Chapter 4
Methodology

4.1 Overview

This chapter explains the research design and the research methodology used in this research in detail. The approach of this study is both qualitative and quantitative in nature and this is basically an exploratory and ex post facto (Kothari, 2000) kind of research, so concepts and models evolve as the research makes progress both in terms of literature review and field work on construction sites and discussions with the knowledge workers. However, the basis for the process is the standard research design and methodology recommended for this kind of research, based on which implications are drawn through the interpretation of the analysis of both qualitative and quantitative data.

The nature of research and the variables involved therein are highlighted in the beginning of this chapter. The methods used in this research are listed. Identification and rationale for the sample selection has been given. The research instruments used and the procedure of developing them have been given. Organizational profile and respondents' profile have also been given. The systematic procedure for performing reliability, validity and practicality test has been described. The best practices incorporated in developing the questionnaire, data collection strategies, statistical procedures, data analysis and limitations of these methods are discussed. Finally, methodological limitations have been discussed and the methods adopted to minimize the effect of confounded relationships have been listed.

4.2 Nature of Research and the Variables

As mentioned before, this is an exploratory research on CSFs of TQM implementation in Indian construction industries. It is to some extent a correlation as well as causation study as it seeks relationships between various variables which affect the TQM implementation. Following are the research variables of interest to this study.
4.2.1 Exogenous Variables

The exogenous variable of this study is CSFs of TQM implementation in Indian construction industries. It has the variables: Customer management, Top management leadership, People management, Organizational learning, Process management, Continual improvement, Quality information management, and Supplier management. Hence, the exogenous variable of study and its indicators are:

\[ \text{CSFs of TQM implementation} = f \{ \text{Customer management, Top management leadership, People management, Organizational learning, Process management, Continual improvement, Quality information management, and Supplier management} \} \]

For secondary level of analysis (Structural model C - Chapter 3), this exogenous variable has been further disintegrated into three components as given below.

\[ \text{CSFs of TQM implementation} = f \{ \text{Strategic factors, tactical factors, operational factors} \} \]

The indicators of the above three factors are:

\[ \text{Strategic factors} = f \{ \text{Top management leadership, Continual improvement} \} \]

\[ \text{Tactical factors} = f \{ \text{People management, Organizational learning, Quality information management} \} \]

\[ \text{Operational factors} = f \{ \text{Supplier management, Customer management, Process management} \} \]

4.2.2 Endogenous Variables

There are two endogenous variables in this study viz., Operational performance and Organizational performance. The indicators of these two variables are given below.

\[ \text{Operational performance} = f \{ \text{Cost reduction, Waste reduction, Improving the quality of products, Improving flexibility, Improving delivery performance} \} \]

\[ \text{Organizational performance} = f \{ \text{Financial performance, Non-financial performance} \} \]

\[ \text{Financial performance} = f \{ \text{Revenue growth, Net profits, Profit to revenue ratio, and Return on assets} \} \]
Non-financial performance = f \{Investments in R&D, Capacity to develop a competitive profile, New products development, Market development and Market orientation\}

4.2.3 Extraneous Variables

No correlation research can be complete with respect to the variable section due to the dynamic nature of business world. New constraints as well as possibilities emerge out each day and the system keeps growing in terms of the number of variables. So, the boundary of research will have to be fixed before the commencement of data collection. In this research all the CSFs other than the eight exogenous factors become extraneous to the study. This research is focussed only on Operational performance and Organizational performance as they are most relevant to this kind of research as elucidated from the literature review. So the factors which may also reflect the performance of the industry such as: Market standing, Brand equity, Share value, Social corporate responsibility, Environmental friendliness, etc., become extraneous factors to this study.

4.3 Method

As such the research design appropriate for such studies must be flexible enough to provide opportunity for considering different aspects of a problem under study (Kothari, 2000). Generally, the following three methods in the context of research design for exploratory study are: (a) the survey of concerning literature; (b) the experience survey, and (c) the analysis of ‘insight-stimulating’ examples. This research has considered all these three methods in arriving at the hypothesis. Strictly speaking, and exploratory research ends with the building of the hypothesis. But as ‘ex post facto’ approach was used in this research it went beyond the formation of the hypothesis. The survey of concerning literature happened to be the most direct and effective method in this research in formulating precisely the research problem and developing hypothesis. Hypotheses stated by earlier workers have been reviewed for their relevance in the Indian context of construction industry. It was also considered whether the already stated hypotheses suggest new hypothesis. In this way researcher has led to the formation of structural models and research hypotheses.

For an exploratory research of this kind a survey with people who are competent and can contribute new ideas have been carefully selected as respondents
to ensure a representation of different types of experience and interviewed in person. Systematic questioning of informants has been carried out but flexibility is ensured to see that they share the difficulties they have faced particularly in the implementation aspect of TQM. Semi-structured interview is the method used for interviewing the respondents. Respondents are also allowed to freely raise issues and questions which the investigator has not previously considered.

Analysis of 'insight-stimulating' examples has been very useful in the introduction of performance measures of this research. Some of the informant asked questions such as what use with the TQM implementation if there is no evidence of business performance improvement. So, this has led to the further reading of literature and develops the stage C of the structural model.

4.4 The Research Design

![Diagram of the Research Design]

Figure 4.1: The Research Design
The research design follows the typical approach of exploratory research followed with hypothesis testing and building of the model (figure 4.1). Following the research questions, an extensive literature review has been carried out (Chapter 2). Based on the literature review, the structural models of research have been developed and working research hypotheses have been developed. Meta-analysis of literature has been adopted as the principal method, which is basically a group of methods focused on contrasting and combining results from different studies, in the hope of identifying patterns among study results, sources of disagreement among those results, or other interesting relationships that may come to light in the context of multiple studies (Greenland, O' Rourke, 2008). The appropriate Research Methodology decided to test the research hypotheses in this research is Structural Equation Modelling using Partial Least Square Method (PLSM) for Multi-variate Analysis has been carried out. Due to multi-collinearity among X values as there are several independent variables varying simultaneously the standard regression method will fail in these cases and PLSM is the only possible solution. The variables studied are grouped into Exogenous, Endogenous and Extraneous variables. For the latent variables of study (CSFs, Operational performance, and Organizational performance) the indicators are identified through meta-analysis of literature as mentioned before.

Based on the hypotheses testing results, answers to various research questions proposed in the beginning of the research will be attempted, findings of the study will be listed, inferences will be drawn and the implication of the study would lead to a model developed for CSFs of TQM implementation for the construction industry in India, which forms the final phase of research.

4.5 Identification of the Sample and Rationale for its Selection

As the main purpose of this research was to explore the CSFs of TQM implementation in Indian construction industries, a cross section of construction industry was surveyed initially. It was found that the entire construction industry comprises: high rise buildings, dams, irrigation network, energy conversion and industrial plants, environmental protection works, infrastructure facilities like roads, bridges, airports and seaports, satellite launching station, onshore and offshore oil terminals etc., These industries were spread across the country but densely populated in Hyderabad, Mumbai, Kolkata, New Delhi, Noida, Bhopal, Chennai, Ahmedabad,
Bangalore, Nagpur, Pune, and Trivandrum. So, the sample was distributed across these regions.

The Indian construction industry comprises 200 firms in the corporate sector, in addition to these firms, there are about 1,20,000 class-A contractors registered with various government construction bodies. There are thousands of small contractors, which compete for small jobs or work as sub-contractors of prime or other contractors. Simple random sampling was found to be the most appropriate method as the purpose was to identify CSFs and not sector-wise comparisons. Selection of respondents was the next important aspect of this study. The employee group included: Manual employees, Skilled operatives, Apprentices, Unskilled and semiskilled employees, Managerial and technical employees, Clerical employees, Foremen and Supervisors. But the respondents most suitable for this research were knowledge workers in the construction industry who have exposure to quality issues and are involved in decision making at different levels.

The hierarchical structure of knowledge workers was found to be: Assistant Engineer, Engineer, Senior Engineer, Assistant Manager, Deputy Manager, Manager, Senior Manager, Assistant General Manager, Deputy General Manager, General Manager, Senior General Manager, Assistant Vice President, Vice President and Executive Vice President. Among these categories, Engineers, Project managers, Supervisors, and Inspectors were available for survey at their leisure. The population size of the knowledge workers is about 12 lakh and the standard formula for sample size (Kothari, 2000) yields the following sample size.

\[ n = \frac{z^2 \cdot p \cdot q \cdot N_u}{e^2 (N_u - 1) + z^2 \cdot p \cdot q} \]

where,

- \( p \) = Proportion of defectives in the universe
- \( q = (1 - p) \)
- \( z = 1.96 \) (as per table of scores in a normal distribution within a selected range of z for a confidence level of 95%)
- \( e \) = Acceptable Error (an error of 2% of the true value is assumed)
- \( N_u \) = Size of Population

The approach of specifying the precision of estimation desired first, and then determining the sample size necessary to ensure it (Kothari, 2000) is adopted, according to which, the sample size necessary is \( n = 188 \). Even though the minimum
sample size recommended is 188, a total of 540 questionnaires were distributed throughout the population to HR managers. After repeated follow-up 380 filled questionnaires were obtained out of which only 331 questionnaire could be considered for analysis. For SEM a minimum sample of 200 is required and through the technique of Bootstrapping it can be extended as desired.

Decision on the exactness of sample size is always a debatable issue in any research. This is based on the 2% defect in sample (based on pilot study) and an acceptable error of 2%. Again, the optimum size of the sample in a social research is based on the nature of the empirical study, time and resources available, and various other considerations such as size of questionnaire, size of universe, nature of classes proposed etc. In practice, the complexity of the competing factors of resources and accuracy means that the decision regarding a sample size tends to be based on experience and good judgment, rather than relying on a strict mathematical formula (Hoinville et. al. 1978). Also the use of surveys in social research does not necessarily have to involve samples of 1000 or 2000 people or events, instead, research involving a number between 30 and 250 cases is adequate (Denscombe, 1999).

4.6 The Research Instrument

Self-administered questionnaire is the instrument used in this research. Self-administered questionnaire as the instrument is that it is a relatively systematic and standardized method of collecting data, which lays emphasis on measurement and conversion of data from qualitative to quantitative form. Further, it is evolved from studying sampling population to probability sampling and provides means for simple counting to statistical description and inferential analysis. Finally, this method is considered to be economical and convenient for this kind of research. The questionnaires have been designed to study the perceptions of the respondents on the research issues. They obtain the answers to the research questions and provide the necessary data to test various hypotheses. Though the literature review and interviews with the teaching faculties of various institutes identified several specific problem areas under the topics of study, only those areas specific to the research questions of this study were selectively chosen. The problem areas were categorized, simplified and redundancy was eliminated to develop a set of questions for the
research questionnaire. Further, while developing the questionnaire the following points were taken into consideration:

- Are the categories of respondents competent enough to provide the necessary information?
- Do the chosen items of each questionnaire truly measure the dimension to which they correspond?
- Questions were framed to be uniformly understood by all respondents belonging to different levels of managerial cadre in the construction industry.

The research questionnaire which is the metric used for measurement in this research is given in Appendix I and the detailed process of its development is given in the following sections.

Semi-structured interviews with the knowledge workers have been conducted in several locations spread across the country. Semi-structured interview is sometimes called "moderately scheduled", which means the interview is not highly structured, as is the case of an interview that consists of all closed-ended questions, nor is it unstructured, such that the interviewee is simply given a license to talk freely about whatever comes up. Semi-structured interviews offer topics and questions to the interviewee, but are carefully designed to elicit the interviewee's ideas and opinions on the topic of interest, as opposed to leading the interviewee toward preconceived choices. They rely on the interviewer following up with probes to get in-depth information on topics of interest. Two underlying principles followed during the interview are: (1) strive to avoid leading the interview or imposing meanings, and (2) strive to create relaxed, comfortable conversation so as to bring out the actual feelings and understandings of the respondents on the topic, and also enable the respondent to express freely the difficulties and shortcomings in the system.

4.7 Development of CSFs of TQM Implementation Questionnaire

The synthesis of the philosophies, principles, and interventions of the TQM proponents as applicable to construction industries has yielded eight possible factors (variables) for the TQM implementation. Chapter 3 (Section 3.2) indicates the screening of the CSFs of TQM implementation in construction industry to arrive at the following eight critical factors.
1. Customer management;
2. Top management leadership;
3. People management;
4. Organizational learning;
5. Process management;
6. Continual improvement;
7. Quality Information Management; and
8. Supplier management.

### 4.7.1 Customer Management

In the CSFs of TQM implementation, researchers have emphasized on Customer Management in different ways. A group of researchers (Lee and Chang, 2006; Zairi, 2000; Lagrosen, 2001; Rampersad, 2001; Escrig-Tena, 2004; and Fotopoulos and Psomas, 2009; Holt and Rowe, 2000; Pheng & Ke-Wei, 1996; Haupt & Whiteman, 2004; Dulami, et al., 1996) have identified the indicators of Customer management as: Maintains close contact with clients, Builds relationship to satisfy customers for repeat business and positive referrals, Continuously assesses customer requirements including changing market trends, Solicits feedback from clients for customer satisfaction/dissatisfaction, Has an effective management process for resolving customer’s complaints, Provides client’s complaints summary to Project Manager, Arranges informal get-together session with clients, and Employees working closely with customers are empowered to take decisions for speedy disposal of customer complaints. These variables are considered to be the indicators of the CSF Customer management.

### 4.7.2 Top Management Leadership

Considers quality while developing long-term goals, Implements comprehensive quality goal-setting. Ensures quality goals and policies are understood by all, Implements comprehensive quality plans, Provides adequate resources for implementing quality related goals, Encourages company-wide quality culture, Views quality more important than schedule, Views quality more important than cost, Senior leaders are responsible for quality performance, and Senior leaders are evaluated for quality performance. So these form the indicators of top management leadership.

4.7.3 People Management

Boon et al. (2005), Karia and Asaari (2006), Kennerley & Neely (2003), Neely et al., 2002, Neely, et al. (2002), Harrington et al., (2012), Sureshchandar et al. (2002), Prajogo & Cooper (2010), Tatum (2000), Hardie, Graeme Newell, (2011), Schmberger & Knod (1997), Dayton (2003), Salaheldin (2009), and Kafafi (2006) have expressed that people management is effective if the industry: Promotes quality awareness on continuous basis, Provides feedback to employees on performance, Encourages participation by non-supervisory staffs, Encourages workers to fix quality problems, Encourages workers to inspect their own works, Provides resources for workers to fix quality problems, Uses cross-functional team to solve problems, Selects employees based on their ability to solve problems, Recognizes employees who come with innovative ideas to improve quality, and Provides opportunities for employee empowerment through training.

4.7.4 Organizational Learning

Holt & Rowe (2000) claim that ‘critical leaders’ encourage self-assessment of attitude and technique in order to promote the idea of learning continually, and practically change the organization into learning organization. Love & Heng (2000), emphasize the importance of a dialogue between TQM and the learning organization for change in construction industry. Kutucuoglu et al. (2001) and Wordsworth (2001) agree on the indicator for performance of TQM, which comprises of the performance of aspects which are related to equipment, task, cost, immediate customer impact and also learning and growth. Kaplan and Norton (1992) advocate different perspective on measuring
performance level in which they classify the properties into tangible aspect as financial and intangible aspects like customers, internal processes and innovation and learning. Drawing from these studies, the indicators of Organizational learning are grouped as: Trains employee to understand how company performs, Develops an environment for on-the-job training, Encourages employees learn to improve skill, Encourages personal mastery, Encourages mental modelling, Trains employees in statistical techniques, Training on best quality management practices are learnt through benchmarking.

4.7.5 Process Management

Porter (1998) had realized the importance of Process management very early and suggested that from the client side, Government could support, rather than limit, such productivity by becoming involved, continually, within the process of project construction, delivery and use. Holt & Rowe (2000) claim that total quality is conveyed when the judgements are not made as one off decisions, but are made continually, throughout the project process. Biazzo (1998) critically re-examines the business process re-engineering phenomenon and suggest methods to strength process management having realized how important it is for an industry. Pheng & Ke-Wei (1996) after a thorough study of the construction industry recommends a more rational management approach for the construction process needs, thus, calling for a proper process management. Their argument is that construction work is undertaken in the main in single batches or projects (i.e. one building, one bridge, etc.) and although many of the basic processes are repeated from job to job (e.g. concreting and plastering), the specifics of application are always changing and hence TQM should look into more of process management. They claim that quality management in construction industry is basically process management. Drawing from these studies, the indicators of Process management have been chosen. In other words an industry is said to have an effective process management if following variables are taken care of: Designs construction processes to be fool-proof, Standardizes many of the repetitive processes, Quality management practices like ISO are in place, Includes quality measures in construction processes, Provides clear construction process instruction, Implements continuous control of construction processes, Conducts process inspection, review, and checking, Conducts final
inspection, review, and checking. Prevents faulty works from being worked on, establishes process checks for timely detection of mistakes or faults to prevent defects, and emphasizes good housekeeping on-site.

4.7.6 Continual Improvement

A group of researchers including Pheng and Wei (1996), Harrington et al., (2012), Fassoula (2006), Yang (2005), Rampersad (2001), Khanna et al., (2011), Spires, C. (1996), Fryer et al., (2007) have emphasized the components of continual improvement and highlighted its importance in TQM. Love et al., (1998) opine that before total quality management procedures governing the event of product and service delivery can operate effectively, concern must be given to the foundations within which such procedures make sense, notably, to nurturing a culture of innovation and continuous improvement. According to Pheng & Ke-Wei (1996), in the construction industry, quality effort involves a process in which a key element to success is continuous improvement and they have listed the following are the keys to continuous improvement in the construction process:

- Learn to work smoothly in teams, i.e. respect the principle of internal supplier to internal customer chains.
- Be proactive to sense reasonable future change and be prepared. Do not wait until you are pressured into change or to act.
- Aim process improvement at the singular goal of meeting clients' expectations.
- Set benchmark at above average incremental process improvement to systems or subsystems and implement/monitor programmes.
- Look for root causes when diagnosing the system malfunction or project process bottlenecks.
- Recognize the integrated and interdependent nature of project system and its parts.

Considering these factors, following indicators have been chosen to measure continual improvement: Uses techniques to identify key processes for improvement, focuses on continuous and incremental improvement, practices kaizen at various levels in the organization, adopts process control and improves core processes with design, assesses improvement of processes, practices, and services, analyzes
performances and cost data to support improvement. Adopts programs to find time-cost losses in all processes. Promotes quality improvement with outside groups, Benchmarks against direct competitors, Benchmarks against non-competing organizations.

4.7.7 Quality Information Management
In today's information and knowledge driven economy, quality information management has become very vital for promoting innovation and gaining competitive advantage. The success of TQM implementation in construction industry is also based on the efficiency of handling information from various sources. Lillrank (2003) and Gotzamani et al. (2006) have very clearly emphasized the importance of quality data and reporting. Rahman's (2001) study of 53 Australian SMEs found information and analysis as one of the important CSFs. Ability to manage information has direct effect on the decision that are made by middle management (Turban et al., 1999). Coyle-Shapiro (1997) have opined that the smooth flow of information, and also, quality-related data reaching the respective departments for necessary action at the earliest moment are important form the point of view of TQM success. Product design and several other processes will also be improved if the information flow is of high quality. Based on this several indicators of quality information management have been identified which include: Implements structured data gathering to ensure reliability, Collects data from the source to reduce any inaccuracy, Uses quality data to evaluate supervisors and managers, Uses quality data to manage quality, Makes available quality data to project site, Furnishes quality data to workers, Uses statistical quality control techniques to all equipment's, Uses statistical quality control to reduce variance in process, and Makes available quality data to client.

4.7.8 Supplier Management
Supplier management is also an important factor for TQM implementation and success. Sharma and Kodali (2008) found that the interdependence of buyers and suppliers has increased dramatically in modern business. Therefore, the importance of long-term relationships with suppliers needs to be established. Many product/process quality problems have their source in defective incoming supplies.
The relationship with suppliers is a major component in attaining competitive advantage (Flynn et al., 1994). Considering these studies and the requirements of construction industries following indicators have been identified as indicators of Supplier management: Involves suppliers/subcontractors in developing construction processes, Places strict requirements on suppliers/subcontractors to achieve quality, Provides technical assistance to suppliers/subcontractors, Maintains long-term relationship with suppliers/subcontractors, Relies on few dependable suppliers/subcontractors, Rates suppliers/subcontractors on delivery performance, and Evaluates quotations not on price factor alone.

4.7.9 Strategic, Tactical and Operational CSFs

As mentioned in Chapter 3 (Section 3.4.3), the eight CSFs were to be grouped into Strategic, Tactical, and Operational factors which would be a better measures in the component form of CSFs Salaheldin (2009). The influence of each of CSFs these three factors on Operational and Organizational performance would be of interest in this exploratory research as it would lead to some key revelations regarding performance of the construction industry. The indicators of these three variables selected for this research are as follows. Strategic factors: Top management leadership and continual improvement; Tactical factors: People management, Organizational learning, and Quality information management; and Operational factors: Supplier management, Customer management, and Process management.

4.8 Operational and Organizational Performance Questionnaire

TQM implementation doesn’t serve any purpose if it doesn’t enhance operational performance. Through research it is observed that TQM enablers have the greatest impact upon operational as well as business performance of the organization. According to Gotzamani et al. (2006), TQM elements are directly related to final product quality and customer satisfaction. Salaheldin (2009) calls operational performance as Primary measure of performance and emphasizes the need to link operational performance to organizational performance to achieve the success of TQM implementation. The variables he has identified as the measures are used in the current study as the indicators and are as follows: Cost reduction, Waste reduction,
Improving the quality of products, Improving flexibility, and Improving delivery performance.

Salaheldin (2009) calls Organizational performance as Secondary measure of performance and emphasizes the need to link CSFs to Organizational performance through operational performance to study the success of TQM implementation. The Organizational performance indicators are further grouped into Financial performance and Non-financial performance. The indicators of these two are, Financial performance: Revenue growth, Net profits, Profit to revenue ratio, and Return on assets; and Non-financial performance: Investments in R&D, Capacity to develop a competitive profile, New products development, Market development and Market orientation (Salaheldin, 2009).

Hence, the complete measurement instrument has eight CSFs which constitute the exogenous variables of study under structural model A & B. In the structural model C, the eight CSFs are grouped into Strategic factors, Tactical factors and Operational factors, which become the exogenous variables. Operational performance and Organizational performance are the endogenous variables. Organizational performance has two components viz., Financial performance and Non-financial performance (endogenous variables). The Operational performance becomes the mediating variable and or intervening variable of study. The Questionnaire used for data collection in given in Appendix I and the brief description and sample items are given in Table 4.1.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Brief Description</th>
<th>Sample Item</th>
</tr>
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<tbody>
<tr>
<td>1. Customer management</td>
<td>Managing a company’s interactions with customers, clients, and sales prospects</td>
<td>Builds relationship to satisfy customers for repeat business and positive referrals.</td>
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<tr>
<td></td>
<td>(Shaw, 1991).</td>
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<tr>
<td>2. Top management leadership</td>
<td>The top management leadership is the management strategy to ensure that sufficient resources are available for quality-related activities (Beer, 2003).</td>
<td>Considers quality while developing long-term goals.</td>
</tr>
<tr>
<td>3. People management</td>
<td>All the management decisions and actions that directly affect or influence people as members of the organisation rather than as job-holders(Henderson, 2011 and Khanna et al., 2011).</td>
<td>Provides feedback to employees on performance.</td>
</tr>
<tr>
<td>Dimension</td>
<td>Brief Description</td>
<td>Sample Item</td>
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<tr>
<td>4. Organizational learning</td>
<td>An organization’s ability to sense changes in signals from its environment (both internal and external) and adapt accordingly (Nonaka &amp; Takeuchi, 1995)</td>
<td>Trains employee to understand how company performs.</td>
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<tr>
<td>5. Process management</td>
<td>Identifying and improving the key processes and improving continuously to achieve better quality of products and processes (Khanna et al., 2011).</td>
<td>Standardizes many of the repetitive processes.</td>
</tr>
<tr>
<td>7. Quality information management</td>
<td>An efficient and effective technological system to collect the information related to quality data and use in the activities of the organization (Mjema et al., 2005 and Khanna et al., 2011).</td>
<td>Uses statistical quality control techniques to all our equipment.</td>
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<td>8. Supplier management</td>
<td>Systems in place to ensure the quality of incoming materials, and delivery performance of the suppliers, and to share this data with suppliers (Khanna et al., 2011).</td>
<td>Involves suppliers/subcontractors in developing construction processes</td>
</tr>
<tr>
<td>9. Strategic factors</td>
<td>They are broad in nature and impact the long-term effectiveness of the company (Davis et al., 2003).</td>
<td>Organizational culture is congenial to accomplish the long term vision.</td>
</tr>
<tr>
<td>10. Tactical factors</td>
<td>The factors affect the decisions that are made by middle management (Turban et al., 1999).</td>
<td>People management methods are effective.</td>
</tr>
<tr>
<td>11. Operational factors</td>
<td>They reflect those factors which produce consequences that will be visible in a short term period (Turban et al., 1999).</td>
<td>Customer management methods are effective.</td>
</tr>
<tr>
<td>12. Operational performance</td>
<td>Internal operation of the company in terms of cost and waste reduction, improving the quality of products, improving flexibility, improving delivery performance; and productivity improvement (Salaheldin, 2009).</td>
<td>Cost reduction is a regular feature in the working environment.</td>
</tr>
<tr>
<td>13. Financial performance</td>
<td>Measure of performance is directly in terms of financial measures (Salaheldin, 2009).</td>
<td>Net profits generated are on the rise.</td>
</tr>
<tr>
<td>14. Non-financial performance</td>
<td>Measures that are not directly in terms of financial figures but are still results of TQM implementation and they will add value to the construction industry and ensure growth and success of the industry (Salaheldin, 2009).</td>
<td>Company invests a lot in research and development</td>
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</tbody>
</table>
4.9 Reliability, Validity and Practicality

Reliability, Validity and Practicality are the indicators of Sound measurement when data collection is through instruments such as questionnaires (Kothari, 2000). ‘Reliability’ has to do with the accuracy and precision of measurement procedure (Litwin, 1995). A reliable instrument should give identical responses if the questionnaire is served two or more times. ‘Validity’ refers to the extent to which a test measures what we wish to measure. Even though validity to a great extent depends upon the judgement of the researcher three types of validity: content, criterion and construct validity are strongly recommended. ‘Practicality’ of a measuring instrument is judged in terms of economy, convenience and interpretability. Economy consideration of practicality suggests that some trade-off is needed between the ideal research project and that which the budget can afford. The length of the questionnaire is an important area where economic pressure is felt. More items in a questionnaire will give greater reliability (Kothari, 2000) but this is time consuming and tedious.

4.9.1 Reliability of the Instrument

The ‘stability’ aspect of reliability is concerned with securing consistent results with repeated measurements of the same person with the same questionnaire. But for a sample size of 331 as in this research it is not very practicable, and hence, the method of determination of the degree of stability by comparing the results of repeated measurements has been adopted. The most common approach of estimating the reliability of an instrument that is presented to respondents only once is ‘split-half reliability’. In this approach the test is split into two equivalent halves and the scores for respondents on one half are correlated with those scores on the second half of the test. The difficulty in this approach is determining whether the two halves are equivalent. Chronbach proposed the coefficient ‘alpha’ (called Chronbach’s Alpha), which may be thought of as the mean of all possible split-half coefficients. A test with ‘robust’ reliability would be expected to display a Chronbach’s Alpha in excess of 0.9. However, values above 0.7 are usually acceptable indicators of internal consistency as suggested in the literature (Santos, 1999; SPSS, 2000, Nunnally & Bernstein, 1994).
4.9.2 Validity of the Instrument

The instrument used in this research have a proved 'content and criterion related' validity, as they are derivatives of standard instruments used before in different organizations and are based on strong theoretical foundation laid through extensive research undertaken by the researchers in construction and manufacturing industries. The language of the questionnaire was revised wherever necessary to make the questionnaire more precise and understandable.

To check the 'construct validity', the interpretative approach by Erickson (cited in Waldrip & Fisher, 1998) was adopted. The main purpose of this was to check whether the scales were measuring what they were designed to measure i.e. they had construct validity. A group of 4 to 5 knowledge workers in the industry was engaged in a discussion in private with complete confidentiality. A semi-structured kind of discussion was adopted as the mode of communication.

Initially, the general aspects of TQM were discussed such as Continuous improvement, People management, Customer satisfaction etc. to tell them about the general nature of this research. They were found to be aware of TQM implantation and project managers even expressed knowledge about six sigma and black belt programmes. Later they were served with the CSFs questionnaire and asked whether the self-administered questionnaire was simple enough to understand. The answer was in affirmative.

Secondly, their perception about the scales was discussed. It was also asked whether the questions under each dimension did justice to the main heading and whether they adequately described the main dimension with the TQM implementation on the focus. The discussion revealed many informal expressions about the difficulties in TQM implementation, which are listed in subsequent chapters in detail.

Thirdly, their responses for different scales were discussed. The degree of variation on a 5-point Likert scale was also discussed for its adequacy. They felt it was adequate in measuring their agreement/disagreement. So a 7-point scale, even though widely used these days was not required in the current research. It was also discussed whether each dimension gave an equal opportunity to score evenly. Their reply was again affirmative.
Finally, there were deliberations about their perception on the key issues focusing on the consistency of their answers. They felt that their rating would be unbiased and would remain consistent. All items were considered to be completely available for their rating.

The questionnaires were subjected to 'item validation' (Pattanayak et al., 2002) through 'Factor Analysis' the purpose of which was to determine the internal structure of the set of given number of items. Principal Component Analysis (PCA) method with varimax rotation using Kaiser variation was used to generate factors. The PCA is very appropriate when the main concern is to predict the minimum number of factors that are required to account for the maximum proportion of the variance when there is a priori set of variables (Ghauri et al., 1995). Hence, this method has been used to test the item validation of the instruments used.

4.9.3 Practicality of the Instrument

'Practicality' of a measuring instrument is judged in terms of economy, convenience and interpretability, as mentioned before (Kothari, 2000). This is one of the reasons why a limited number of items with were used in the questionnaires of this research. Through factor analysis the total variables were reduced by eliminating factors with lower loadings. However, care was taken to give a maximum coverage of the study topic.

'Convenience' forms another key factor of practicality. The questionnaire was designed to be self-administrative in nature and clear guidelines were given in the instrument itself, so that the queries regarding how it has to be filled would be minimum. The Likert scale scoring keys were stated in the beginning and separate columns were provided for ticking under each category. Interpretability of the items was given enough importance to see that each question gives only one meaning, free from ambiguity.

4.10 Best Practices Incorporated in Developing the Questionnaire

The following best practices (Salant & Dilman, 1994; Erdos, 1983, Czaja & Blair, 1996; Fink, 1995; Brockett & Levive, 1984) were identified and incorporated into the questionnaire. The guidelines included:

- Limit instrument to minimum number of pages (< 8 pages).
• Introduce the study with a simple and clear explanation of purpose.
• Pre-code response categories by assigning a number to each possible answer for the respondent to tick.
• Space the categories for ease of comprehension.
• Provide simple instructions.
• Use common wording and simple plain English found in everyday use – no complex terms, undefined abbreviations, or jargon should be used.
• The questions and format should have no subjective tones, which would introduce bias.
• Design the questionnaire to be easy and interesting to answer in order to avoid non-response error.
• Develop questions in a closed format (no open ended questions) so that the respondents may respond accurately without any ambiguity.
• Group questions into sections with similar qualities and relevance.
• Questions should be applicable to and answerable by most respondents.
• Choices must be mutually exclusive to prevent inaccuracies in response.

Throughout the questionnaire the same ranking technique i.e. 5, 4, 3, 2, 1 was used in order to maintain consistency and avoid confusion. The questionnaire was made as readable as possible, paying attention to its layout (alignments, spaces, font size, and size) in order to give it an appealing and uncluttered look. All of the listed “Best Practices” in questionnaire design were incorporated into the questionnaire. The questionnaires were developed, reviewed, and tested prior to final dissemination.

4.11 Data Collection Strategies
The following process model (Figure 4.2) was developed and used to assure an effective survey dissemination and collection. The research questions have been consolidated into the variables of questionnaires based on the literature review and theoretical models (Chapters 2 & 3).
Research Area
CSFs of TQM

Develop Survey Questionnaire

Pilot Run, Test & Consolidate

Distribute & Collect

Obtain Raw Data

Data Analysis

Test Hypotheses

Draw Inference
Make Implications
Develop Models

Fig. 4.2: The Research Process
4.12 Statistical Procedures and Software

- Microsoft Excel 2000 has been used to enter the data into the spreadsheet and calculate the simple statistical parameters such as sum, mean, ranking etc.

- IBM SPSS has been used for following statistical analysis:
  - Reliability and factor analysis,
  - Indices of perception,
  - Descriptive statistics such as standard deviation, skewness, mean in %, ranking, etc.,

- SmartPLS has been used for Structural Equation Modelling.

4.12.1 Types of Data Analysis

Descriptive Analysis was used to provide general description of the sample such as sample size, mean, standard deviation, percent mean, and skewness. Some of the key terms used are given in table 4.2.

Inferential Analysis using Structural Equation Modelling was used for testing hypotheses.

Structural equation modelling follows positivist epistemological belief, which means, there exists an objective, physical and social world, nature of this can be characterized and measured, and researcher plays a passive and neutral role and does not intervene in the phenomenon of interest. SEM can be applied only for empirically testable theories i.e. these theories can be confirmed or rejected, premised on the existence of a priori fixed relationships, relationship between theory and practice are primarily technical and researchers can objectively evaluate or predict actions or processes (SmartPLS, 2012).

SEM is considered to be second generation multi-variate analysis as the researcher can simultaneously consider relationships among multiple independent and dependent constructs. SEM also supports latent variables (hypothetical constructs invented by the researcher) (Bentler, 1980).
Table 4.2
(Statistical Terms used in the Analysis)

<table>
<thead>
<tr>
<th>Statistical Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size (n)</td>
<td>The total number of data within the area of description.</td>
</tr>
<tr>
<td>Range</td>
<td>The difference between the largest and the smallest numbers in the set.</td>
</tr>
<tr>
<td>Min. and Max.</td>
<td>The minimum and maximum numbers within a set.</td>
</tr>
<tr>
<td>Mean</td>
<td>Sum of all responses divided by the sample size.</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>Measure of how the values are spread along the mean (clustered or widely dispersed).</td>
</tr>
<tr>
<td>Variance</td>
<td>A measure of dispersion around the mean, equal to the sum of squared deviations from the mean divided by one less than the number of cases.</td>
</tr>
<tr>
<td>Skewness</td>
<td>A measure of the asymmetry of a distribution. The normal distribution is symmetric, and has a skewness value of zero.</td>
</tr>
<tr>
<td>Observed Significance Level</td>
<td>Often called the p value. The basis for deciding whether or not to reject the null hypothesis. It is the probability that a statistical result as extreme as the one observed would occur if the null hypothesis were true. If the observed significance level is small enough, usually less than 0.05 or 0.01, the null hypothesis is rejected.</td>
</tr>
</tbody>
</table>

4.13 Limitations

One important methodological limitation that applies to this study is that the data collected will represent the perceptions of the respondents. As the respondents selected for the research sample were considered to be the most appropriate persons to provide expert opinions on the issues chosen for this research, the downside of this limitation was expected to be minimal. Further, construction industry as such is large and has several types and categories and each one is unique in its own way, and while generalization of the results is done these issues will have to be considered. Finally, all the limitations of statistical methods, such as inability to study qualitative phenomenon directly, issues of exactness of answer, ability to deal only with aggregate numbers etc., are applicable to this research also.

4.14 Summary

In this chapter, a detailed explanation for the research methodology adopted in this research has been given. The nature of the variables has been identified so that the analysis would be easier and the methods used in this research have been discussed. The complete research design in the form of framework has been depicted and
explained. Identification of the sample and the rationale for its selection has been discussed. The metric of the research for measuring the research variables in Indian construction industry has been explained from its development to its validity and practicality. Best practices followed in questionnaire design and the collection strategies have also be explained. Finally, the types of data analyses, as applicable to this research, have been explained.

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