CHAPTER 5

WEB-BASED DEVELOPMENT OF QUALITY INSTRUMENT TO MEASURE THE LEVEL OF IMPLEMENTATION OF TOTAL QUALITY MANAGEMENT

5.1 QUALITY MANAGEMENT IN INDIA

Indian industries are facing lot of challenges from the global competitors. They are forced to achieve world class manufacturing standards by adopting and practicing TQM philosophy. While the growth and spread of quality practices are slow in India, TQM has firmly seated itself in other Asian countries. In a cover feature on “Quality in Asia” reported in World Executive Digest (1996), it is stated that as Asia grapples with the challenge of globalisation, more and more companies seek ISO 9000 certification and adopt TQM. Companies in Hong Kong, Malaysia, Singapore, South Korea and China are overtly involved in embracing practices of total quality to march ahead in global markets.

The growth of TQM across Asia however means that new approaches are being developed in the region. These observations clearly suggest that India has to carefully watch the developments in the Asian region, as TQM principles have been successfully applied by several countries improving their output quality, attracting more foreign investment, and hence capable of restricting India's share in the global market.

5.2 EMPIRICAL STUDIES IN INDIA

Total quality management (TQM) programmes and practices are primarily embraced in large multinational organizations. Little has been written on how TQM has been applied in Indian organizations. Indian industries have reached a stage of development where they are able to apply TQM effectively. A better understanding is therefore required to investigate the current status of TQM implementation. The current work was focused on the
manufacturing sector and attempts were made to gauge how far this sector has moved towards implementing TQM.

Motwani et al. (1994), on the basis of study of 73 executives of Indian manufacturing organizations, reported that manufacturing quality products is one of the major objectives of Indian manufacturers. They found that nearly all (96%) of surveyed organizations have maintained formal quality policies.

Mohanty & Lakhe (1998) conducted an empirical study to identify the CSFs of TQM in Indian Industries. The survey questionnaire contained 18 items and it was despatched to 284 executives in 35 industries. A total of 175 completed questionnaires were received. The 18-item was subjected to principal components analysis and varimax rotation using the SPSS program which resulted in 4 factors. The authors suggested to use these factors to establish quantitative goals as the basis for a major organizational change effort.

Joseph et al. (1999) developed an empirically based instrument for measuring the TQM implementation in business units in India. This study offers a set of 10 TQM factors with a total of 106 QAPs of quality management as a comprehensive measure of TQM implementation. The reliability and validity analysis were performed to validate the results. The authors still call for a great deal of further research to be done because the scope of this study is limited to the manufacturing industry sector in India and moderate sample size.

Wali et al. (2003) conducted a survey among Indian industries. Through a postal survey method, 114 organizations responded to the questionnaire which yielded 22.8% response rate. After the analysis was performed by using SPSS software, they got 12 TQM factors as final and they strongly argued that these TQM factors may provide a rational basis for resource allocation for improvement.
The above four empirical studies in India are different in terms of TQM factors and input performance measures. Each has its own strengths and weaknesses. The present work differs significantly from them in terms of the overall approach to scale development and validation.

5.3 TQM CRITICAL SUCCESS FACTORS

After a comprehensive review of quality gurus, quality award models, and other existing literature, the following ten TQM CSFs are identified as the most primary TQM CSFs.

1. The role of top management and quality policy
2. Role of the quality department
3. Training
4. Product design
5. Supplier quality management
6. Process management
7. Quality data and reporting
8. Employee relations
9. Customer focus
10. Lean manufacturing

5.4 EXPLANATION OF CRITICAL SUCCESS FACTORS

TQM CSFs are those few things that must go well to ensure success for a manager or an organization, and, therefore, they represent those managerial or enterprise areas that must be given special and continual attention to bring about high performance. Alternatively, it can be said that the TQM CSFs are the select few over arching requirements that must be present for an organization to be able to attain its vision, and to be guided towards its vision.

5.4.1 THE ROLE OF TOP MANAGEMENT AND QUALITY POLICY

Top management commitment has been identified as one of the major determinants of successful TQM implementation (Deming, 1986; Juran, 1986; Flynn, 1994). Top management leadership acts as a class a driver of QM
implementation, creating values, goals, and systems to satisfy customer expectations and to improve organization performance. In realizing the strategic role of quality, top management is expected to understand that its responsibility for quality control cannot be delegated (Rao et al., 1999). Garvin (1986) reports that high levels of quality performance were always accompanied by an organizational commitment to that goal; high product quality did not exist without strong top management commitment. In addition to having an impact on quality performance, top management attitudes and behaviours have also been found to be related to quality management practices in an organization.

Malcolm Baldrige quality award and European quality award recognize the crucial role of top management leadership in creating the goals, values and system that guide the pursuit of continuous performance improvement. Recognition of the critical role of top management and its responsibility in pursuit of quality improvement echoes the arguments put forward by gurus of quality such as Deming, Juran and Crosby. Lack of top management commitment is one of the reasons for the failure of TQM efforts (Brown et al., 1994). Top management should not only give high priority to quality, but should also demonstrate its quality commitment by providing adequate resources to the implementation of QM efforts, particularly considerable investment in human and financial resources (Ahire et al., 1996). Various quality related issues should also be discussed in top management meetings. Top management should pursue a long term business success and focus on product quality rather than yields (Zhang, 2000).

5.4.2 THE ROLE OF QUALITY DEPARTMENT.

The quality department's access to top management, visibility and autonomy of the quality department are essential for the success of total quality management (Saraph et al., 1989). The major responsibilities of the quality department include formulating and improving major quality improvement programmes and working closely with other departments (Rao et al., 1999). Procedures for quality control covered the entire business, from development to marketing, purchasing, manufacturing and distribution. The
reports of defects and failures at the various stages of processing and final inspection, compilation of quality costs, and field failures are also the responsibilities of quality department.

5.4.3 TRAINING

Human resources are one of the most important factors contributing to the long-term success of quality management in a company (Rao et al., 1999). Further, training is the key to releasing the full potential of workers. Usage of worker's knowledge has become so important that training has become a fundamental requirement to achieve world-class manufacturing status. Deming (1986) stresses the importance of education and training for continuous improvement. Many research results reveal that education and training is one of the most important elements in a successful implementation of TQM (e.g., Mann, 1992).

Only when employees are trained in the quality concepts and tools, they can understand quality-related issues (Ahire et al., 1996). First and foremost, companies need to view training costs as investments instead of costs. Availability of adequate resources is a prerequisite for an organization-wide training. Numerous case studies have documented the link between training and productivity, product quality, process quality, costs of implementation of advanced manufacturing technologies etc.

5.4.4 PRODUCT DESIGN

Product design is an important dimension of quality management (Flynn et al., 1994). The greatest source of product failure often lies in design weaknesses, with failure costs multiplying when discovered in the field (Cole., 1981). Product design can be related to all of Garvin's (1987) critical dimensions of quality performance: performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality. When the product components are designed in such a way that are easy to manufacture and assemble, the manufacturing process variance is reduced (Rao et al., 1999). The reduction in variance will be reflected on different measures of internal quality performance (Waste, rework, etc.).
Juran (1981) strongly recommended investment of time and resources in designing quality into products. Approaches such as quality function deployment (QFD), Taguchi's design of experiments, and Shingo's error proofing techniques are very useful quality design tools (Ahire et al., 1996). Today's complex products cannot be designed by the design engineers alone. An inter-disciplinary approach such as concurrent engineering is essential. Such a team approach results in a faster response to customer needs and superior product quality. Also marketing and manufacturing experience of the design team enhance their ability to design quality products (Juran, 1981).

5.4.5 SUPPLIER QUALITY MANAGEMENT

Supplier quality management is an important aspect of TQM since materials and purchased parts are often a major source of quality problems. The Malcolm Baldrige National Quality Award (1997) also recognizes the importance of supplier quality. Garvin (1983) finds that organizations that manufacture the highest quality products have purchasing department that rank quality rather cost minimization as their major objective. The suppliers role is critical in many ways. First, the quality of incoming parts from suppliers determines the level of inspection efforts of a buyer organization (Ahire et al., 1996). Second, the quality of the supplied material, to an extent, determines the final product quality. Third, the supplier's capability to react to a buyer firms' needs, in turn, can determine the buyer's flexibility in responding to the customer's needs. Juran (1986) recommends extensive, long term partnership with supplier's organizations that pursue good supplier's quality management, establishing long–term co–operative relations with suppliers, often participate in supplier quality activities, have detailed information concerning supplier performance, give feedback on the performance of supplier's products, regularly conduct supplier audits, and regard product quality the most important factor for selecting suppliers.

Plants which emphasize QM are more likely to use a process of supplier certification or qualification (Juran, 1978). Plants commit to using only suppliers which have previously certified, based on willingness to operate in
an atmosphere of teamwork, statistical process control training, the quality of prior deliveries for similar products and other important criteria (Flynn et al., 1994).

5.4.6 PROCESS MANAGEMENT

Process refers to some unique combinations of machines, tools, methods, materials and people engaged in production (Juran and Gryna, 1988). Process management focuses on manufacturing process so that it operates as expected, without breakdowns, missing materials, fixtures, tools etc, and despite workforce variability (Flynn et al., 1994). The important aspect of process management is the equipment maintenance which ensures that dimensional variation is maintained within acceptable limits. Good process management involves precisely documenting various process procedures, including the work instructions to operations to minimize operator related errors. Documentation increases the flexibility of workers to perform a variety of operations, keeping the manufacturing process running smoothly, despite absenteeism and turnover (Flynn et al., 1994). Plants which emphasize good process management are more likely to develop their own proprietary manufacturing equipment, in order to be highly knowledgeable about the production process (Wheel right and Hayes., 1985). Although they may continue to buy some equipment, enough is produced or modified internally that equipment technology is customized to their unique needs and state-of-the art. Techniques such as PDSA cycle, seven QC tools, statistical process control (SPC), sampling and inspection are effective for process control and process improvement (Zhang, 2000).

5.4.7 QUALITY DATA & REPORTING

Availability and the use of quality data is an essential ingredient of a strong quality program (Juran, 1986). When products are being manufactured on the shop floor, variations in the manufacturing process variables (such as raw material quality, machine conditions, worker skills, etc) contribute to a variation in product quality (Ahire et al., 1996). Hence the role of quality control and quality data are as critical as the design quality of products and processes. Statistical process control (SPC) techniques are often used to
detect assignable causes contributing to the variation in manufacturing quality, to provide useful information for product design, and to determine process capability. A wide range of SPC tools such as scatter diagrams, Pareto charts, cause and effect diagrams, and control charts are used to monitor quality. To use the SPC tools effectively, production workers should have an adequate knowledge regarding their usage (Ebrahimpour et al., 1992).

An important component of quality information is the provision of timely and accurate information about the operation of manufacturing process (Hayes, 1981). Both quality performance and process information should be collected at source, where immediate problems solving action can be taken. (Flynn et al., 1994). Also the quality data is to be made available to the managers, supervisors, and the operators as control charts at their respective work stations.

5.4.8 Employee Relations

Employee relations are essential component in total quality management programmes. In order to increase performance, companies need to change the way they are organized as well as their management systems so as to get greater involvement of all employees in problem-solving, in decision-making and in financial success of the firm (Rao et al., 1999). The basic idea behind involvement is that employees are in control of their work and are able to participate in the business of the organization.

Employee involvement groups have been found to positively impact employee commitment to quality. However, organizations must develop formal systems to encourage, track and reward employee involvement (Ahire et al., 1996). The use of cross-functional quality improvement teams and quality circles, along with a framework of appropriate evaluation and reward systems for quality improvement projects, have been shown to improve quality significantly.
5.4.9 CUSTOMER FOCUS

From the perspective of the customer, the plant is the supplier. Thus, many of the generalizations about supplier involvement apply in reverse, to customer focus (Flynn et al., 1994). Quality must be incorporated into all activities of an organization with a clear customer focus (Ahire et al. 1996). Despite the use of latest process improvement techniques and capable management, a firm's neglect of its customers may lead to a disaster. The importance of customer focus is also evident from the fact that it is assigned the highest weight among the MBNQA award criteria. To achieve quality, it is essential to know what the customer wants and to provide products or services that meet their requirements (Ishikawa. 1985). Key to quality management is maintaining a close relationship with the customer, in order to fully determine the customer's needs, as well as to receive the feedback on the extent to which those needs are being met. The customer should be closely involved in the product design and development process, with input at every stage of the process; so that there is less likelihood of quality problems once full production begins. Garvin (1984) found that plants with the highest quality had permanent customer review boards which tested and evaluated products from the customer's perspective.

In order to improve customer satisfaction, customer complaints should therefore be treated with top priority. Warranty on sold items should also be provided. Methods that can be used for customer focus efforts include collection of customer complaints information, market research, and customer satisfaction surveys.

5.4.10 LEAN MANUFACTURING

Lean Manufacturing is a philosophy, based on the Toyota Production System, and other Japanese management practices that strives to shorten the time line between the customer order and the shipment of the final product, by consistent elimination of waste, in other words, producing more with less. Much as mass production was the production system of the 20th century, lean manufacturing, which focuses on the elimination of waste in the production process, has been heralded as the production system of the 21st
Three researchers from the Massachusetts Institute of Technology (MIT), the National Institute of Standards and Technology (NIST) and Manufacturing Extension Partnership's Lean Network (MEPLN) offers the following definition of lean manufacturing: “A systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection.”

All types of companies, manufacturing, process, distribution, software development or financial services can benefit from adopting lean philosophy. As long as a company can identify a value stream, from when customers order a product to when they receive it, lean principles can be applied and waste removed. Many of the changes we need to make to eliminate waste don’t make sense under the old paradigms. The change to lean is not just an application of a few techniques; it’s a whole new way of looking at the world.

Eliminating waste in all phases of operations is a world class concept which can be used to achieve continuous improvement. The areas identified in which wasteful practices exist are: work in process, delay and waiting and inventories.

5.5 INSTRUMENT DEVELOPMENT PROCESS

The Saraph et al. (1989) instrument pioneered the efforts to identify and empirically validate QM CSFs. Drawing primarily upon QM principles espoused by the quality “gurus” including Deming, Crosby, Juran and Ishikawa, they identified items relevant to integrated QM. Based on judgements of academic researchers and quality professionals, these items were grouped into eight critical QM CSFs. Using divisional quality managers as respondents, they gathered responses about the importance of various QM issues. The response sample of 162 managers spanned both the manufacturing and service sector, and included about 20 firms. Cronbach’s alpha was primarily used for scale refinement. Construct validity was checked using principal components factor analysis on each CSF. In addition, content validity and criterion-related validity were also checked.

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A major strength of this instrument was the high level of external validity ensured through inclusion of manufacturing and service industries in the sample. While the Saraph et al. was the first attempt to operationalize QM CSFs, it excluded at least two important CSFs: customer focus and SPC (Ahire et al., 1996). Also it reflected several instances of tautologies among various scales. In the current project, all the CSFs validated by Saraph et al., (1989) were included in the instrument development process. Further, two additional CSFs 1) customer focus and 2) lean manufacturing were also included to make the instrument more comprehensive.

Psychologists have developed rigorous methods for constructing instruments to measure social science variables. The process used in this study to develop measures of the TQM CSFs quality management was based on generally accepted psychological principles of instrument design (Saraph et al., 1989). The Fig. 5.1 shows the steps involved in instrument development.

Step 1, the literature review, various papers were reviewed for developing a quality management framework to understand the TQM practices in Indian manufacturing firms. In Step 2, 10 critical success factors were identified for successful implementation of TQM. Quality-related action programs (QAPs) were developed in Step 3. The pre-tests helped in eliminating/reclassifying the QAPs (Steps 4, 5).

To enable managers to indicate the degree or extent of practice of each quality-related action program by their business unit, a 5 point interval rating scale was used (Step 6). A typical questionnaire item is shown in Fig.5.2.
Fig. 5.1 Instrument development process
Using the above mentioned scale, data were collected through internet from various industries. In step 7, an internal consistency test has been carried out. Detailed analysis of reliability and validity has been carried out in steps 8 through 11. For each CSF, the actual level of practice can be represented by the average of the measurement item ratings for that CSF. A vector of the averages for the ten TQM critical success factors can be used as a profile of the business unit's actual level of quality performance (Saraph et al., 1989).

5.6 WEB-BASED QUALITY INSTRUMENT DEVELOPMENT

The empirical studies conducted so far described survey research as 'mail interviewing' which means that a randomly selected sample of firms or human respondents were questioned using a written questionnaire delivered by mail. The current era is fortunately an era of
information and technology. Hence, for the present study, survey based on Visual Basic (VB) software has been developed for collecting responses through e-mail and internet. The software was designed to meet the respondent's convenience of answering and also for faster response rate. At present, most of the companies have web-site, e-mail ID's and hence it was easy to get responses through internet. A sample VB survey questionnaire form is shown in Fig. 5.3. After a pre-test with experts, a survey questionnaire with 75 QAPs was prepared for the present empirical survey. The questionnaire consisted of 61 QAPs (items) corresponding to the 8 CSFs of Saraph et al. (1989) instrument and fourteen new QAPs developed for CSFs 'employee relations, customer focus and 'lean manufacturing' (Appendix 5).

There were 66 QAPs in Saraph et al. final instrument. Five QAPs of Saraph et al. instrument were dropped in the present study by the experts during pre-test mainly for the following reasons: (1) lack of relevance to the Indian industries; (2) inability to conceive the content of the quality-related action programs by practitioners; and (3) some of the quality-related action programs were perceived by the experts to be replications of other quality action programs.

The QAPs dropped are:

1. Amount of incoming inspection, review, or checking;
2. Amount of in-process inspection review, or checking,
3. Amount of final inspection review, or checking,
4. Effectiveness of quality circle or employee involvement type programs in the division.
5. Effectiveness of supervisors in solving problems/issues.

The QAPs of Saraph et al. (1989) instrument were reworded to suit the present context of Indian manufacturing industries. Sixteen output performances were also included to get a measure of quality and firm performances of the organizations. Some QAPs were reverse coded to judge the respondent's level of involvement in the survey. Quality-related action programs were arranged in a random order and presented to the respondents.
Three hundred e-mails with survey questionnaire file attached were sent to selected ISO 9001 certified companies in India. The respondents entered their responses by clicking the right button of the computer mouse next to the question in 5 point Likert scale. A total of 82 responses were received through internet, response rate was 27%. Although the response rate was initially not encouraging, telephone calls to the respondents were used to improve the response rate. Through posts, 22 additional responses were received. The responses, 104 in total were analyzed using the SPSS Version 9.05 statistical package. The profile of the respondents is presented in Table 5.1.

<table>
<thead>
<tr>
<th>Extent or Degree of Current Practice is</th>
<th>VL</th>
<th>L</th>
<th>M</th>
<th>H</th>
<th>VH</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent to which top executive assumes responsibility for quality Performance</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

VL – Very Low; L – Low; M – Medium; H – High; VH – Very High; NO – No opinion

Fig. 5.2 Measurement scale

5.7 PRE-TEST

Eighty five QAPs of quality management, derived from the analysis and suggestions from experts and practitioners were used to develop the questionnaire. The 85 item questionnaire was presented to experts who were well versed with TQM for their critical evaluation. After review, 75 QAPs recommended by the experts were used to develop the instrument for measuring TQM implementation.

There were 66 quality action programs in Saraph et al. final instrument. Five QAPs in Saraph et al. instrument were dropped by the experts during pre-test for the following reasons: (1) lack of relevance to the Indian industries; (2) inability to conceive the content of the QAPs by practitioners;
and (3) some of the QAPs were perceived by the experts to be replications of other quality action programs.

The quality action programs dropped are:

1) Amount of incoming inspection, review, or checking;
2) Amount of in-process inspection review, or checking,
3) Amount of final inspection review, or checking,
4) Effectiveness of quality circle or employee involvement type programs in the division.
5) Effectiveness of supervisors in solving problems/issues.

Out of final 75 QAPs, 14 quality action programs were new to Saraph et al. model of TQM. Sixteen output performances were also included to get a measure of quality and firm performances of the organisations. QAPs were arranged in a random order and presented to the respondents. (Final set of questionnaire is given in appendix 5).

5.8 SOFTWARE DEVELOPMENT

Previous empirical studies described survey research as 'mail interviewing' which means that a randomly selected sample of firms or human respondents are questioned using a written questionnaire delivered by mail. Some of the advantages in this method include respondent anonymity, confidentiality, and leisureliness of response made. However, mail surveys take longer period of time. To overcome the delay of mail survey, survey based on Visual Basic software has been developed for collecting responses through e-mail and internet. The software was designed to meet the respondent's convenience of answering and also for faster response rate. E-mail surveys are economical and very fast. At present, most of the companies have website, e-mail ID's and hence it was easy to get responses through internet.

5.8.1 VISUAL BASIC PROGRAMMING

Visual basic (VB) is an ideal programming language for developing applications for Microsoft windows and internet. The set of questionnaire
containing 91 questions (75 QAPs and 16 output performance measures) and the instructions for filling up the questionnaire were designed into three forms for reply through internet.

Form 1: Instruction form.
Form 2: Respondent’s Information
Form 3: Survey questionnaire.

5.8.2 EXPLANATION OF THE VB FORMS

The explanation and the sample VB forms are presented in the following sections.

5.8.2.1. FORM 1 - INSTRUCTIONS

The first step in any survey is deciding what we want to learn. The purpose of the survey is to know about the level of quality management practices at respondent's organization when comparing with ideal quality management. The instruction form (Form 1) was developed for this purpose. Fig. 5.3 shows the form 1.

5.8.2.2. FORM 2- RESPONDENT’S INFORMATION

Through this form, respondent's information like company address, designation, working experience, industry type, annual turnover, total number of employees and number of employees in the quality department was collected. The answers to some of these questions are of written type. The data obtained in this section was useful in determining whether the company's profile matches with the survey requirements. The company must have an ISO 9000 certification with a minimum annual turnover of 10 Million Indian rupees to participate in this study. Open ended text box was provided to declare the awards received if any. Form 2. is shown in Fig. 5.4.
Dear Sir,

Sub: A survey of Quality management practices and performances in the Indian organizations

We are conducting an all India level survey of quality management practices and performances of selected organizations. We came to know about your esteemed organization after we visited your website. We will be pleased to include your valuable response in our research.

The questionnaire, containing 30 questions, is enclosed. We request you to answer these questions with reference to the level of actual practice at your organization when comparing with ideal Quality management. Please send your response within a week.

We will post the summary of our research conclusion through e-mail.

We assure that your identity/response will be kept confidential.

Thanking you with kind regards,

Prof. G. Karuppusami,
(Research Scholar),
Production Engineering Department,
PSG college of Technology,
Coimbatore 641 004.

Fig. 5.3 Form I - instructions

5.8.2.3. FORM 3 - SURVEY QUESTIONNAIRE

The questionnaire was designed to evaluate the quality management practices in Indian industries. This section contained 75 questions related to ten TQM CSFs such as top management commitment, employee relations, training, customer focus, supplier quality management etc. and 16 output performance measures. Each page of the form contained 10 questions for ease of answering. Fig. 5.5 shows a sample of the form 3.
Respondent's Information

Company address (Optional):

E-mail:

Designation/Working experience:

Department/Section:

TQM practices implemented:  □ Yes □ No  [If yes, when ________]

Industry type:  □ Manufacturing  □ Textile  □ Electronics  □ Service  □ Process

Annual Turnover (Rs in crores):

□ 1-50 □ 51-100 □ 101-200 □ 201-500 □ 501-1000 □ >1000

Total No. of Employees:

□ <100 □ 101-500 □ 501-1000 □ 1001-2000 □ >2000

No. of Employees in quality department:

□ 1-10 □ 11-20 □ 21-30 □ 31-50 □ 51-100 □ >100

Certificates/Awards obtained so far:

Fig. 5.4 Form 2- Respondents' Information

The respondents entered their responses by clicking the right button of the computer mouse next to the question in Likert type scale, specified in section 5.6.

5.8.2.4. SCORING OF THE RESPONSES

For example, when the response to the 'amount of feedback provided to employees' is very low, the matching score is 1. If the respondent is uncertain to answer any of these questions, 'No opinion' scale was provided to enter his/her response. A score of '0' was assigned if a 'No Opinion' response is given and this will not bias the result in any way. The 'No Opinion scale' was added to enable the respondent of the questionnaire to provide accurate response. If many 'No opinion' responses are obtained, it might point to question ambiguity, and can thus be rectified. Fig. 5.6 shows the details of scores.
1. Employees are held responsible for error-free output

2. Employees are never recognized for superior quality performance

3. Degree to which top management is evaluated for quality performance

4. Specificity of quality goals within the department

5. Amount of review of quality issues in top meetings

6. Amount of preventive equipment maintenance

7. Extent of the application of best layout and materials handling systems for continuous quality improvement process

8. Clarity of work or process instructions given to employees

9. Amount of coordination between the quality department and other departments

10. Amount of training in advanced statistical techniques (such as design of experiments and regression analysis)

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**FIG. 5.5 FORM 3 - SURVEY QUESTIONNAIRE**

<table>
<thead>
<tr>
<th>VL-VERY LOW</th>
<th>L-LOW</th>
<th>M-MEDIUM</th>
<th>H-HIGH</th>
<th>VH-VERY HIGH</th>
<th>NO- NO OPINION</th>
</tr>
</thead>
</table>

1. Extent to which quality circle or employee involvement type programs are implemented in the department

**Score**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>1</td>
</tr>
<tr>
<td>Low</td>
<td>2</td>
</tr>
<tr>
<td>Medium</td>
<td>3</td>
</tr>
<tr>
<td>High</td>
<td>4</td>
</tr>
<tr>
<td>Very high</td>
<td>5</td>
</tr>
<tr>
<td>No opinion</td>
<td>0</td>
</tr>
</tbody>
</table>

**FIG. 5.6 SCORING OF RESPONSES**

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5.9 REVERSE CODING OF QUESTIONS

Some reverse coded questions were included in the questionnaire, which means the question has its meaning opposite to what is intended to measure. For example, 'quality department cannot access top management' indicates the relationship between quality department and top management in opposite sense. These questions were used to judge the respondent's level of involvement in the survey. (Question No. 15, Appendix 5).

5.10 SUBJECTS AND ADMINISTRATION

The main objective of the present work was to develop an instrument for measuring the level of TQM implementation in manufacturing industries. General Managers and quality managers have been chosen as the subjects. They were asked to respond to the questionnaire according to how they perceived their rating on quality management progress. Email survey method was adopted to cover wide range of companies throughout the country. To empirically validate the 10 TQM CSFs, a survey instrument was developed. Five-point likert scale was used for all QAPs to ensure higher statistical variability among survey responses.

This work focused on multiple industries. In addition to the 75 performance measures, 16 output measures were also included to estimate the relationship between the TQM CSFs and firm performances. The questionnaire file was sent through internet to respondent's e-mail address. A list of e-mail addresses were collected from Indian Product Promotion Centre (IPPC), ISO 9000 directory and also from industrial directory.

Three hundred e-mails were sent to various companies in India and a total of 82 responses were received through internet, response rate was 27%. Although the response rate was initially not encouraging, telephone calls to the respondents were used to improve the response rate. Through posts, 22 additional responses were received. The responses 104 in total were analysed using the SPSS Version 10 statistical package.
The profile of the business units that participated in this study is presented in Table 5.1. It is seen from the table that the participating industries comprised of manufacturing, textile, process, service and electronics industries which represented a wide cross section of manufacturing sectors in India.

5.11 MEASUREMENT EVALUATION

In the questionnaire, 75 QAPs and 16 output performance measures were used to measure TQM implementation. Each CSF had measurement scales (Appendix 5). Before testing the theoretical models, it was necessary to first evaluate the reliability and validity of the instruments.

5.12 RELIABILITY ANALYSIS

Reliability refers to whether the same answer is arrived by using an instrument to measure something more than once. Reliability concerns the extent to which an experiment, test, or any measuring procedure yields the same results if repeated. It is a statistical measure of how reproducible the survey instrument’s data are. There are four methods commonly used for assessing reliability, namely, (1) the test-retest method, (2) the alternate-form method, (3) the split halves method, and (4) the internal consistency method (Nunnally, 1967).

Internal consistency reliability is a commonly used psychometric measure in assessing survey instruments and scales. Internal consistency is an indicator of how well the different items measure the same concept. This is important because a group of items that propose to measure one variable should indeed be clearly focused on that variable. Internal consistency is measured by calculating a statistic known as Cronbach’s coefficient alpha (Cronbach, 1951; Nunnally, 1967). Coefficient alpha measures internal consistency reliability among a group of items combined to form a single scale. It is a statistic that reflects the homogeneity of the scale. Generally, reliability coefficients of 0.70 or more are considered good (Nunnally, 1967).
<table>
<thead>
<tr>
<th>Respondent's Information</th>
<th>Frequency</th>
<th>Percent %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Position</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CEO</td>
<td>14</td>
<td>13.46</td>
</tr>
<tr>
<td>Managing director</td>
<td>23</td>
<td>22.11</td>
</tr>
<tr>
<td>Deputy general manager</td>
<td>20</td>
<td>19.23</td>
</tr>
<tr>
<td>Manager – Quality / Manufacturing</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>Engineer – Quality / Manufacturing</td>
<td>11</td>
<td>10.57</td>
</tr>
<tr>
<td>Others</td>
<td>10</td>
<td>9.61</td>
</tr>
<tr>
<td><strong>Type of industry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td>28</td>
<td>36.54</td>
</tr>
<tr>
<td>Process</td>
<td>17</td>
<td>16.34</td>
</tr>
<tr>
<td>Service</td>
<td>19</td>
<td>18.26</td>
</tr>
<tr>
<td>Electronics</td>
<td>9</td>
<td>8.65</td>
</tr>
<tr>
<td>Textile</td>
<td>23</td>
<td>22.11</td>
</tr>
<tr>
<td>Others</td>
<td>8</td>
<td>7.69</td>
</tr>
<tr>
<td><strong>Experience in years</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-10</td>
<td>35</td>
<td>33.65</td>
</tr>
<tr>
<td>11-20</td>
<td>22</td>
<td>21.15</td>
</tr>
<tr>
<td>20-30</td>
<td>20</td>
<td>19.23</td>
</tr>
<tr>
<td>&gt;30</td>
<td>27</td>
<td>25.96</td>
</tr>
<tr>
<td><strong>No. of employees in the quality department</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-10</td>
<td>21</td>
<td>20.19</td>
</tr>
<tr>
<td>11-20</td>
<td>15</td>
<td>14.42</td>
</tr>
<tr>
<td>21-50</td>
<td>32</td>
<td>30.76</td>
</tr>
<tr>
<td>51-100</td>
<td>16</td>
<td>15.38</td>
</tr>
<tr>
<td>&gt;100</td>
<td>20</td>
<td>19.23</td>
</tr>
</tbody>
</table>
The internal consistency method does not require either the splitting or repeating of items. Instead, it requires only a single test administration and provides a unique estimation of reliability for the given test administration. It is the most general form of reliability estimation (Nunnally, 1967). Therefore, the internal consistency method was used in evaluating the reliability of the survey instruments in this research.

Table 5.2  Cronbach's alpha value for TQM critical success factors

<table>
<thead>
<tr>
<th>S. No.</th>
<th>TQM CSFs</th>
<th>Number of items</th>
<th>Cronbach's Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The role of management leadership and quality policy</td>
<td>13</td>
<td>0.9362</td>
</tr>
<tr>
<td>2</td>
<td>Role of the quality department</td>
<td>5</td>
<td>0.9291</td>
</tr>
<tr>
<td>3</td>
<td>Training</td>
<td>8</td>
<td>0.9308</td>
</tr>
<tr>
<td>4</td>
<td>Product design</td>
<td>6</td>
<td>0.9308</td>
</tr>
<tr>
<td>5</td>
<td>Supplier quality management</td>
<td>8</td>
<td>0.9284</td>
</tr>
<tr>
<td>6</td>
<td>Process management</td>
<td>7</td>
<td>0.9261</td>
</tr>
<tr>
<td>7</td>
<td>Quality data and reporting</td>
<td>8</td>
<td>0.9299</td>
</tr>
<tr>
<td>8</td>
<td>Employee relations</td>
<td>8</td>
<td>0.9305</td>
</tr>
<tr>
<td>9</td>
<td>Customer focus</td>
<td>7</td>
<td>0.9305</td>
</tr>
<tr>
<td>10</td>
<td>Lean manufacturing</td>
<td>5</td>
<td>0.9273</td>
</tr>
</tbody>
</table>

There were 75 input performance measures for measuring the 10 TQM CSFs for Indian industries. For each scale, there were a number of items to measure it (Appendix 5). The survey data was entered into the SPSS 9.05 reliability program. The results obtained (Cronbach’s alpha) are presented in Table 5.2 for different TQM implementation scales. This table shows that the
reliability coefficients ranged from 0.9261 to 0.9362. Reliability co-efficient Cronbach alpha of 0.700 or more is acceptable (Nunnally) for instrument. Accordingly, the instrument developed for measuring TQM implementation TQM CSFs was judged to be reliable.

5.12.1 ITEM ANALYSIS

Nunnally (1967) developed a method of evaluating the assignment of items to scales that considers the correlation of each item with each scale. Specifically, the item-score to scale score correlations are used to determine whether an item belongs to the scale as assigned, to some other scales, or should be eliminated scale-score is obtained by computing the arithmetic average of the scores of the items that comprise that scale. The values of item to scale correlations should be greater than 0.50; those lower than 0.50 do not share enough variance with the rest of the items in that scale. Therefore, it is assumed that if the items are not measuring the same factor then it should be deleted from the scale. Saraph et al. (1989) used this method to evaluate the assignment of items to scales in developing their instrument for measuring the TQM CSFs of quality management. It was judged that item analysis should be performed in order to understand whether items were assigned appropriately. All items had high correlations with the scales to which they were originally assigned relative to all other scales. In this analysis item numbers 66, 69, 72 and 73 were deleted because the correlation was low with assigned factors.

5.12.2 VALIDITY

Validity is defined as the extent to which any instrument measures what it is intended to measure. The three most popular methods of evaluating the validity of a measurement instrument are content validity, criterion-related validity, and construct validity.

5.12.3 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 with some knowledge of the subject matter. The evaluation of content validity typically involves an organized review of the survey's contents to ensure that it includes everything it should, and does not include anything it should not Saraph et al. (1989). Strictly speaking, content validity is not a highly scientific measure of a survey instrument's accuracy. Nevertheless, it provides a solid foundation on which to build a methodologically rigorous assessment of a survey instrument's validity.

In this research, however, it was argued that the 10 TQM CSFs for measuring TQM implementation practices and the 10 scales for measuring overall business performance had content validity since the development of these input performance measures was based mainly on an extensive review of the literature and detailed evaluations by academicians and practitioners. Items were deleted, added, or modified based on these reviews prior to the pilot test.

5.12.4 CRITERION VALIDITY

Criterion-related validity, sometimes called predictive validity or external validity, is concerned with the extent to which a measurement instrument is related to an independent measure of the relevant criterion Saraph et al. (1989). The ten measures of quality management in a business unit have high criterion related validity if these measures are highly and positively correlated with quality performance in a business unit. The criterion-related validity of the combined set of ten measures of quality management was evaluated by examining the multiple correlation coefficients computed for the ten measures and a measure of business unit quality performance. The multiple correlation coefficients of the quality performance measures and the ten measures of quality management was 0.6, indicating that the ten measures have a high degree of criterion-related validity when taken together.
5.12.5 CONSTRUCT VALIDITY

The program of SPSS 9.05 was used to perform factor analysis, each scale being factor analysed separately. From the analysis, it was clear that all of the items had high factor loadings greater than 0.50 on construct. When the items in a scale loaded on more than one factor, the rotated (varimax, quartimax if necessary) solution was examined. According to Hair et al. (1992), the latent root criterion (eigenvalue) is the most commonly used method of judging whether items are loading on one factor. In principal component analysis, only the TQM constructs having eigenvalues greater than 1 are considered significant; all TQM constructs with eigenvalues less than 1 are considered insignificant and disregarded. It should be noted that percentage of variance and scree test can also be used as criteria for judging whether items in a scale load on one factor. However, these two criteria are not easy to use in practice. For example, in the social sciences, where information is often less precise, it is not uncommon for the analyst to consider a solution that accounts for 60% of the total variance (and in some instances even less) as a satisfactory solution (Hair et al., 1992).

5.13 RESULTS AND DISCUSSION

Reliability and validity analyses were used to test and validate the measurement instruments. The procedures for testing the reliability and validity of the instruments (TQM implementation and overall business performance) have been described in greater detail in this chapter. The data obtained from the instrument can be used for testing the theoretical models. Practitioners can use the validated instrument for measuring the TQM implementation and overall business performance, and researchers can use to study the effects of TQM implementation on overall business performances. A comparison of instrument development process is presented in Table 5.3. Quality management programs, such as TQM, quality control and ISO 9000 standards, are very popular in Indian manufacturing industries now. By implementing these programmes, Indian manufacturers have improved their product quality and their competitive edge.
Table 5.4 presents the mean and standard deviation values of 10 TQM CSFs developed in the present study. Mean values for the 10 TQM CSFs are all 3.00 and above. Respondent companies have relatively higher mean values (≥ 3.50), for the TQM CSFs 'the role of management leadership and quality policy, product design, employee relations, customer focus and lean manufacturing'. Mean values for the TQM CSFs of 'process management, training, the role of quality department and supplier quality management' were less than 3.30.

In general, top management in Indian industries expressed a high commitment to quality management. Managers had strong quality awareness and were willing to take responsibility for quality improvement. Most Indian manufacturers have implemented effective quality management programmes and have set clear specifications for their products and services. They obtained many positive quality results. This study found that Indian manufacturers provided enough on-the-job training in quality management to employees.

This work showed most of the employees had chance of taking part in quality strategy planning and assessment. The present study found that few companies asked their suppliers (mean value = 3.03) to give their opinions on product design, manufacturing and marketing. Even fewer presented training and technological support to suppliers. The relationship between manufacturers and suppliers is just the relationship between buyers and sellers.
Table 5.3  Comparison of instrument development process with previous works in India

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of TQM CSFs</td>
<td>9</td>
<td>4</td>
<td>10</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Responses</td>
<td>73</td>
<td>175</td>
<td>50</td>
<td>114</td>
<td>104</td>
</tr>
<tr>
<td>Response rate</td>
<td>97%</td>
<td>62%</td>
<td>100%</td>
<td>22.8%</td>
<td>31.5%</td>
</tr>
<tr>
<td>Type of industry</td>
<td>Chemical, Pharmaceutical and manufacturing</td>
<td>Cement, Textile, Chemical and Electronics</td>
<td>Manufacturing</td>
<td>Cement, Textile, Chemical, Electronics and Manufacturing</td>
<td></td>
</tr>
<tr>
<td>Questionnaire focus</td>
<td>Quality assurance &amp; General managers</td>
<td>Senior level managers</td>
<td>Chief Executive Officers</td>
<td>Plant Manager</td>
<td>Quality assurance engineers &amp; General managers</td>
</tr>
</tbody>
</table>

Overall, the state of quality management in Indian manufacturing industries is considerably towards the right course. Though numerous quality practices have been undertaken and many benefits have been achieved, Indian manufacturers still need to pay more attention to solving problems that hold back the further development of quality management.

The data obtained through this instrument can be used for subsequent data analysis. The tested and validated TQM implementation instrument had 10 scales that consisted of 75 input performance measures. When compared to the other quality management instruments developed in India, the instrument developed in this study has the highest external validity.
Table 5.4  Means and Standard Deviations for 10 TQM CSFs

<table>
<thead>
<tr>
<th>TQM CSFs</th>
<th>No of items</th>
<th>Means</th>
<th>Standard Deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>The role of management</td>
<td>13</td>
<td>3.84</td>
<td>0.69</td>
</tr>
<tr>
<td>leadership and quality policy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Role of the quality department</td>
<td>5</td>
<td>3.28</td>
<td>0.60</td>
</tr>
<tr>
<td>Training</td>
<td>8</td>
<td>3.10</td>
<td>0.63</td>
</tr>
<tr>
<td>Product design</td>
<td>6</td>
<td>3.50</td>
<td>0.73</td>
</tr>
<tr>
<td>Supplier quality management</td>
<td>8</td>
<td>3.03</td>
<td>0.67</td>
</tr>
<tr>
<td>Process management</td>
<td>7</td>
<td>3.19</td>
<td>0.56</td>
</tr>
<tr>
<td>Quality data and reporting</td>
<td>8</td>
<td>3.47</td>
<td>0.62</td>
</tr>
<tr>
<td>Employee relations</td>
<td>8</td>
<td>3.57</td>
<td>0.60</td>
</tr>
<tr>
<td>Customer focus</td>
<td>7</td>
<td>3.60</td>
<td>0.62</td>
</tr>
<tr>
<td>Lean manufacturing</td>
<td>5</td>
<td>3.50</td>
<td>0.59</td>
</tr>
</tbody>
</table>

A paper based on the contents of this chapter is under review for a possible publication in the International Journal of Total Quality management and Business Excellence.