human resource development | Human resource management |
| 5 | Employee relations | - | Employee empowerment Employee involvement | Employee involvement | Resources | - | - |
| 6 | Product/service design Process management | Product design Process management | Design quality management Statistical process control usage | Product/process design | System and process Improvement tools and techniques | Strategic planning process of quality management | Process management |
| 7 | Supplier quality management | Supplier involvement | Supplier quality management | Supplier quality | Supplier quality assurance | Supplier quality | Supplier management |
| 8 | - | - | Product quality | Internal quality results | - | Quality results | Organizational effectiveness |
| 9 | - | - | - | - | - | Quality assurance of products and services | - |
| 10 | - | - | Supplier performance | External quality results | Continuous improvement process | - | Financial and market results |

## MBNQA & EFQM

The quality award models such as the Malcolm Baldrige National Quality Award (MBNQA) and European Foundation for Quality Management (EFQM) Excellence Model are used as a guide to QM implementation by large number of organizations.

The assessment criteria used in ISO 9000 can be compared to the Malcolm Baldrige National Quality Award (MBNQA). There are seven categories of assessment in this. They are

1) Leadership
2) Information and Analysis
3) Strategic planning
4) Human Resource Development and Management
5) Process Management
6) Business results
7) Customer focus and Satisfaction

Various studies reveal that these quality models really are QM frameworks.

### 2.6.3 The model of Quality Management

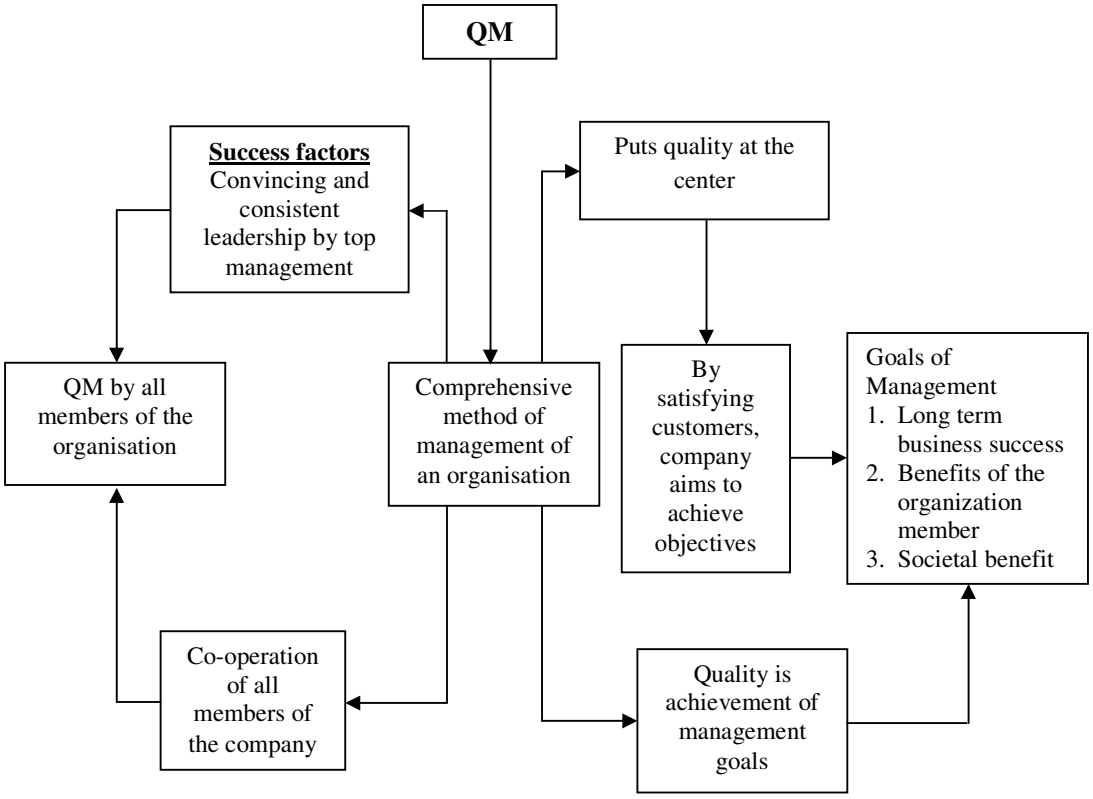


**Fig.2.1: The Model ofQM**

*(QM by Dr. Uday Kumar Haldar, DhanpatRai& Co.)*

## 2.7 INDIAN SOFTWARE INDUSTRY - A PROFILE

### 2.7.1 Introduction

The modern business and marketing have a major role to play in the new liberalized and globalised business era. In India, the trend of developing business has been positive until now. For this progress the Information Technology field has played an important role. There was a time probably till a decade ago, when no Indian company would dream of becoming a global player. Then the software industry showed what was possible with a combination of enterprise, quick thinking and luck. Now the entire world thinks of India as one of the places from where to execute its Information Technology strategy. The IT Industry is India's first truly global industry.

The Indian IT industry has been steering the growth of the Indian economy like no other industry in the past decade by generating jobs, pushing exports, enticing FDI, creating wealth, bolstering forex exchange reserves and in umpteen other visible and invisible ways. It has grown at an incredible rate of 50 per cent per annum over the past few years and has the potential to grow even further and faster. It is highly export oriented and extremely knowledge intensive. The nation is pinning high hopes on this industry in its developmental agenda.

The year 2005 witnessed the coming of age of the Indian IT multinationals, with the traditionally India – Centric indigenous players beginning to build noticeable presence in other locations – through cross border acquisitions, onshore contract wins and by global majors continuing to significantly ramp-up their offshore delivery capabilities – predominantly in India, vindicating the success of the global delivery model and highlighting India's increasingly important role in the new world IT order.

The size of the software business in the domestic market in the 1970's was not big enough for these companies to generate revenues year after year. As a result they had

to look towards foreign shores to generate revenues. In the 1980's, technological changes in the IT sector offered new opportunities for the Indian software firms. The big opportunity and potential to earn huge revenues attracted firms like Wipro, HCL, Infosys, Satyam and other to enter the software business. These firms acquired considerable expertise in various types of IT related work. The excellent skill sets possessed by Indian engineers and the 12 hour time difference between India and the US attracted a few foreign companies to locate their software development centers in India. These foreign companies also realized the cost advantage of using the services of Indian engineers.

In the early 1990's India adopted globalization and competition through its New Economic Policy dispensation. By this time the reputation of Indian Engineers as excellent software programmers has spread and a number of Multinational Companies (MNCs) like British Telecom, Digital Equipment, AT & T and Northern Telecom, have established software development centers hiring Indian professionals. These centers acted as low cost outsourcing locations where Indian engineers developed software. This type of business model gave rise to a new type of software services model, known as 'offshore model'. The Indian software companies also started setting up offshore development centers right in India dedicated to specific US clients to take advantage of higher margins on projects, as the billing rates in USA were higher. To win more projects from the US and to compete with the big US IT Vendors, the Indian software firms realized the need to move away from being bracketed as low-price and low-quality producers to competitively priced and high – quality producers. The large Indian IT companies such as TCS, Wipro and Infosys adopted the ISO 9000 international standard for quality management and assurance.

By 2000, the top Indian software firms gained expertise in onsite model. In order to meet the increasing competition from the established players and emerging companies, both foreign and local, in outsourcing business, various steps were taken. They got actively involved in the setting of certification norms for service production like the Capability Maturity Model (CMM) of Carnegie Mellon University's Software Engineering Institute. TCS, Wipro, Infosys, and Satyam opened representative offices in the US. Seeing the growth and success of Indian Software Industry, global IT vendors such as Accenture, EDS and IBM Global Services have rushed to set up their software development in India. NASSCOM (National Association of Software and Services Companies) has reported that the growth rate of these global companies was almost twice that of the Indian IT companies.

The world software market is growing rapidly due to fast technological change, free trade and strong competitive pressures. Two of the developments which provided avenues for the growth of software firms worldwide were Millennium bug and Internet.

The last decade has seen the Indian software industry make impressive strides and carve out an identity for itself in the international technology services market. This industry has successfully withstood many business challenges in the past. The emergence of IT enables business process outsourcing, the sustained interest of global majors in sourcing software and related services from India and the proliferation of captive development arms of multinational companies are indications of the continued importance of the Indian IT industry.

The internal structure of the Indian IT industry has exhibited some peculiar developments. The larger players have managed to sustain their high growth rates and have grown from strength to strength. An analysis of NASSCOM membership shows that between 1994-95 and 2001-02, there was a fourfold increase growing from 262 to

854. These 854 members' together accounts for about 95 percent of the revenues of the software industry in India virtually the entire industry.

### 2.7.2 Development of Information Technology Field in India

In Information Technology field, India is super power nation. Indian IT professionals and companies are considered top-notch. After many years of phenomenal growth, the first year of the new millennium saw enormous challenges confronting the Indian IT software and service industry. In the year 2006, the software and service industry accounted for 16 percent of the country's overall exports, for 5 Lakh jobs and over $1.5 billion in investments.

Information technology has developed Indian corporate sector and business field."The Information Technology plus Indian Talent is equal to Indian Tomorrow (IT+IT+ = IT)" said Mr. NarendraModi, Hon. Chief Minister, Gujarat. With the help of Information Technology the market in India has also been moving inexorably towards the path of increased sophistication on the whole. In India, the IT industry is in a strong position to take on the global software opportunity and establish India as the IT destination.

History highlights that industrial revolution took centuries to spread to different areas of the world but Information Technology has created a super imposed impact on human society in a much shorter time than anything ever. IT's power to promote innovations has brought a revolution in BPO industry. From the early 1990s, revolution in Information Technology has changed the whole life style of entrepreneur of large and small organizations by its new technologies in terms of speed of processing, data transportation and communication, database maintenance and electronic resources. Since the last decade IT has brought a tremendous change in the methods of doing business. The role of Information Technology is to boost up the business operation of an

organisation. The emergence of the Indian software industry offers a unique setting to ask whether globalization can promote convergence in corporate governance. India is home to a globally competitive set of software powerhouse, the success and generally positive reputation of India's software firms-in contrast to most of India's other firms – provides at least surface firms credence to the idea that the global markets to which these firms are exposed has affected their governance systems.

Software has played an unforgettable part where database management system, data warehouse, management information system, decision support systems, ERP (Enterprise Resource Planning), CRM (Customer Relationship Management) and many other types of software are used to carry out the operation of BPO industry.

As per a NASSCOM study for the year 1996-97, over 127 new software products were launched by domestic software companies and over 156 new software products were launched by overseas companies in the Indian domestic market. There was also 48 per cent increase in the CAD/CAM software market; an increase of 46 per cent in ERP solution market; 23 per cent increase in sale of RDBMS packages; 25 per cent increase in sale of financial accounting package and 65 per cent increase in sale of networking products.

TCS has emerged as the top software and service exporter in the country during 2004-05 followed by Infosys and Wipro. As per the 'Top 20 IT software and service exporters in India (excluding ITES-BPO revenues)' ranking by National Association of software and services companies (NASSCOM), TCS topped the list with export revenues of Rs. 7449 crore followed by Infosys (Rs. 6806 crore) and Wipro (Rs.5426 crore). Software exports, the mainstay of the industry grossed $ billion in 2004-05, up from $ 9.2 billion in 2003-04, indicating a growth of 30.4 per cent for the year. With offshore adoption amongst the Fortune 500 companies increasing rapidly from 300 in

2003 to 400 companies in 2004, NASSCOM expressed optimism about the long-term potential of this industry.

## 2.8 EVOLUTION OF INDIAN SOFTWARE INDUSTRY

Though the Indian software industry has risen to prominence in the last decade, it has a history of well over thirty years. The process of evolution has been chronicled from multiple perspectives. The common factors that are widely perceived to have been positive availability of skilled, English speaking manpower, export orientation, policy initiatives of the government and the wide network of expatriate Indians in the global customer organizations.

Rapid advances in Information Technology and its convergence with communication technologies gave rise to a few growth accelerators. Some of the accelerators were in the form of new opportunities (Y2K and the internet) and some were in the form of new business models (offshore development and remote services).

The growth in the number of firms in any industry is a direct consequence of the perceived attractiveness of the industry. Low entry barriers, high profitability, a favorable regulatory regime and a buoyant high growth market encouraged entry of new players to the software industry at a rapid pace. The market for software services comprises three distinct segments. First and by far the largest in terms of potential is the enterprise segment, whose core business is not IT. The second segment is the Independent Software Vendors (ISVs), whose core business is the development and sale of packaged software products and tools, along with a certain level of implementation and customization. The third segment consists of the intermediaries who service the requirements of enterprise customers.

Rapid advances in information and communication technologies and their convergence have significantly altered the role of IT in all organizations. This changing

role of IT has in turn altered their outsourcing strategy and buying behaviour. The IT spend of any organisation can be seen to provide a hierarchy of benefits. At the higher end of the hierarchy are the ideas and solutions that generate the competitive advantage for the organisation. At the lower end of the hierarchy is the operation and maintenance of the IT infrastructure, covering all aspects of the organizations operations. Large enterprises are likely to have a greater proportion of their IT spend occurring at the lower end of the hierarchy. The ISVs are likely to spend a greater proportion of their IT budgets at the higher end of the hierarchy since IT products are their core business. In case of intermediaries, their IT spend is directed towards building their core competence and hence will tend to get bunched at the higher end of the hierarchy.

The history of the Indian software industry may be reckoned from 1974, when Tata Consultancy Services (TCS) started off its operations. TCS with its joint ventures became one of the largest software exporters in the early days. However, exports became the core focus of companies sometime around the late 1980s and early 1990s. A major event in the industry was when Texas Instruments proposed to start a 100 per cent export-oriented, foreign owned and operated subsidiary. This caught on rapidly, with large software companies like Siemens, Motorola and many more setting up shop in India as subsidiaries. Software companies became R & D partners for big multinational firms, helping them to reach market faster.

Much of the growth that the Indian software industry saw came from the outsourcing wave. Increasing cost pressures on global corporations, a growing focus and core operations by customers and technological advances made offshoring to India the most viable option and the Indian software and service industry turned the slowdown into an opportunity.

Small and Medium IT Companies (SMITs) constitute over 60 per cent of the software industry and their contribution to the total software exports increased from 25 per cent in 200-01 to 35 per cent in 2001-02. SMITs with a sound business model and focused activity grew despite a challenging market environment. The successful technologies that SMITs focused on were:

- Manufacturing of chips and software that dramatically cut the cost of internet access devices needed for sending voice, video and data on the net;
- Specification in telecom software solutions embedded on the chip used in wide band CDMA phones;
- E – Security solutions to customers.

### 2.8.1 Fragmentation

The Indian IT industry, software in particular, is highly polarized. At one end of the spectrum, large companies with global operations and infrastructure have emerged; while on the other, many small techno-entrepreneur-driven companies functioning in niche segments have started playing an important role in the evolution of the software industry. However, a significant number of companies which were earlier involved primarily with low-end services, have disappeared because of the challenging market conditions made worse by the lack of any core-competence.

There are two major delivery models in use for software and services exports, namely on site services and offshore services. Onsite services involve project implementation at the client facility overseas. Offshore services involve the use of high-speed data communication links, which allow computers situated anywhere in the world to be used by programmers in India on a real-time and on-line basis. The off shore model allows a client located anywhere in the world to monitor the software development on a minute-by-minute basis, ensuring quality checks, easy communication with remote

programmers, and efficient software development translating into significant time and cost savings. The gross margins in the offshore business are typically higher than the margins in onshore business.

Revenue from software services is derived from technology and software services provided on either variable-price, variable-time frame basis or fixed price, fixed-time frame basis. Revenue from services provided on variable time-and-materials basis is recognized in the period in which the services are provided and costs incurred. Revenue from fixed price, fixed-time frame projects is recognized only on a percentage of completion basis.

### 2.8.2 Government Policies – Impact on Software Sector

- **Zero Duty Regime**

India joined the Information Technology Agreement (ITA) on 25.3.1997 which is a multinational agreement within the WTO which aims to expand world trade in Information Technology products. According to the agreement, customers tariff on IT items were to be brought down in stages to zero by 2005.

- **STPs**

Software Technology Park (STP) is an autonomous body and comes under the department of electronics of Government of India. The STP scheme allows 100 per cent export oriented firms a tax-free status for five years from the first eight years of operation. The scheme provides them project approvals, market analysis, marketing support and training. The GOI has promoted several STPs in several locations across India. Units located in STP enjoy the benefits of single-window duty free imports of professional equipment and duty free purchases.

- **100 per cent FDI**

The GOI allows for 100 per cent FDI equity in ITES companies.

- **Liberalization of the Telecom Sector**

Liberalization of the telecom sector is allowing private players in International Long Distance (ILD), National Long Distance (NLD) and Leased line services.

- **State Governments**

Various stage governments have introduced initiatives to encourage investments in the ITES sector.

The demand for software services over the short to medium term is likely to be expert-led. However, India has a significant presence in only 2 of the 10 major IT services worldwide. ie, custom Application development and Application outsourcing.

### 2.8.3 Impact of IT

The rapid growth of ITES-BPO (Information Technology-Enabled Services-Business Process Outsourcing) and the IT industry as a whole is having a deep impact on the socio-economic dynamics of India. The sector has become the biggest employment generator with the number of jobs added almost doubling every year. India has become one of the most favoured destinations for outsourcing and ITES and is estimated to have achieved an export value of $ 12.8 billion in 2003-04. India ranks high in several, critical parameters including level of government support, quality of the human resource pool, English language skills, cost advantages, project management skills and overall quality control.

Communication has paved the way for business opportunities, such as BPO and network management services as well as new technologies and applications such as mobile phones and the internet. The IT industry grew 24 per cent (Rs. 92924 crore) in 2003-04 and the domestic market (Rs. 33374 crore) and exports (Rs. 59550 crore) shared the same growth of 24 per cent.

### 2.8.4 The Buoyancy in Export Market

India has become one of the most preferred destinations for sourcing software and IT enabled services. India in comparison to other low cost locations ranks high in several critical parameters including level of government support, quality of the labour pool, cost advantage, entrepreneurial culture, strong customer relationships and exposure to new technologies. As per the 'Top 20 IT software and service Exporters in India' ranking by NASSCOM, TCS topped the list followed by Infosys, Wipro, Satyam Computers and HCL. These five companies have been consistently maintaining their ranks in the same order since 2002-2003.

At a time when Indian software product companies are marking significant headway in overseas markets such as West Asia and Africa, the $4.8 billion domestic IT market, with a healthy forecast of a 25 percent growth continues to prove elusive for most players. These homebred companies feel that despite the advantages attached to choosing Indian vendors, including their deep understanding of the local markets, and assurance of strong onsite support, a slow decision making process, temptation of Indian buyer to opt for products offered by global companies and sometimes huge product discounts offered by MNC players to grab significant chunk of market share, are factors that are cited as severe constraints when it comes to doing IT business in their own market.

It is not unusual to find foreign players offering huge discounts to gain market share. Indian companies find it difficult to compete on this front, given the financial prowess of the MNC firms. The players feel this is because the global companies, while making inroads into a new market, may not be looking for profitability on every sale. In many cases where foreign joint venture partners are involved, particularly in the insurance business, the overseas firm may prefer to go with a more visible standard

product from the international market rather than choosing a local one. Indian companies are, in fact, in a better position to serve clients in the local markets, but given the hurdles, products become a tough business in the Indian market.

Average annual growth rate of exports for ten years from 1995-96 to 2005-06 is 39 percent.

The most high profile and commonly understood services in the ITES are the call centers and the medical transcription services. ITES also includes several other services viz. Customer interaction services, Business process outsourcing, Back office operations, Transcription and translation services, Legal data bases, Digital content/Animation, Website services, remote Education, Data Digitization, Global information systems and market Research.

Table No: 2.5A decade of Indian IT industry Exports

| Year | Software ((US$n) | Export Growth (%) | Year | Software Export(US$m) | Export Growth (%) |
|---|---|---|---|---|---|
| 1980 | 4.00 | | 1993-94 | 314.00 | 43 |
| 1981 | 6.80 | 70 | 1994-95 | 480.00 | 53 |
| 1982 | 13.50 | 99 | 1995-96 | 668.00 | 39 |
| 1983 | 18.20 | 35 | 1996-97 | 997.00 | 49 |
| 1984 | 25.30 | 39 | 1997-98 | 1650.00 | 65 |
| 1985 | 27.70 | 9 | 1998-99 | 2180.00 | 32 |
| 1986 | 38.90 | 40 | 1999-2000 | 3600.00 | 65 |
| 1987 | 54.10 | 38 | 2000-2001 | 5300.00 | 47 |
| 1988-89 | 69.70 | 29 | 2001-2002 | 6200.00 | 17 |
| 1989-90 | 105.40 | 51 | 2002-2003 | 7550.00 | 22 |
| 1990-91 | 131.20 | 24 | 2003-2004 | 8800.00 | 17 |
| 1991-92 | 173.90 | 33 | 2004-2005 | 12400.00 | 41 |
| 1992-93 | 219.80 | 26 | 2005-2006 | 17500.00 | 41 |

Source: Indian Department of Electronics Annual Reports, Dataquest (India) Surveys.

IT industry has over the past decade emerged as a key growth engine of the economy.

The IT industry continues its winning streak, registering a 34 per cent increase in exports in 2005-06, the highest in over a decade, while retaining its leadership position in the global off-shoring market with 64 per cent and 46 per cent market share in IT and Business Process Outsourcing respectively. As the NASSCOM Mckinsey Annual survey released in December 2005 highlights, the industry has demonstrated that it has truly come of age, not merely as a niche player in software services, but has also acquired the capability to become one of the leading export sectors by 2010. The report further states that in the next five years India's offshore industries could generate $ 60 billion in export revenues, accounting for 17 per cent of incremental GDP growth, and sustain 9 million jobs, thus making it one of the largest export sectors in the world.

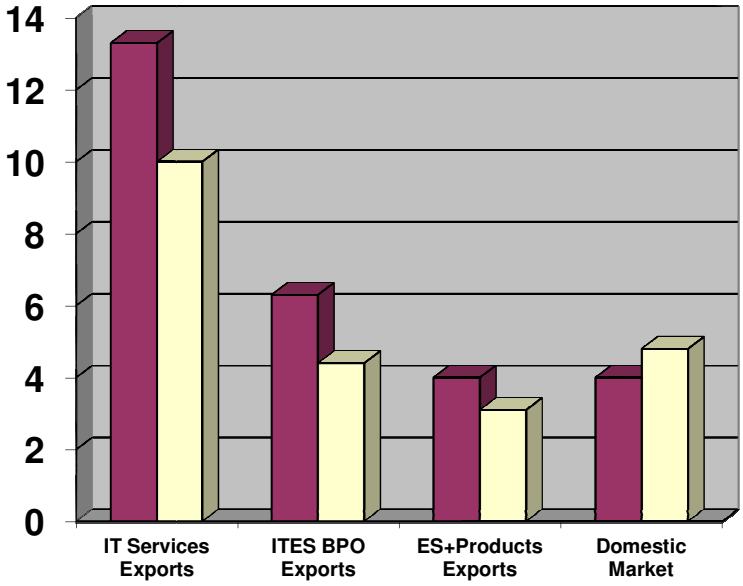


**Fig.2.2: Indian IT Exports**

Source: The Economic Challenger, No.9 Issue 34, Jan-March, 2007

The NASSCOM Mckinsey report identifies the following key challenges that could slow down growth:

- The lower global demand for off-shoring in the face of increasing political opposition and cost;

- Potential shortage of skilled workers;
- Competition from new countries; and
- Inadequate urban infrastructure.

### 2.8.5 Opportunities

IT is today the foremost productivity tool of our times. Information and communication technologies play an important part. The use of IT tools and e-learning present an unprecedented opportunity for enhancing the capabilities of knowledge of the poor for creating, sharing and exchanging knowledge and knowledge products and for accessing new and profitable markets.

In recent years, there is increased awareness among global corporations about the potential of off shoring. Today over 70 per cent of the fortune 500 firms off shore some of their internal business processes. Indian firms started offering customer services, accounting services and CAD services. Talk about the Indian IT industry almost invariably boils down to a highly adrenalised discussion on our success in the software exports arena. Software and services exports from the country have been growing at an enviable pace.

India has emerged as a global player in Information Technology with software exports of US Dollars 12 billion in 2003-04 and $ 17.2 billion in 2004-05. The revenue from exports of IT and related services is expected to reach US $ 65 billion by 2010, according to a Mckinsey report. Of the fortune 500 companies 220 outsource their software from India. 80 out of world's 117 SEI CMM level - 5 companies are from India. India's IT and ITES exports go to 133 countries. Indian IT companies train people in 55 countries; NIIT and APTECH have 200 training centres in China.

Software exports, the mainstay of the industry crossed $ 12 billion in 2004-05, up from $ 9.2 billion in 2003-04, indicating a growth of 30.4 per cent for the year. In an

economically challenging environment that characterized global markets, the export-oriented software and services sector logged in 26 per cent growth during 2002-03. It was a creditable performance marked by a hike in software and services exports and a major jump in ITES.

## 2.9 QUALITY MANAGEMENTSTUDIES IN INDIA

There are only very few surveys conducted in India. Singh (1991) conducted a survey in Indian industries to study the concept and practice of QM in India, and conducted that the business units in India are catching up with QM. He pointed out that the participation and team work were conducted in the manufacturing sector and it is found that Quality-circle type of participation is generally preferred in India as compared to other forms. Out of 52 organisations responded to Singh's survey, 30 organisations mentioned that QM practice in their companies were more than two years old. About 12 companies mentioned that the concept was only around one year old. Few companies mentioned that they are planning to start soon and have made the necessary background preparation suitable to QM or they have just started. From the survey, Singh concluded that the function of quality assurance was well accepted in the manufacturing organizations in India.

NPC-IFC Group (1994) conducted a survey in Indian industries to understand the perception of Indian Management about the application of inter firm comparison and bench-marking. Of the survey participants, almost all belonged to large companies. The questionnaire was filled by senior management persons belonging to QM, Finance and corporate management areas. The NPC-IFC Group concluded that many Indian organizations have initiated several steps towards QM in order to increase competitiveness. Indian industry as a whole has been gearing itself to accept changes and the adaptation of international quality assurance standards has been the most popular

vehicle to do so. But Indian organizations also realized that continuous improvement would be the major in days to come. This group also suggested that a comprehensive performance and benchmarking could be a very useful tracking mechanism to find out the gap and set the goal for the future.

A study on Software industries in India was conducted to find out the significance of quality certification and its impact on the operational performance (Issac.G, C.Rajendran and R.N. Anantharaman, 2004). Results of the study indicate that quality certification help the implementation of quality management programs based on QM principles, and that the quality certification has an impact on operational performance. A study conducted by Jaideep.G.Motwani (1994) indicates that it is not necessary for all the factors to be present to ensure the success of the quality management programme. In other words, even if a few of the factors were not present, it was possible to obtain the required level of quality. Another finding was that Managers, regardless their position, expect an organization to implement these critical quality factors to a great extent.

## 2.10. OPERATIONAL PERFORMANCE INDICATORS

Following the path set by the manufacturing and service industries, the software industry has accepted quality as a key factor that helps organisations to achieve success and competitive edge in the global market. As a result, the software organization also adopts different manufacturing philosophies and quality standards. The following Table No: 2.6gives the difference between manufacturing, service and software industry.

The most popular philosophy is QM, and quality standards such as ISO 9000 and CMM are believed to be the milestones in the journey to QM. A study by Issac *et al* (2004) found that there is no significant difference between the non-certified firms and ISO 9000 certified firms, whereas there are significant differences between the non-

certified firms and CMM certified firms with respect to QM constructs and operational performance indicators. A study on the various literatures available till date from the manufacturing and the areas nearly 170 indicators were found. After discussion with many software engineers in this area, these indicators were reduced to 150.

**Table No: 2.6 Table showing the difference between manufacturing, service and software industry**

| Manufacturing industry | Service industry | Software industry |
|---|---|---|
| End product is a consumable product<br>End product deteriorates with usage/time<br>Powered machines used for transforming raw material to finished product<br>Fuel is required to supply energy to the machines<br>Controlling is relatively easier<br>Manufacturing process is continuous<br>Same output, time and again (that is, output is repeatable)<br>Facilities are to be built only after the products and processes are well defined (unlike software industries)<br>Consumer is mostly concerned only with the end product, not the process<br>Inspection is reactive in nature<br>Metrics are often quantitative<br>Quality is about "reducing variance and conformance to specifications" | Level of involvement of human brains and logical thinking is (less) that is, not comparable with that of software industry<br>The basic process is repeatable<br>Measures are different<br>Quality is about managing the emotions, expectations/experiences of customers<br>People-related issues<br>Metrics are often qualitative | Software development is a creative process<br>A high level of intellectual task is required<br>Controlling function is more severe<br>High level of human involvement<br>Output does not involve repeatability<br>Software development is an industrial process<br>Input-data/program<br>Output-data/program<br>Program itself is the factory that works on the raw data into usable form<br>Human brains in place of powered machines<br>Fuel is "logical thinking ability"<br>Customers are more interested in the quality of the software (analogous to process)<br>Inspection is preventive in nature<br>Quality is explained/judged by features of the software (for example, reliability, integrity, usability, maintainability, and portability<br>Customers will not tolerate errors<br>Highly people oriented<br>Infrastructure requirement-facilities to be provided in the beginning itself (unlike mfg.)<br>Highly dynamic and volatile environment<br>Higher "risks" due to obsolescence and brain drain.<br>Metrics are often qualitative |

# CHAPTER 3

# INSTRUMENT DEVELOPMENT FOR PERFORMANCE MEASURES

## 3.1 INTRODUCTION

This chapter presents the work carried out for developing an instrument for measuring the levels of QM in the software units.

Much of the literature on quality focuses in the following areas: Japanes equality management practices (Juran, 1978; Schoenberger, 1982); the development of organization-wide quality improvement programmes ( Crosby, 1979); the application of various statistical quality control techniques ( Deming, 1981, 1982, 1986; Gitlow1983; Wood, 1981); the concept of organization – wide and total quality control and the importance of critical factors such as top management leadership, process management, employment training and employee involvement in quality (Feigenbaum,1986). For the purpose of identifying critical factors, the philosophies of quality experts such as Deming, Juran, Crosby, Ishikawa, Feigenbaum and Garvin were reviewed.

Silvestro(1998) tried to study and explain the transferability of QM factors in manufacturing organizations to service organizations Parasuraman *et al*., 1988) formulated an instrument called SERVQUAL to measure service quality. Cronin and Taylor (1994) proposed another performance based measure called SERVPERE. Sureshchandar, Rajendran and Anantharaman (2001) identified a set of 12 critical factors/dimensions for service quality and they also proposed a holistic framework to measure the QM practices with respect to the banking industry.

The software industry operates in highly dynamic and volatile environment which makes the implementation issues surrounding QM much more complex than in other industries. Although there are some similarities between service industry and

software industry, the differences are quite significant. The characteristics and then comparison among the three types of industries, with respect to QM, are given in Table No 6.

The quality of software is of paramount importance to everyone, including users and developers. Because of fierce global competition, many software companies are suffering financial setbacks and hence they are trying to control costs. Both practitioners and academicians agree that software quality improvement techniques lead to a reduction in software development costs, and therefore, software quality is one of the critical issues (Kan, Basili & Shapiro 1994; Wein berg 1996 and Yang 2001). These researchers also opined that there is inadequacy and insufficiency of empirical studies investigating the management and control of quality of software development. The need for quality management in software project becomes highly relevant in this context (Wali, Gupta and Desmukh, 2000).

Based on an extensive literature review, Rai, Song, and Troutt (1998) presented an overview of software quality assurance and tried to identify the areas that are being currently investigated. They pointed out that theories and principles are being drawn from other areas, but the empirical research is still in a rudimentary stage. They advocated that future research should examine how quality can be engineered into to the development process and also highlight the need for better management of efforts during the implementation.

Herner (1997) stated that continuous process improvement and improved quality culture and the primary objectives in any software development process. Jovenovic and Shoemaker [1997] argued that ISO 9000 is appropriate for software development as well. Jalote [2000] found the Software Engineering Institutes Capability Maturity Model (CMM) to be widely used framework for quality management in software companies.

The People Capability Maturity Model (PCMM) is another framework that has been embraced by software companies all over the world. It considers the people aspects of quality management, in addition to process and technology. Both CMM and PCMM have five levels of maturity. Organizations that have acquired the fifth level of CMM and PCMM are expected to maintain very high quality standards (Harter *et al*. 2000). Tervonen and Kerola (1998) proposed that the soft aspects of quality need to be understood fully for a better understanding of the quality of the software, since software quality has some unique characteristics, such as its dependability on the individual skill of the developers, when compared to quality in other areas like manufacturing and service industries. Krishnan [1998] highlighted the significance of the team work and communication in the software industry.

Many researchers have explored the potential benefits of the QM and went on to explain how QM, which is a holistic approach combining human and technical elements could be applied to software development. Each key element of QM, identified from the literature on manufacturing management, was explained and analysed in relation to software development. The key elements of QM identified in relation to software quality management are customer focus, communication and participation, process quality, standards such as ISO and CMM, continuous improvement, leadership and management measurement and analysis of data, organizational culture, technical innovation and human factors such as co-operation, participation, education and training, empowerment and team work. Carroll (1996) argued that these key elements of QM, if applied to software development have the potential to improve the quality of software. It was further observed that QM could provide a conceptual framework when the customer's quality requirements were specified and then met by the software developers. Vitharana and Mone (1998) presented the efforts to methodically identify the critical factors and

proposed an instrument to measure the critical factors of software quality management. They argued that some of the general quality management practices endorsed by Gurus like W.Edward Deming, Crosby and Juran could be extended to software development as well. Vitharan and Mone (1998) identified six critical factors; management commitment, education and training, customer focus, process management, software matrics and employee responsibility. Their proposed instrument consists of 57 items to measure the level of quality management practices across the firms. Parzinger and Nath (1998, 2000) observed that many software development enterprises used to the QM philosophy to enhance the quality of software, and to improve their developmental efficiencies. They empirically examined the link between QM implementation and software quality. The authors identified eight QM factors with 43 items, and four software quality measures. The QM factors are executive commitment, employee empowerment; customer needs assessment, quality measures, process evaluation, general training methods, specific skills training and cycle time reduction. The measures of quality were taken as customer satisfaction, extent of compliance with ISO 9000, CMM levels and change in cost of quality. All of the QM factors were found to have a significant positive relationship with all measures of software quality, except the change in cost of quality. Yang (2001) advocated that the quality of the software product could be estimated using its attributes such as reliability, maintainability, portability, extensibility and usability. It was suggested that further research was necessary to identify the quality concepts, tools and techniques that would lead to the success of software development organization. (Parzinger and Nath, 1998; 2000).

The following table gives the list of critical factors as recommended by various authors.

**Table No.3.1 List of critical factors recommended by various authors**

| **Authors → Factors ↓** | **Juran 1974** | **Ishikawa 1976** | **Crosby 1979** | **Feigenbaum 1983** | **Deming 1986** | **Garvin 1987** | **Saraph *et al.* *1989*** | **Lu &Sohal 1993** | **Porter & Parker 1993** | **Motwani *et al.* 1994** | **Powel 1995** | **Black & Porter 1995** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Employee Relation/ Empowerment | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | **12** |
| Top Management Leadership | √ | | √ | √ | √ | | √ | √ | √ | √ | √ | √ | **10** |
| Quality Policies/ Process Management | √ | | √ | √ | √ | √ | √ | √ | √ | √ | √ | | **10** |
| Quality Measurement System/Quality Data | √ | √ | √ | | √ | √ | √ | √ | | √ | √ | √ | **10** |
| Training | √ | √ | √ | √ | √ | | √ | √ | √ | √ | √ | | **10** |
| Quality Technology/ Process Design (SQC) | √ | √ | √ | | √ | √ | | | √ | √ | √ | | **8** |
| Supplier Quality Management | √ | | | | √ | √ | √ | | | √ | √ | √ | **7** |
| Quality Planning/ Product Design (Service) | √ | | √ | √ | | √ | √ | | | √ | | √ | **7** |
| Role of Quality Department | √ | √ | √ | | √ | | √ | | | √ | √ | | **7** |
| Team work Structures | | | | | | | | √ | √ | | √ | √ | **4** |
| Customer Satisfaction | | | | | | | | √ | | √ | √ | | **3** |
| Orientation | | | | | | | | | | | | | |
| Strategic Quality Management | | | | | | | | √ | √ | | | √ | **3** |
| Communication of Information | | | | | | | | | √ | | √ | √ | **3** |
| Benchmarking | | | | | | | | √ | | | √ | | **2** |

## 3.2 CRITICAL FACTORS OF QUALITY MANAGEMENT

Different sets of organizational requirements are prescribed by quality management gurus and practitioners for the effective practice of QM (Crosby, 1979; Juran and Grync, 1980; Deming, 1982; Garvin, 1983; Ishikawa, 1985, Deming, 1986; Feigenbaum, 1986; Imai, 1986; Juran, 1986; Snee, 1986; Juran and Gryna, 1988). These requirements for an effective quality management are based on judgment and experience of QM gurus and practitioners with different organizations as consultants, researchers and/or managers. These requirements are perhaps not formulated on the basis of a systematic empirical research.

Saraph *et al* (1989) identified eight critical factors of quality management at the production based unit level. These critical factors are described in Table No: 3.1 for a detailed description of factors, measurement items and measurement instrument, see Saraph *et al* (1989).

The study by Saraph *et al* (1989) has been used as a guide line for developing an instrument for measuring QM in the present study of software companies. The author had identified 72 items, in additions to the 78 items presented by Saraph *et al* (1989)model of QM, that could theoretically measure additional focus area of a QM programme as far as software business is concerned. This selection was done by a cross-sectional analysis of the practices of the quality management in software areas in India based on the literature availability. Since this is the first approach towards such a study in software area, suggestions from practitioners and academicians were taken. One hundred and fifty measures derived from the analysis and suggestions from practitioners were used to develop this questionnaire.

## 3.3 METHODOLOGY

First, a research instrument was developed in the form of a questionnaire containing several items. This was developed based on a variety of inputs such as literature review, inputs from practitioners, a comparative study of quality award models and field visits. The questionnaire was pilot tested and it was sent to people at various levels working in the software areas. They were asked to respond to the questions according to how they perceived their company rating on a five-point scale. The page of the questionnaire highlighted the objective of the study.

The quality of questionnaire developed will influence the quality of the study. In order to enhance the quality of the study, the instrument should exhibit relevance, reliability, freedom from bias, and acceptability to management. The critical factors of quality management with respect to the software industry were identified through the literature survey and by discussions with professionals in the software industry. The following factors give a list of critical factors of quality management in software industry from the literature survey of the current study.

Top Management Commitment and leadership (TMCL), Organizational Culture (OC), Customer Focus (CF), Process Quality Management (PQM), Quality Measures or Metrics (QMET), Human Resource Management (HRM), Employee Empowerment (EE), Communication (COM), Continuous Improvement (CI), Bench Marking (BM), Infrastructure and Facilities (IF), Employee Attitude (EA), Risk Management (RM). A brief description of each factor and the references that support the literature for each factor are given in Appendix I.

### 3.3.1 Constructs of QM

Theoretical, empirical and practitioner literature was explored to determine the constructs of quality management practice in the software industry. The factors were

determined after a thorough review and synthesis of the literature and discussions with professionals in charge of software development and quality control in the software industry. The factors identified are:

1. Top Management Commitment and Leadership
2. Quality Policy
3. Training to Employees
4. Product Design and Operating System
5. Quality Information System
6. Employee Participation and Empowerment
7. Human Resource Management
8. Customer focus and Satisfaction
9. Team work for Continuous Improvement
10. Organizational Culture
11. Infrastructure and Facilities
12. Financial growth

These 12 factors are identified independent variables. A brief discussion of the CFs is given below:

#### 3.3.1.1 Top Management Commitment and Leadership (TMCL)

The leadership of top management is essential to the creation of a QM organization. Many other researchers also pointed out that the impetus for the quality management efforts in any organization should start from the top and unfold downward to the lower level (Milakovich, 1995; Ahire, 1996; Li *et al*, 2000; Sureshchandran *et al.,* 2001, 2002). In the absence of committed leadership, the effort may fail (Jorguesen, 1999). Leadership is identified as a critical factor for achieving better quality practices in

the software industry as well (Vitharane and Mone, 1998; Parzinger and Nath, 1998; Wynekoop and Walz, 2000).

#### 3.3.1.2 Quality Policy

Research has shown that attitude and philosophy alone are seldom enough to improve quality. A company's programme, policies and systems are practical representation of its attitude towards quality (Garvin, 1983, Juran, 1978; Garvin, 1984). This study offers significant statistical support for the hypothesis that specific quality policies are the practical embodiments of an organizations's attitude towards quality and therefore help in improving the level of quality. This can be attributed to several reasons. First, in the Indian organizations surveyed, well documented quality policies with clear objectives existed for each and every department in the organization. The quality policies were oriented mainly towards customer satisfaction. Second, the organization's policies concerning quality were determined by the achievement of the following goals: compliances with the Government regulations, meeting customer expectations, market share growth, company reputation and profitability. To satisfy the clients, the quality policies should be reviewed periodically and all levels of personnel should aware of their responsibilities towards quality.

#### 3.3.1.3 Training to Employees

Emphasis on quality training improves the level of quality. If an organization is to grow and prosper; formal quality training programme must exist (Juran, 1978; Crosby, 1979; Deming,1986). Effective and efficient training programmes to educate and communicate a focus on quality to managers and employees should be there. In addition to the on-the-job training, off-the-job training programmes should also be used. In total, the training programme plays a significant role in improving the quality of the organizations products and services.

### 3.3.1.4 Product Design and Operating Procedure (PDOP)

This also plays an important role in QM. Normally these are the activities of the research and development department as far as the Indian Organizations are concerned. There is lack of sufficient interaction between the research and development department and the quality assurance department.

### 3.3.1.5 Quality Information System (QIS)

Availability and use of quality data is an essential ingredient of a strong quality management programme. Availability and use of quality cost data improves the level of quality. For this there should be a proper quality information system and it should also be updated on a regular basis. Data should be available to the workers and they are used as a tool by the management and to make necessary quality improvements.

### 3.3.1.6 Employee Participation and Empowerment (EPE)

Empowerment means the assigning of responsibility with authority to the employees. The proponents of high performance and high commitment believe that high levels of employee empowerment can be successfully used to transform organizations. Individual freedom and empowerment are found to encourage employees to participate in discussions and decision making (Truss, 2001). Creativity, ability, utilization and achievement are likely when employee gets a certain degree of autonomy. Freedom for all team members to make suggestions during software development or project execution is found to be a good practice for improving the quality of software (Gong *et al*., 1998; Li *et al*., 2000).

### 3.3.1.7 Human Resources Management (HRM)

It is claimed that human resources (HR) is a potential source of sustained competitive advantage (Barney, 1995) and investments in HR practice improve organizational performance (Ulrich, 1997). The argument here is that the soft practices

provide the key to QM performance in any type of organization. Powel (1995) concluded that certain tacit, behavioral, imperfectly imitable features, rather than mere QM tools and techniques would improve quality. Schneider and Bowen (1995) also advocated that employee should be treated as "valuable and long term assets" The soft aspects not only have a direct influence on organizational performance but also have an indirect influence, since they have an impact on the hard aspects as well. Hence it is indispensable for firms to look upon HRM as an important weapon in their arsenal.

Since the software industry is a man-power intense industry, the availability and productivity of the people are critical to its functioning.(Brooks ,1987).The very survival and success of software companies depend on the availability and use of talented people (Paul and Anantharaman, 2002). Therefore, the HR practices in the organization provide the best source/opportunity for improving software development productivity (Boehm, 1994).

***Employee competence***

Individual ability was found to be the most significant determinant of performance among the software developers. (Rasch and Tosi, 1992; Ravichandran and Shareef, 2001 Curtis *et al*., 1988) advocated that individuals who have superior application knowledge, communication skills, high level of motivation, team spirit and dependability are essential for the success of a project. Boehm (1994) observed that the competence and the level of the talent of the personnel in the software industry were the strongest predictors of its results. Boehm (1994) also stated that personnel incompetence is one of the strongest project risks. Stolterman (1991) argued that software personnel should have creativity and vision, while also being logical and analytical. Jalote (2000) also emphasized that the software development capability of individual software engineers is vital to the success of a software project. The ability to learn and adapt to

change is very important in the case of personnel in the software industry (Vijaybasker *et al*., 2001).

### *Recruitment, Selection and Retention*

The recruitment, development and retention of good software professionals are key concerns of software organizations. Software personnel need some special skills such as creativity, programming ability and logical skills (Humphrey, 1989; Jalote, 2000). Curtis *et al*., (1988) observed that individuals with good knowledge, communication skills and high levels of motivation, team spirit and dependability are a scarce resource, though such individuals are essential for the success of a project. Peoplesoft (1999) observed that there is a strong demand-supply gap in the availability of talent people.

Tomko (2000) identified that core competency personality traits and reference checking are some critical dimensions that are to be focused on in the recruitment and selection of software personnel. It was also observed that Japanese recruitment had sought to find the candidate with the proper character whom it could train. The candidate's ability to grow and develop as a member of the organization is an important factor. Therefore recruitment, selection and retention of employees with necessary skills are highly critical from an organizational point of view (Kossek and Block, 2000).

Employee turnover is one of the major issues faced by software companies. Though turnover is inevitable, a high level of turnover will be detrimental to an organization in a people-driven industry like software. Therefore, many retention strategies are adopted by such organizations. These strategies include providing opportunities to work abroad (overseas assignments), employee-stock-option-programmes and career development paths for their employees (Heeks, 2000).

### *Training and education*

Training is involved in gaining the skills necessary to accomplish a task. It is a planned programme, designed to improve performance in individual, group and organizational levels. Training brings about changes in knowledge, skills, attitudes and social behaviour of employees for doing a particular job and it a vital factor in the journey towards continuous improvement. Training activities influence the performance in two ways;1) by improving skills and abilities relevant to employee's tasks and 2) the development and improvement of employee's satisfaction with their jobs and work place. Training also helps propagate the priorities and missions of the organization, and it improves employee participation and involvement in quality programs (Harel and Tzafrir, 1999). Li *et al*, (2000) advocated that the managers and all other employees should be trained both in the soft aspects such as quality culture, interpersonal communication, team building and group dynamics and in hard topics such as statistics, engineering and accounting.

### *Teamwork*

Teamwork is an important tool associated with quality management. It is one of the key factors to the successful implementation of QM in an organization. Teams rather than individuals are seen as the relevant unit of contribution to QM (Kossek and Block, 2000).

Team building is an effective way of organizing the work force to focus on the tasks or processes. Many organizations have been successful in achieving quality improvement by deploying teams as a strategic imperative (Cortada, 1995; Truss, 2001). The proponents of QM recommended the establishment of cross-functional teams comprising managers and workers (Imai, 1986). Cross functional teams are one of the common functional features of the QM organizations (Rungtusanatham, 2001). The key

to achieving a flatter organizational structure and greater worker involvement lies in the development of self-managed teams. Many organizations are going for a flat organizational structure, downsizing and reengineering their organizations to remain competitive. The benefits attributed to high-functioning teams include greater organizational productivity, flexibility and quality (Hendricks and Singhal, 2001).

Teamwork is a crucial factor in software development. Most of the software projects involve the combined efforts of personnel across various departments in the organization. Therefore, interdependence and coordination among team members become critical. Teamwork gives a sense of importance to each employee. The effectiveness with which the team members are coordinated and the degree of their cooperation determine the success of a project (Bunse *et al*, 1998; Li *et al*., 2000). The significance of team work and its coordination become more evident in the context of the importance attached to schedule and delivery date in a software project.

### *Quality of work life*

The question of what motivates the people resulted out of the concept of Quality of Work Life (QWL) from a variety number of studies conducted in industrial and organizational psychology and related disciplines (Sinha and Sayeed, 1980).The quality of work life refers to the general atmosphere and human relations at the workplace. Individual performance depends on many factors such as organizational culture, employee attitude and quality of work life prevailing in the organization (Joseph *et al* 1999). QWL has an effect on the quality of product or services. Improving working conditions, employee compensation, work relations among team members, and opportunities for professional development for the employees can enhance QWL. The implementation of core practices should be achieved through embracing the supportive (soft) practices like the QWL (Ho *et al*., 2001).

An essential factor that decides the effectiveness of software companies is 'conducive work environment'. Software organizations create an environment that can nurture creativity and innovation and develop a spirit of community. The work environment involves both physical and social environments in which the employee operates. "Physical environment" symbolically communicates the organization's culture, values and beliefs, whereas "social environment" refers to the way in which the things are done in the organization (Bahrami and Evans, 1997).

### 3.3.1.8 Customer focus and satisfaction

The term "customer" includes both the end users of the product (external customers) as well as people within the company, acting as internal customers (Deming1986). Many studies agree on what quality means, and their agreement can be enshrined by the phrase, "satisfaction of customer requirements". Responsiveness to customer needs and timeliness of response were found to be the main ingredients of competitiveness (Zairi and Youssef, 1998). Adam *et al*., (2001) concluded that customer focus leads to improved quality irrespective of the countries and their culture. Customer satisfaction and service quality are related. The importance of customer satisfaction in service organizations is evident from the works of Zeithaml *et al*. (1993) and Sureshchander *et al*. (2001, 2002). Understanding the users' requirements and maximizing user satisfaction are critical in the software industry. At each stage of software development, there are customers (internal and external) whose requirements should be satisfied.

### 3.3.1.9 Teamwork for continuous improvement

Quality has become the essential factor for survival in highly competitive global business. According to QM philosophy, the key to quality is satisfying the needs and expectations of the customer through a system wide continuous improvement strategy

(Goyal and Islam, 2001). The customer's needs keep changing continuously because of new expectations and requirements that arise in response to changes in the environment or system (Hellans, 1997). The changes that occur in customer's needs/requirements demand corresponding changes in the product/service. The improved products/services will generate new requirements and expectations in the customers. This is a perpetual cycle. Therefore a culture of continuous improvement, driven by measurement is essential for quality improvement. The philosophy of continuous improvement is one of the core methodologies to sustain and guarantee the quality of products and services (Kuhn, 2000).

#### 3.3.1.10 Organizational culture

Stable organizational structures are essential for maintaining a quality culture. One of the major barriers to QM implementation is the employees' resistance to change (Pearson, Vaughn, and Butler1998). Cultural change is the essence of QM. It is hard to be inculcated and difficult to be sustained (Sohal *et al*, 1998). Successful implementation of quality management requires a radical change (Youssef *et al* 1998). Quality cannot be achieved without the cooperation of each employee in the organization and the organization culture should change before one can expect significant process improvement (Cortada1995). Providing a supportive environment (organizational culture) helps to build the commitment of everyone to quality. Therefore it is evident that a conducive atmosphere should prevail in the organization to achieve product quality.

#### 3.3.1.11 Infrastructure and Facilities

Good workmanship and high motivation levels alone do not create good quality. Quality of products and services also relies on good infrastructure- that is, tools, good

materials, good methods and management techniques, and latest technological developments (Li, Chen, and Cheung2000).

Infrastructure becomes critical in the case of software companies, where technological advancement is rapid and its adaptation is compulsory for survival. The term 'facilities' also includes sufficient conference rooms; training areas; physical resources like furniture, computers and application software; and communication technologies such as telephone, fax and e-mail. Rao (1999) claimed that the facilities and work environment add to the motivational value of the employee. A survey conducted by Data Quest (2001) also revealed that facilities emerged as one of the prime motivators in software companies. The hardware/processor, operating systems and communication facilities, such as high speed internet access, were found to influence the quality of software developed. The term 'facilities' also includes sufficient conference rooms, training areas, physical resources such as furniture and computers, and application software communication technologies such as telephone, fax, and e-mail. Facilities and comfortable physical environment could enhance employee productivity. It is also observed that software organizations provide state-of-the-art software laboratories and computer centers, libraries, recreation centers, 24 hour canteen facilities and so on.

For the above twelve factors, questionnaire was prepared with 174 questions. It was reviewed by the faculty members of the Department of Business Administration, College of Engineering, Trivandrum and by software professionals from the software companies of Technopark, Trivandrum to check the content relevance and clarity. Recommended changes were incorporated before pre-testing. It was finally settled down to 150 questions.

#### 3.3.1.12 Financial Growth

For the existence of a company financial growth is very important. If a company wants to be in business, it should earn profits which are the main tool for financial growth. For this each and every employee is responsible and they should follow quality management practices. This growth will be due to lower absenteeism, short project duration times, employees training in different areas of management, reduced operating costs, ability to complete the project within budget, the frequency of getting repeated business in the firm and cost reduction through improvement.

### 3.3.2 Sampling Method

The purpose of sampling is to enable one to estimate some unknown characteristics of the population. There are nine methods which could be used for sampling (Metri, 2001). They are convenience sampling, judgment sampling, snowball sampling, quota sampling, simple random sampling, systematic sampling, stratified sampling cluster sampling and multistage sampling.

All the methods have some advantages and disadvantages; of the nine methods snowball sampling is useful in locating members of rare population by referrals. This sampling according to Goodman (1961) is a judgment sample that is used to sample special population. Reduced sample size and costs are clear cut advantages of snowball sampling. In snowball sampling, the initial respondents were selected by probability methods and additional respondents were obtained from the information given by the initial respondents. This method is therefore very appropriate for expert's data collection in which the researcher is interested in the view of articulate individuals on a particular subject rather than taking a representative positive sample (Metri, 2001). Furthermore random sampling is representative only when its size is large. In the case of small number of sample unit, it may not give representative set of units (Saraph *et*

*al*., 1989). Also, attempting to get a random sample on a relatively new area may increase the chance of non response. Hence snowball sampling method has been considered appropriate and used in this study. The limitations of snowball sampling are that bias may likely to enter into the study because a person who is known to someone, in the sample, has a higher probability of being similar to the first person. If there are differences between those who are widely known by others, and those who are not, may be problem with snowball sampling. To reduce the bias, initially 10 respondents were selected by probability method from the various sources (technopark list, NASSCOM list, CMM list etc.). Then additional respondents were obtained from information provided by the initial respondents. This process was continued till the number reached the targeted sample size. This sample covered medium and small sized organizations and also from various positions in the organization. Therefore, it can be assumed that the snowball sampling method used in this study is not biased and has given an adequate representative set of samples.

### 3.3.4 Sample size

Despite the wide spread use of non-probability samples, there is no available theoretical basis for determining the sample error or sample size (Tull *et al*., 1997). Observations suggests that non-probability sample size decisions are made by calculating the size either as if it were a probability sample or else on an 'all –you-can-afford ' basis (Tull *et al*.,1997). Uhlik and Lores (1998) determined the sample size using the formulae applicable to probability sampling, even though they used both probability and non-probability sampling methods for the data collection on constructability practices among general professionals. Therefore an estimate of the sample (n) for the present study has been calculated by using the formulae

$$N=(Z/B)^2[P(1-P)]$$

Where n=sample size

Z=a particular value of confidence coefficient.

B= variability or bound error

P=proportion of participants having at least 5 years experiences

The P value of 80 %is considered as appropriate value. The other values used are B=10%, and a confidence value of 95%.

The estimated sample size is 62. From the literature it is clear that, in a survey, not all the participants return the questionnaire. After considering the expected response rate, data collection method, the requirements for performing statistical analysis, and the survey cost, a sample size of 80 was targeted initially. The size of the sample in this study justifies with those reported in the literature for similar studies. (Saraph *et al*., 1989; Flynn *et al*.,1994; Metri,2001, Digalwar, 2006).

### 3.3.4 Instrument administration

Nunnally (1967) and Sellitz *et al* (1976) postulated that when a measuring instrument is developed, the subject should be those for whom the instrument is intended. The main objective of this study is to develop an instrument for measuring top manager's perception of the current practice of QM in the software companies. The Chief Executive Officers, (CEOs) or General Managers (GMs) and Chief Quality Managers (CQMs) of the companies were the subjects for the study since these people are considered to be the "thought leaders" with respect to QM in this respective software companies. Almost all the companies are working in the Technopark, Trivandrum and some more companies were also identified from other places like Chennai, Bangalore, Hyderabad, Poone etc. Request was sent by the researcher to the CEO's of the companies requesting for their full co-operation in this study.

The questionnaire was sent through e-mail and also tried to contact them in person. Nearly 780 companies were contacted and the response was very poor of the order of 3 to 4 % only. Then the company executives were contacted in person and through other people and the questionnaire got filled up from them directly. Due to the understanding between them, the names of the companies are not revealed here. Each and every execution was given the full explanation about the questionnaire and the purpose of the study also. The response was encouraging from them. Even with their busiest schedules in the company, they were ready to co-operate with my study and during the discussion also they were able to give some inputs apart from the study. The personal contact to get the response was very encouraging from the CEOs. Each manager was requested to evaluate the extent of quality management in their companies by rating each measurement item on a five point scale, taking into consideration their performance for the last 3 to 5 years, where 1 indicated very low and 5 indicated very high levels with 3 as average. Follow up procedure was found to be more effective to get the response filled up since the questions were also more than 150. Sending questionnaires and collecting their responses took more than expected time in this study. Total of 74 responses were received.

From the data collected, the response obtained was given a weightage of 1 for very low to 5 for very high and it was found that the score of these companies varied from 620 to 120. The distribution of the score and the numbers of companies are given in the following Table No.3.8 and Fig. 3.4

**Data Preparation**

For effective and proper data analysis its preparation and management is necessary. The length of the questionnaire, the number of completed surveys anticipated and the data analysis software to be used all had to be considered in selecting a data

management system. A rational data management programme, Microsoft Excel was chosen for this purpose. The survey response was coded in the data base. Both quantitative and non-quantitative open-ended responses were recorded for possible future analysis. This also helped to clarify quantitative responses.

**Classification of data**

Data from the survey is classified for analysis in three parts: descriptive analysis, importance index analysis and statistical analysis. Descriptive analysis is to present the results in tables. The objective of Importance Index Analysis is to determine the numerical scores of each item. The statistical analysis is to determine the relationship between the variables and validate the performance measures/factors. A proper analysis requires investigation of the descriptive characteristics of the organization and experts as well as statistical analysis of the factors. Descriptive and importance index analysis are presented in the following sections and the statistical analysis in the next chapter.

**Table 3.2: Regional distribution of respondents**

| State and region | % response |
|---|---|
| Kerala, Trivandrum | 37% |
| Tamil Nadu, Chennai | 22% |
| Karnataka, Bangalore | 19% |
| Andhra Pradesh, Hyderabad | 14% |
| North India , Delhi | 08% |

**Table 3.3: Respondents by experience**

| Years of experience | % response |
|---|---|
| 0-4 | 26% |
| 4-8 | 36% |
| 8-15 | 24% |
| 15-20 | 08% |
| More than 20 | 06% |

**Table 3.4: Respondents by Designation**

| Designation | % response |
|---|---|
| Project Assistant/Engrs. | 32% |
| Project Leaders/Senior Engrs. | 38% |
| DGM/GM | 30% |

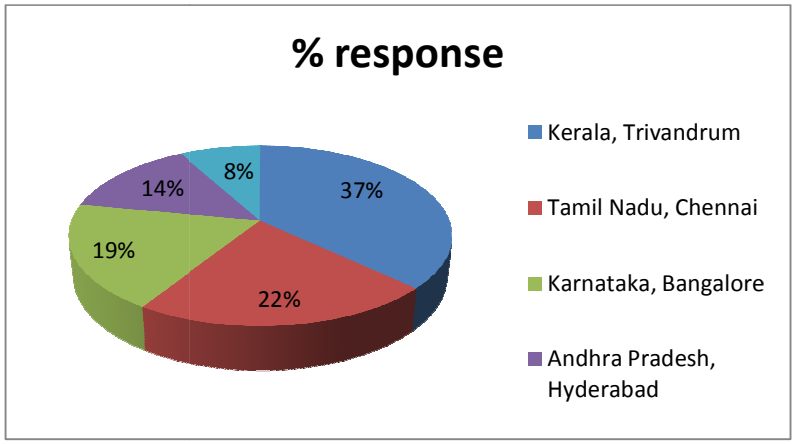


**Figure 3.1: Regional distribution of respondents**

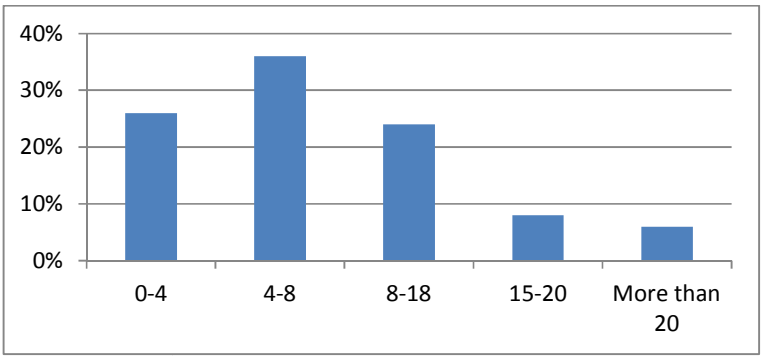


**Figure 3.2: Respondents by experience**

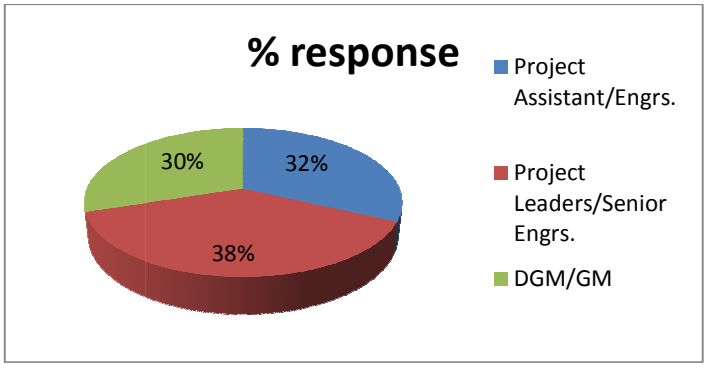


**Figure 3.3: Respondents by Designation**

Almost all the companies have a written vision/mission statement, quality policy statement. Some of the companies have CMM level certification also. The respondents have shown their interest in this performance measurement.

**Importance Index Analysis**

The numerical scores obtained from the software practioners is a measure of the strength of their opinion on each of the quality management constructs. These scores can be subsequently transformed into a relative importance index using the following formulae (adopted from Metri, 2001).

Importance Index on an item/variable $x(I_x) = \left[ \frac{\sum_{i=1}^{5} a_i x_i}{5\sum_{i=1}^{5} x_i} \right]$

Where $a_i$ =constant expressing weight given to $i$

$x_i$ =variable expressing frequency of response for $i$

$i$ =1,2,3,4,5.

This calculated index varies from 0 to 1.These values reflect the relative importance of the factors listed in the questionnaire. These values are again classified into four categories to reflect the respondent's ratings as follows.

| | | |
|---|---|---|
| Very Important | : | $0.75 \leq I_x \leq 1.00$ |
| Important | : | $0.50 \leq I_x \leq 0.75$ |
| Less Important | : | $0.25 \leq I_x \leq 0.50$ |
| Not Important | : | $0.00 \leq I_x \leq 0.25$ |

Based on the above classification there are 58 variables that are found to be rated as 'very important' and 92 variables as 'important'. There are no variables rated as 'less important' or 'not important' category (Table 3.5). Variables / items according to the ranking are given in Table 3.6. There are some items that are found to have the same

importance index. They are ranked according to their appearance in the data sheet of the constraints and variables ie from Top Management Commitment and Leadership, TMC 1 to 18, related items to Financial Growth related items, FG1 to FG9.

**Table 3.5: Summary of Importance Index Analysis**

| S. No | Performance measures | Very Important | Important | Less Important | Not Important |
|---|---|---|---|---|---|
| 1 | Total Management Commitment | 8 | 10 | - | - |
| 2. | Quality Policy | 2 | 10 | - | - |
| 3. | Employee Training | 2 | 8 | - | - |
| 4 | Software Product Design | 4 | 6 | - | - |
| 5. | Quality Information System | 4 | 4 | - | - |
| 6. | Employee participation | 8 | 10 | - | - |
| 7. | Human Resource Management | 4 | 21 | - | - |
| 8. | Customer Focus | 8 | 3 | - | - |
| 9 | Continuous Improvement | 3 | 6 | - | - |
| 10 | Organisation Culture | 7 | 9 | - | - |
| 11 | Infrastructure and Facilities | 3 | 1 | - | - |
| 12 | Financial growth | 5 | 4 | - | - |
| | Total | 58 | 92 | | |

**Table 3.6: Importance Index Table (Item Ranking)**

| Rank | Item Code | Item Description | Importance Index |
|---|---|---|---|
| 1 | FG 9. | The extent of getting repeat business in the firm. | 0.827 |
| 2 | SPD 10. | The ability to predict the project delivery date. | 0.802 |
| 3 | FG 1. | Extent of overall increase in profitability for the last three years. | 0.802 |
| 4 | CI 2. | The level of spirit of cooperation and team work in the organization. | 0.800 |
| 5 | TMC 1. | Extent to which the top executive assumes responsibility for quality performance of the products and services of the company. | 0.794 |
| 6 | SPD 1. | Extent to which the customer requirements are thoroughly considered in new product design. | 0.794 |
| 7 | EPE 12. | Extent to which the involvement of team members at various stages in software projects are encouraged. | 0.791 |
| 8 | CFS 11. | The degree of service level provided by the firm. | 0.791 |
| 9 | QIS 4. | Extent to which the quality feedback from the clients is taken care-off for further improvement. | 0.789 |
| 10 | OC 2. | Degree to which the employees realize the importance of customer satisfaction in achieving quality. | 0.789 |
| 11 | OC 9. | The level of coordination between project teams and customers. | 0.789 |
| 12 | CFS 9. | Quality related customer complaints are treated with top priority. | 0.786 |
| 13 | OC 16. | Extent to which the salaries are paid on time. | 0.786 |
| 14 | IF 1. | Adequacy of hardware facilities provided. | 0.786 |
| 15 | CFS 10. | The on-line delivery of the projects by the organization. | 0.781 |
| 16 | CI 5. | The regularity in monitoring of quality of products and services. | 0.781 |
| 17 | CFS 1. | People in my work unit care about our Customers. | 0.778 |
| 18 | CFS 2. | We monitor customer complaints and feedback and use these items as basis for determining customer satisfaction. | 0.778 |
| 19 | FG 3. | The overall revenue growth of the company. | 0.778 |
| 20 | EPE 13. | The level of staff morale in the organization. | 0.775 |
| 21 | CFS 8. | Extent to which attempts are made to satisfy the explicit, implicit and delight needs of the customers. | 0.775 |
| 22 | OC 7. | The level of coordination between the team members and their leader. | 0.775 |
| 23 | EPE 16. | The ability of the employees for innovative ideas. | 0.772 |
| 24 | TMC 2. | Extent to which the top executives define quality from consumer's point of view. | 0.770 |

**Item Ranking(Continued)**

| Rank | Item Code | Item Description | Importance Index |
|---|---|---|---|
| 25 | TMC 17. | Extent to which the feedback data from after sales are used for continuous improvement of quality in the company as a whole. | 0.770 |
| 26 | EPE 4. | Employees are encouraged to contribute for improving quality and developmental performance. | 0.770 |
| 27 | QIS 2. | Extent to which quality data are available to managers and supervisors. | 0.767 |
| 28 | HRM 2. | Extent of effort to recruit quality manpower. | 0.767 |
| 29 | IF 3. | Adequacy of information facilities such as Internet, access to journals and other publications, training and other facilities. | 0.767 |
| 30 | SPD 11. | The ability to reuse the developed software modules. | 0.764 |
| 31 | QIS 8. | Extent to which the quality data are available to workers. | 0.764 |
| 32 | FG 6. | The ability to complete the project within budget. | 0.764 |
| 33 | QP 6. | Effectiveness of quality department in improving quality. | 0.762 |
| 34 | CFS 6. | Extent to which the organization encourages the interaction between the customers and employees. | 0.762 |
| 35 | IF 2. | Adequacy of software facilities provided. | 0.762 |
| 36 | TMC 8. | Willingness of top management to identify and remove the root-cause problems of quality. | 0.759 |
| 37 | SPD 7. | The extent of customer satisfaction by the company due to the new practices. | 0.759 |
| 38 | CFS 7. | Extent to which service is provided after project completion/project delivery. | 0.759 |
| 39 | FG 10. | The level of increase in the market share of the company. | 0.759 |
| 40 | TMC 5. | Level to which the top management adopts quality management as a competitive strategy. | 0.756 |
| 41 | TMC 11. | Extent to which the quality goals and policy are understood by the work force in the division. | 0.756 |
| 42 | TMC 13. | Extent to which the top management believes quality Improvement as a means to increase profits. | 0.756 |
| 43 | EPE 10. | The degree to which the employees are given freedom and authority for operational independence and experimentation with respect communicated to the employees to project management activities. | 0.756 |
| 44 | HRM 8. | The effectiveness with which the company aligns human resource planning and management with company's strategic plans. | 0.756 |
| 45 | HRM 17. | The level of training of employees in quality management system such as CMM, ISO 9000 etc. | 0.756 |
| 46 | CFS 4. | The level of customer involvement during the specification and design stages of the software project. | 0.756 |

**Item Ranking(Continued)**

| Rank | Item Code | Item Description | Importance Index |
|---|---|---|---|
| 47 | CI 8. | Extent of quality related bench marking system in the organization. | 0.756 |
| 48 | TMC 12. | Amount of review of quality issues in top Management meetings. | 0.754 |
| 49 | ET 4. | Extent to which the management considers employee education and training as an investment. | 0.754 |
| 50 | ET 9. | Extent to which the employees are regarded as valuable, long term resources worthy of receiving education and training throughout their career. | 0.754 |
| 51 | OC 6. | The level of trust and openness between employees and management. | 0.754 |
| 52 | OC 11. | The degree of respect and fairness in treatment that the employee to get within the organization. | 0.754 |
| 53 | FG 5. | Trends in cost relative to competitors. | 0.754 |
| 54 | QP 12. | The ability of the firm for customer retention. | 0.751 |
| 55 | QIS 5. | Extent to which the customer-contact personnel communicate with middle and top management on matters related to customer requirements and satisfaction. | 0.751 |
| 56 | EPE 11. | Extent to which the employees are given freedom to express their opinions, comments and criticisms on organizational functioning. | 0.751 |
| 57 | EPE 14. | How far the company allows flexible work practices. | 0.751 |
| 58 | HRM 6. | Quality emphasis by marketing and sales personnel. | 0.751 |
| 59 | OC 8. | The level of coordination between project teams and top management. | 0.751 |
| 60 | QP 1. | Extent to which the company has a clear long-term vision statement. | 0.748 |
| 61 | ET 2. | Resources available for employee quality training. | 0.748 |
| 62 | SPD 3. | How far the new programmes/products are thoroughly reviewed before they are marketed. | 0.748 |
| 63 | SPD 5. | Coordination among various departments in the product/process development process. | 0.748 |
| 64 | TMC 9. | Commitment of top management towards implementing quality standards or quality policy. | 0.745 |
| 65 | ET 6. | Quality of training in the “total quality concept” given to the employees in the division for quality development. | 0.745 |
| 66 | ET 8. | Extent of training in the advanced statistical techniques such as failure mode analysis, Regression analysis, six sigma etc. | 0.745 |
| 67 | QIS 6. | The overall effectiveness of communication process in the organization. | 0.745 |
| 68 | EPE 9. | Reporting of work problems are encouraged in our company. | 0.745 |

**Item Ranking(Continued)**

| Rank | Item Code | Item Description | Importance Index |
|---|---|---|---|
| 69 | CI 6. | How far the problem – solving tools for continuous improvement in quality is used. | 0.745 |
| 70 | TMC 3. | Extent to which the top executives view quality as more important than cost. | 0.743 |
| 71 | QP 11. | Role and contribution of quality department with respect to quality policy, new software product development, specification etc. | 0.743 |
| 72 | EPE 3. | Employees are encouraged to deal with the customer's complaints and needs. | 0.743 |
| 73 | EPE 15. | The level of overall employee's satisfaction. | 0.743 |
| 74 | HRM 13. | Degree of participation and contribution by major departmental heads in the quality improvement process. | 0.743 |
| 75 | IF 4. | The degree to which the physical layout of the workplace and the environment at the work place are comfortable to the employees. | 0.743 |
| 76 | TMC 10. | Extent to which the top management supports long-term quality management policy. | 0.740 |
| 77 | TMC 14. | Level of participation of major department heads in the quality improvement programme. | 0.740 |
| 78 | ET 5. | Specific work skill training, technical and vocational given to employees throughout the division. | 0.740 |
| 79 | EPE 7. | Employees are actively involved in quality related activities. | 0.740 |
| 80 | HRM 1. | Extent to which employees are treated as long term assets of the organization. | 0.740 |
| 81 | TMC 6. | Willingness of top management to allocate adequate resources and time for quality improvement efforts. | 0.737 |
| 82 | QP 8. | Extent to which the top management supports long term quality improvement programmes. | 0.737 |
| 83 | HRM 19. | The level of training of employees in skills related to the monitoring and control of s/w project management activities. | 0.737 |
| 84 | CI 3. | Extent to which the members of the team are from various departments. | 0.737 |
| 85 | OC 1. | Degree to which the employees accept quality as a strategic weapon to gain competitive advantage. | 0.737 |
| 86 | OC 4. | Support and cooperation of the employees towards the implementation of quality standards. | 0.737 |
| 87 | FG 2. | Extent of increase in return on investment. | 0.737 |
| 88 | TMC 15. | Extents to which quality data such as cost of quality, defects, errors, rework etc. are used as tools to manage quality. | 0.735 |
| 89 | EPE 8. | Employees are very committed to the success of our company. | 0.735 |

**Item Ranking(Continued)**

| Rank | Item Code | Item Description | Importance Index |
|---|---|---|---|
| 90 | HRM 11. | The effectiveness with which the company evaluates and improves its human resource planning and management using employee related data. | 0.735 |
| 91 | FG 7. | The value added per employee to the organization. | 0.735 |
| 92 | TMC 4. | Level of top executives' dynamism in leading the quality programme. | 0.732 |
| 93 | TMC 7. | Extent to which the quality mission forms the basis of strategic planning and decision making. | 0.732 |
| 94 | TMC 16. | Extent of time spent by the top management in evolving competitive bench marking. | 0.732 |
| 95 | ET 1. | Amount of training provided to employees in quality principles and policies. | 0.732 |
| 96 | HRM 15. | Degree to which the employees are trained for developing their communication skills (written and verbal). | 0.732 |
| 97 | CI 4. | Extent to which the data are monitored for efficiency and effectiveness | 0.732 |
| 98 | OC 12. | Availability of opportunities for career advancement. | 0.732 |
| 99 | SPD 9. | The ability in "early detection of defects. | 0.729 |
| 100 | CFS 5. | The level of customer involvement during the development and testing stages of the software project. | 0.729 |
| 101 | QP 4. | Extent to which various quality plans and policies are communicated to the employees. | 0.727 |
| 102 | SPD 2. | Level of participation of various departments in new product development. | 0.727 |
| 103 | QIS 3. | Extent to which the quality data are used to evaluate supervisor and managerial performance. | 0.727 |
| 104 | HRM 21. | The extent to which the employees are trained in the estimation and auditing of costs related to software development. | 0.727 |
| 105 | CI 1. | Extent to which the ability to work in team is taken as a criteria in employee selection | 0.727 |
| 106 | OC 3. | The extent to which the employees believe in "doing things right first time and every time" | 0.727 |
| 107 | TMC 18. | Specificity of quality goals in the company's business plans | 0.724 |
| 108 | QP 5. | Amount of co-ordination between quality department and other departments. | 0.724 |
| 109 | SPD 8. | The level in reduction of project cycle times in the organization. | 0.724 |
| 110 | EPE 2. | Most employee suggestions are implemented after evaluation. | 0.724 |
| 111 | CI 7. | The involvement of each and every member of the organization in improving quality. | 0.724 |
| 112 | OC 10. | Attractiveness of salary and perks paid to the employees. | 0.724 |

**Item Ranking(Continued)**

| Rank | Item Code | Item Description | Importance Index |
|---|---|---|---|
| 113 | OC 13. | Presence of incentive schemes based on performance to motivate employees. | 0.724 |
| 114 | EPE 1. | All employee suggestions are evaluated in our company. | 0.721 |
| 115 | HRM 20. | The degree to which the employees are trained in using metrics for quality improvement. | 0.721 |
| 116 | CFS 3. | We compare our customer satisfaction with our competitors. | 0.721 |
| 117 | FG 4. | The level of operating cost of the company. | 0.721 |
| 118 | QIS 7. | Extent to which reports on the effectiveness of quality management programme are communicated to the employees. | 0.718 |
| 119 | HRM 10. | Effectiveness of quality improvement teams in the division. | 0.718 |
| 120 | HRM 12. | How far financial incentives are used for employee motivation. | 0.718 |
| 121 | HRM 16. | Degree to which the employees are trained for developing their diagnostic and problem solving skills such as cause and effect analysis & brainstorming. | 0.718 |
| 122 | OC 15. | Extent to which the roles and responsibilities of employees are specified clearly. | 0.718 |
| 123 | ET 7. | Extent of training given to the employees in the basic statistical techniques. | 0.716 |
| 124 | EPE 5. | Extent of company's cross-functional teams' involvement in quality. | 0.716 |
| 125 | HRM 3. | Effectiveness of strategies adopted for retaining talented and experienced people. | 0.716 |
| 126 | HRM 22. | The level of education and training given to the employees in assessing the cost of quality and return on quality. | 0.716 |
| 127 | FG 8. | The extent of savings in cost due to improvement. | 0.716 |
| 128 | SPD 6. | Extent to which quality data, control charts are displayed at the employee workplace | 0.713 |
| 129 | OC 14. | Extent to which achievements in quality are recognized and rewarded. | 0.713 |
| 130 | QP 7. | Degree to which divisional top management is evaluated for quality performance. | 0.710 |
| 131 | QP 10. | Extent to which the goals and policies with respect to quality management are understood by the employees. | 0.710 |
| 132 | HRM 9. | Extent of effectiveness of Management Development Programme for the improvement of quality and productivity. | 0.710 |
| 133 | OC 5. | The level of trust and openness among team members. | 0.710 |
| 134 | QIS 1. | System existing in the organization to collect the cost of quality. | 0.708 |
| 135 | QP 3. | The goals of QM and their benefits to people in achieving them are made known to all the employees. | 0.705 |

**Item Ranking(Continued)**

| Rank | Item Code | Item Description | Importance Index |
|---|---|---|---|
| 136 | EPE 6. | Our company has several Quality Control circles(within one function) | 0.705 |
| 137 | HRM 4. | Extent of effectiveness of the human resources plans with respect to human resource development training and empowerment. | 0.705 |
| 138 | CI 9. | The extent to which the software development processes are systematically measured and evaluated. | 0.705 |
| 139 | QP 2. | The level at which the company's short term business plan influence the quality management practices. | 0.700 |
| 140 | QP 9. | Extent to which quality data obtained after the implementation of QM practice are used to evaluate middle level management and their supervisory performance. | 0.700 |
| 141 | SPD 4. | Extent of application of experimental design is in programme design. | 0.700 |
| 142 | ET 3. | Involvement of top management in quality training to employees. | 0.697 |
| 143 | HRM 5. | Attitude of labour unions towards quality improvement and management process. | 0.697 |
| 144 | HRM 23. | The level of absenteeism in the company. | 0.694 |
| 145 | ET 10. | Additional training required for the workers. | 0.691 |
| 146 | HRM 7. | The extent of application of non-financial incentives for employee motivation. | 0.691 |
| 147 | HRM 14. | Degree to which employees are trained in team building and group dynamics for achieving the quality mission. | 0.691 |
| 148 | HRM 18. | The extent to which the employees are trained to identify and assign the right job for each person. | 0.691 |
| 149 | HRM 24. | The level of labour turn-over in the company. | 0.691 |
| 150 | HRM 25. | The level of complaints from the workers. | 0.672 |

Respondents have given very great importance to the item "The extent of getting repeated business in the firm (FG9) ie 0.8270. All the other items / variables are ranked as" very important" or as "important" no variable is coming under "less important" or "not important" category. So ideally all the variables are to be considered for performance measurement study and for further analysis purpose. The frequency of favourable responses to the performance measures indicates that majority / all the

representative professionals in the software area have recognized the concept and its potential.

**Table No.3.7: No of Companies with their QM score**

| Rating | No of Companies |
|---|---|
| < 250 | 4 |
| 251-300 | 1 |
| 301-350 | 2 |
| 351-400 | 10 |
| 401-450 | 9 |
| 451-500 | 22 |
| 501-550 | 19 |
| 551-600 | 3 |
| 601-620 | 4 |

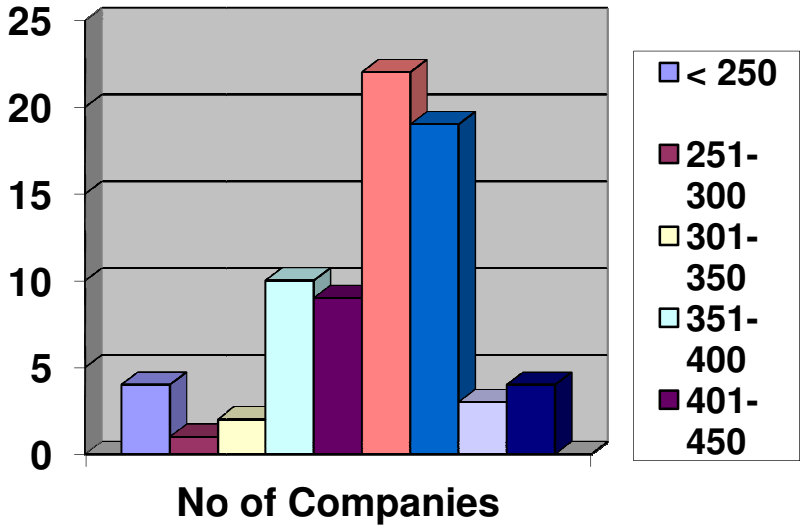


**Fig. 3.4: QM score and No. of Companies**

These companies were divided into 4 segments based on their QM score and for analysis 25 % of the top performing companies and 25 % of low performing companies based on their QM score.

The following table gives the Cronbach alpha for finding the internal consistency (reliability). The alpha value varied between 0.756 and 0.942. Reliability coefficients of 0.70 or more are considered adequate.

**Table No.3.8: Critical Success factors and their reliability**

| No. | Critical Factors | Cronbach alpha |
|---|---|---|
| 1. | Top Management Commitment and leadership (D1) | 0.927 |
| 2. | Quality Policy (D2) | 0.906 |
| 3. | Training to employees (D3) | 0.942 |
| 4. | Product design and operating system (D3) | 0.756 |
| 5. | Quality Information System (D5) | 0.932 |
| 6. | Employee participation and empowerment (D6) | 0.902 |
| 7. | Human resources management (D7) | 0.941 |
| 8. | Customer focus and satisfaction (D8) | 0.898 |
| 9. | Team work for continuous improvement (D9) | 0.893 |
| 10. | Organization culture (D10) | 0.923 |
| 11. | Infrastructure and facilities (D11) | 0.861 |
| 12. | Financial Growth (D12) | 0.925 |

# CHAPTER 4

# RELATION BETWEEN QUALITY MANAGEMENT AND ORGANIZATIONAL FACTORS

## 4.1 Dimensional Analysis of QM factors

Dimensional Analysis (DA) is meant for accommodating multiple dimensions in terms of their implication in quality management. All the dimensions defined here have mutual dependence/association between them as well. This method may be considered as fresh/new, it will make the analysis simpler and convincing. This analysis has been in steps-first counting each dimension independently following which the dimensional similarity has been presented in a matrix form, which represents the clustering of dimension in the response collected.

This study of DA is done for 74 companies with respect to 12 dimensions. They are:

1. Top Management Commitment and leadership (D1)
2. Quality Policy (D2)
3. Training to employees (D3)
4. Product design and operating system (D3)
5. Quality Information System (D5)
6. Employee participation and empowerment (D6)
7. Human resources management (D7)
8. Customer focus and satisfaction (D8)
9. Team work for continuous improvement (D9)
10. Organization culture (D10)
11. Infrastructure and facilities (D11)
12. Financial Growth

From the data collected, it is found that 38 companies have dimensional similarity (DS) between the dimension 1, Top management Commitment and leadership and dimension 2, Quality Policy. If little more emphasis is given to the quality policy like co-ordination of quality department with other departments, the goals of QM and its benefits to the people in achieving them are made known to all the employees with little more emphasis, communicating the various plans and policies to the employees, using of quality data obtained after the implementation of QM to evaluate the middle level management and their supervisory performance etc. another 20 more companies will also have the same dimensional similarity, totally to 58 companies. A little emphasis in D1 like the policy of adopting QM as a competitive strategy, defining the quality from the consumer's point of view, commitment of top management towards implementing quality standards etc. will bring another 10 more companies into DS, totaling to 68 companies.

Between D1 and D6, employee participation and empowerment, 43 companies have dimensional similarity. In D6 if little more emphasis is given in factors like consideration of evaluating the suggestions of the employees in the company,implementation of employee suggestion after evaluation, encouraging the employees for improving quality and developmental performance of the company, formation of more quality circles and using their complete involvement in the quality programmes and in related activities etc., another 15 more companies will also have the same dimensional similarity, totally to 58 companies.

As far as D1 and D7, Human Resource Management is concerned; already 36 companies are having dimensional similarity. If little more care is given to some of the factors in HRM like considering the employees as long term assets of the organization, effective recruitment policy, strategies for retaining talented and experienced people,

more emphasis on the attitude of the labour unions towards quality improvement programmes, quality emphasis by marketing and sales personnel, effectiveness of quality improvement teams in the division, using financial incentives for motivating employees, increasing the communicate skills of the employees etc. another 19 more companies will also have the same DS, totaling to 55 companies. A small change in the factors mentioned above in D1 will also bring another 14 more companies also into Dimensional similarity, totally to 69 companies.

Between D1 and D8, Customer focus and satisfaction, already 41 companies are having DS. If some more emphasis is given by the management in D1, top management commitment and leadership another 17 more companies will have DS, totaling to 58 companies. If we give little more emphasis in factors like caring about the customer, monitory of customer complaints and feed back to assess the customer satisfaction, comparing the customer satisfaction with competitor firms, involvement of clients during the development and testing stage of software projects, the service provided after project completion/delivery consideration of quality related complaints from the customers with top priority etc., some more companies will fall under DS, totally to 69 companies.

36 companies have DS between D1and D10, organization culture. Top management commitment and leadership is having more impact on the organization culture of the company. They are very closely related and one goes along with the other. If little more emphasis is given for the factors like the concept of defining quality from the consumer's point of view, consideration of quality as more important than cost, the dynamism of top executives in leading the quality programmes, willingness of top management in identifying and removing root-cause problems, commitment of top management towards implementing quality standards and quality policies etc. it will

bring another 13 companies also into dimensional similarity totally to 49 companies. A small positive change in dimension 10 will bring another 17 companies also into DS, totaling to 66 companies.

From the study of dimension 1 with other factors, it is found that a small change in the factor 1, Top management commitment and leadership can bring more companies into dimensional similarity with other dimension also.

Dimension 2, quality policy have DS with Dimension 3, Training to employees with 36 companies. As pointed out earlier, a little more commitment in the quality policy of the companies will bring another 15 more companies also into DS, totally to 51 companies. An emphasis into the different factors in the Dimension 3 will bring more companies into DS, totally to 69 companies.

Between Dimension 2 and Dimension 5, Quality information system, 36 companies have DS. A little care in the factors like the existing system in the organization, extent of availability of quality data to managers and supervisors, use of these datas for the evaluation of supervisor and managerial performance, the extent of using quality feed backs from the clients for further improvement, the availability of quality data to workers under the Dimension Quality Information system of the company will bring another 21 more companies into DS, totaling to 57 companies.

Dim:2 have very good DS with Dim:6, Employee participation and empowerment. There are 44 companies with DS. As pointed out earlier under the quality policy, a small change will bring another 15 more companies also into DS, totaling to 59.

Quality Policy has very good DS with Dim:8, Customer focus and satisfaction with 40 companies. As pointed out earlier, a more care into the different facets of the quality policy will bring another 20 more companies with DS, totaling to 60 companies.

From the above analysis it is seen that a small change in the positive direction in Dim:2, quality policy will have more impact on almost all the dimensions in quality management.

As far as Dim: 3, Training to employees is considered it is having very good DS with Dim:6, Employee participation and empowerment, with 40 companies. An analysis of the DS matrix will give all indication that a small emphasis in Dim: 6 will bring another 17 companies also into DS. The following table will give the Dimensional Similarity Matrix for the different dimension with entries showing the number of companies.

**Table No. 4.1: Table showing the dimensional similarity of companies**

| Dimensional Factors | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **D1** | - | | | | | | | | | | | |
| **D2** | 38 | - | | | | | | | | | | |
| **D3** | 30 | 36 | - | | | | | | | | | |
| **D4** | 34 | 35 | 35 | - | | | | | | | | |
| **D5** | 32 | 36 | 34 | 34 | - | | | | | | | |
| **D6** | 43 | 44 | 40 | 40 | 38 | - | | | | | | |
| **D7** | 36 | 34 | 44 | 35 | 43 | 38 | - | | | | | |
| **D8** | 41 | 40 | 17 | 25 | 33 | 36 | 30 | - | | | | |
| **D9** | 34 | 34 | 33 | 34 | 32 | 39 | 35 | 34 | - | | | |
| **D10** | 36 | 28 | 34 | 34 | 36 | 42 | 40 | 31 | 35 | - | | |
| **D11** | 21 | 24 | 26 | 28 | 26 | 21 | 20 | 28 | 25 | 31 | - | |
| **D12** | 41 | 44 | 40 | 39 | 37 | 42 | 40 | 36 | 38 | 42 | 37 | - |

**Dimensional Factors**

Dim: 3, have very good DS with 44 companies with Dim:7, Human Resource Management policy of the company. Without proper emphasis on the HRM policy of the company it is very difficult task to achieve QM. A small improvement in the HRM for the factors mentioned earlier will bring almost all the companies into DS.

Dim:4, software product design and operating procedure has DS with Dim: 6, with 40 companies. An improvement in the design procedure as mentioned earlier will bring another 19 more companies also into DS, totaling to 59.

As far as D5, Quality Information System is considered, it has DS with Dim:6 with 38 companies. A small change in both the dimensions will bring almost all the companies into DS.

With respect to D5 and D7, HRM it has got DS with 43 companies. A little change in the HRM policy will bring another 17 companies also into DS, totaling to 60 companies.

Dim:5 is having DS with D10, organization culture with 36 companies. The HR policy and the management commitment towards QM will affect the organization culture. A little emphasis in the above two dimensions will bring almost all the companies into DS.

Dim: 6, is having DS with Dim: 7 in 38 companies. As emphasized earlier, a change in the HRM policy will increase this DS, by bringing another 18 more companies also into DS. HRM will increase the employee participation and empowerment also. Thus almost all the companies will have dimensional similarity.

As far as Dim: 6 and Dim: 8, Customer focus and satisfaction is considered, there are 36 companies with DS. A change in Dim: 6 as mentioned earlier will increase the DS, totaling to 57 companies. If the customer care is taken with little more care with proper delivery date, listening to the complaints of the clients, by company our customer satisfaction with the competitors, by involving customers also in the development and testing stages of the software project, and by providing service after project delivery, considering customer complaints with top priority etc. can increase the level of customer satisfaction which will bring almost all the companies under DS.

Similarly Dim: 6 and Dim: 9, Team work for continuous improvement, 39 companies are having DS. If care is given for the improvement in Dim:6, another 21

more companies will also have DS, thus totaling to 60 companies. A little focus in the team work for continuous improvement will also bring all the companies under DS.

Between Dim: 6 and Dim:10, Organizational Culture, there is dimensional similarity in 42 companies. As mentioned earlier, if Dim: 6, Employee participation and empowerment is improved by the various factors mentioned above, it will bring another 16 companies also into DS, totaling to 58.

As far as Dim: 7 and Dim: 10 are concerned, there are 40 companies with DS. A change in HRM policies, as mentioned earlier will bring almost all the companies into DS.

Dim: 11, Infrastructure and facilities have very low DS with all other dimensions. On the analysis of the dimensional similarity matrix, it is found that Dim: 11 is having very low score compared to the other dimensions. It can be assumed that Dim: 11 is having only little impact on the QM. Dim: 12 has very good dimensional similarity with all other factors. There is also scope for improving the dimension qualities.

In total it can be found that a small emphasis in the dimensions 1,2,5,6 and 7 will bring more companies into the dimensional similarity. Also it is found that DS is towards the higher side, i.e. greater than 50 to 60 %.

## 4.2 Coefficient of variation in the QM factors

According to Prof: KarlPearson Coefficient of variation is the percentage variation in the mean, standard deviation is being considered as the total variation in the mean. The series having greater coefficient of variation is said to be more variable than the other and the series having lesser coefficient of variation is said to be more consistent than the other.

Coefficient of variation analysis is done for the factor 1, Top management Commitment and leadership for all the collected data. The relative value of range ore coefficient of range for this dimension was found to be 0.666 and the coefficient of variation was found to be 22.2 %.

If we delete the response of companies who gave their response very pessimistically, it can be seen that the coefficient of range was found to be 0.46 and the coefficient of variation18%. A low value of coefficient of variation shows that response of the companies to this factor is more or less consistent.

The same type of analysis was done for all the companies for the factor 2, quality policy. The initial analysis shows the coefficient of range for this dimension as 0.61 and the corresponding coefficient of variation as 23.6 %.

On the analysis of the data it was found that some companies gave very pessimistic response for this factor. If we delete the response of these companies (3), the coefficient of range changed to 0.50 and the corresponding coefficient of variation as 19.6 %.

The same analysis was done for all the factors and the corresponding values obtained are given in the following table.

**Table No. 4.2: Table showing the coefficient of range and coefficient of variation for QM factors**

| Factor | Description of QM factors | Initial | | Revised | |
|---|---|---|---|---|---|
| | | CR | CV | CR | CV |
| 1 | Top Management commitment and leadership | 0.666 | 0.222 | 0.46 | 0.18 |
| 2 | Quality Policy | 0.617 | 0.236 | 0.50 | 0.196 |
| 3 | Training to employees | 0.646 | 0.223 | 0.40 | 0.18 |
| 4 | Product design and operating system | 0.666 | 0.2068 | 0.46 | 0.169 |
| 5 | Quality Information system | 0.666 | 0.229 | 0.53 | 0.185 |
| 6 | Employee participation and empowerment | 0.666 | 0.212 | 0.41 | 0.170 |
| 7 | Human resources management | 0.654 | 0.214 | 0.41 | 0.176 |
| 8 | Customer focus and satisfaction | 0.666 | 0.228 | 0.50 | 0.175 |
| 9 | Team work for continuous improvement | 0.636 | 0.2207 | 0.50 | 0.183 |
| 10 | Organisational culture | 0.666 | 0.207 | 0.40 | 0.155 |
| 11 | Infrastructure and facilities | 0.666 | 0.291 | 0.42 | 0.236 |
| 12 | Financial Growth | 0.666 | 0.214 | 0.43 | 0.172 |

As stated earlier, the series having lesser coefficient of variation is said to be more consistent than the other. For factor/ dimension 1, it is 0.18 with a coefficient of range of 0.46.

If we analyze the response with respect to the 18 sub factors, it can be seen that six firms have only low score and 14 are having only average. If the top executives can assume little more responsibility for quality performance, it will decrease the variation and range. Top management assumes more importance for cost than the quality. The dynamism of the top executives in leading the quality programmes, adopting quality management as a competitive strategy, their attitude towards long-term quality improvement programmes, involvement of different quality heads in the quality improvement programmes etc. are to be given more importance so as to achieve the QM goals. If these factors are taken care off, it will give a low coefficient of variation showing consistency in the policy. The scores obtained for this dimension is given below.

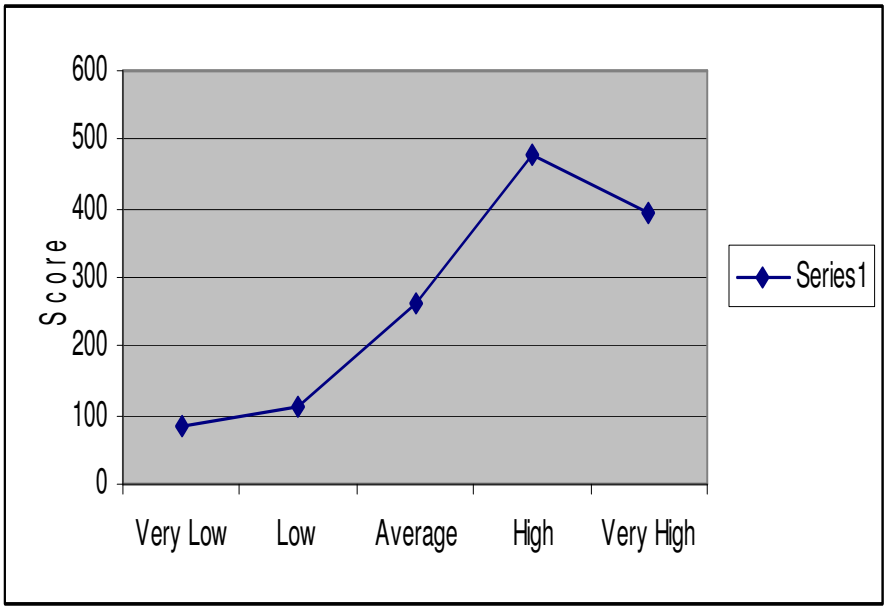


**Fig. 4.1: The response score obtained for QM dimension 1**

The score obtained in this study for the dimension 2, Quality Policy is shown in the following figure.4.2

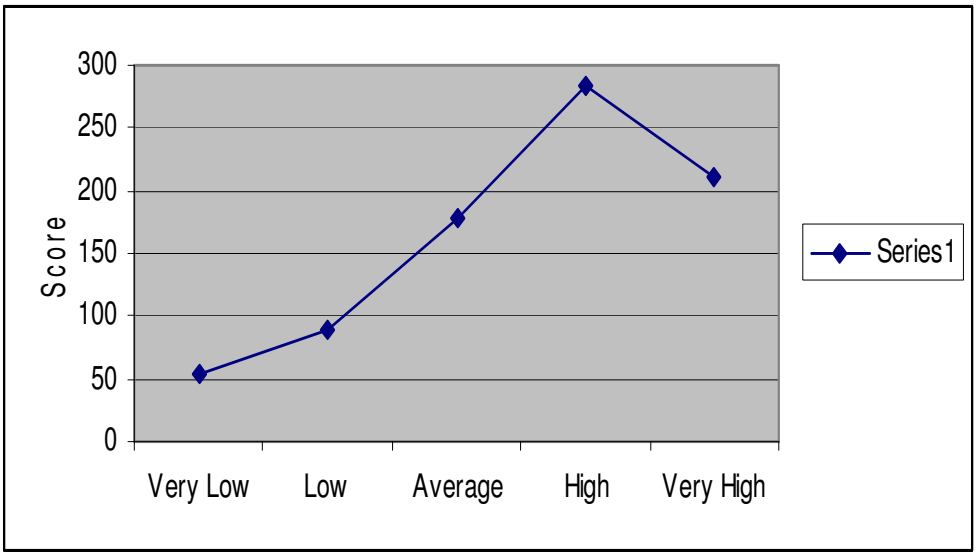


**Fig. 4.2: The response score obtained for QM dimension 2**

From the data collected the following remarks can be obtained.

There is a very low long term vision statement. Also the various plans and policies are not properly communicated to the employees. Also the evaluation of the divisional top managements for their quality performance is also found to be very low. The top management should support long-term quality improvement programmes also. After effect of the QM implementation is to be assessed using the data available after its implementation for the middle level and top management people. It is also found that the concept of QM is not fully understood by the employees of the organization such as its goals and policies. If more emphasis is given in the above factors, this concept can be implemented for more productive output, thus reducing the coefficient of variation.

The response collected towards the dimension 3, training to employees is shown below:

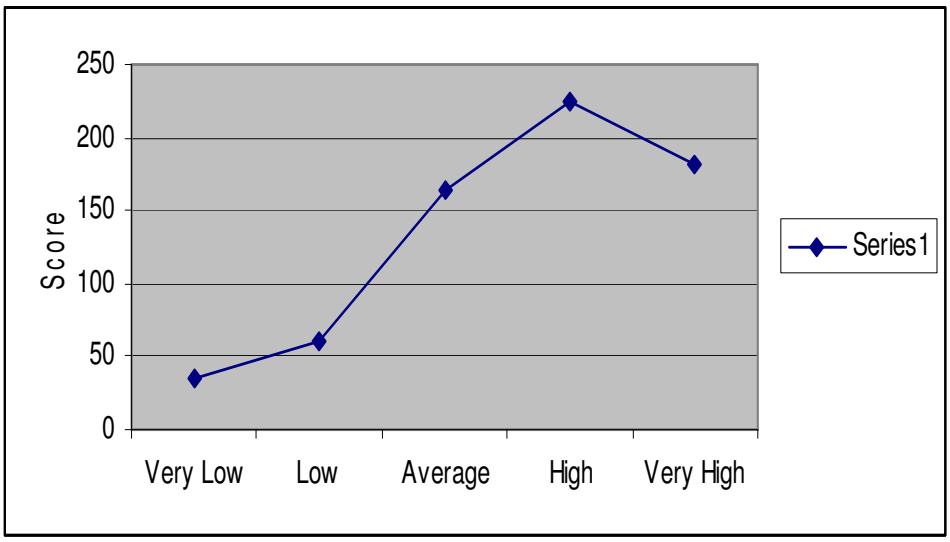


**Fig. 4.3: The response score obtained for QM dimension 3**

The amount of training given to the employees must be increased further. Involvement of the top management in the quality training for the employees should be more compared to what is prevailing today. The employee training should be considered as an investment in the human resource towards achieving good performance. The concept of different statistical techniques should be given to the employees. The resources available for quality training of the employees should also to be increased, assuming it to be a long-term investment. They are to be considered as long-term valuable resources by the management as far as the training programme is considered.

Dimension 4, Software product design and operating procedure were considered for analysis and the response obtained is given in the following figure.

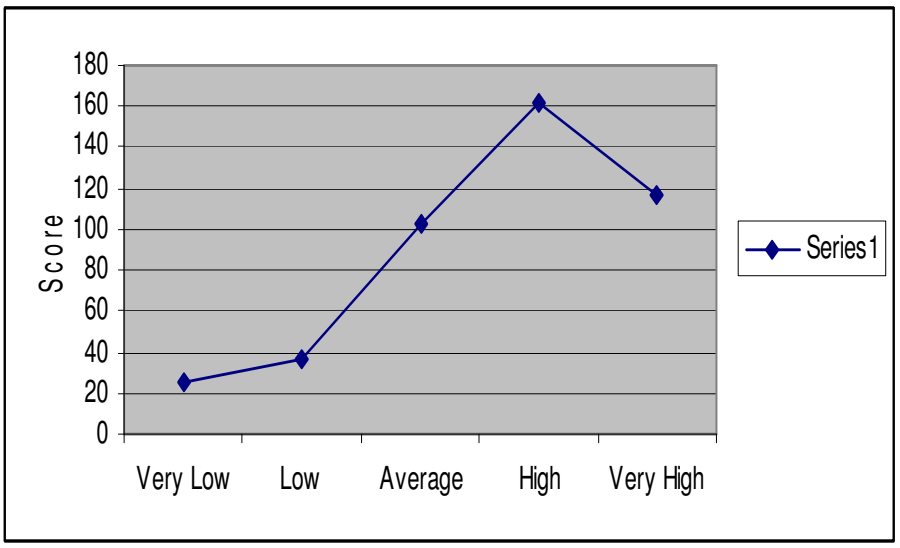


**Fig. 4.4: The response score obtained for QM dimension 4**

From the data collected the following observation were made. The co-ordination among various departments in the process development is to be improved. The new programmes should be thoroughly reviewed before they are marketed. All departments should involve in the process development. If these points can be considered with little more emphasis, it will lead to good performance by the companies.

The 5$^{th}$ factor named as Quality information system and communication of information was taken for measuring the QM implementation. The following observations were made. The feedbacks of the quality data to the management and to the employees are found to be low. This has to be improved further for the proper awareness of the programme.

The quality data obtained should be used to evaluate the performance of the superiors. Much more emphasis should be given for getting feedback from the clients for further improvement. The overall effectiveness of the communication in the organization is found to be little above average. Only few firms have quoted very low. The summary of response obtained is given shown in the following figure.

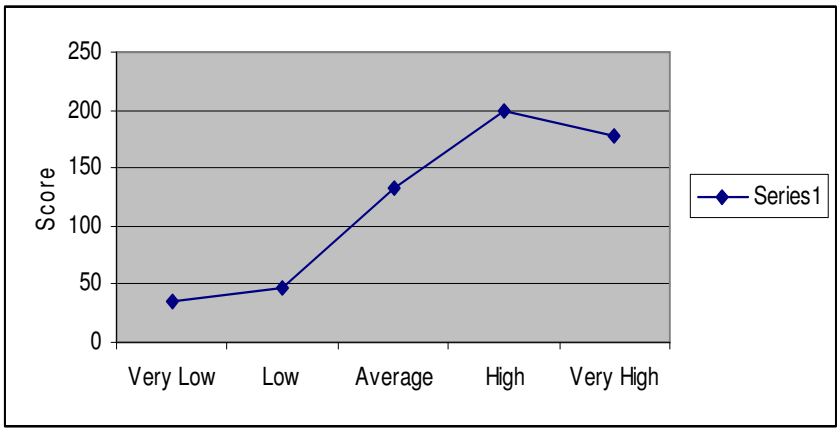


**Fig. 4.5: The response score obtained for QM dimension 5**

The report of the effectiveness of the quality management programme should be communicated more to the employee's level for getting more involvement by them in the programme.

Regarding the 6$^{th}$ factor, Employee participation and empowerment, the response obtained is shown in the following figure.

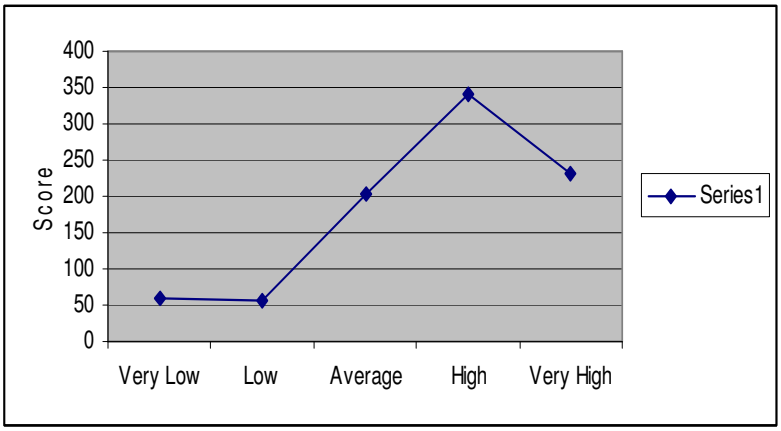


**Fig. 4.6: The response score obtained for QM dimension 6**

The rating obtained is high as far as this factor is concerned. High weightage is given for the suggestion given by the employees of the company and their suggestions are implemented after evaluation. The employees are also encouraged to deal with customer's complaints and needs. The participation of the employees are rated very high and are encouraged to contribute for improving quality and developmental performance.

Most of the companies are also using quality circle for improving the performance like that in the case of manufacturing companies. The commitment of the employees for the success of their company is rated high in the responses received. For the total improvement in the companies it was found that employees are given freedom and authority for operational independence and experimentationwith respect to project management activities. They are also given freedom to express their opinions, comments and criticism on organizational functioning. The involvement of team members at various stages in software project is also encouraged to a high and very high extent by the companies. In total it was found that this dimension is very important as far as the QM practice is concerned.

The role of human resources management is very crucial in the QM process. The responses obtained from different sources were encouraging and their summary is given in the following figure.

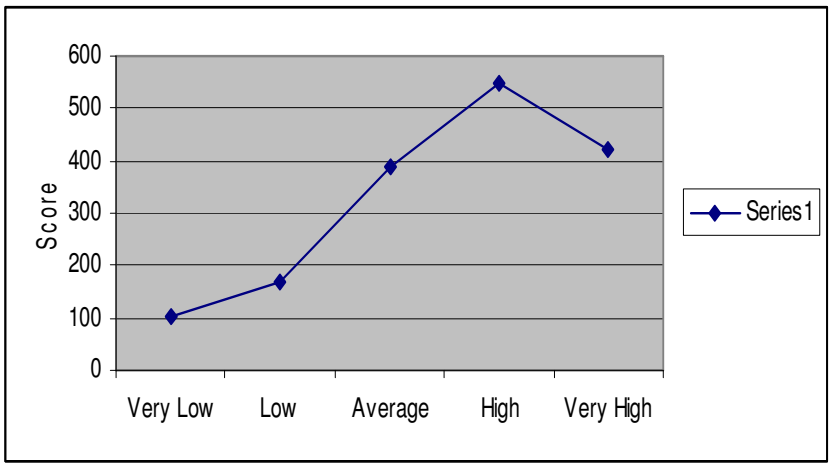


**Fig. 4.7: The response score obtained for QM dimension 7**

The employees are treated as long term assets of the organization and great effort is used to recruit quality man power also. Very good strategies are adopted for retaining talented and experienced people in the organization. The attitude of the employees and the labour unions towards the total quality improvement and management process is

found to be high. The emphasis given by the marketing personnel and sales personnel are found to be very high. The non-financial incentives are also found to have an important effect on the motivation of the employees towards quality management process. The management development programmes are also found to have very high effectiveness for the improvement of quality and productivity. Along with the non-financial incentive, financial incentive also places a very important role in the quality improvement programme. The participation and contribution of major departmental heads in the quality improvement process is also found to be high to very high. The effect of training on the employees towards improving their communication skills is also found to have very high impact on their performance towards achieving the goal of the organization. The employees are also given training in the estimation and auditing of costs related to software development is also found to have very great impact on their performance. In total it is found that the various types of trainings given to the employees, helps in total towards the improvement of the organization.

The customer focus with their satisfaction is another important dimension in the measurement of QM in software companies. The response obtained from the data collected is shown in the following figure.

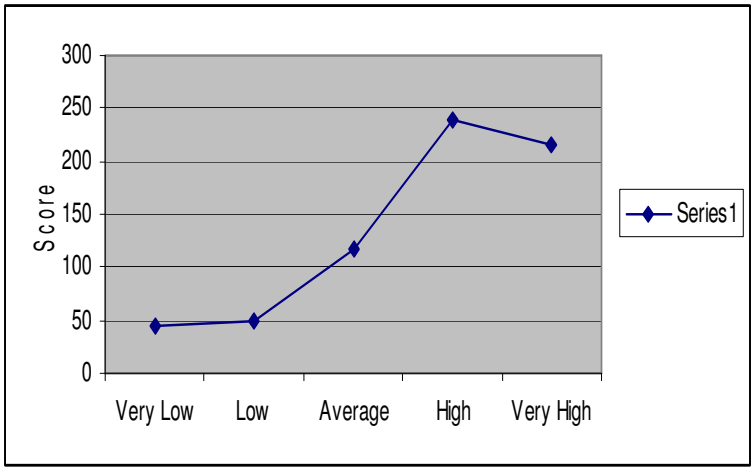


**Fig. 4.8: The response scoreobtained for QM dimension 8**

The careof the customers in the work units of the software companies is found to be very high. The graph shows askewness towards the right. The monitoring of customer complaints and their feedback is used mainly to monitor the customer satisfaction. It is found to be very high in the organization. To some great extent the companies compare their customer satisfaction with competing companies also. It is also found to be high in the organization. To have better quality effect on the product, the level of customer involvement during the specification and design stages of the software project is also found to be very high. Also customer involvement during the development and testing stages of the project is also found to be high. Many companies to some great extent encourage the interaction between the customers and employees. The service provided after the delivery of the project or the completion of the project is also very high for customer satisfaction. Data collected shows that the organization gives very high priority for quality related complaints from the customers.

Continuous improvement is one of the slogans of QM. No firm can move towards quality management without continuous improvement. The response of the companies towards their dimension is shown in the following figure.

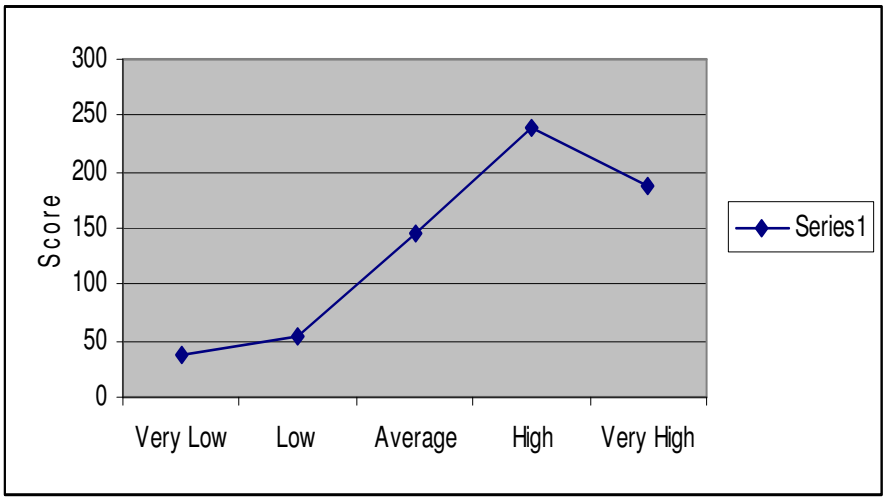


**Fig. 4.9: The response score obtained for QM dimension 9**

The ability of the employee to work in a team is considered as one factor here and it is found that it has got high and very high ratings. Level of spirit of co-operation and team work in the organization is also found to be high in this measure.Someof the companies responded with low rating for the factor to consider the members of the team in the process to be from a variety of departments.Some companies rated this factor from high to very high also. Monitoring of the data for the effectiveness and efficiency is also found to be high to very high.This shows that continuous improvement without monitoring data is impossible.Similarly in monitoring quality of the software products and services, the regularity in doing it is found to be extremely very good-more than 70% of the companies responded from high to very high. To a great extent, the problem solving tools are also used for the continuous improvement in quality. The response for this factor is also found to be high to very high.Each member in the team is having a major and equal role towards QM.The response also proves this.The involvement of each and every member of the organization in improving the quality is found to be much above average to high and very high.Most of the firms are found to be systematically measuring and evaluating the software development process. The response towards this factor is found to be high to very high. In Toto, we can find that almost all the firms are totally committed towards continuous improvement for achieving the objective.

The tenth dimension used for this study is Organizational Culture.The factor is very important to measure its role in the QMprocess. Each firm will develop its own culture and it will indicate their path towards QM.The response obtained from the companies towards this measure is shown in the following figure.

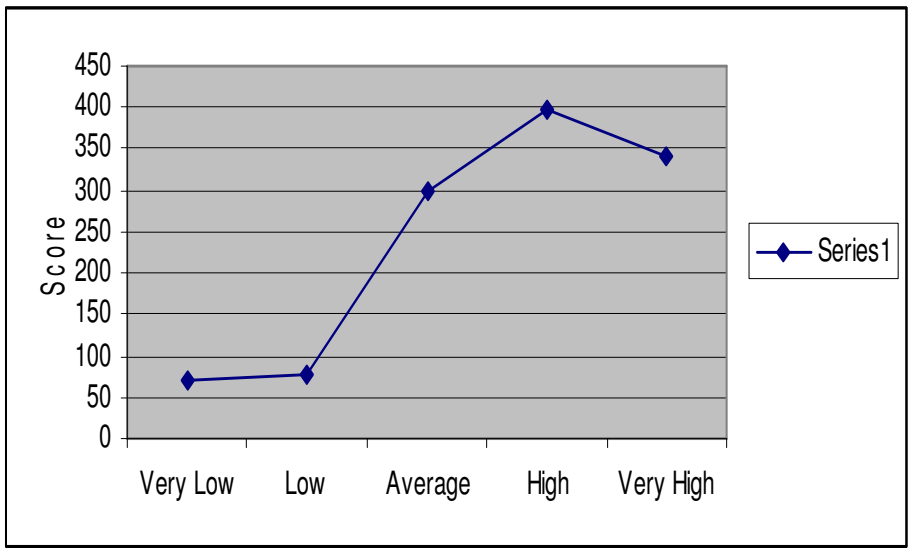


**Fig4. 10 The response score obtained for QM dimension 10**

Response is found to be favourable and impressive. Most of the companies' responds that their employees accept quality as a strategic weapon for the given competitive advantage. Response is high to very high. Company culture accepts the fact that the employees realize the importance of customer satisfaction in achieving the quality. The response was from high to very high. The support and co-operation of the employees towards the implementation of quality standards are also rated as high to very high. The extent of openness among team members is very good. They freely discuss each and every step formally and informally. The level of trust and openness among the employees and the management is also rated high to very high. Similarly the co-ordination between the team members and their leaders, between project teams and customers is also rated to very high. Most of the firms having high to very high rating in the organization culture are also found to be very good pay masters also. The response shows high to very high rating for the factor towards the salary and perks paid to the employees. The opportunities for career advancement for the employees are also high in the organization. Organization promotes incentive schemes also based on the performance to motivate the employees. Most of the firms clearly specify the roles and

responsibilities of its employees towards achieving the objective. Great emphasis is given by the companies to give the salaries of the employees on time. The response was very good from the data available from the companies – most of them rate very high to very high.

Next dimension used in this study is the importance of infrastructure and facilities in QM achievement. The response is favourable. The adequacy of the availability of proper software in these companies is rated high and very highand also the hardware facilities,both are rated on the higher side. The availability of information facilities like internet access, accept to journals and other publication, training and to other facilities are found to be high and very high. The ergonomic design of the workplace and its environment is also having an impact on the performance of the employees. These parameters should be comfortable to the employees. The response shows that the comfortness of the layout and its environment at the workplace are rated high and very high.

The data available for this factor is shown in the following figure.

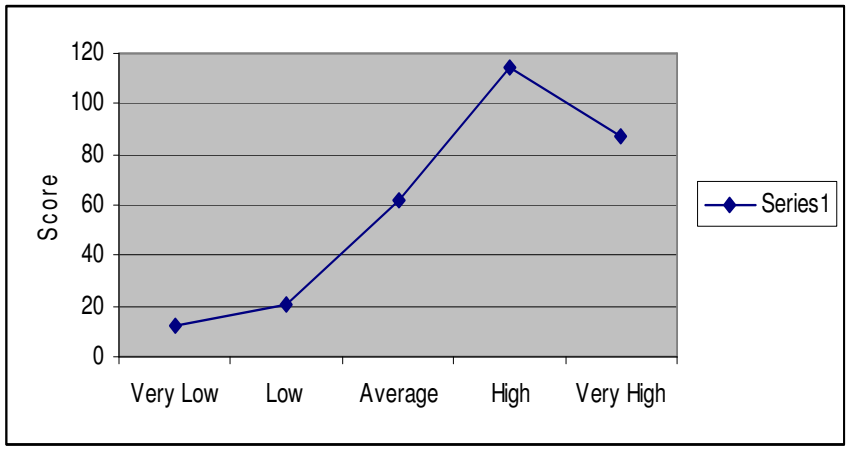


**Fig. 4.11: The response score obtained for QM dimension 11**

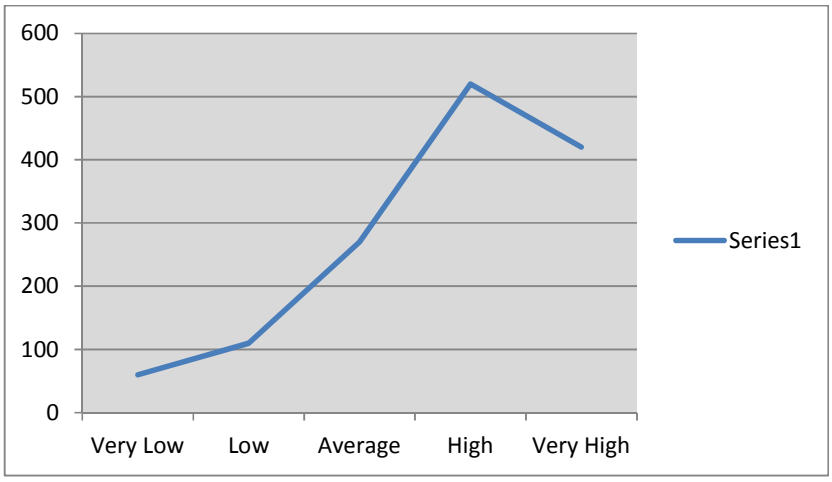


**Fig. 4.12: The response score obtained for QM dimension 12**

The responses available for the above 12 different dimensions are summarized below:

The average response of the companies towards the twelve dimensions taken to measure the organizational performance is found to be very good and is given in the following table.

**Table No.4.3: Table showing the average score of dimensional factors**

| Factor | Description of QM factors | Average Score |
|---|---|---|
| 1 | Top Management commitment and leadership | 3.742 |
| 2 | Quality Policy | 3.622 |
| 3 | Training to employees | 3.686 |
| 4 | Product design and operating system | 3.694 |
| 5 | Quality Information system | 3.733 |
| 6 | Employee participation and empowerment | 3.710 |
| 7 | Human resources management | 3.624 |
| 8 | Customer focus and satisfaction | 3.803 |
| 9 | Team work for continuous improvement | 3.728 |
| 10 | Organisational culture | 3.726 |
| 11 | Infrastructure and facilities | 3.820 |
| 12 | Financial growth | 3.823 |

To calculate the above score, 25 % of top performing companies and 25 % of lowest performing companies from the data collected is taken separately and the analysis

was done for the above twelve dimensions. It was found that the average score of all the top 25% companies were between 4.32 and 4.55 which is a very high score; since the weightage given for very high is 5 (it is close to very high).

Same type of analysis for the low performing companies was calculated and it was found that the average value varies between 2.52 to 2.95, where the weightage given for average is 3. So, almost all dimensions are having the average score around average. The calculated data is shown in the following table.

**Table No. 4.4: Table showing the average score of top and bottom 25% companies**

| Factor | Description of QM factors | Low 25 % Companies | High 25 % Companies |
|---|---|---|---|
| 1 | Top Management commitment and leadership | 2.599 | 4.512 |
| 2 | Quality Policy | 2.525 | 4.42 |
| 3 | Training to employees | 2.592 | 4.456 |
| 4 | Product design and operating system | 2.759 | 4.324 |
| 5 | Quality Information system | 2.562 | 4.519 |
| 6 | Employee participation and empowerment | 2.680 | 4.451 |
| 7 | Human resources management | 2.578 | 4.435 |
| 8 | Customer focus and satisfaction | 2.77 | 4.526 |
| 9 | Team work for continuous improvement | 2.666 | 4.526 |
| 10 | Organisational culture | 2.816 | 4.474 |
| 11 | Infrastructure and facilities | 2.958 | 4.553 |
| 12 | Financial Growth | 2.792 | 4.793 |

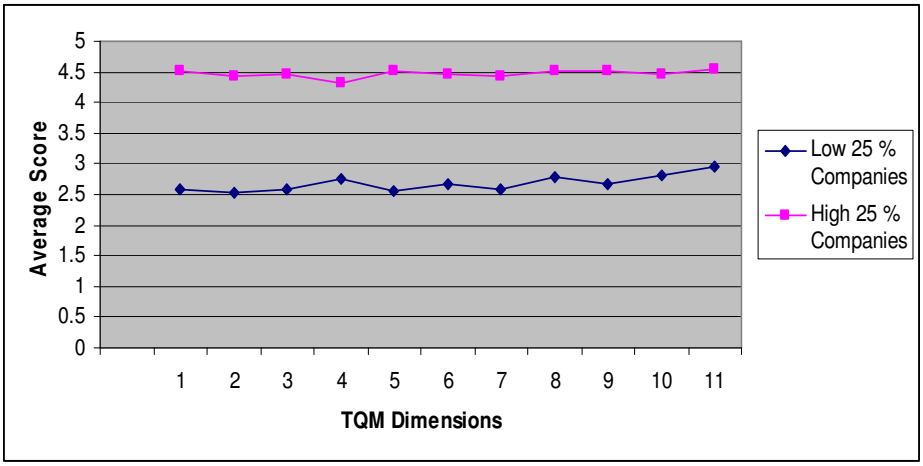


**Fig. 4.13: Figure showing the variation of average score for QM factors**

## 4.3 PERFORMANCE MEASURES

The impact of QM on financial growth was measured using different criteria.It was found that the profitability of the firms practicing QM has increased for the last three years and the average score was 4.01 on a 5 point scale.The return on investment is also highfor these companies with anaverage score of 3.71. Along with this it was found to have overall growth in the revenue also with an average score of 3.89. Most of the responses give their opinion as high in this case. It is also found that the overall operating cost of the company is also above average with a score of 3.60. 40% of the companies says that this cost is only average.The ability of the companies to complete the project within the budget is also found to be high to very high,with a score of 3.45.Due to the implementation of QM policies it was found that the value added per employee in the organization also increased to the higher side,with a score of 3.68 on an average.The savings in cost is also found to be high with a score of 3.59.These responses show that impact of QM has improved the financial performance of the companies by reducing the cost and by increasing the revenue and the value added per employee.The total score on this is 3.761.

## 4.4 BIVARIATE CORRELATION AMONG THE FACTORS

The discussion based on quality management literature reveals that quality management is an integrated approach where there is a lot of interdependence among its dimensions (factors). It has been proven that the soft aspects have a crucial role to play in achieving quality of products and services, though they are not quantitative and hence difficult to measure. Many quality gurus and practitioners have proposed these notions time and again. Several researchers also have reemphasized these views through their research findings (for example: Saraph *et al*., 1989; Joseph *et al* 1999; Suresh Chandar *et al*., 2001). This reinforces the view that a holistic philosophy and a set of practices that

are to be executed as a whole rather than piece by piece, would be more suitable to software industry since it is highly human oriented in nature. To obtain a glimpse of the relationship among various dimensions (factors) a bi-variate correlation analysis was performed. The results of the analysis are summarized in Table 4.5.

**Table No.4.5: Correlation among the QM factors – significant at 0.01 level for top 25% companies**

| | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **D1** | - | | | | | | | | | | | |
| **D2** | 0.915 | - | | | | | | | | | | |
| **D3** | 0.834 | 0.878 | - | | | | | | | | | |
| **D4** | 0.920 | 0.959 | 0.839 | - | | | | | | | | |
| **D5** | 0.786 | 0.866 | 0.915 | 0.785 | - | | | | | | | |
| **D6** | 0.817 | 0.868 | 0.846 | 0.817 | 0.856 | - | | | | | | |
| **D7** | 0.859 | 0.870 | 0.928 | 0.854 | 0.848 | 0.907 | - | | | | | |
| **D8** | 0.733 | 0.664 | 0.668 | 0.752 | 0.630 | 0.753 | 0.794 | - | | | | |
| **D9** | 0.859 | 0.777 | 0.747 | 0.730 | 0.705 | 0.897 | 0.891 | 0.852 | - | | | |
| **D10** | 0.826 | 0.897 | 0.794 | 0.752 | 0.862 | 0.843 | 0.835 | 0.694 | 0.769 | - | | |
| **D11** | 0.872 | 0.856 | 0.774 | 0.873 | 0.775 | 0.682 | 0.768 | 0.773 | 0.72 | 0.772 | - | |
| **D12** | 0.920 | 0.870 | 0.846 | 0.872 | 0.795 | 0.857 | 0.835 | 0.852 | 0.823 | 0.815 | 0.849 | - |

The above table gives the bivariate co-relation between the QM factors for the top 25 % of the companies.

All the correlations are found to be statistically significant at a level of 0.01. It is to be noted that all the correlations are positive. The high co-relation among the factors indicate a high degree of interdependence among the factors, which supports the view that a holistic approach for quality management is indeed appropriate in the case of the software industry. There is very high correlation between top management commitment and leadership and the other quality management dimensions. The highest among them are product design and operating procedure (0.920), financial growth (0.920), quality policy (0.915), infrastructure and facilities (0.872), Human resources management (0.859), team work for continuous improvement (0.859) and training to employees (0.834). This implies that the impetus for any quality management effort should come from top management. It also implies that the high correlation among top management

commitment and leadership, product design and operating procedure, quality policy, infrastructure facilities and human resource management emphasis the fact that top management commitment and leadership is a must and mandatory requirement. It can be seen that all the above highly co-related factors with the top management commitment and leadership form the part of the organizational system of a QM environment. Human resource management has reasonably high correlation with almost factors except with infrastructure and facilities. This shows that human resource management is a very important as far as QM is concerned. Low correlation with infrastructure and facilities indicates that it is only a means to achieve continuous improvement and therefore are not directly associated with customer satisfaction.

## 4.5 HIGH QUALITY ORIENTATION OF INDIAN COMPANIES

India has the largest number of quality certified software companies in the world (approximately 50 % of CMM level 5 companies in the world are in India). Quality has almost become an obsession with the software developers in India. They have seized upon the quality doctrine in the same way the Japanese embraced the quality concepts in manufacturing in 1950s and 1960s. Moreover, Indian software development firms are keen on attaining quality certification and implementing proven quality management techniques to maintain their competitive position in the global market. This has been acknowledged by software companies in the United States and other countries will begin to address quality issues when they start losing revenues and market share because of competition from India and elsewhere.

- Also on-time delivery track record has built a high reliability factor for Indian software and services companies.
- Supporting Govt. policy, rapidly improving telecom infrastructure and high quality offerings are some of the encouraging factors. The Indian Ministry of Information

and Telecommunication Technology is playing an active role in developing the infrastructure.

- Availability of a large human resource with strong technical skills is another strength for Indian Companies. Mostly our quantitative concepts coupled with English proficiency have resulted in these skills.
- Investments from non-resident Indians eagerness to accommodate clients and venture into capital funding to start-up software and IT units in the small scale sector also provide strength and stability to the Indian Software Industry.

According to market survey reported by the National Association of Software and Service Companies (NASSCOM), Indian software companies had 15 % of the global market share in the year 2002. Analysts say that India's quality and cost benefit edge is one of the major advantages for these organizations (NASSCOM 2002). The quality maturity of the Indian software Industry can be ascertained from the fact that already 342 Indian software companies have acquired quality certification and about 70 more are in line to do so. It may be noted that out of the total companies with CMM level 5 certification worldwide, nearly 50 % of them are in India. Nearly 75 % of off-shoring companies surveyed by Sand Hill Group are working in India. According to NASSCOM, software and service export revenue hit $ 17.9 billion in 2005. Again according to NASSCOM the Indian IT exports will touch with Rs. 132300 crores and if this continues the industry may rake in Rs.270000 crores by 2010.

**STRUCTURE OF INDIAN SOFTWARE EXPORTS INDUSTRY (2005-06)**

| Annual turn over | No. of Companies |
|---|---|
| Above Rs.1000 crores | 5 |
| Rs. 500 or to Rs. 1000 Cr | 5 |
| Rs. 250 crore to Rs. 500 | 16 |
| Rs. 100 cr to Rs. 250 cr. | 27 |
| Rs. 50 cr to 100 cr | 53 |
| Rs. 10 cr to Rs. 50 cr | 194 |
| Below Rs. 10 cr. | 614 |

# CHAPTER 5

# RELIABILITY AND VALIDITY ANALYSIS OF QUALITYMANAGEMENT PRACTICE MEASURES

In this chapter the reliability and validity analysis of the quality management performance measures is discussed and finally proposes a performance measurement frame work for quality management practice.

## 5.1 INTRODUCTION

A thorough measurement analysis on instruments used in empirical research is essential for several reasons. First, it provides a confidence that the empirical findings accurately reflect the proposed performance measures. Secondly empirically validated performance measures can be used directly in other studies in the field for different populations. They also yield valid tools to practitioners for assessment, bench marking and longitudinal evaluation of their programs.

Performance measures are useful for different applications, by different researchers in different studies, only if they are statistically reliable and valid. Reliability refers to the degree of dependability and stability of a performance measures (Ahire, *et al*., 1996). It reflects the performance measure's ability to consistently yield the same response (Flynn *et al*., 1994). A performance measure has construct validity if it is measuring the concept that it is intended to measure (Churchill, 1979)

In the following section, reliability and detailed item analysis are used to refine the items/variables of the performance measures for quality management practices in software industries.

In particular, measurement items are evaluated and, it shows to detract from the reliability of performance measures, are eliminated. Thus the performance measures are evaluated by conducting the content and construct validity.

## 5.2 RELIABILITY ASSESSMENT AND ITEM ANALYSIS

To arrive at a set of highly correlated items for further analysis, purification is carried out by corrected item minus total correlation (CIMTC).In order to initially assess the internal consistency of the item, an item intercorrelation matrix was constructed for each factor.In purification process,items are eliminated if their CIMTC is very less.CIMTC is the Pearson Correlation Coefficientbetween the scores on the individual item and the sum of the scores on the remaining items.

For example, the correlation between the score on item "HRM22"and the sum of the scores on items 1-150 is only 0.4071 (Table 5.1). This indicates that the relationship between HRM22 and other items are found to be low. On the other side item HRM3 has the highest correlation, 0.8067 with other items. Items having a relatively low correlation, less than 0.40 with the other items have to be deleted prior to further analysis in accordance with the recommendations of Flynn *et al*. (1994).Here a factor of 0.4 is taken as the cut off point for the purpose of improving the factor analysis results. All the values of CIMTC were found to be more than 0.40.

**Table 5.1: Item Statistics**

| Sl. No. | Item Code | Item Description | Mean | StdDev | CIMTC |
|---|---|---|---|---|---|
| 1. | TMC1 | Extent to which the top executive assumes responsibility for quality performance of the products and services of the company. | 3.9730 | 1.0851 | 0.5659 |
| 2. | TMC2 | Extent to which the top executives define quality from consumer's point of view. | 3.8514 | 1.1187 | 0.7223 |
| 3. | TMC3 | Extent to which the top executives view quality as more important than cost. | 3.7162 | 1.2444 | 0.7234 |
| 4. | TMC4 | Level of top executives' dynamism in leading the quality programme. | 3.6622 | 1.1501 | 0.6869 |
| 5. | TMC5 | Level to which the top management adopts quality management as a competitive strategy. | 3.7838 | 1.2081 | 0.6402 |
| 6. | TMC6 | Willingness of top management to allocate adequate resources and time for quality improvement efforts. | 3.6892 | 1.1459 | 0.7050 |
| 7. | TMC7 | Extent to which the quality mission forms the basis of strategic planning and decision making. | 3.6622 | 1.2744 | 0.7228 |
| 8. | TMC8 | Willingness of top management to identify and remove the root-cause problems of quality. | 3.7973 | 1.0201 | 0.6285 |
| 9. | TMC9 | Commitment of top management towards implementing quality standards or quality policy. | 3.7297 | 1.1855 | 0.6046 |
| 10. | TMC10 | Extent to which the top management supports long-term quality management policy. | 3.7027 | 1.2357 | 0.6851 |
| 11. | TMC11 | Extent to which the quality goals and policy are understood by the work force in the division. | 3.7838 | 1.1736 | 0.7516 |
| 12. | TMC12 | Amount of review of quality issues in top Management meetings. | 3.7703 | 1.1293 | 0.7106 |
| 13. | TMC13 | Extent to which the top management believes quality Improvement as a means to increase profits. | 3.7838 | 1.1967 | 0.5900 |
| 14. | TMC14 | Level of participation of major department heads in the quality improvement programme. | 3.7027 | 1.1554 | 0.7363 |
| 15. | TMC15 | Extent to which quality data such as cost of quality, defects, errors, rework etc. are used as tools to manage quality. | 3.6757 | 1.2062 | 0.6473 |
| 16. | TMC16 | Extent of time spent by the top management in evolving competitive bench marking. | 3.6622 | 1.1260 | 0.4759 |
| 17. | TMC17 | Extent to which the feedback data from after sales are used for continuous improvement of quality in the company as a whole. | 3.8514 | 1.0940 | 0.8061 |
| 18. | TMC18 | Specificity of quality goals in the company's business plans | 3.6216 | 1.0816 | 0.7311 |
| 19. | QP1 | Extent to which the company has a clear long-term vision statement. | 3.7432 | 1.2934 | 0.5841 |
| 20. | QP2 | The level at which the company's short term business plan influence the quality management practices. | 3.5000 | 1.1497 | 0.5237 |
| 21. | QP3 | The goals of QM and their benefits to people in achieving them are made known to all the employees. | 3.5270 | 1.1961 | 0.7024 |
| 22. | QP4 | Extent to which various quality plans and policies are communicated to the employees. | 3.6351 | 1.1771 | 0.6275 |
| 23. | QP5 | Amount of co-ordination between quality department and other departments. | 3.6216 | 1.1669 | 0.6881 |

| Sl. No. | Item Code | Item Description | Mean | StdDev | CIMTC |
|---|---|---|---|---|---|
| 24. | QP6 | Effectiveness of quality department in improving quality. | 3.8108 | 1.1308 | 0.7715 |
| 25. | QP7 | Degree to which divisional top management is evaluated for quality performance. | 3.5541 | 1.1365 | 0.7295 |
| 26. | QP8 | Extent to which the top management supports long term quality improvement programmes. | 3.6892 | 1.2042 | 0.6108 |
| 27. | QP9 | Extent to which quality data obtained after the implementation of QM practice are used to evaluate middle level management and their supervisory performance. | 3.5000 | 1.1378 | 0.6633 |
| 28. | QP10 | Extent to which the goals and policies with respect to quality management are understood by the employees. | 3.5541 | 1.1243 | 0.7503 |
| 29. | QP11 | Role and contribution of quality department with respect to quality policy, new software product development, specification etc | 3.7162 | 1.2109 | 0.7180 |
| 30. | QP12 | The ability of the firm for customer retention | 3.7568 | 1.1080 | 0.5846 |
| 31. | ET1 | Amount of training provided to employees in quality principles and policies. | 3.6622 | 1.0106 | 0.7455 |
| 32. | ET2 | Resources available for employee quality training. | 3.7432 | 1.0862 | 0.6969 |
| 33. | ET3 | Involvement of top management in quality training to employees. | 3.4865 | 1.2191 | 0.7982 |
| 34. | ET4 | Extent to which the management considers employee education and training as an investment. | 3.7703 | 1.1171 | 0.7407 |
| 35. | ET5 | Specific work skill training, technical and vocational given to employees throughout the division. | 3.7027 | 1.1554 | 0.7875 |
| 36. | ET6 | Quality of training in the “total quality concept” given to the employees in the division for quality development. | 3.7297 | .9972 | 0.4517 |
| 37. | ET7 | Extent of training given to the employees in the basic statistical techniques. | 3.5811 | 1.1587 | 0.5065 |
| 38. | ET8 | Extent of training in the advanced statistical techniques such as failure mode analysis, Regression analysis, six sigma etc. | 3.7297 | 1.1262 | 0.6342 |
| 39. | ET9 | Extent to which the employees are regarded as valuable, long term resources worthy of receiving education and training throughout their career. | 3.7703 | 1.2447 | 0.7195 |
| 40. | ET10 | Additional training required for the workers | 3.4595 | 1.0623 | 0.6028 |
| 41. | SPD1 | Extent to which the customer requirements are thoroughly considered in new product design. | 3.9730 | 1.0333 | 0.6545 |
| 42. | SPD2 | Level of participation of various departments in new product development. | 3.6351 | 1.0280 | 0.6317 |
| 43. | SPD3 | How far the new programmes/products are thoroughly reviewed before they are marketed. | 3.7432 | 1.0862 | 0.6125 |
| 44. | SPD4 | Extent of application of experimental design is in programme design. | 3.5000 | 1.2414 | 0.5552 |
| 45. | SPD5 | Coordination among various departments in the product/process development process. | 3.7432 | .9940 | 0.6363 |
| 46. | SPD6 | Extent to which quality data, control charts are displayed at the employee workplace | 3.5676 | 1.2830 | 0.6376 |
| 47. | SPD7 | The extent of customer satisfaction by the company due to new practices. | 3.6216 | 1.1669 | 0.5877 |

| Sl. No. | Item Code | Item Description | Mean | StdDev | CIMTC |
|---|---|---|---|---|---|
| 48. | SPD8 | The level in the reduction of project cycle times in the organization. | 3.6486 | 1.1637 | 0.5846 |
| 49. | SPD9 | The ability in the early detection of defects. | 4.0135 | .9721 | 0.6092 |
| 50. | SPD10 | The ability to predict the project delivery date. | 3.8243 | 1.0773 | 0.5703 |
| 51. | QIS1 | System existing in the organization to collect the cost of quality. | 3.5405 | 1.1958 | 0.6459 |
| 52. | QIS2 | Extent to which quality data are available to managers and supervisors. | 3.8378 | 1.0602 | 0.7486 |
| 53. | QIS3 | Extent to which the quality data are used to evaluate supervisor and managerial performance. | 3.6351 | 1.0543 | 0.7025 |
| 54. | QIS4 | Extent to which the quality feedback from the clients is taken care-off for further improvement. | 3.9459 | 1.0713 | 0.6943 |
| 55. | QIS5 | Extent to which the customer-contact personnel communicate with middle and top management on matters related to customer requirements and satisfaction. | 3.7568 | 1.3730 | 0.7234 |
| 56. | QIS6 | The overall effectiveness of communication process in the organization. | 3.7297 | 1.1016 | 0.6624 |
| 57. | QIS7 | Extent to which reports on the effectiveness of quality management programme are communicated to the employees. | 3.5946 | 1.1216 | 0.7344 |
| 58. | QIS8 | Extent to which the quality data are available to workers. | 3.8243 | 1.1746 | 0.7317 |
| 59. | EPE1 | All employee suggestions are evaluated in our company. | 3.6081 | 1.1565 | 0.6614 |
| 60. | EPE2 | Most employee suggestions are implemented after evaluation. | 3.6216 | 1.1551 | 0.6583 |
| 61. | EPE3 | Employees are encouraged to deal with the customer's complaints and needs. | 3.7162 | 1.0793 | 0.7287 |
| 62. | EPE4 | Employees are encouraged to contribute for improving quality and developmental performance. | 3.8514 | 1.1064 | 0.5625 |
| 63. | EPE5 | Extent of company's cross-functional teams' involvement in quality. | 3.5811 | 1.1227 | 0.7241 |
| 64. | EPE6 | Our company has several Quality Control circles(within one function) | 3.5270 | 1.2075 | 0.6721 |
| 65. | EPE7 | Employees are actively involved in quality related activities. | 3.7027 | 1.0433 | 0.6754 |
| 66. | EPE8 | Employees are very committed to the success of our company. | 3.6757 | 1.0868 | 0.6622 |
| 67. | EPE9 | Reporting of work problems are encouraged in our company. | 3.7297 | 1.2197 | 0.7389 |
| 68. | EPE10 | The degree to which the employees are given freedom and authority for operational independence and experimentation with respect communicated to the employees to project management activities. | 3.7838 | 1.0633 | 0.6585 |
| 69. | EPE11 | Extent to which the employees are given freedom to express their opinions, comments and criticisms on organizational functioning. | 3.7568 | 1.1325 | 0.7884 |
| 70. | EPE12 | Extent to which the involvement of team members at various stages in software projects are encouraged. | 3.9595 | .9992 | 0.5175 |

| Sl. No. | Item Code | Item Description | Mean | StdDev | CIMTC |
|---|---|---|---|---|---|
| 71. | EPE13 | The level of staff morale in the organization. | 3.8784 | .9502 | 0.6192 |
| 72. | EPE14 | How far the company allows flexible work practices. | 3.7162 | .8993 | 0.5958 |
| 73. | EPE15 | The level of overall employee satisfaction. | 3.8649 | 1.0112 | 0.6726 |
| 74. | EPE16 | The ability of the employees for innovative ideas. | 3.7568 | 1.1445 | 0.5113 |
| 75. | EPE17 | The ability to reduce the developed software modules. | 3.7162 | .8993 | 0.5958 |
| 76. | EPE18 | The level of increase in the market share of the company | 3.8649 | 1.0112 | 0.6726 |
| 77. | HRM1 | Extent to which employees are treated as long term assets of the organization. | 3.7027 | 1.1789 | 0.5402 |
| 78. | HRM2 | Extent of effort to recruit quality manpower. | 3.8378 | 1.1590 | 0.7274 |
| 79. | HRM3 | Effectiveness of strategies adopted for retaining talented and experienced people. | 3.5811 | 1.1587 | 0.8067 |
| 80. | HRM4 | Extent of effectiveness of the human resources plans with respect to human resource development training and empowerment. | 3.5270 | 1.0755 | 0.6523 |
| 81. | HRM5 | Attitude of labour unions towards quality improvement and management process. | 3.4865 | 1.1733 | 0.4844 |
| 82. | HRM6 | Quality emphasis by marketing and sales personnel. | 3.7568 | 1.1080 | 0.6212 |
| 83. | HRM7 | The extent of application of non-financial incentives for employee motivation. | 3.4595 | 1.1842 | 0.6221 |
| 84. | HRM8 | The effectiveness with which the company aligns human resource planning and management with company's strategic plans. | 3.7838 | 1.1137 | 0.6534 |
| 85. | HRM9 | Extent of effectiveness of Management Development Programme for the improvement of quality and productivity. | 3.5541 | 1.2066 | 0.6245 |
| 86. | HRM10 | Effectiveness of quality improvement teams in the division. | 3.5946 | 1.2266 | 0.5977 |
| 87. | HRM11 | The effectiveness with which the company evaluates and improves its human resource planning and management using employee related data. | 3.6757 | 1.1117 | 0.5821 |
| 88. | HRM12 | How far financial incentives are used for employee motivation. | 3.5946 | 1.1927 | 0.7411 |
| 89. | HRM13 | Degree of participation and contribution by major departmental heads in the quality improvement process. | 3.7162 | 1.2222 | 0.7329 |
| 90. | HRM14 | Degree to which employees are trained in team building and group dynamics for achieving the quality mission. | 3.4595 | 1.1958 | 0.5611 |
| 91. | HRM15 | Degree to which the employees are trained for developing their communication skills (written and verbal). | 3.6622 | 1.1381 | 0.6375 |
| 92. | HRM16 | Degree to which the employees are trained for developing their diagnostic and problem solving skills such as cause and effect analysis & brainstorming. | 3.5946 | 1.0969 | 0.6744 |
| 93. | HRM17 | The level of training of employees in quality management system such as CMM, ISO 9000 etc. | 3.7838 | 1.0240 | 0.5601 |

| Sl. No. | Item Code | Item Description | Mean | StdDev | CIMTC |
|---|---|---|---|---|---|
| 94. | HRM18 | The extent to which the employees are trained to identify and assign the right job for each person. | 3.4595 | 1.1842 | 0.6098 |
| 95. | HRM19 | The level of training of employees in skills related to the monitoring and control of s/w project management activities. | 3.6892 | 1.0970 | 0.5894 |
| 96. | HRM20 | The degree to which the employees are trained in using metrics for quality improvement. | 3.6081 | 1.2143 | 0.6850 |
| 97. | HRM21 | The extent to which the employees are trained in the estimation and auditing of costs related to software development. | 3.6351 | 1.1771 | 0.6419 |
| 98. | HRM22 | The level of education and training given to the employees in assessing the cost of quality and return on quality. | 3.5811 | 1.1937 | 0.4071 |
| 99. | HRM23 | The level of absenteeism in the company. | 3.4730 | 1.2521 | 0.5409 |
| 100. | HRM24 | The level of labour turn-over in the company. | 3.4595 | 1.2072 | 0.6838 |
| 101. | HRM25 | The level of complaints from the workers. | 3.3649 | 1.1051 | 0.5484 |
| 102. | CFS1 | People in my work unit care about our Customers. | 3.8919 | 1.1653 | 0.7434 |
| 103. | CFS2 | We monitor customer complaints and feedback and use these items as basis for determining customer satisfaction. | 3.8919 | 1.1886 | 0.6841 |
| 104. | CFS3 | We compare our customer satisfaction with our competitors. | 3.6081 | 1.0957 | 0.5723 |
| 105. | CFS4 | The level of customer involvement during the specification and design stages of the software project. | 3.7838 | 1.1618 | 0.7005 |
| 106. | CFS5 | The level of customer involvement during the development and testing stages of the software project. | 3.6486 | 1.2099 | 0.5774 |
| 107. | CFS6 | Extent to which the organization encourages the interaction between the customers and employees. | 3.8108 | 1.1308 | 0.6981 |
| 108. | CFS7 | Extent to which service is provided after project completion/project delivery. | 3.7973 | 1.0977 | 0.6892 |
| 109. | CFS8 | Extent to which attempts are made to satisfy the explicit, implicit and delight needs of the customers. | 3.8784 | 1.2923 | 0.6670 |
| 110. | CFS9 | Quality related customer complaints are treated with top priority. | 3.9324 | 1.1267 | 0.6158 |
| 111. | CFS10 | The on-line delivery of the projects by the organization. | 3.9054 | 1.0226 | 0.5933 |
| 112. | CFS11 | The degree of service level provided by the firm | 3.9595 | .9572 | 0.6427 |
| 113. | CI1 | Extent to which the ability to work in team is taken as a criteria in employee selection | 3.6351 | 1.1771 | 0.6492 |
| 114. | CI2 | The level of spirit of cooperation and team work in the organization. | 4.0000 | .9792 | 0.6388 |
| 115. | CI3 | Extent to which the members of the team are from various departments. | 3.6892 | 1.2488 | 0.6224 |
| 116. | CI4 | Extent to which the data are monitored for efficiency and effectiveness | 3.6622 | 1.1260 | 0.7400 |
| 117. | CI5 | The regularity in monitoring of quality of products and services. | 3.9054 | 1.1606 | 0.6675 |

| Sl. No. | Item Code | Item Description | Mean | StdDev | CIMTC |
|---|---|---|---|---|---|
| 118. | CI6 | How far the problem – solving tools for continuous improvement in quality is used. | 3.7297 | 1.1503 | 0.7327 |
| 119. | CI7 | The involvement of each and every member of the organization in improving quality. | 3.6216 | 1.0560 | 0.7902 |
| 120. | CI8 | Extent of quality related bench marking system in the organization. | 3.7838 | 1.0888 | 0.6592 |
| 121. | CI9 | The extent to which the software development processes are systematically measured and evaluated | 3.5270 | 1.1253 | 0.7541 |
| 122. | OC1 | Degree to which the employees accept quality as a strategic weapon to gain competitive advantage. | 3.6892 | 1.1459 | 0.7122 |
| 123. | OC2 | Degree to which the employees realize the importance of customer satisfaction in achieving quality. | 3.9459 | 1.1455 | 0.6900 |
| 124. | OC3 | The extent to which the employees believe in "doing things right first time and every time" | 3.6351 | 1.0800 | 0.5945 |
| 125. | OC4 | Support and cooperation of the employees towards the implementation of quality standards. | 3.6892 | 1.1339 | 0.6587 |
| 126. | OC5 | The level of trust and openness among team members. | 3.5541 | 1.0222 | 0.5420 |
| 127. | OC6 | The level of trust and openness between employees and management. | 3.7703 | 1.1533 | 0.6820 |
| 128. | OC7 | The level of coordination between the team members and their leader. | 3.8784 | 1.1220 | 0.6660 |
| 129. | OC8 | The level of coordination between project teams and top management. | 3.7568 | 1.1682 | 0.6685 |
| 130. | OC9 | The level of coordination between project teams and customers. | 3.9459 | 1.0322 | 0.5898 |
| 131. | OC10 | Attractiveness of salary and perks paid to the employees. | 3.6216 | 1.1902 | 0.5132 |
| 132. | OC11 | The degree of respect and fairness in treatment that the employee to get within the organization. | 3.7703 | 1.0923 | 0.7599 |
| 133. | OC12 | Availability of opportunities for career advancement. | 3.6622 | 1.1138 | 0.6706 |
| 134. | OC13 | Presence of incentive schemes based on performance to motivate employees. | 3.6216 | 1.1902 | 0.6257 |
| 135. | OC14 | Extent to which achievements in quality are recognized and rewarded. | 3.5676 | 1.0348 | 0.6367 |
| 136. | OC15 | Extent to which the roles and responsibilities of employees are specified clearly. | 3.5946 | 1.1577 | 0.7164 |
| 137. | OC16 | Extent to which the salaries are paid on time | 3.9324 | 1.1387 | 0.5084 |
| 138. | IF1 | Adequacy of hardware facilities provided. | 3.9324 | 1.1021 | 0.7894 |
| 139. | IF2 | Adequacy of software facilities provided. | 3.8108 | 1.0426 | 0.6522 |
| 140. | IF3 | Adequacy of information facilities such as Internet, access to journals and other publications, training and other facilities. | 3.8378 | 1.0472 | 0.6794 |
| 141. | IF4 | The degree to which the physical layout of the workplace and the environment at the work place are comfortable to the employees. | 3.7162 | 1.0666 | 0.6937 |

| Sl. No. | Item Code | Item Description | Mean | StdDev | CIMTC |
|---|---|---|---|---|---|
| 142. | FG1 | Extent of overall increase in profitability for the last three years. | 4.0135 | 1.0662 | 0.4675 |
| 143. | FG2 | Extent of increase in return on investment | 3.6892 | 0.9782 | 0.5405 |
| 144. | FG3 | The overall revenue growth of the company | 3.8919 | 1.0542 | 0.4304 |
| 145. | FG4 | The level of operating cost of the company. | 3.6081 | 0.9038 | 0.6302 |
| 146. | FG5 | Trends in cost relative to competitors. | 3.7703 | 1.0540 | 0.5336 |
| 147. | FG6 | The ability to complete the project within budget. | 3.8243 | 0.9842 | 0.5486 |
| 148. | FG7 | The value added per employee to the organization. | 3.6757 | 1.0868 | 0.5963 |
| 149. | FG8 | The extent of savings in cost due to improvement | 3.5811 | 1.0069 | 0.6463 |
| 150. | FG9 | The extent of getting repeat business in the firm | 3.7973 | 1.0201 | 0.5921 |

There are four methods to assess the reliability of empirical measurements as given below:

1. The re-test method
2. The alternative form method
3. The split-halves method.
4. The internal consistency method

The first three methods have limitations,particularly for field studies,such as requiring twoindependent administration of the instrument on the same group of peopleor requiring two alternate forms of the measuring instrument. In contrast,the internal consistency method work quite well in field studies because it requires only one administration.Also, it is the most general form of reliability estimation (Nunnally, 1967).

The internal consistency of a set of measurement items refers to the degree to which items in the set are homogenous.Internal consistency can be estimated using reliability coefficient, such as Cronbach's alpha (Nunnally, 1967; Saraph *et al*., 1989; Flynn *et al*., 1994; Wee and Quazi, 2005)

Prior to further analysis, using the SPSS® 11.5 for Windows®, reliability coefficient Cronbach's alpha was calculated for each construct. Although an alpha value of 0.70 is often considered as the criteria for internally consistent established performance measures/constructs/scale, Nunnally (1978) stated that permissible alpha value can be somewhat lower for new construct, suggesting the use of minimum alpha value of 0.60. Because there are new constructs, we have taken alpha value as 0.60.

Flynn *et al* (1994) suggested three methods to improve the reliability coefficient. First the construct should be accepted without any change if it has a strong alpha value (at least 0.70), with consistent item intercorrelation values. Second, constructs with acceptable, at least 0.60, but not high, alpha value should be further analyzed to determine whether alpha could be improved by removal of some items. The item inter correlation matrix served as a guide in determining which items contributed least and thus the best candidate for deletion. If their removal did not significantly alter the content of the construct, the relevant item should be eliminated. But at least three items should be retained in each construct in order to provide good resolution of the dimensionality of the construct. Third, a similar elimination analysis should be performed on the constructs, which failed to achieve the minimum criteria alpha value.If the construct still failed to achieve the criterion after elimination of items with lower item inter correlations, the entire construct should be discarded.

Table 5.2 provides a summary of the analysis using SPSS® 11.5 for MS Windows®. None of the items was deleted for improving the alpha value. Cronbach's alpha was acceptable for all the twelve proposed performance measures, ranging from 0.8575 to 0.9441.

**Table 5.2: Internal Consistency Analysis Results**

| Sl. No. | Item Description | Original No. of Items | Item deleted | Cronbach's alpha |
|---|---|---|---|---|
| 1. | Total Management Commitment & Leadership | 18 | Nil | 0.9427 |
| 2. | Quality Policy | 12 | Nil | 0.9132 |
| 3. | Employee Training | 10 | Nil | 0.8958 |
| 4. | Software Product Design & OP | 10 | Nil | 0.8589 |
| 5. | Quality Information System | 8 | Nil | 0.8868 |
| 6. | Employee Participation & Empowerment | 18 | Nil | 0.9355 |
| 7. | Human Resources Management | 25 | Nil | 0.9441 |
| 8. | Customer Focus & Satisfaction | 11 | Nil | 0.9006 |
| 9. | Continuous Improvement | 9 | Nil | 0.8962 |
| 10. | Organization Culture | 16 | Nil | 0.9286 |
| 11. | Infrastructure & facilities | 4 | Nil | 0.8575 |
| 12. | Financial Growth | 9 | Nil | 0.8788 |

After assessing the reliability of all the twelve performance measures, detailed item analysis was carried out by adopting Nunnally method for proper assignment of items to each construct. After elimination of items during reliability assessment,construct scores were calculated by averaging the scores of the remaining items under each construct.Item correlation score to each construct score was used to examine if an item belonged to the construct was assigned or not.Since the construct scores were the average of the respective hypothesized items under each construct,high correlation between each construct score and its respective items were expected.If an item correlates highly to its construct score, it is deemed that the particular item has been properly assigned to that construct. An item that correlated highly to other constructs scores relative to its own was dropped. Both reliability tests and item analysis were performed again.

Table 5.3 shows the new Cronbach's alpha values, ranging from 0.8401 to 0.9174, after the items were dropped.This demonstrates that the performance measures have relatively high scoresof reliability.

**Table 5.3: Summary of item analysis results**

| Sl. No. | Item Description | Original No. of Items | Item deleted | Remaining No. of items | Final Cronbach's Alpha |
|---|---|---|---|---|---|
| 1. | Total Management Commitment & Leadership | 18 | 7 | 11 | 0.9162 |
| 2. | Quality Policy | 12 | 0 | 12 | 0.9132 |
| 3. | Employee Training | 10 | 3 | 7 | 0.8779 |
| 4. | Software Product Design & OP | 10 | 2 | 8 | 0.8401 |
| 5. | Quality Information System | 8 | - | 8 | 0.8868 |
| 6. | Employee Participation & Empowerment | 18 | 6 | 12 | 0.9086 |
| 7. | Human Resources Management | 25 | 13 | 12 | 0.9174 |
| 8. | Customer Focus & Satisfaction | 11 | - | 11 | 0.9006 |
| 9. | Continuous Improvement | 9 | - | 9 | 0.8962 |
| 10. | Organization Culture | 16 | 5 | 11 | 0.9178 |
| 11. | Infrastructure & facilities | 4 | - | 4 | 0.8575 |
| 12. | Financial Growth | 9 | - | 9 | 0.8788 |

Table 5.4 shows the reliability assessment using item analysis. Column 1 of this table shows the performance measures and the remaining items under each measure. Column 2 shows the Cronbach's alpha for each performance measures taking into account all the remaining items. Column 3 shows the value of alpha and column 4 shows the value of correlation coefficient under each item if that item is also deleted from the remaining items in column 1. The value in column 3 and column 4 clearly shows that the removal of any of the remaining itemsdoes not improve the reliability of performance measures.

## Table 5.4: Detailed item analysis results

| Factor / Item | | Cronbach's Alpha | Cronbach's Alpha if item deleted | Correlation Coeff. |
|---|---|---|---|---|
| **Factor 1: Total Management Commitment & Leadership** | | **0.9162** | | |
| TMC1 | Extent to which the top executive assumes responsibility for quality performance of the products and services of the company. | | 0.9171 | 0.5059 |
| TMC4 | Level of top executives' dynamism in leading the quality programme. | | 0.9064 | 0.5789 |
| TMC7 | Extent to which the quality mission forms the basis of strategic planning and decision making. | | 0.9058 | 0.6639 |
| TMC8 | Willingness of top management to identify and remove the root-cause problems of quality. | | 0.9146 | 0.4028 |
| TMC10 | Extent to which the top management supports long-term quality management policy. | | 0.9089 | 0.5437 |
| TMC11 | Extent to which the quality goals and policy are understood by the work force in the division. | | 0.9014 | 0.728 |
| TMC12 | Amount of review of quality issues in top Management meetings. | | 0.9057 | 0.6038 |
| TMC13 | Extent to which the top management believes quality Improvement as a means to increase profits. | | 0.9131 | 0.4403 |
| TMC14 | Level of participation of major department heads in the quality improvement programme. | | 0.9034 | 0.6877 |
| TMC15 | Extent to which quality data such as cost of quality, defects, errors, rework etc. are used as tools to manage quality. | | 0.9142 | 0.4744 |
| TMC17 | Extent to which the feedback data from after sales are used for continuous improvement of quality in the company as a whole. | | 0.9048 | 0.6796 |
| **Factor 2: Quality Policy** | | **0.9132** | | |
| QP1 | Extent to which the company has a clear long-term vision statement. | | 0.9087 | 0.5097 |
| QP2 | The level at which the company's short term business plan influence the quality management practices. | | 0.9123 | 0.291 |
| QP3 | The goals of QM and their benefits to people in achieving them are made known to all the employees. | | 0.9034 | 0.5603 |
| QP4 | Extent to which various quality plans and policies are communicated to the employees. | | 0.9061 | 0.5878 |
| QP5 | Amount of co-ordination between quality department and other departments. | | 0.9033 | 0.5872 |
| QP6 | Effectiveness of quality department in improving quality. | | 0.8997 | 0.6833 |

| Factor / Item | | Cronbach's Alpha | Cronbach's Alpha if item deleted | Correlation Coeff. |
|---|---|---|---|---|
| QP7 | Degree to which divisional top management is evaluated for quality performance. | | 0.9021 | 0.6637 |
| QP8 | Extent to which the top management supports long term quality improvement programmes. | | 0.9098 | 0.3864 |
| QP9 | Extent to which quality data obtained after the implementation of QM practice are used to evaluate middle level management and their supervisory performance. | | 0.9041 | 0.5713 |
| QP10 | Extent to which the goals and policies with respect to quality management are understood by the employees. | | 0.9038 | 0.5359 |
| QP11 | Role and contribution of quality department with respect to quality policy, new software product development, specification etc | | 0.9016 | 0.6444 |
| QP12 | The ability of the firm for customer retention | | 0.9117 | 0.4167 |
| **Factor 3: Employee Training** | | **0.8779** | | |
| ET1 | Amount of training provided to employees in quality principles and policies. | | 0.8528 | 0.5915 |
| ET2 | Resources available for employee quality training. | | 0.8593 | 0.5062 |
| ET3 | Involvement of top management in quality training to employees. | | 0.8471 | 0.6228 |
| ET4 | Extent to which the management considers employee education and training as an investment. | | 0.862 | 0.4514 |
| ET5 | Specific work skill training, technical and vocational given to employees throughout the division. | | 0.8466 | 0.6736 |
| ET8 | Extent of training in the advanced statistical techniques such as failure mode analysis, Regression analysis, six sigma etc. | | 0.8767 | 0.3548 |
| ET10 | Additional training required for the workers | | 0.8751 | 0.3398 |
| **Factor 4: Software Product Design** | | **0.8401** | | |
| SPD1 | Extent to which the customer requirements are thoroughly considered in new product design. | | 0.8195 | 0.3517 |
| SPD2 | Level of participation of various departments in new product development. | | 0.8137 | 0.5055 |
| SPD3 | How far the new programmes/products are thoroughly reviewed before they are marketed. | | 0.8177 | 0.3789 |
| SPD5 | Coordination among various departments in the product/process development process. | | 0.8078 | 0.5797 |
| SPD6 | Extent to which quality data, control charts are displayed at the employee workplace | | 0.8282 | 0.3078 |
| SPD7 | The extent of customer satisfaction by the company due to new practices. | | 0.8151 | 0.4741 |

| Factor / Item | | Cronbach's Alpha | Cronbach's Alpha if item deleted | Correlation Coeff. |
|---|---|---|---|---|
| SPD9 | The ability in the early detection of defects. | | 0.8188 | 0.4367 |
| SPD10 | The ability to predict the project delivery date. | | 0.8193 | 0.3914 |
| **Factor 5: Quality Information System** | | **0.8868** | | |
| QIS1 | System existing in the organization to collect the cost of quality. | | 0.8736 | 0.5947 |
| QIS2 | Extent to which quality data are available to managers & supervisors. | | 0.8671 | 0.5942 |
| QIS3 | Extent to which the quality data are used to evaluate supervisor and managerial performance | | 0.8762 | 0.562 |
| QIS4 | Extent to which the quality feedback from the clients is taken care-off for further improvement. | | 0.8737 | 0.5983 |
| QIS5 | Extent to which the customer-contact personnel communicate with middle and top management on matters related to customer requirements and satisfaction. | | 0.8673 | 0.6771 |
| QIS6 | The overall effectiveness of communication process in the organization. | | 0.874 | 0.5623 |
| QIS7 | Extent to which reports on the effectiveness of quality management programme are communicated to the employees. | | 0.8697 | 0.6026 |
| QIS8 | Extent to which the quality data are available to workers. | | 0.8709 | 0.5516 |
| **Factor 6: Employee Participation** | | **0.9086** | | |
| EPE1 | All employee suggestions are evaluated in our company. | | 0.9008 | 0.6321 |
| EPE3 | Employees are encouraged to deal with the customer's complaints and needs. | | 0.8938 | 0.6896 |
| EPE5 | Extent of company's cross-functional teams' involvement in quality. | | 0.9013 | 0.4966 |
| EPE6 | Our company has several Quality Control circles (within one function) | | 0.9049 | 0.4207 |
| EPE8 | Employees are very committed to the success of our company. | | 0.8982 | 0.5332 |
| EPE9 | Reporting of work problems are encouraged in our company. | | 0.8947 | 0.6414 |
| EPE10 | The degree to which the employees are given freedom and authority for operational independence and experimentation with respect communicated to the employees to project management activities. | | 0.9004 | 0.5727 |

| Factor / Item | | Cronbach's Alpha | Cronbach's Alpha if item deleted | Correlation Coeff. |
|---|---|---|---|---|
| EPE11 | Extent to which the employees are given freedom to express their opinions, comments & criticisms on organizational functioning. | | 0.8957 | 0.6282 |
| EPE12 | Extent to which the involvement of team members at various stages in software projects are encouraged. | | 0.9037 | 0.3828 |
| EPE13 | The level of staff morale in the organization. | | 0.904 | 0.4267 |
| EPE14 | How far the company allows flexible work practices. | | 0.9044 | 0.3816 |
| EPE16 | The ability of the employees for innovative ideas. | | 0.9077 | 0.2941 |
| **Factor 7: Human Resources Management** | | **0.9174** | | |
| HRM2 | Extent of effort to recruit quality manpower. | | 0.9113 | 0.5176 |
| HRM3 | Effectiveness of strategies adopted for retaining talented and experienced people. | | 0.907 | 0.6011 |
| HRM6 | Quality emphasis by marketing and sales personnel. | | 0.9121 | 0.4528 |
| HRM8 | The effectiveness with which the company aligns human resource planning & management with company's strategic plans. | | 0.9087 | 0.5305 |
| HRM9 | Extent of effectiveness of Management Development Programme for the improvement of quality and productivity. | | 0.9133 | 0.4688 |
| HRM10 | Effectiveness of quality improvement teams in the division. | | 0.9077 | 0.5958 |
| HRM11 | The effectiveness with which the company evaluates and improves its human resource planning and management using employee related data. | | 0.9141 | 0.4424 |
| HRM13 | Degree of participation and contribution by major departmental heads in the quality improvement process. | | 0.9047 | 0.6926 |
| HRM14 | Degree to which employees are trained in team building and group dynamics for achieving the quality mission. | | 0.9058 | 0.6299 |
| HRM15 | Degree to which the employees are trained for developing their communication skills (written and verbal). | | 0.914 | 0.4194 |
| HRM17 | The level of training of employees in quality management system such as CMM, ISO 9000 etc. | | 0.9106 | 0.549 |
| HRM24 | The level of labour turn-over in the company. | | 0.916 | 0.4954 |
| **Factor 8: Customer Focus** | | **0.9006** | | |
| CFS1 | People in my work unit care about our Customers. | | 0.8868 | 0.5621 |
| CFS2 | We monitor customer complaints and feedback and use these items as basis for determining customer satisfaction. | | 0.8875 | 0.6658 |

| Factor / Item | | Cronbach's Alpha | Cronbach's Alpha if item deleted | Correlation Coeff. |
|---|---|---|---|---|
| CFS3 | We compare our customer satisfaction with our competitors. | | 0.8994 | 0.4262 |
| CFS4 | The level of customer involvement during the specification and design stages of the software project. | | 0.8884 | 0.6421 |
| CFS5 | The level of customer involvement during the development and testing stages of the software project. | | 0.8985 | 0.3673 |
| CFS6 | Extent to which the organization encourages the interaction between the customers and employees. | | 0.8882 | 0.6314 |
| CFS7 | Extent to which service is provided after project completion/project delivery. | | 0.8884 | 0.6273 |
| CFS8 | Extent to which attempts are made to satisfy the explicit, implicit and delight needs of the customers. | | 0.8897 | 0.6522 |
| CFS9 | Quality related customer complaints are treated with top priority. | | 0.8917 | 0.5853 |
| CFS10 | The on-line delivery of the projects by the organization. | | 0.8979 | 0.407 |
| CFS11 | The degree of service level provided by the firm | | 0.8995 | 0.3458 |
| **Factor 9: Continuous Improvement** | | **0.8962** | | |
| CI1 | Extent to which the ability to work in team is taken as a criteria in employee selection | | 0.8846 | 0.6421 |
| CI2 | The level of spirit of cooperation and team work in the organization. | | 0.8839 | 0.5074 |
| CI3 | Extent to which the members of the team are from various departments. | | 0.8951 | 0.4118 |
| CI4 | Extent to which the data are monitored for efficiency and effectiveness | | 0.88 | 0.5442 |
| CI5 | The regularity in monitoring of quality of products and services. | | 0.8859 | 0.4485 |
| CI6 | How far the problem – solving tools for continuous improvement in quality is used. | | 0.8741 | 0.6452 |
| CI7 | The involvement of each and every member of the organization in improving quality. | | 0.876 | 0.6119 |
| CI8 | Extent of quality related bench marking system in the organization. | | 0.8879 | 0.4927 |
| CI9 | The extent to which the software development processes are systematically measured and evaluated | | 0.8757 | 0.6863 |
| OC1 | Degree to which the employees accept quality as a strategic weapon to gain competitive advantage. | | 0.908 | 0.6261 |
| OC2 | Degree to which the employees realize the importance of customer satisfaction in achieving quality. | | 0.909 | 0.6579 |
| OC6 | The level of trust and openness between employees and management. | | 0.909 | 0.6796 |

| Factor / Item | | Cronbach's Alpha | Cronbach's Alpha if item deleted | Correlation Coeff. |
|---|---|---|---|---|
| **Factor 10: Organization Culture** | | **0.9178** | | |
| OC7 | The level of coordination between the team members and their leader. | | 0.9086 | 0.5994 |
| OC8 | The level of coordination between project teams and top management. | | 0.912 | 0.631 |
| OC9 | The level of coordination between project teams and customers. | | 0.9113 | 0.4637 |
| OC11 | The degree of respect and fairness in treatment that the employee to get within the organization. | | 0.9058 | 0.6338 |
| OC12 | Availability of opportunities for career advancement. | | 0.9133 | 0.4594 |
| OC13 | Presence of incentive schemes based on performance to motivate employees. | | 0.9153 | 0.401 |
| OC14 | Extent to which achievements in quality are recognized and rewarded. | | 0.9132 | 0.5147 |
| OC15 | Extent to which the roles and responsibilities of employees are specified clearly. | | 0.9052 | 0.7308 |
| **Factor 11: Infrastructure & facilities** | | **0.8575** | | |
| IF1 | Adequacy of hardware facilities provided. | | 0.8255 | 0.4773 |
| IF2 | Adequacy of software facilities provided. | | 0.8165 | 0.5183 |
| IF3 | Adequacy of information facilities such as Internet, access to journals and other publications, training and other facilities. | | 0.8328 | 0.4436 |
| IF4 | The degree to which the physical layout of the workplace and the environment at the work place are comfortable to the employees. | | 0.7979 | 0.5728 |
| **Factor 12: Financial Growth** | | **0.8788** | | |
| FG1 | Extent of overall increase in profitability for the last three years. | | 0.8663 | 0.5018 |
| FG2 | Extent of increase in return on investment | | 0.8614 | 0.5238 |
| FG3 | The overall revenue growth of the company | | 0.8647 | 0.5513 |
| FG4 | The level of operating cost of the company. | | 0.8616 | 0.4982 |
| FG5 | Trends in cost relative to competitors. | | 0.8694 | 0.3975 |
| FG6 | The ability to complete the project within budget. | | 0.8701 | 0.347 |
| FG7 | The value added per employee to the organization. | | 0.8659 | 0.4695 |
| FG8 | The extent of savings in cost due to improvement | | 0.8613 | 0.5178 |
| FG9 | The extent of getting repeat business in the firm | | 0.8599 | 0.5414 |

## 5.3 VALIDITY ANALYSIS

Once performance measures have been determined to be reliable, its validity can be assessed. The validity of a measure refers to how well it measures what it sets out to measure (Litwin, 1995). Content validity and construct validity approaches are normally considered to establish the validity.A measure has content validity if there is a general agreement among the subjects and researchers that the instrument has measurement items covering all aspects of the variable being measured. Thus content validity depends on how well the researchers created measurement items to cover the content domain of the variable being measured, (Saraph *et al*., 1989). A measure has construct validity if it measures the theoretical construct or trait that it was designed to measure (Saraph *et al*., 1989)

### 5.3.1 Content Validity

Content validity depends on the extent to which an empirical measurement reflects a specific domain of content.It cannot be evaluated numerically-it is a subjective measure of how appropriate the items seem to various reviewers who have some knowledge of the subject matter (Nunnally, 1967). The evaluation of content validity typically involves an organized review of the survey contents to ensure that it includes everything it should and does not include any thing that it should not.The instrument developed in this study demonstrates that the twelve performance measures for measuring the quality management practices in software industries have content validity since the development of the measurement items was mainly based on an extensive review of the literature and detailed evaluation by the academician and practitioners. The detailed process of developing the research instrument has been already described in the previous chapters.

Content validity, although mainly resting on rational rather than on empirical grounds, can be assessed to a higher degree, from information given by analytical results provided by item analysis (Saraph *et al*., 1989; Flynn *et al*., 1994; Black and Porter, 1996) discussed in the previous sections. The item analysis supports the rational acceptability of the item appearing in each of the twelve performance measures.

### 5.3.2 Construct Validity

A measure is said to have construct validity if it measures the theoretical construct that it is designed to measure. There are three method of determining construct validity

1. Multi-trait, multi method analysis
2. Factor analysis
3. Correlational and partial correlational analysis.

Factor analysis is used usually to identify the performance measures and their associated item/variables .Black and Porter (1996) used factor analytical method for identification of critical success factors of QM. Hoxley (2000) also developed a 26 item scale using the same method for assessing the service quality in UK construction industry. Saraph *et al*., (1989) used this method to evaluate the assignment of items to scales for developing their instrument for quality management.

Wee and Quazi (2005) used the factor analytical method for the identification of performance measures of environmental management. The test of factor ability has been conducted on a personal computer using the statistical computing package SPSS® 11.5 for MS Widows®. In recent past ,factor analysis has been carried out by using SPSS® 11.5 for MS Windows® in various survey related data analysis studies.(Ex: Saraph *et al*.,1989;Flynn *et al* ., 1994; Badri and Davis,1995; Black and Porter,1996; Quazi *et al* ., 1998; Wali *et al*., 2003; Wee and Quazi, 2005)

Factor analysis addresses the problem of analyzing the inter relationships among a large number of variables and then explaining these variables in terms of their common underlying factors/dimensions. The general purpose of factor analysis is to find a way of condensing or summarizing the information into a smaller set of new composite dimensions/factors with a minimum loss of information. There are two forms of factor analysis namely Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA).

The EFA is designed for the situation where links between the observed and latent variables are unknown or uncertain. The analysis thus proceeds in an exploratory mode to determine how and to what extent the observed variables are linked to their underlying factors. Factor loading is used to present these relations.The EFA helps to identify whether selected items cluster on one or more than one factor. The unidimensionality of factor is thus assessed. Usually three or more items are selected for a latent variable /construct. However, the aim of CFA is to test or conform a pre – specified relationship between factors and latent variables. EFA was carried out for the validation of the underlying factors. In general, there are two steps in a factor analysis:

1) The extraction of factors and 2) the rotation of factors.

The former finds number of factors and the latter obtains a clear picture of what these factors represent.

Next the appropriateness of the factor model is determined by examining the strength of the relationship among the items/variables. Correlation matrix, Barlett's test of sphericity and Kaiser-Meyer-Oklin (KMO) measure of sampling adequacy are the three measures recommended in the literature for this purpose (Heir *et al.*, 1995, Norusis 1994)

### 5.3.2.1 Correlation matrix

Visual inspection of the correlation values (Table 5.4) between the items in each factor reveals that all the correlations are greater than 0.30. This implies that the respective items under each factor are likely to have common factors (Heir *et al*., 1995, Norusis 1994)

### 5.3.2.2 Barlett's test of sphericity

This test assesses the overall significance of the correlation matrix. If the value of the statistic test of sphericity is large and the associated significance level is small, then it can be conclude that the variables are correlated( Heir *et al*.,1995, Norusis 1994) Barett's test of sphericity demonstrated sufficiently high values for all the twelve performance measures(at p<=0.0001)

### 5.3.2.3 KMO measure of sampling adequacy

The KMO test results shown in table 5.5 gives factors having KMO values ranging from 0.776 to 0.908, which is above the suggested minimum standard of 0.5 required for running factor analysis (Heir *et al*., 1995, Norusis 1994). Hence based on the above test, it is concluded that all twelve measures are suitable for applying factor analysis

**Table 5.5: KMO Measures of different factors**

| Performance Measure | KMO | Performance Measure | KMO |
|---|---|---|---|
| Total Management Commitment & Leadership | 0.881 | Human Resources Management | 0.908 |
| Quality Policy | 0.892 | Customer Focus & Satisfaction | 0.848 |
| Employee Training | 0.866 | Continuous Improvement | 0.855 |
| Software Product Design & OP | 0.777 | Organization Culture | 0.874 |
| Quality Information System | 0.776 | Infrastructure & facilities | 0.814 |
| Employee Participation & Empowerment | 0.899 | Financial Growth | 0.855 |

### 5.3.2.4 Factor Analysis

Factor analysis was conducted on items under each factor, based up on principle component analysis with varimax rotation. A total of twelve analyses were carried out. The number of factors to be extracted in each analysis was determined by the Eigen value of factors. Factors will be extracted in accordance to the number of Eigen value over 1. (Table 5.6)

**Table 5.6: Summary of Factor Analysis for each QM performance Measure**

| Performance Measure QM | Item loading range | Eigen Values | % variance | Number of factors Extracted |
|---|---|---|---|---|
| Total Management Commitment & Leadership | 0.571 – 0.857 | 6.074 | 55.216 | 1 |
| Quality Policy | 0.568 – 0.832 | 6.216 | 51.798 | 1 |
| Employee Training | 0.643 – 0.849 | 4.077 | 58.243 | 1 |
| Software Product Design & OP | 0.556 – 0.745 | 4.425 | 44.255 | 1 |
| Quality Information System | 0.706 – 0.786 | 4.469 | 55.865 | 1 |
| Employee Participation & Empowerment | 0.571 – 0.837 | 6.054 | 50.452 | 1 |
| Human Resources Management | 0.603 – 0.840 | 6.346 | 52.880 | 1 |
| Customer Focus & Satisfaction | 0.571 – 0.797 | 5.588 | 50.796 | 1 |
| Continuous Improvement | 0.606 – 0.822 | 4.955 | 55.051 | 1 |
| Organization Culture | 0.648 – 0.826 | 6.070 | 55.177 | 1 |
| Infrastructure & facilities | 0.811 – 0.870 | 2.804 | 70.096 | 1 |
| Financial Growth | 0.662 – 0.761 | 4.582 | 50.910 | 1 |

As seen from the table all factors /constructs are uni-factorial. This means that items hypothesized under these factors formed a single factor. Next an analysis of the factor loading was performed. The factor loading represents the correlation between the variables and their respective factor. The squared loading of each variable is the amount of the variable's total variants accounted for by its factor. Based upon the sample size of 74, factor loading is considered to be significant if they are greater that ±0.45 (Heir *et*

*al*., 1995). The factor loading of all the items under all twelve factors have met the above criterion, with the lowest loading at 0.556 as shown in table 5.6 and table 5.7. Since the factor loading exceeded ±0.45 values all items contributed to the factor represented. Thus the findings indicate that the factor have the construct validity.

**Table 5.7: Detailed Factor Analysis Result for QM Performance Measures**

| Factor | Code | Mean | StdDev | Commune | Factor Loading |
|---|---|---|---|---|---|
| 1. Total Management Commitment & Leadership | TMC1 | 3.9730 | 1.0851 | 0.326 | 0.571 |
| | TMC4 | 3.6622 | 1.1501 | 0.616 | 0.785 |
| | TMC7 | 3.6622 | 1.2744 | 0.636 | 0.798 |
| | TMC8 | 3.7973 | 1.0201 | 0.383 | 0.619 |
| | TMC10 | 3.7027 | 1.2357 | 0.540 | 0.735 |
| | TMC11 | 3.7838 | 1.1736 | 0.735 | 0.857 |
| | TMC12 | 3.7703 | 1.1293 | 0.635 | 0.797 |
| | TMC13 | 3.7838 | 1.1967 | 0.440 | 0.663 |
| | TMC14 | 3.7027 | 1.1554 | 0.693 | 0.833 |
| | TMC15 | 3.6757 | 1.2062 | 0.409 | 0.64 |
| | TMC17 | 3.8514 | 1.0940 | 0.661 | 0.813 |
| 2. Quality Policy | QP1 | 3.743243 | 1.293406 | 0.433 | 0.658 |
| | QP2 | 3.5 | 1.149747 | 0.323 | 0.568 |
| | QP3 | 3.527027 | 1.196146 | 0.581 | 0.762 |
| | QP4 | 3.635135 | 1.177114 | 0.495 | 0.703 |
| | QP5 | 3.621622 | 1.166927 | 0.580 | 0.762 |
| | QP6 | 3.810811 | 1.130834 | 0.692 | 0.832 |
| | QP7 | 3.554054 | 1.136468 | 0.617 | 0.786 |
| | QP8 | 3.689189 | 1.204167 | 0.399 | 0.632 |
| | QP9 | 3.5 | 1.13777 | 0.565 | 0.752 |
| | QP10 | 3.554054 | 1.124349 | 0.575 | 0.759 |
| | QP11 | 3.716216 | 1.210912 | 0.629 | 0.793 |
| | QP12 | 3.756757 | 1.108013 | 0.327 | 0.571 |

| | | | | | |
|---|---|---|---|---|---|
| 3. Employee Training | ET1 | 3.6622 | 1.01059 | 0.669 | 0.818 |
| | ET2 | 3.7432 | 1.08616 | 0.597 | 0.773 |
| | ET3 | 3.4865 | 1.21906 | 0.698 | 0.836 |
| | ET4 | 3.7703 | 1.11708 | 0.556 | 0.745 |
| | ET5 | 3.7027 | 1.15545 | 0.720 | 0.849 |
| | ET8 | 3.7297 | 1.12624 | 0.413 | 0.643 |
| | ET10 | 3.4595 | 1.06230 | 0.424 | 0.651 |
| 4. Software Product Design & OP | SPD1 | 3.9730 | 1.03332 | 0.452 | 0.672 |
| | SPD2 | 3.6351 | 1.02802 | 0.519 | 0.720 |
| | SPD3 | 3.7432 | 1.08616 | 0.461 | 0.679 |
| | SPD5 | 3.7432 | 0.99397 | 0.582 | 0.763 |
| | SPD6 | 3.5676 | 1.28299 | 0.381 | 0.617 |
| | SPD7 | 3.6216 | 1.16693 | 0.483 | 0.695 |
| | SPD9 | 4.0135 | 0.97212 | 0.451 | 0.672 |
| | SPD10 | 3.8243 | 1.07726 | 0.457 | 0.676 |
| 5. Quality Information System | QIS1 | 3.5405 | 1.1958 | 0.533 | 0.730 |
| | QIS2 | 3.8378 | 1.0602 | 0.618 | 0.786 |
| | QIS3 | 3.6351 | 1.0543 | 0.499 | 0.706 |
| | QIS4 | 3.9459 | 1.0713 | 0.526 | 0.725 |
| | QIS5 | 3.7568 | 1.3730 | 0.626 | 0.791 |
| | QIS6 | 3.7297 | 1.1016 | 0.524 | 0.724 |
| | QIS7 | 3.5946 | 1.1216 | 0.574 | 0.757 |
| | QIS8 | 3.8243 | 1.1746 | 0.569 | 0.754 |
| 6. Employee Participation & Empowerment | EPE1 | 3.6081 | 1.15649 | 0.505 | 0.711 |
| | EPE3 | 3.7162 | 1.07932 | 0.701 | 0.837 |
| | EPE5 | 3.5811 | 1.12270 | 0.482 | 0.695 |
| | EPE6 | 3.5270 | 1.20754 | 0.403 | 0.635 |
| | EPE8 | 3.6757 | 1.08676 | 0.577 | 0.759 |
| | EPE9 | 3.7297 | 1.21967 | 0.664 | 0.815 |
| | EPE10 | 3.7838 | 1.06334 | 0.519 | 0.720 |
| | EPE11 | 3.7568 | 1.13247 | 0.647 | 0.804 |
| | EPE12 | 3.9595 | 0.99917 | 0.424 | 0.651 |
| | EPE13 | 3.8784 | 0.95017 | 0.416 | 0.645 |
| | EPE14 | 3.7162 | 0.89932 | 0.390 | 0.624 |
| | EPE16 | 3.7568 | 1.14450 | 0.327 | 0.571 |

| | | | | | |
|---|---|---|---|---|---|
| 7. Human Resources Management | HRM2 | 3.8378 | 1.15897 | 0.510 | 0.714 |
| | HRM3 | 3.5811 | 1.15873 | 0.627 | 0.792 |
| | HRM6 | 3.7568 | 1.10801 | 0.474 | 0.689 |
| | HRM8 | 3.7838 | 1.11368 | 0.584 | 0.764 |
| | HRM9 | 3.5541 | 1.20662 | 0.448 | 0.67 |
| | HRM10 | 3.5946 | 1.22663 | 0.606 | 0.779 |
| | HRM11 | 3.6757 | 1.11168 | 0.411 | 0.641 |
| | HRM13 | 3.7162 | 1.22217 | 0.706 | 0.84 |
| | HRM14 | 3.4595 | 1.19576 | 0.668 | 0.817 |
| | HRM15 | 3.6622 | 1.13810 | 0.412 | 0.642 |
| | HRM17 | 3.7838 | 1.02396 | 0.536 | 0.732 |
| | HRM24 | 3.4595 | 1.20716 | 0.363 | 0.603 |
| 8. Customer Focus & Satisfaction | CFS1 | 3.8919 | 1.16534 | 0.636 | 0.797 |
| | CFS2 | 3.8919 | 1.18862 | 0.620 | 0.788 |
| | CFS3 | 3.6081 | 1.09566 | 0.341 | 0.584 |
| | CFS4 | 3.7838 | 1.16184 | 0.600 | 0.774 |
| | CFS5 | 3.6486 | 1.20992 | 0.380 | 0.616 |
| | CFS6 | 3.8108 | 1.13083 | 0.597 | 0.773 |
| | CFS7 | 3.7973 | 1.09769 | 0.606 | 0.779 |
| | CFS8 | 3.8784 | 1.29226 | 0.582 | 0.763 |
| | CFS9 | 3.9324 | 1.12665 | 0.530 | 0.728 |
| | CFS10 | 3.9054 | 1.02261 | 0.369 | 0.607 |
| | CFS11 | 3.9595 | 0.95715 | 0.327 | 0.571 |
| 9. Continuous Improvement | CI1 | 3.6351 | 1.17711 | 0.525 | 0.724 |
| | CI2 | 4.0000 | 0.97924 | 0.528 | 0.727 |
| | CI3 | 3.6892 | 1.24884 | 0.367 | 0.606 |
| | CI4 | 3.6622 | 1.12599 | 0.596 | 0.772 |
| | CI5 | 3.9054 | 1.16064 | 0.484 | 0.696 |
| | CI6 | 3.7297 | 1.15031 | 0.676 | 0.822 |
| | CI7 | 3.6216 | 1.05600 | 0.658 | 0.811 |
| | CI8 | 3.7838 | 1.08880 | 0.459 | 0.678 |
| | CI9 | 3.5270 | 1.12534 | 0.661 | 0.813 |

| | | | | | |
|---|---|---|---|---|---|
| 10. Organization Culture | OC1 | 3.6892 | 1.14588 | 0.607 | 0.779 |
| | OC2 | 3.9459 | 1.14547 | 0.570 | 0.755 |
| | OC6 | 3.7703 | 1.15328 | 0.584 | 0.764 |
| | OC7 | 3.8784 | 1.12204 | 0.592 | 0.769 |
| | OC8 | 3.7568 | 1.16820 | 0.504 | 0.710 |
| | OC9 | 3.9459 | 1.03225 | 0.515 | 0.718 |
| | OC11 | 3.7703 | 1.09228 | 0.674 | 0.821 |
| | OC12 | 3.6622 | 1.11376 | 0.458 | 0.677 |
| | OC13 | 3.622 | 1.1902 | 0.420 | 0.648 |
| | OC14 | 3.5676 | 1.03475 | 0.463 | 0.681 |
| | OC15 | 3.5946 | 1.15769 | 0.682 | 0.826 |
| 11. Infrastructure & facilities | IF1 | 3.9324 | 1.10207 | 0.682 | 0.826 |
| | IF2 | 3.8108 | 1.04260 | 0.708 | 0.842 |
| | IF3 | 3.8378 | 1.04720 | 0.658 | 0.811 |
| | IF4 | 3.7162 | 1.06656 | 0.757 | 0.870 |
| 12. Financial Growth | FG1 | 4.0135 | 1.06621 | 0.477 | 0.691 |
| | FG2 | 3.6892 | 0.97820 | 0.559 | 0.748 |
| | FG3 | 3.8919 | 1.05425 | 0.491 | 0.700 |
| | FG4 | 3.6081 | 0.90384 | 0.561 | 0.749 |
| | FG5 | 3.7703 | 1.05399 | 0.439 | 0.662 |
| | FG6 | 3.8243 | 0.98423 | 0.422 | 0.649 |
| | FG7 | 3.6757 | 1.08676 | 0.495 | 0.703 |
| | FG8 | 3.5811 | 1.00692 | 0.560 | 0.749 |
| | FG9 | 3.7973 | 1.02007 | 0.579 | 0.761 |

Finally table 5.8 shows the validated quality management performance measures along with their items.

**Table 5.8: Final Quality Management Performance Measures**

| Item | Performance Measures/Items |
|---|---|
| | **Total Management Commitment & Leadership** |
| TMC1 | Extent to which the top executive assumes responsibility for quality performance of the products and services of the company. |
| TMC4 | Level of top executives' dynamism in leading the quality programme. |
| TMC7 | Extent to which the quality mission forms the basis of strategic planning and decision making. |
| TMC8 | Willingness of top management to identify and remove the root-cause problems of quality. |
| TMC10 | Extent to which the top management supports long-term quality management policy. |
| TMC11 | Extent to which the quality goals and policy are understood by the work force in the division. |
| TMC12 | Amount of review of quality issues in top Management meetings. |
| TMC13 | Extent to which the top management believes quality Improvement as a means to increase profits. |
| TMC14 | Level of participation of major department heads in the quality improvement programme. |
| TMC15 | Extent to which quality data such as cost of quality, defects, errors, rework etc. are used as tools to manage quality. |
| TMC17 | Extent to which the feedback data from after sales are used for continuous improvement of quality in the company as a whole. |
| | **Quality Policy** |
| QP1 | Extent to which the company has a clear long-term vision statement. |
| QP2 | The level at which the company's short term business plan influence the quality management practices. |
| QP3 | The goals of QM and their benefits to people in achieving them are made known to all the employees. |
| QP4 | Extent to which various quality plans and policies are communicated to the employees. |
| QP5 | Amount of co-ordination between quality department and other departments. |
| QP6 | Effectiveness of quality department in improving quality. |
| QP7 | Degree to which divisional top management is evaluated for quality performance. |
| QP8 | Extent to which the top management supports long term quality improvement programmes. |
| QP9 | Extent to which quality data obtained after the implementation of QM practice are used to evaluate middle level management and their supervisory performance. |
| QP10 | Extent to which the goals and policies with respect to quality management are understood by the employees. |

| | |
|---|---|
| QP11 | Role and contribution of quality department with respect to quality policy, new software product development, specification etc |
| QP12 | The ability of the firm for customer retention |
| | **Employee Training** |
| ET1 | Amount of training provided to employees in quality principles and policies. |
| ET2 | Resources available for employee quality training. |
| ET3 | Involvement of top management in quality training to employees. |
| ET4 | Extent to which the management considers employee education and training as an investment. |
| ET5 | Specific work skill training, technical and vocational given to employees throughout the division. |
| ET8 | Extent of training in the advanced statistical techniques such as failure mode analysis, Regression analysis, six sigma etc. |
| ET10 | Additional training required for the workers |
| | **Software Product Design & OP** |
| SPD1 | Extent to which the customer requirements are thoroughly considered in new product design. |
| SPD2 | Level of participation of various departments in new product development. |
| SPD3 | How far the new programmes/products are thoroughly reviewed before they are marketed. |
| SPD5 | Coordination among various departments in the product/process development process. |
| SPD6 | Extent to which quality data, control charts are displayed at the employee workplace |
| SPD7 | The extent of customer satisfaction by the company due to new practices. |
| SPD9 | The ability in the early detection of defects. |
| SPD10 | The ability to predict the project delivery date. |
| | **Quality Information System** |
| QIS1 | System existing in the organization to collect the cost of quality. |
| QIS2 | Extent to which quality data are available to managers and supervisors. |
| QIS3 | Extent to which the quality data are used to evaluate supervisor and managerial performance. |
| QIS4 | Extent to which the quality feedback from the clients is taken care-off for further improvement. |
| QIS5 | Extent to which the customer-contact personnel communicate with middle and top management on matters related to customer requirements and satisfaction. |
| QIS6 | The overall effectiveness of communication process in the organization. |
| QIS7 | Extent to which reports on the effectiveness of quality management programme are communicated to the employees. |
| QIS8 | Extent to which the quality data are available to workers. |

| | |
|---|---|
| | **Employee Participation & Empowerment** |
| EPE1 | All employee suggestions are evaluated in our company. |
| EPE3 | Employees are encouraged to deal with the customer's complaints and needs. |
| EPE5 | Extent of company's cross-functional teams' involvement in quality. |
| EPE6 | Our company has several Quality Control circles(within one function) |
| EPE8 | Employees are very committed to the success of our company. |
| EPE9 | Reporting of work problems are encouraged in our company. |
| EPE10 | The degree to which the employees are given freedom and authority for operational independence and experimentation with respect communicated to the employees to project management activities. |
| EPE11 | Extent to which the employees are given freedom to express their opinions, comments and criticisms on organizational functioning. |
| EPE12 | Extent to which the involvement of team members at various stages in software projects are encouraged. |
| EPE13 | The level of staff morale in the organization. |
| EPE14 | How far the company allows flexible work practices. |
| EPE16 | The ability of the employees for innovative ideas. |
| | **Human Resources Management** |
| HRM2 | Extent of effort to recruit quality manpower. |
| HRM3 | Effectiveness of strategies adopted for retaining talented and experienced people. |
| HRM6 | Quality emphasis by marketing and sales personnel. |
| HRM8 | The effectiveness with which the company aligns human resource planning and management with company's strategic plans. |
| HRM9 | Extent of effectiveness of Management Development Programme for the improvement of quality and productivity. |
| HRM10 | Effectiveness of quality improvement teams in the division. |
| HRM11 | The effectiveness with which the company evaluates and improves its human resource planning and management using employee related data. |
| HRM13 | Degree of participation and contribution by major departmental heads in the quality improvement process. |
| HRM14 | Degree to which employees are trained in team building and group dynamics for achieving the quality mission. |
| HRM15 | Degree to which the employees are trained for developing their communication skills (written and verbal). |
| HRM17 | The level of training of employees in quality management system such as CMM, ISO 9000 etc. |
| HRM24 | The level of labour turn-over in the company. |
| | **Customer Focus & Satisfaction** |
| CFS1 | People in my work unit care about our Customers. |
| CFS2 | We monitor customer complaints and feedback and use these items as basis for determining customer satisfaction. |

| | |
|---|---|
| CFS3 | We compare our customer satisfaction with our competitors. |
| CFS4 | The level of customer involvement during the specification and design stages of the software project. |
| CFS5 | The level of customer involvement during the development and testing stages of the software project. |
| CFS6 | Extent to which the organization encourages the interaction between the customers and employees. |
| CFS7 | Extent to which service is provided after project completion/project delivery. |
| CFS8 | Extent to which attempts are made to satisfy the explicit, implicit and delight needs of the customers. |
| CFS9 | Quality related customer complaints are treated with top priority. |
| CFS10 | The on-line delivery of the projects by the organization. |
| CFS11 | The degree of service level provided by the firm |
| | **Continuous Improvement** |
| CI1 | Extent to which the ability to work in team is taken as a criteria in employee selection |
| CI2 | The level of spirit of cooperation and team work in the organization. |
| CI3 | Extent to which the members of the team are from various departments. |
| CI4 | Extent to which the data are monitored for efficiency and effectiveness |
| CI5 | The regularity in monitoring of quality of products and services. |
| CI6 | How far the problem – solving tools for continuous improvement in quality is used. |
| CI7 | The involvement of each and every member of the organization in improving quality. |
| CI8 | Extent of quality related bench marking system in the organization. |
| CI9 | The extent to which the software development processes are systematically measured and evaluated |
| | **Organization Culture** |
| OC1 | Degree to which the employees accept quality as a strategic weapon to gain competitive advantage. |
| OC2 | Degree to which the employees realize the importance of customer satisfaction in achieving quality. |
| OC6 | The level of trust and openness between employees and management. |
| OC7 | The level of coordination between the team members and their leader. |
| OC8 | The level of coordination between project teams and top management. |
| OC9 | The level of coordination between project teams and customers. |
| OC11 | The degree of respect and fairness in treatment that the employee to get within the organization. |
| OC12 | Availability of opportunities for career advancement. |
| OC13 | Presence of incentive schemes based on performance to motivate employees. |

| | |
|---|---|
| OC14 | Extent to which achievements in quality are recognized and rewarded. |
| OC15 | Extent to which the roles and responsibilities of employees are specified clearly. |
| | **Infrastructure & facilities** |
| IF1 | Adequacy of hardware facilities provided. |
| IF2 | Adequacy of software facilities provided. |
| IF3 | Adequacy of information facilities such as Internet, access to journals and other publications, training and other facilities. |
| IF4 | The degree to which the physical layout of the workplace and the environment at the work place are comfortable to the employees. |
| | **Financial Growth** |
| FG1 | Extent of overall increase in profitability for the last three years. |
| FG2 | Extent of increase in return on investment |
| FG3 | The overall revenue growth of the company |
| FG4 | The level of operating cost of the company. |
| FG5 | Trends in cost relative to competitors. |
| FG6 | The ability to complete the project within budget. |
| FG7 | The value added per employee to the organization. |
| FG8 | The extent of savings in cost due to improvement |
| FG9 | The extent of getting repeat business in the firm |

## 5.4 RESULTS AND DISCUSSIONS

Empirical values of this study shows that the performance measures of quality management are reliable and valid. The systematic literature review and the comprehensive pre-testing of the performance measures helped to ensure that the measure have content validity.

The obtained reliability coefficient Cronbach's alpha, of the twelve performance measures ranged from 0.8401 to 0.9178, all exceeding the minimum criterion value of 0.7. This is quite good for an instrument which is composed of new performance measures, particularly for those performance measures which do not contain large number of items.

Items had shown high correlation with the performance measures that they are assigned to. For example, the range of correlation coefficient for top management commitment ranged between 0.4028 to 0.7280;for quality policy 0.2910 to 0.6833; for employee training 0.3398 to 0.6736; for software product design 0.3078 to 0.5797; for quality information system 0.5516 to 0.6771; for employee participation 0.2941 to 0.6896; for human resource management 0.4194 to 0.6926; for customer focus 0.3458 to 0.6658; for continuous improvement 0.4118 to 0.6863; for organization culture 0.4010 to 0.7308; for infrastructure and facilities 0.4436 to 0.5728 and for financial growth 0.3470 to 0.5513.

Hence it can be concluded that all the items had been properly assigned to their respective performance measures. Barlett's test of sphericity and KMO measures of sampling adequacy also show that there exists high strength of relationships among items/variables.

Factor analysis of each performance measure was used to test the construct validity of each performance measure. The factor matrix showed that they were all unifactorial, that is the items in all of the twelve performance measures formed a single factor. This was seen as a tentative evidence of construct validity of the twelve performance measures.

## 5.5. PROPOSED PERFORMANCE MEASUREMENT FRAMEWORK FOR QUALITY MANAGEMENT

Based on the exhaustive literature survey, twelve performance measures have been developed to measure the performance of quality management practices. For each performance measure, a number of items/variables have been developed to gauge the measure of each performance measure. The data collected from various software companies was used for reliability and validity assessment of these performance

measures. These reliable and valid performance measures and their item/variables are shown in table 5.8.

A frame work of performance measures is proposed for the assessment of quality management practices as shown in fig 5.1

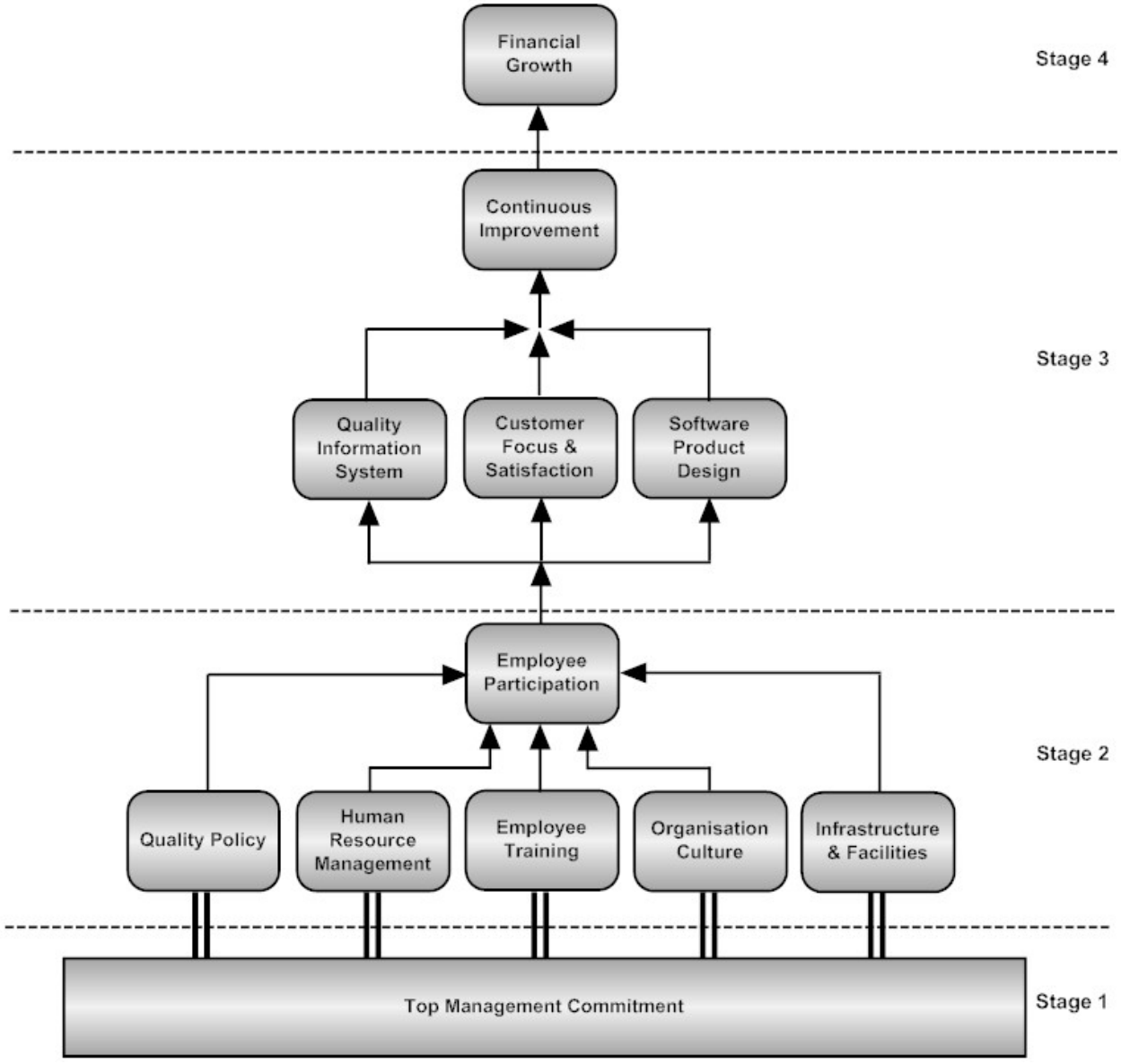


***Fig 5.1Proposed Performance Measurement Framework for Quality Management***

The five stages are:Stage 1-top management commitment and leadership; Stage 2-learning and growth; Stage 3- internal process in the organization; Stage 4–customer

care stage and Stage 5-financial growth. All the twelve performance measures are included in these five stages.

Top Management Commitment and Leadership are at the base /foundation of the frame work. An attitude change is necessary for the implementation of all the aspects of QM. Without the support of top management in the area of resource allocation,continuous monitoring of the progress and the change management, the cultural change is impossible. Also top management commitment to the employee training and learning and empowerment is critical for the successful implementation of QM. Especially in the software industries, continuous employee training and empowerment is very essential due to the competitive nature of the industry .As on today with the vast area of knowledge available, employee should be trained in all the technical areas to enhance the knowledge to have innovative software products to the satisfaction of the global customers.

Empowered cross functional teams are also necessary in the organization. Willing participation of an employee in various cross functional teams is possible only if an employee is empowered, satisfied, trained and with proper attitude. The ability of an organization to deliver customized quality goods and products to the satisfaction of the customer is dependent upon the internal processes/culture of the organization. Now due to global market and global competition, customer satisfaction is vital for an organization to stay in businessmanagers/decision makers/project leaders in the software area can use this proposed frame work to measure the performance of their software companies The prevailing status of the organization can be measured by this frame work, can assign responsibilities and resources if needed and can monitor the progress towards the implementation of QM.

# CHAPTER 6

## CONCLUSIONS

Global competitions, especially from China, changing technologies and the shorter life cycles of the products have made the software area very competitive. Nowadays companies face significant uncertainties and continuous changes, also global depression in software area. Customer requires low priced high quality products at specific target dates. So, new methods and technologies are to be developed. A firm which follows total quality management principles can meet all the challenges as and when they occur. Progress can be made only with continuous improvement in all the areas .In this work, development and validation of performance measures has focused.

Chapter 3 presents the method developed and used for the development and validation of the performance measures of total quality management. A set of twelve performance measures for total quality management-top management commitment and leadership; quality policy; employee training; software product design; quality information system; employee participation and empowerment; human resources management; customer focus; continuous improvement; organization culture; infrastructure and facilities and financial growth. These were developed from the review of the literature and by personal discussions with the working software professionals .Finally 150 variables were identified under twelve performance measures.

Chapter 4 describes the development of a survey instrument and its pre-testing along with the data collection methodology and the analysis of the collected data. The respondents by size and by their turnover showed that these companies are mainly medium and small sized. Mean experiences of the respondents were between 6 to 10 years which is much more sufficient in the software industries to give a good response

for the various performance measurements concerned. In software companies, much hierarchy is not there, only the expertise is important. People with good technical knowhow will lead the team of people in the projects. All the companies have a mission and vision and written quality management practices. Most of the companies have CMM 5 level certification, means they practice quality management practices. The importance index analysis of the collected data shows that the items/variables established for the measurement of the performance measures have been properly selected as practitioners categorized the item/variables as very important 38.5 % and important 61.5 %., There was none under less important and not important category. Dimensional analysis is also carried out for the top performance scoring companies and bottom score companies.

Chapter 5 discusses the reliability and validity analysis of the performance measure carried out by using SPSS® 11.5 for MS Windows®. The Pearson Correlation Coefficient (CIMTC) for the various measurement items /variables of the performance measures indicates that the items have a high correlation among themselves (average CIMTC is 0.74) and no item was found to have less than the generally accepted correlation value of 0.3.All the twelve performance measures are found to be reliable as the value of the reliability coefficient, Cronbach's alpha, for these performance measures are greater than the generally accepted value of 0.6.The Cronbach's alpha value for the performance measures ranges from 0.8575 to 0.9441. However during the detailed item analysis, 36 of the items correlated highly to other construct scores relative to their own construct score and have been dropped. Finally the Cronbach's alpha values ranged from 0.8401 to 0.9178. This demonstrates that the performance measures have relatively high scores of reliability. The computed value of correlation matrix, Barlett's test of sphericity and KMO measure of sampling (0.776 to 0.908) adequacy show a high strength of relationship among the remaining items. The factor analysis shows that all

the proposed twelve performance measures are one-dimensional with adequate item loading ranges. From these results, it can be concluded that all the proposed performance measures have construct validity. Finally, the proposed framework of the twelve performance measures is presented at the end of the chapter.

**Some contribution of the work**

- The extensive review of the literature revealed that the organizations adopting quality management practices needs new methods of performance measurement based on continuous improvement.
- Developed a method for the development and validation of the performance measures.
- Developed twelve performance measures based on a detailed review of literature and with discussions with actual software practitioners.
- Developed item/variables for measuring the performance.
- Developed a survey instrument to collect the data for the validation of performance measure.
- Assessed reliability and validity of the performance measures by using SPSS® 11.5 for MS Windows®.
- Developed a framework for performance measures of total quality management

**Limitations and scope for future work**

This study covered only software companies in India. Similar study can be undertaken among a large number of other industries and it can be compared. Performance measures were developed based upon self-reported information from the respondents. Questions were subjective in nature. Respondents were asked to rate the items based upon their perception, as to the extent to which the items were applicable in their respective companies. Hence, a certain amount of bias might have been introduced into the data

collected. This study can be extended to compare the practices followed in other countries also for competing efficiently in the global market. Research can be done to find out whether any other critical factors can enhance the validity and reliability of the study. Also a comparison can be done between clustered and non-clustered companies also for further enhancement of the TQM idea.

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# Appendix I

## Critical factors of quality management in software industry (QM factors)

| Factor | Description | Important Reference |
|---|---|---|
| TMLC | It is the art of leading and imposing a change in the organization by formulating a long-range vision for the development of the organization. Leadership also involves propagating the vision throughout the organization, developing a plan of action, and propelling the organization toward to accomplishment of the vision. | Ahire, Landeros, and Golhar 1995; Parzinger and Nath 1998; Jorgensen 1999; Wynekoop and Walz 2000; Li, Chen, and Cheung 2000; Sureshchandar, Rajendran, and Anantharaman 2002 |
| OC | Refers to the significance of a favorable atmosphere in the organization, its role in creating an enjoyable work culture in the organizations, and its consequences. | Ahire, Landeros, and Golhar 1995; Adam, Flores, and Macias 2001 |
| CF | It addresses responding to customers' needs and demands. It also includes anticipating and responding to their evolving interests and wants. | Adam, Flores, and Macias 2001; Sureshchander, Rajendran, and Anantharaman 2002 |
| PQM | Refers to the function of process management, and the measurement and analysis of data or information. | Flynn, Schroeder, and Sakakibara 1994; Bunse, Verlage, and Giese 1998; Jalote 2000 |
| QMET | Metrics, in general, are used to quantify the schedule, effort, size, defect density, and other measures of quality performance. They are also used to track the effectiveness of process implementation practices | Parzinger and Nath 1993; Jalote 2000 |
| HRM | Refers to many organizational behaviour issues such as recruitment, selection, training, and so on. The basic issue is to treat employees as precious assets. Its significance is underscored in people-centered organizations such as the software industry. | Powell 1995; Schneider and Bowen 1995; Bunse, Verlage, and Giese 1998; Arora et al. 200; Paul and Anantharaman 2002 |
| EE | Means sanctioning authority with responsibility to employees at all levels. This leads an organization to have total involvement of all employees in the organization. | Shrednick, Shutt, and Weiss. 1992; Li, Chen, and Cheung 2000 |

| | | |
|---|---|---|
| CI | Improvement must be viewed as a never-ending process, and targets must be reset regularly. Therefore, it sets up an endless race, always probing for breakthroughs that will result in transforming the organization into a better one. | Ahire, Golhar, and Waller 1996 |
| BM | Means a comparison standard. It also consists of collecting information, then analyzing and using information to improve one's own products and compare it with the best competitor in business. | Cortada 1995; Li, Chen, and Cheung 2000 |
| IF | Good workmanship and high motivation levels alone do not create good quality. It depends on tools, good materials, good methods, and management techniques. The term "facilities" also includes sufficient conference rooms; training areas; physical resources such as furniture, computers, application software; and communication technologies such as telephone, fax, and e-mail | Bahrami and Evans, 1997; Li Chen, and Cheung 2000; Jalote 2000 |
| COM | Communication helps to provide better control of processes, which in turn helps to improve quality. It is necessary for the successful and efficient implementation of a quality system. Communication helps to provide clarity of roles and responsibilities of each employee. | Bunse, Verlage, and Giese 1998; Parzinger and Nath 1998; Li, Chen, and Cheung. 2000 |
| EA | The attitude of the employees will affect the performance of any organization. TQM philosophy advocates that quality should be treated as the responsibility of each and every employee in an organization. | Cortada 1995; Bahrami and Evans 1997; Ravichandran and Shareef 2001 |
| RM | A risk is a probabilistic event or condition, whose occurrence is not certain, but if it occurs, it can affect the outcome in an unfavourable manner so as to cause damage to the project or the product. Risk is a function of both uncertainty and constraints. This is an exclusive feature of software industry. | Bunse, Verlage, and Giese 1998; Jalote 2000; Ravichandran and Shareef 2001 |

# Appendix II

## QUESTIONNAIRE

### I. Top Management Commitment and Leadership (TMC)

| | |
|---|---|
| TMC 1 | Extent to which the top executive assumes responsibility for quality performance of the products and services of the company. |
| TMC 2 | Extent to which the top executives define quality from consumer's point of view. |
| TMC 3 | Extent to which the top executives view quality as more important than cost. |
| TMC 4 | Level of top executives' dynamism in leading the quality programme. |
| TMC 5 | Level to which the top management adopts quality management as a competitive strategy. |
| TMC 6 | Willingness of top management to allocate adequate resources and time for quality improvement efforts. |
| TMC 7 | Extent to which the quality mission forms the basis of strategic planning and decision making. |
| TMC 8 | Willingness of top management to identify and remove the root-cause problems of quality. |
| TMC 9 | Commitment of top management towards implementing quality standards or quality policy. |
| TMC 10 | Extent to which the top management supports long-term quality management policy. |
| TMC 11 | Extent to which the quality goals and policy are understood by the work force in the division. |
| TMC 12 | Amount of review of quality issues in top Management meetings. |
| TMC 13 | Extent to which the top management believes quality Improvement as a means to increase profits. |
| TMC 14 | Level of participation of major department heads in the quality improvement programme. |
| TMC 15 | Extent to which quality data such as cost of quality, defects, errors, rework etc. are used as tools to manage quality. |
| TMC 16 | Extent of time spent by the top management in evolving competitive bench marking. |
| TMC 17 | Extent to which the feed back data from after sales are used for continuous improvement of quality in the company as a whole. |
| TMC 18 | Specificity of quality goals in the company's business plans |

## II. Quality Policy (QP)

QP 1 Extent to which the company has a clear long-term vision statement.

QP 2 The level at which the company's short term business plan influence the quality management practices.

QP 3 The goals of TQM and their benefits to people in achieving them are made known to all the employees.

QP 4 Extent to which various quality plans and policies are communicated to the employees.

QP 5 Amount of co-ordination between quality department and other departments.

QP 6 Effectiveness of quality department in improving quality.

QP 7 Degree to which divisional top management is evaluated for quality performance.

QP 8 Extent to which the top management supports long term quality improvement programmes.

QP 9 Extent to which quality data obtained after the implementation of TQM practice are used to evaluate middle level management and their supervisory performance.

QP 10 Extent to which the goals and policies with respect to quality management are understood by the employees.

QP 11 Role and contribution of quality department with respect to quality policy, new software product development, specification etc

QP 12 The ability of the firm for customer retention.

## III. Employee Training (ET)

ET 1 Amount of training provided to employees in quality principles and policies.

ET 2 Resources available for employee quality training.

ET 3 Involvement of top management in quality training to employees.

ET 4 Extent to which the management considers employee education and training as an investment.

ET 5 Specific work skill training, technical and vocational given to employees throughout the division.

ET 6 Quality of training in the "total quality concept" given to the employees in the division for quality development.

ET 7 Extent of training given to the employees in the basic statistical techniques.

ET 8 Extent of training in the advanced statistical techniques such as failure mode analysis, Regression analysis, six sigma etc.

ET 9 Extent to which the employees are regarded as valuable, long term resources worthy of receiving education and training throughout their career.

ET 10 Additional training required for the workers.

## IV. Software Product Design and Operating Procedure (SPD)

SPD 1 Extent to which the customer requirements are thoroughly considered in new product design.

SPD 2 Level of participation of various departments in new product development.

SPD 3 How far the new programmes/products are thoroughly reviewed before they are marketed.

SPD 4 Extent of application of experimental design is in programme design.

SPD 5 Coordination among various departments in the product/process development process.

SPD 6 Extent to which quality data, control charts are displayed at the employee workplace

SPD 7 The extent of customer satisfaction by the company due to new practices.

SPD 8 The level in the reduction of project cycle times in the organization.

SPD 9 The ability in the early detection of defects.

SPD 10 The ability to predict the project delivery date.

## V. Quality Information System (QIS)

QIS 1 System existing in the organization to collect the cost of quality.

QIS 2 Extent to which quality data are available to managers and supervisors.

QIS 3 Extent to which the quality data are used to evaluate supervisor and managerial performance.

QIS 4 Extent to which the quality feed back from the clients is taken care-off for further improvement.

QIS 5 Extent to which the customer-contact personnel communicate with middle and top management on matters related to customer requirements and satisfaction.

QIS 6 The overall effectiveness of communication process in the organization.

QIS 7 Extent to which reports on the effectiveness of quality management programme are communicated to the employees.

QIS 8 Extent to which the quality data are available to workers.

## VI. Employee Participation and Empowerment (EPD)

| | |
|---|---|
| EPD 1 | All employee suggestions are evaluated in our company. |
| EPD 2 | Most employee suggestions are implemented after evaluation. |
| EPD 3 | Employees are encouraged to deal with the customer's complaints and needs. |
| EPD 4 | Employees are encouraged to contribute for improving quality and developmental performance. |
| EPD 5 | Extent of company's cross-functional teams' involvement in quality. |
| EPD 6 | Our company has several Quality Control circles(within one function) |
| EPD 7 | Employees are actively involved in quality related activities. |
| EPD 8 | Employees are very committed to the success of our company. |
| EPD 9 | Reporting of work problems are encouraged in our company. |
| EPD 10 | The degree to which the employees are given freedom and authority for operational independence and experimentation with respect communicated to the employees to project management activities. |
| EPD 11 | Extent to which the employees are given freedom to express their opinions, comments and criticisms on organizational functioning. |
| EPD 12 | Extent to which the involvement of team members at various stages in software projects are encouraged. |
| EPD 13 | The level of staff morale in the organization. |
| EPD 14 | How far the company allows flexible work practices. |
| EPD 15 | The level of overall employee satisfaction. |
| EPD 16 | The ability of the employees for innovative ideas. |
| EPD 17 | The ability to reduce the developed software modules. |
| EPD 18 | The level of increase in the market share of the company. |

## VII. Human Resources Management (HRM)

| | |
|---|---|
| HRM 1 | Extent to which employees are treated as long term assets of the organization. |
| HRM 2 | Extent of effort to recruit quality manpower. |
| HRM 3 | Effectiveness of strategies adopted for retaining talented and experienced people. |
| HRM 4 | Extent of effectiveness of the human resources plans with respect to human resource development training and empowerment. |
| HRM 5 | Attitude of labour unions towards quality improvement and management process. |
| HRM 6 | Quality emphasis by marketing and sales personnel. |
| HRM 7 | The extent of application of non-financial incentives for employee motivation. |
| HRM 8 | The effectiveness with which the company aligns human resource planning and management with company's strategic plans. |

| | |
|---|---|
| HRM 9 | Extent of effectiveness of Management Development Programme for the improvement of quality and productivity. |
| HRM 10 | Effectiveness of quality improvement teams in the division. |
| HRM 11 | The effectiveness with which the company evaluates and improves its human resource planning and management using employee related data. |
| HRM 12 | How far financial incentives are used for employee motivation. |
| HRM 13 | Degree of participation and contribution by major departmental heads in the quality improvement process. |
| HRM 14 | Degree to which employees are trained in team building and group dynamics for achieving the quality mission. |
| HRM 15 | Degree to which the employees are trained for developing their communication skills (written and verbal). |
| HRM 16 | Degree to which the employees are trained for developing their diagnostic and problem solving skills such as cause and effect analysis & brainstorming. |
| HRM 17 | The level of training of employees in quality management system such as CMM, ISO 9000 etc. |
| HRM 18 | The extent to which the employees are trained to identify and assign the right job for each person. |
| HRM 19 | The level of training of employees in skills related to the monitoring and control of s/w project management activities. |
| HRM 20 | The degree to which the employees are trained in using metrics for quality improvement. |
| HRM 21 | The extent to which the employees are trained in the estimation and auditing of costs related to software development. |
| HRM 22 | The level of education and training given to the employees in assessing the cost of quality and return on quality. |
| HRM 23 | The level of absenteeism in the company. |
| HRM 24 | The level of labour turn-over in the company. |
| HRM 25 | The level of complaints from the workers. |

## VIII. Customer Focus and Satisfaction (CFS)

| | |
|---|---|
| CFS 1 | People in my work unit care about our Customers. |
| CFS 2 | We monitor customer complaints and feed back and use these items as basis for determining customer satisfaction. |
| CFS 3 | We compare our customer satisfaction with our competitors. |
| CFS 4 | The level of customer involvement during the specification and design stages of the software project. |
| CFS 5 | The level of customer involvement during the development and testing stages of the software project. |

CFS 6 Extent to which the organization encourages the interaction between the customers and employees.

CFS 7 Extent to which service is provided after project completion/project delivery.

CFS 8 Extent to which attempts are made to satisfy the explicit, implicit and delight needs of the customers.

CFS 9 Quality related customer complaints are treated with top priority.

CFS 10 The on-line delivery of the projects by the organization.

CFS 11 The degree of service level provided by the firm.

## IX. Continuous Improvement (CI)

CI 1 Extent to which the ability to work in team is taken as a criteria in employee selection

CI 2 The level of spirit of cooperation and team work in the organization.

CI 3 Extent to which the members of the team are from various departments.

CI 4 Extent to which the data are monitored for efficiency and effectiveness

CI 5 The regularity in monitoring of quality of products and services.

CI 6 How far the problem – solving tools for continuous improvement in quality is used.

CI 7 The involvement of each and every member of the organization in improving quality.

CI 8 Extent of quality related bench marking system in the organization.

CI 9 The extent to which the software development processes are systematically measured and evaluated.

## X. Organization Culture (OC)

OC 1 Degree to which the employees accept quality as a strategic weapon to gain competitive advantage.

OC 2 Degree to which the employees realize the importance of customer satisfaction in achieving quality.

OC 3 The extent to which the employees believe in “doing things right first time and every time”

OC 4 Support and cooperation of the employees towards the implementation of quality standards.

OC 5 The level of trust and openness among team members.

OC 6 The level of trust and openness between employees and management.

OC 7 The level of coordination between the team members and their leader.

OC 8 The level of coordination between project teams and top management.

OC 9 The level of coordination between project teams and customers.

OC 10 Attractiveness of salary and perks paid to the employees.

OC 11 The degree of respect and fairness in treatment that the employee to get within the organization.

OC 12 Availability of opportunities for career advancement.

OC 13 Presence of incentive schemes based on performance to motivate employees.

OC 14 Extent to which achievements in quality are recognized and rewarded.

OC 15 Extent to which the roles and responsibilities of employees are specified clearly.

OC 16 Extent to which the salaries are paid on time.

## XI. Infrastructure and Facilities (IF)

IF 1 Adequacy of hardware facilities provided.

IF 2 Adequacy of software facilities provided.

IF 3 Adequacy of information facilities such as Internet, access to journals and other publications, training and other facilities.

IF 4 The degree to which the physical layout of the workplace and the environment at the work place are comfortable to the employees.

## XII. Financial Growth (FG)

FG 1 Extent of overall increase in profitability for the last three years.

FG 2 Extent of increase in return on investment

FG 3 The overall revenue growth of the company

FG 4 The level of operating cost of the company.

FG 5 Trends in cost relative to competitors.

FG 6 The ability to complete the project within budget.

FG 7 The value added per employee to the organization.

FG 8 The extent of savings in cost due to improvement

FG 9 The extent of getting repeat business in the firm.

## List of Publications and Presentations

1. Published a book on "Foundry Engineering" in local language for the students of Diploma in Engineering, Govt. of Kerala.
2. Presented the paper "Application of Industrial Engineering Techniques in Hospital Management" at the International Conference on Industrial Engineering, Benghazi, SPLAJ, 1989.
3. Presented a paper on "Importance of Quality Management" at the 47th National Conference of Indian Institute of Industrial Engineering 2004.
4. Presented a paper "An evaluation of critical factors in Total Quality Management" at the 49th National Conference of Indian Institute of Industrial Engineering, 2006. (Included as a Case study in the book "TQM" (Text and cases) by Dr. Uday Kumar Haldar, Dhanpat Rai & Co, 2007.

## Biography of the Candidate

I am P. Haridas, took my B.Sc (Engg.) in Mechanical Engineering in 1969 from College of Engineering, Trivandrum, under university of Kerala with 1st class. I was the all India toper in the examination conducted by CPWD for the post of Junior Engineers in 1971. Joined in the same college as Lecturer in Mechanical Engineering in Feb 1974. Took my M.Tech from Indian Institute of Technology Kharagpur in Industrial Engineering and Operations Research in the 1983. Worked as a faculty member in the University of Garyounis, Benghazi, S.P.L.A.J from 1985-1990.

Became Professor and Head of the Department of Mechanical Engineering in the same college and retired from service at the age of 55. No I am 63.

Took PGDMM from IGNOU in the year 1996 and MBA in 2009. Also attended Strategic Management programs at IIM Banglore, IIM Kozhikode, IIM Culcutta, MDI Gurgaon. Wrote a book on "Foundry Engineering" in local language for Diploma students in Kerala in the year 1980. Presented two papers in the National Conference of Industrial Engineering and one paper at the International Conference at Benghazi in 1989. Was an examiner, question paper setter for AMIE, Kerala University, CUSAT and for BITS-Misra-Ranchi.

After retirement joined as Professor in the Department of Business Administration on contract basis. Guided more than 80 M.Tech & MBA students in their project work.

## Biography of Supervisor

I am Dr. Nelson Joseph aged 56 years. I took my B.Sc Engg. Mech from Kerala University in 1975. I passed PGDIE from NITIE Bombay in first class with distinction. Also I took a PG Diploma in Operations Management from J Bajaj Institute of Management in Bombay. I did Ph.D in Total Quality Management from IIT Madras, the Ph.D thesis was highly commented by the examiners. I have published research papers in international and national referred journals. I have presented papers in international conference and national conferences. I was a book reviewer of TataMcgraw Hill in Information Technology.

I am an approved research guide of University of Kerala for Ph.D in management. I was a member of both faculty of management studies and board studies of Kerala University. I was Chairman for board of examinations of MBA of Kerala University. I was question paper setter of B.Tech, M.Tech and MBA of both Kerala University and BITS Pilani. I have guided more than 50 projects at MBA and guiding 5 Ph.D thesis. I organized seven national conferences in various Management topics and organized number of EDP for the benefit of working executives. My research interest includes Quality Management, HRM and Industrial Engineering.

I have 28 years of teaching experience and five years of industrial experience. I worked as Prof and Head of Dept. of Business Administration, in the College of Engineering, Trivandrum for 8 years and now working as Principal, Marian Engineering College, Trivandrum.

**Biography of Co-supervisor**

Abhijeet K. Digalwar is a Assistant professor of Mechanical Engineering at the Birla Institute of Technology & Science (BITS), Pilani. He has received a PhD from BITS Pilani. He has over 16 years of teaching experience at graduate and post graduate levels. His current research and teaching interests are in the areas of Manufacturing System Engineering and Management, Manufacturing Processes, World Class Manufacturing, Green Manufacturing, Sustainable Manufacturing, Knowledge Management, Performance Measurement Systems, Total Quality Management, Machine Tool Engineering, Cutting tools.

He has published many research papers in National and International journals and Conferences. He has been a reviewer for several international journals and conferences. Also, he is an Editorial board member of the International Journal of Manufacturing System publishing by Science Alert USA. He has been a Member of the PMA (Performance Measurement Association) of a Cranfield University UK, Society of Operations Management and Life Member of the ISTE.