Development of TQM Implementation Process Model for Construction Industry

THESIS

Submitted in partial fulfilment
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

by

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BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE
PILANI (RAJASTHAN)
2005

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CERTIFICATE

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This research work is dedicated to the memories of my beloved father, educationist and philanthropist

Shri C. R. KRISHNE GOWDA
(September 1934 – October 2004)
Retired Principal
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- by his most beloved son
PRAKASHA

Very special gratitudes to:

My mother Smt. R. S. NANJAMMA
Women of never ending enthusiasm and clemency

ACKNOWLEDGEMENTS

I wish to express deep sense of gratitude and sincere thanks to thesis supervisor Dr. Bhimaraya A. Metri, Assistant Professor, BITS, Pilani for his able guidance, encouragement and continued support throughout the period of this research work. It has been a privilege for me to work under his guidance.

Gratitude is also accorded to BITS, Pilani for providing the necessary facilities to complete the research work. My special thanks to Prof. S. Venkateswaran, Vice Chancellor, BITS for giving me an opportunity to do research at the institute. I thank Prof. Maheshwari, Pro-Vice chancellor and Director BITS, Pilani Campus for his timely moral support. I also take this opportunity to thank Prof. K. E. Raman, Deputy Director (Administration), and Prof. V. S. Rao, Deputy Director (Off-Campus Programmes) for providing the necessary infrastructure and other facilities required for carrying out the research work. I express my sincere thanks to Prof. Ravi Prakash, Dean, Research and Consultancy Division for his encouraging support during research work. I also thank Prof. R. N. Saha for providing grant to participate in conferences.

I wish to express gratitude towards the members of Doctoral Advisory Committee Prof. Rajiv Gupta, Dean, Educational Hardware Division and Dr. Srinivas Raju, Associate Professor and Civil Engineering Group Leader for their constructive criticism on the research work. The support of Prof. Anil Bhat, Management Group Leader at critical juncture of research work is gratefully acknowledged. Thanks are due to Dr. M. Ishwara Bhat, Librarian for making timely availability of various books and on-line journals.

Special thanks to Prof. J.P. Mishra, Unit Chief, IPC, for his unique support to carry out my research work. The support of Staff members of Management Group and IPC is gratefully acknowledged.

The cooperation of various personnel and quality experts of various construction organizations is hereby acknowledged.

Finally, a very special expression of appreciation is extended to my parents, family members, without their encouragement, patience and understanding; this endeavour would have never been possible. I would like to record my special affection to my daughters Abhijna Prakash, Ila Prakash and wife Radha whose constant persuasion and moral support has been a source of inspiration to me.

Shivaprakash C. K.

ABSTRACT

Construction industry, though it is a major contributor to the economy of any country, is facing the problems of high fragmentation, instability, low productivity, poor quality and lack of standards. Construction related firms recognize the need for providing a quality product that will satisfy both customer and maintain their competitiveness in an ever changing and demanding market. In this context, total quality management (TQM) is considered as the key transformation philosophy for continuous improvement and customer satisfaction.

The contemporary quality management literature is overwhelmingly manufacturing oriented and there is a dearth of studies (from the construction perspective) addressing the implementation process of TQM that will depict a holistic TQM philosophy in construction organizations. Though TQM is becoming popular in the construction industry, the problems that are encountered in the implementation process remain to be serious. This is due to lack of TQM implementation model for construction organizations.

TQM has been recognized as a successful management philosophy in the manufacturing and service industries. TQM can likewise be embraced in the construction industry to help raise quality and productivity. The benefits experienced include reduction in quality costs, better employee job satisfaction because they do not need to attend to defects and client complaints, recognition by clients, work carried out correctly right from the start, subcontractors with proper quality management systems, and closer relationships with subcontractors and suppliers.

TQM is defined broadly as an integrated management philosophy and set of practices that emphasizes among other things, continuous improvement, meeting customer requirements, reducing rework, long-range thinking, increased employee involvement and team work, process redesign, competitive bench marking, team based, problem solving, constant measurement of results and closer relationship with suppliers. Based on this, a conceptual base was developed for this research, which looks at broad issues, also

offers a systematic and descriptive coverage of the whole body of the TQM literature. Here the aim is to synthesize, organize, structure, knowledge from academic, research, and application stand point. It mainly reflects on literature from the field of construction quality and TQM written in the context of quality management, focusing on an integrated view of managing quality and maintaining broader TQM perspective. This work does not directly cover specific topics such as analytical quality tools (e.g. quality control, statistical techniques, cost models, etc.). Literature specifically related to quality awards, TQM scholarly works, and single individual component of TQM (e.g. leadership, supplier involvement etc.) is reviewed. The focus of research is explicitly towards construction quality.

While many organizations collect quality data such as defects rates, error rates, rework costs, and scrap costs; these are not measures of organization wide quality management. Analysis of the literature suggested following dimensions of quality management, namely, top management commitment, strategic quality management, process quality management, quality results, education and training, human resource management, information and analysis, impact on society and environment, and benchmarking. A TQM model is developed based on the above findings and critical analysis of these dimensions, also known as critical success factors (CSF). The developed model was compared with prominent quality Deming prize, Malcolm baldrige national quality award (MBNQA) and European quality award (EQA) using Criterium decision plus (CDP) software package, which is based on Analytical hierarchy process (AHP).

A 22 step TQM implementation process model is developed to suit the project oriented construction organizations. The implementation process model is result of fusion of organizational characteristics and project characteristics, which are unique to construction organizations. This was tested for usefulness and usability with well known construction organizations and found to be innovative and acceptable.

In order to bridge the existing gap and provide construction companies with practical assistance in the area of TQM implementation, this research is aimed at developing TQM

implementation process model for construction organization. Construction practitioners, organization will be able to use this model while implementing TQM to achieve customer satisfaction through continuous improvement.

This research makes several important contributions to the area of construction quality and TQM. It proposes a TQM model, develops TQM implementation process model for construction organizations. Also, establishes the link between the two and empirically tests the model for application in construction industry.

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LIST OF ACRONYMS

Acronym	Description
AHP	Analytical Hierarchy Process
BOT	Build, Operate, Transfer
C and D	Construction and Demolition
CDP	Criterium Decision Plus
CSF	Critical Success Factor
EFQM	European Foundation for Quality Management
EQA	European Quality Award
ISO	International Organization for Standards
JUSE	Union of Japans Scientists and Engineers
MBNQA	Malcolm Baldrige National Quality Award
NED	Non Excusable Delay
TQM	Total Quality Management
UK	United Kingdom
USA	United States of America
QFD	Quality Function Deployment

CHAPTER 1

INTRODUCTION

1.1 Background of the Construction Industry

Construction industry of any country is the backbone of its infrastructure and economy. The significance of construction industry in attainment of a nation's quest for development and self-reliance cannot be over emphasized. Some of the social areas in which construction plays a vital role include housing, industry, education, and recreation.

The problem of high cost of contracts in all aspects of construction constitutes a stumbling block in the path of the industry. Though problems are often discussed, it appears little has been done to minimize the problems. Consequently, substantial increases are observed in project costs (Arditi and Patel, 1989).

Construction industry is not following the lead of the manufacturing industry and increase profit by reducing the cost of quality problems. Increasing number of professionals, researchers, scientists, publications associated with construction industry of USA have expressed great concern over the problems facing the industry (Burati et al., 1992).

1.2 International Perspective

The characteristics of the construction industry in different parts of the world give an idea and significance of it. For instance, in Saudi Arabia, the government is the major source of construction expenditure accounting for approximately 67% of the nation's construction industry volume (Bubshait and Al-Musaid, 1992). This industry employs 15% of labour work force in Saudi Arabia (Assaf et al., 1995). In developed countries like USA, construction volume is $500 billion and 10 million people are employed (Chinowsky and Meredith, 2000). Similarly, construction sector is the largest industrial employer in the European continent. Construction investment in European Union is at some 690 billion euro representing approximately 12% of GDP and it employs more than 7% of Europe's workforce (Proverbs et al., 1999).

Construction industry, though it is a major contributor to the economy of any country, is facing the problems of high fragmentation, instability, low productivity, poor quality and lack of standards. Several studies (Assaf et al., 1995; Arditi and Patel, 1989; Elinwa and Buba, 1993; Hensey, 1993; Householder and Rutland, 1990; Kraiem and Diekman, 1987; Okpala and Aniekwu, 1988; Yates, 1993; Fisher et al., 1995) on construction project revealed that time overruns and cost overruns are very common.

1.3 Indian Perspective

Construction is the second largest activity in India next only to agriculture. Nearly half of the development budget in government and private sector is spent on construction. 12 to 14% of people in India earn their livelihood through construction activity (Gupta, 1998). It employs 30 million people every year and produces goods and services worth Rs 2,10, 000 crores as at the end of 1999 (Narayan, 2000). The infrastructure investment would total at Rs 3, 91, 900 crore in financial year 2004-2005. The construction expenses would account for Rs 2, 58, 700 crore of the total spending (Sahad, 2005). The world construction market is Rs 1, 10, 00, 00 and India's share is presently estimated at around 0.2 percent (Iyer and Devkar, 2005). Among the build operate transfer (BOT) projects in India, roads account for Rs 85,900 crores, ports account for Rs 50,000 crores, power accounts for Rs 27,800 crores, pipelines for Rs 40,000 crores and railways account for Rs 16,000 crores (Sahad, 2005).

In India, the construction industry operates under scarcity of bulk materials, poor infrastructure, unfriendly legal system, unequal contract condition, poor financial back up, lack of latest machine and equipment, design and techniques and poor availability of labour. For instance, in India Ministry of Statistics and Programme Implementation monitored 446 projects in the month of September 1999, out of them 209 projects have reported cost overruns, which amounted to 41.5% of the original cost and 210 projects reported time overruns in the range of 1-189 months of the original schedule and the reasons for these over runs are fund constraint, land acquisition, government clearance,

environmental clearance, technology selection, delay in award of contract and supply of equipment (Gupta, 1998: Narayan, 2000).

1.4 Objectives of the Research

Based on current quality and TQM literature, this research aims at achieving the following research objectives.

i. Development of TQM model by reviewing existing TQM models.
ii. To develop a TQM implementation process model for construction industry.

Thus new knowledge related to TQM can be generated and its implementation in construction can be derived. In this research, new knowledge is generated from existing TQM models. After reviewing existing TQM literature, it has become clear that this research project is the one that systematically examines the TQM models, from the construction perspective. In addition this research attempts to develop TQM implementation process model which can be used construction industry.

1.5 Methodology

Following steps are adopted to conduct the research.

- Identification of quality problems in construction industry and research gap
- Identification and selection of TQM models
- Overview and critical analysis of the selected TQM models
- Development and justification of TQM model
- Development of TQM implementation process model for construction industry
- Validation of the TQM implementation process model

1.6 Organization of Thesis

Chapter 1 gives background of the present research work, briefs on the significance of construction industry and its problems in global and Indian context. It also briefs about objectives, methodology and organization of thesis. Chapter 2 provides literature review

about construction and quality problems and TQM scenario. The research gap is identified and TQM implementation process model for construction industry is proposed. Chapter 3 presents an overview of the TQM models along with explanation of the contents. The TQM models are critically analysed. In Chapter 4 CSFs of TQM are identified. analysed and a new TQM model is proposed. Corroboration of CSFs is carried out. The sub criteria for the CSFs of the proposed TQM model are identified, analysed and selected. Chapter 5 deals with justification of the proposed model. Decision plus software based on AHP is used to compare the proposed model with other prominent quality awards like Deming prize, MBNQA and EQA. Chapter 6 elaborates the development of TQM implementation process model focused on construction organizations. Based on the TQM model studies and TQM techniques/tools, a 22 step TQM implementation process model is developed and validated. Chapter 7 gives the general conclusions and specific contributions of the research work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter gives an overview of literature on two major issues for the present research work. First, a review of literature on construction and quality is presented here with a view to identify the present quality problems faced by the construction industry and the necessity of improving the construction quality. Second, a review of the TQM literature is presented to identify the present status of the TQM keeping construction industry in the view. This chapter identifies the research gap and suggests the necessity of a TQM implementation process model for construction industry to improve the quality.

2.1.1 Search Steps

In literature search, the titles of the articles containing words TQM, construction quality, individually or in combination were searched from the journals (Appendix I and II). The abstract part was referred, to know the relevance of article, before going into depth study. In online search, the online databases used to identify the articles published in the related journals relevant to the objectives of this research are Science direct, Emerald, Taylor and Francis, and Springer.

The databases search resulted in hundreds of articles. The individual article was examined to ensure the relevance of content to TQM. Articles with holistic approach to construction quality / TQM and/or focused one or more specific aspects of construction quality (like cost overrun, time overrun, design defects, obstacles) / TQM (like human resource management, leadership) were also considered in the present search. This process yielded a total of 231 construction quality / TQM related articles / TQM awards for the study (Appendix III). In this study, both survey based and case study based works are focused, because the advantages of survey methods (anonymity, confidentiality, large number of respondents and leisureliness) and case study methods (detailed documentation of practices and explanation of findings) help to bring synergy between both. This study investigates the construction quality / TQM research from 1989 to 2004.

The number of construction quality / TQM studies in the literature in recent years and presence of compiled information about these studies is the base for the present research. The articles were first categorised into broad groups based on their focus of subject (Appendix III). The studying of these categories gives a present picture of TQM models, TQM implementation efforts. TQM focused works, and construction related quality works. The review of the selected construction quality / TQM research articles are given in subsequent paragraphs.

2.2 Construction and Quality

Records show delays and cost over runs are common in construction projects. Also material waste has been recognized as another major problem in construction industry that has important implication on efficiency of industry and environmental impact. Construction and demolition (C and D) waste presents large amounts of production cost. Another factor is most of the workers have a very low education level when compared with other sectors like industrial mining (Serpell and Alarcon, 1998).

The construction industry is slow in adopting and utilizing new technologies with negative consequences productivity and innovation. Technology, communication, market advances are fundamentally changing the global perspectives of time, distance and spatial boundaries. Local, regional, national, international boundaries have been blurred to the point where any organization can theoretically participate in a design and construction project in any location (Chinowsky and Meredith, 2000).

A survey conducted in Saudi Arabia comprising of engineers, architects, contractors and found all the three groups were in agreement regarding major causes of delay as bad weather, labour supply and subcontractors. Building project delays in developing countries and found lack of adequate planning at early stages increased the cost and time over runs. Some of the problems such as productivity relate to special characteristics of this part of world, others are inherent in nature of construction projects such as planning and control problems. The causes of these grouped into 9 major areas as material,

manpower, equipment, financing environment, changes, government relations, contractual relationship, scheduling and controlling techniques (Assaf et al., 1995).

In Nigeria, delays and cost over runs are principal factors leading to high cost of construction. Quality of contract document, nature of inter personal relation on the project, policies of the contractor influenced the cost over run (Elinwa and Buba, 1993). The identified major factors causing delays occurred within different economic climates and in countries with different industrialized status. Data extracted shows in case of project delays such as time and cost over run, 50% reasons cited are non- excusable delays for which contractor is responsible (Abd. Majid and McCaffer, 1998).

Studies of Okpala (1988) in South Nigeria disclosed reasons for high construction cost being shortage of materials, method of financing and payment for completed works, poor contract management, and price fluctuation. Also findings indicated contracts with award amount less than government estimate likely to have cost over run rate above 5% and time over run of 8% to 142%. In USA, one of every 3 projects is perceived to be over budget, over schedule and fails to achieve profit objective (Anderson and Tucker, 1994). The average effect of all changes was 30% loss of efficiency. Deviations accounted for 12.4% of total project cost. Design deviations and construction deviations amounted for 9.5% and 2.5% of the total project cost. Also, results indicate that rework cost are significant of total cost (Burati et al., 1992).

Another major factor affecting quality is C and D waste. This is likely to generate a waste of 1-10% of construction material used at site. In Australia 20-30%, USA 20%, Germany 19%, Finland 13-15% of materials used for construction leave the site as waste (Bossink and Brouwers, 1996). Also, construction companies do not openly talk to their clients about their quality and service. Clients are frequently critical of contractors, so contractors logically tend to mind their own their own business within terms of contract (Ahmed and Kangari, 1995).

Kraiem and Diekman (1987) classify delays into three categories as excusable delays with compensation, excusable delays without compensation and non- excusable delays (NED). Abd. Majid and McCaffer (1998) studied more than 4200 projects for the recorded overruns, which involved more than 400 construction contracting organizations from both developed and developing countries like USA, UK, India and Turkey. The reasons cited for delays show that at least 50% of them can be categorized as non excusable delays (NED) for which contractors are responsible. The identified major causes contributing to overruns are material related delays, labour related delays, financial delays, improper planning, lack of control, sub contractor delay, poor coordination, inadequate supervision, improper construction methods, technical personnel shortage and poor communication (Hensey 1993, Kraiem and Diekman 1987, Yates 1993). Abd. Majid and McCaffer (1998) further established that most countries are dealing with the same common problems despite the differences in their economies. The persistent occurrence of overruns sends a clear signal to the construction industry to at least be aware of the factors contributing to NED (Abd. Majid and McCaffer, 1998). Uhlik and Lores (1998) in their studies mentioned that a complex and fragmented characteristics of modern constructions have produced a decrease in quality and cost efficiency of projects. They further highlight that one of the roots of the complex problems faced by the construction industry is the lack of integration between construction and design.

Modern construction has been characterized by a complex and fragmented process. These characteristics produce decrease in quality and cost efficiency of projects. It is found that under traditional method of contracting difficulties encountered by contractors were specification and unrealistic schedules. Also, designers' reluctance to include contractors in constructability review for fear of marring their reputation is affecting quality.

Efforts of quality improvements

Quality improvement by adopting new technologies and ISO 9000 system found inadequate and did not yield much result due to lack of proper strategy (Burleson et al., 1998; Mitropoulos and Tatum 1999). This industry has failed to use potential, powerful,

participative, creative approaches due to mismatch commonly seen between participative long term, people building process and hostile environment. McGeorge and Palmer (1997) pointed out that need for reform within construction industry is acute with growing pressure for organizational, structural and cultural transformations. However this industry has lagged behind other industries in implementing reform through TQM. The main reason is perception that TQM is for manufacturing only (Ahmed and Kangari, 1995).

Recently, many companies are frustrated in their effort to improve quality through TQM because these companies exclusively focused on financial measures instead of quality measures (Torbica and Stroh, 1999). Other studies, in recent past also observed the failure of TQM. These failures are due to too much- too soon effort without proper foundation and focus (Culp et al., 1993).

Another reason of failure is the adoption of existing TQM models. The review of the quality management literature reveals several models of quality management namely, Deming Prize (DP) Malcolm baldrige national quality award (MBNQA), European quality award (EQA), Quality gurus approaches and scholarly models. These different approaches have been put forward by its numerous contributors. The major shortcomings of these existing models are that they are limited to manufacturing and they do not provide the systematic approach for implementation of TQM. Various studies (Chase and Federley 1992, McCambridge and Tucker 1998, Riley and Clare-Brown 2001) highlighted the fact that TQM operations are directly not transferable to construction management but modified strategy what best fits the culture of construction firm should be adopted rather superimposing any of existing quality model.

Due to all above quality problems, construction clients are not satisfied with the performance achieved on many of their projects (Kometa and Olomolaiye 1997). Kometa and Olomolaiye (1997) state that despite many efforts, apart from time and cost overruns, unsatisfied clients and other difficulties continue to plague the industry. Thus the reputation of the construction industry is ill suited for meeting competitive challenges of

today's fast changing market (Torbica and Stroh 1999), where competitive edge is with those who manage their resources most effectively and offer a timely response to the demands of the market.

2.3 TQM Scenario

TQM is a management philosophy and TQM implementation is an organizational effort to diffuse the same into an organization. Different TQM models are available for implementation of the same, which translates top management quality intent into plant level operational performance (Calingo, 2002). Researchers have noted that many firms have reaped the operational and financial benefits of TQM while numerous others have failed miserably in TQM implementation (Ahire and Ravichandran, 2001).

Most of the literature described the concept of organization wide quality control. Literature survey carried out indicates, most of the authors repeatedly discuss the importance of such critical factors as top management leadership, supplier quality management, process management, employee training and employee involvement in quality.

Efforts of TQM implementation

The practice of TQM as an improvement strategy is being embraced by more and more organizations around the world, as quality has become a competitive mandate. The premise of TQM is quite clear: quality improvement can be achieved if an organization develops a management philosophy of continuous improvement and provides the necessary supporting organizational practices. With patience, persistence and hard work, many organizations have successfully implemented these practices during the past decade with outstanding results (Longnecker and Scazzero, 1996). If one could see completely across the global corporate horizon, there are possibly as many stories of TQM successes as there are stories of TQM implementation disasters. TQM is an ideal founded on common sense and mutual respect. Why then, there are some firms unsuccessful in its implementation (Babbar and Aspelin, 1994)?

Although many adherents openly praise TQM, others have identified implementation obstacles. The failures of TQM have been attributed to the pre-existence of factors that conflict with TQM philosophy and practice. These include lack of cooperation and time and financial commitments. Shortcomings of TQM or the reasons for its failure can be attributed to implementation problems or a disregard for contextual factors. Reasons for friction or failure to implement a quality program may include a mismatch of organizational culture, a lack of management leadership and inadequate training (Chin and Pun, 2002).The literature on TQM has described the various concepts, philosophies, benefits, needs, value, and experiences associated with TQM. However, little has been offered in the everyday management tools so necessary to make TQM work (Hensey, 1993).

Many companies fail to realize the full potential of TQM, despite their commitment to this (Hides 2000). What kinds of challenges are experienced while dealing with the new management approach? What barriers have been identified and which are most important? It is argued that when TQM has failed, it is not because there was a basic flaw in the principles of TQM, but because an effective system was not created to execute TQM principles properly (Ghobadian and Gallear, 2001).

Many TQM efforts have failed from trying to do too much too soon without proper foundation and focus (Culp et al., 1993) and the lack of clearly defined, measurable goals that are aligned with the firms overall objectives. By merely carrying over techniques used in manufacturing applications, quality efforts may be measured by statistics that do not track the essence of successful work. Overlaying a TQM model or training that has worked well in the manufacturing to a service organization without modification will fail because of the differences in customer relationships, and people in the organization (Culp et al., 1993).

Unsuccessful companies did not develop new measures for quality in order to provide the executives with essential information on quality. Or, alternatively, unsuccessful companies focused exclusively on financial measures (sales, profits, ROI) and they

lacked some essential measures of quality (measures of customer satisfaction, competitive quality) (Torbica and Stroh, 1999).

It is argued that perceiving TQM narrowly as a set of tools and techniques (i.e. hard aspects) has proven to be one of the primary failures of TQM implementation. Empirical studies tend to focus on the articulation of TQM practices and not TQM culture. While this does not indicate the ignorance or abandonment of the importance of defining TQM-type culture, it may be that the result of the imprecise boundary between TQM as management practices and TQM as an organizational culture is not well defined values. TQM adopters may not appreciate that TQM success depends not only on adopting TQM attributes, but also on the *pre-existence* of complementary factors apparently unrelated to TQM, yet more difficult to imitate than TQM itself (Prajogo and Sohal, 2001).

While many western firms have adopted integrated quality management strategies, their implementation has not been equally successful. The implementation failure has been attributed to a shift in emphasis from improving product quality to unfocused improvement effort, such as installing a piece meal system (Ahire et al., 1996).

Al-Ghamdi (1998) studies revealed the major problems surfaced during implementation of TQM as key implementation tasks and activities were not defined in enough details, information systems used to monitor implementation were not adequate, leadership and direction provided by departmental managers were not adequate enough, capabilities of employees involved were not sufficient, problems requiring top management involvement were not communicated to them fast enough, uncontrollable factors in the external environment had an adverse impact on implementation.

Unlike the construction industry, it is also a well-known precept that the manufacturing sector has notably well instituted quality systems. This is due to the differing nature of the two sectors. Manufacturing calls for repeat processes with products primarily put out in large batches. On the other hand, construction work is undertaken in the main in single batches or projects (i.e. one building, one bridge, etc.). Although many of the basic

processes are repeated from job to job (e.g. concreting and plastering), the specifics of application are always changing (Pheng and Wei, 1996).

Limitations of TQM works

TQM is misunderstood by organizations, because there is no adequate explanation of how to operationalized TQM in organizations. For example, in using the systems approach in the UK, managers think that the adoption of BS5750 or quality assurance represents the systems model (Nwabueze, 2001).

Holistic implementation model of TQM that could serve as a reference point are very few. The paucity of such model makes managers, to be directed only by generalized prescriptions. They have adopted their own approaches to TQM implementation based on their thinking and experiences. To a large extent attempts to implement TQM have become, vague and partial, far from being coherent and comprehensive.

Studies that have been devoted to examining TQM by and large have concluded that there is a cause and effect relationship between TQM practices and improved corporate performance. Despite TQM's perceived importance, examination of the published material reveals that little attention is devoted to examining the TQM implementation process.

2.4 Research Gap

The TQM is becoming popular in the construction industry but the problems that are encountered in the implementation process continue to be serious. A literature search performed from 1989 to 2004 found, publication of many articles concerning TQM in construction industry, but none of the references mentioned detailed TQM implementation process for construction projects and treatment of the subject from construction management point of view is too generic. Therefore, it is concluded that there are currently no detailed TQM implementation process model available for construction industry.

The literature review on construction quality problems reveals, with the exception of only handful researchers, the focus of literature has been descriptive. Although the current literatures provide the evidence of importance of TQM in construction, its implementation is not addressed. Therefore, the current situation of TQM implementation in construction companies still remains unclear. Thus, there is a need to develop TQM implementation process model.

In order to bridge the gap and provide construction organizations with practical assistance in the area of TQM implementation, this research aimed developing an implementation process model for construction industry.

CHAPTER 3

AN OVERVIEW OF TQM MODELS

3.1 Introduction

In an attempt to develop a TQM implementation process model for construction industry, the TQM models are discussed here, along with a brief account of basic models like Deming prize, MBNQA and EQA.

A good number of models are available which are of both business and academic interest, in addition to Quality Gurus philosophies, which are inbuilt in all the models. The review of the TQM literature reveals several awards (models) of TQM. The important models include Deming Prize (2004), MBNQA (2004), and EQA (2004). Different TQM models have been put forward by its numerous contributors, with disparate sets of concepts, management practices, tools and techniques developed (Saraph et al., 1989; Oakland, 1993; Flynn et al., 1994; Babbar and Aspelin, 1994; Ahire et al., 1996; Black and Porter, 1996; Pheng and Wei, 1996; Ang et al., 2000; Zhang et al., 2000; Nwabueze, 2001; Thiagarajan et al., 2001; Westerveld, 2003). The philosophies of quality gurus like Deming, Juran and Crosby lead the quality revolution by their unique contributions and can be found in all the models in different forms. The salient features of these are discussed in the subsequent paragraphs.

3.2 TQM Models

3.2.1 Deming Prize

The Deming prize was established in 1951 by Union of Japans scientists and engineering (JUSE). Deming's 14 points make the content of Deming's prize. It reveals the important TQM areas ranging from policy, organization, training, information and analysis, standardization, quality control and assurance, to planning for the next cycle of the TQM. It has six critical success factors (CSFs), which focus on all TQM areas from strategies to tactics and operations. The stress is on standardization of processes and use throughout the organization. The Deming prize 2004 version has driver, core quality system, people management and results as basic core elements. Figure 3.1 presents the model.

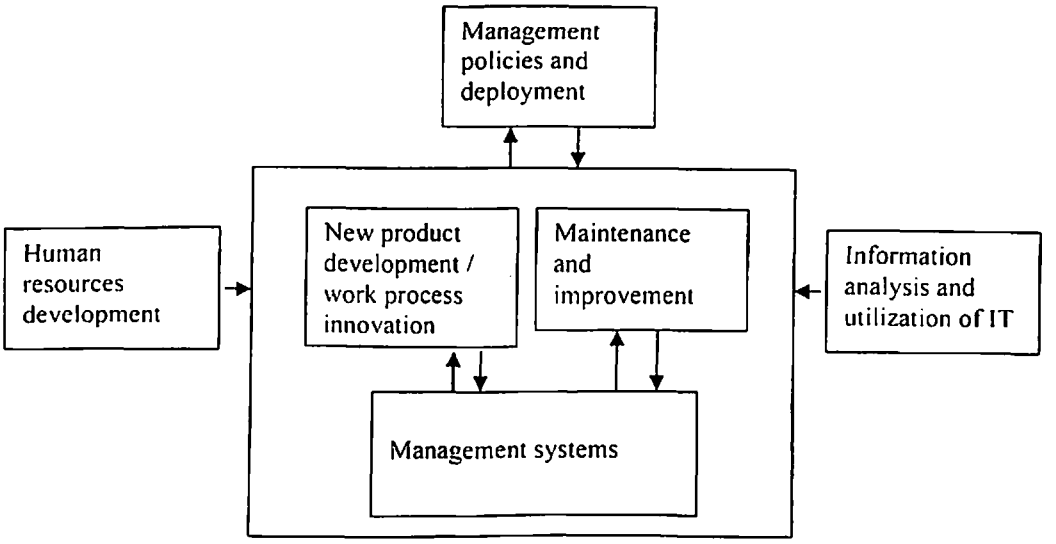

Figure 3.1 Deming Prize Model

3.2.2 MBNQA

The Malcolm baldrige national quality award (MBNQA) was established by the US in 1987 and it is built upon seven CSFs. There is a strong emphasis on the non procedural aspects such as leadership, human resource management and customer satisfaction. The analysis of the results of the quality improvement process is an important element. Figure 3.2 shows how the model connects and integrates the categories. This has four basic elements are: driver, system, measures of progress, and goal.

3.2.3 EQA

The European quality award (EQA) was launched during the 1991 European foundation for quality management (EFQM). This model recognizes that processes are the means by which a company or organization harnesses and releases the talents of its people to produce results. Moreover, the processes and the people are the enablers which produce results. EQA considers areas like impact on society, resource utilization as more important (Figure 3.3).

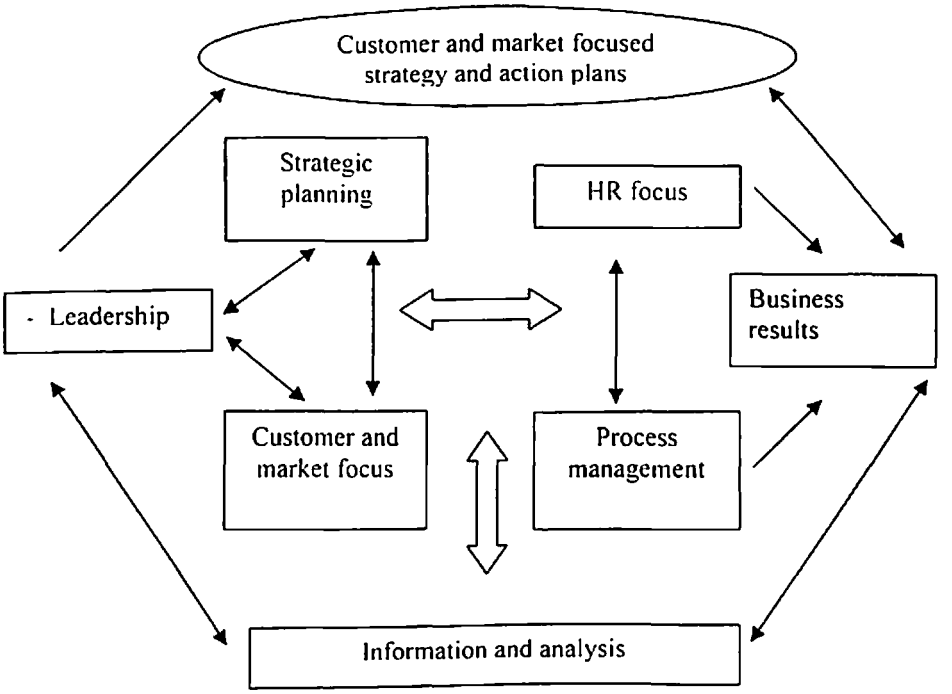

Figure 3.2 MBNQA Model

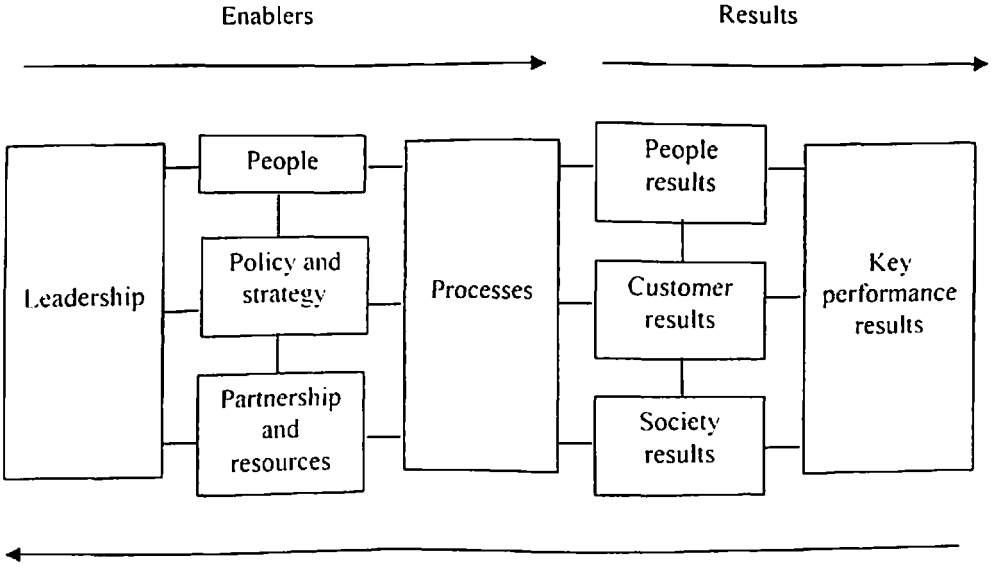

Figure 3.3 EQA Model

3.2.4 Saraph et al. Model

Based on a thorough review and synthesis of quality literature, Saraph et al. (1989) identified eight critical areas of managerial planning and action that must be practiced to achieve effective quality management in a business unit. They developed a 78-item quality management model to measure the extent to which some technical aspects of a quality system have been implemented in a plant or company. This model derived TQM CSFs primarily using the quality prescriptions of quality gurus, including Deming, Juran, and Crosby. Operational measures of these critical factors developed can be used individually or in concert to produce a profile of organization wide quality management. Table 3.1 shows eight CSFs of Saraph et al. model.

Table 3.1 CSFs of Saraph et al. Model

1. Management leadership and quality policy
2. Role of quality department
3. Training
4. Product/service design
5. Supplier quality management
6. Process management
7. Quality data and reporting
8. Employee relations

3.2.5 Oakland Model

Oakland (1993), using the MBNQA categories and supplemented with EQA additional categories of business results and impact on society (community) built a TQM model of criteria against which an organization may face and measure itself, to examine any gaps. The major features of the Oakland's model are represented in the Table 3.2.

3.2.6 Flynn et al. Model

The Flynn *et al.* (1994) study, built on the Saraph *et al.* (1989) study, focused on a plant rather than an organization as a unit of analysis and utilized the perceptions of both line

Table 3.2 Oakland Model

1. Leadership and behaviour
2. Strategic planning
3. Techniques and continuous improvements
4. People
5. Quality assurance
6. Quality and business results
7. Customer satisfaction
8. Community

and managerial level employees. Seven CSFs of quality management (Table 3.3) were identified in this study primarily from the empirical and practitioner literature. The scale refinement and validation used for the development of this model was similar to that of Saraph *et al.*'s model.

Table 3.3 CSFs of Flynn et al. Model

1. Top management support
2. Quality information
3. Process management
4. Product design
5. Workforce management
6. Supplier involvement
7. Customer involvement

3.2.7 Babbar and Aspelin Model

Babbar and Aspelin (1994) argued that there can be no model built in concrete for TQM implementation, and proposed sequential steps to a successful TQM journey as shown in Figure 3.4. He has drawn the attention that managerial commitment, empathy, use of personal power, management by example and fairness, provide the foundation for a structure that enables the organizations to achieve TQM goals.

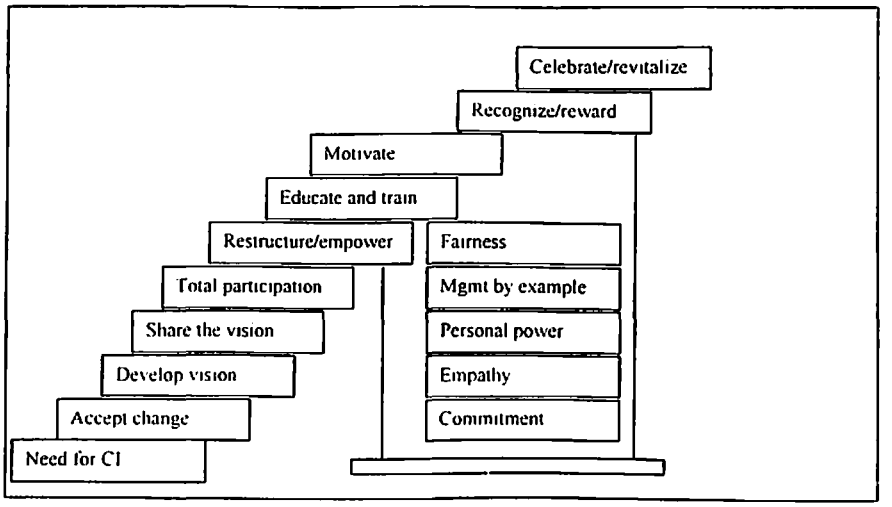

Figure 3.4 Babbar and Aspelin Model

3.2.8 Ahire et al. Model

Ahire *et al.* (1996) identified, validated, and tested TQM CSFs (Table 3.4) of integrated quality management through an empirical survey of 371 manufacturing firms. This model is based on a thorough review of the conceptual and empirical literature on TQM. A comprehensive scale refinement and validation approach was employed. Also, in this model, scales pertaining to product quality and supplier performance represent TQM outcomes (outputs).

Table 3.4 CSFs of Ahire et al. Model

1. Top management commitment
2. Customer focus
3. Supplier quality management
4. Design quality management
5. Bench marking
6. SPC usage
7. Internal quality information usage
8. Employee empowerment
9. Employee involvement
10. Employee training
11. Product quality
12. Supplier performance

3.2.9 Black and Porter Model

Black and Porter (1996) developed a model based on MBNQA model (Table 3.5) and established literature. A survey model was developed and sent to over 200 managers drawn from a target sample of members of the EFQM. Data was examined using analytical and validity techniques. The ten factors extracted in this study exhibited an acceptable degree of reliability. All the ten factors generated by this empirical analysis are consistent with the factors proposed by studies of Saraph et al. (1989), Flynn et al. (1994), and Ahire et al. (1996).

Table 3.5 CSFs of Black and Porter Model

1. People and customer management
2. Supplier partnerships
3. Communication of improvement information
4. Customer satisfaction orientation
5. External interface management
6. Strategic quality management
7. Teamwork structures for improvement
8. Operational quality planning
9. Quality improvement measurement system
10. Corporate quality culture

3.2.10 Pheng and Wei Model

Pheng and Wei (1996) model, is probably the only model which refers to construction projects exclusively. It Promotes the TQM philosophy for the construction industry. Explains the rationale for TQM in construction; discusses the factors which affect construction quality; and proposed a model (Figure 3.5) for implementing TQM in the construction industry as well as at the project level in construction.

3.2.11 Ang et al Model

In Ang et al. (2000) frame work, the CSFs were derived through a process involving identification and synthesis of the requirements for quality management that have been

prescribed by quality practitioners and academics. This model has much in common with the MBNQA model (Oakland, 1993) which may be used to judge the face validity of any QM model proposed (Flynn et al, 1994). The only modification made was to divide the scope of the process management category in the MBNQA model into two: output quality assurance and important innovations.

Data was collected from 110 public organizations that have applied for the Malaysian prime minister's quality award (Public Sector) and a field survey was carried out to enable a rigorous examination of the CSFs operationalized. Analysis of literature suggested eight CSFs of quality management as shown in the Table 3.6.

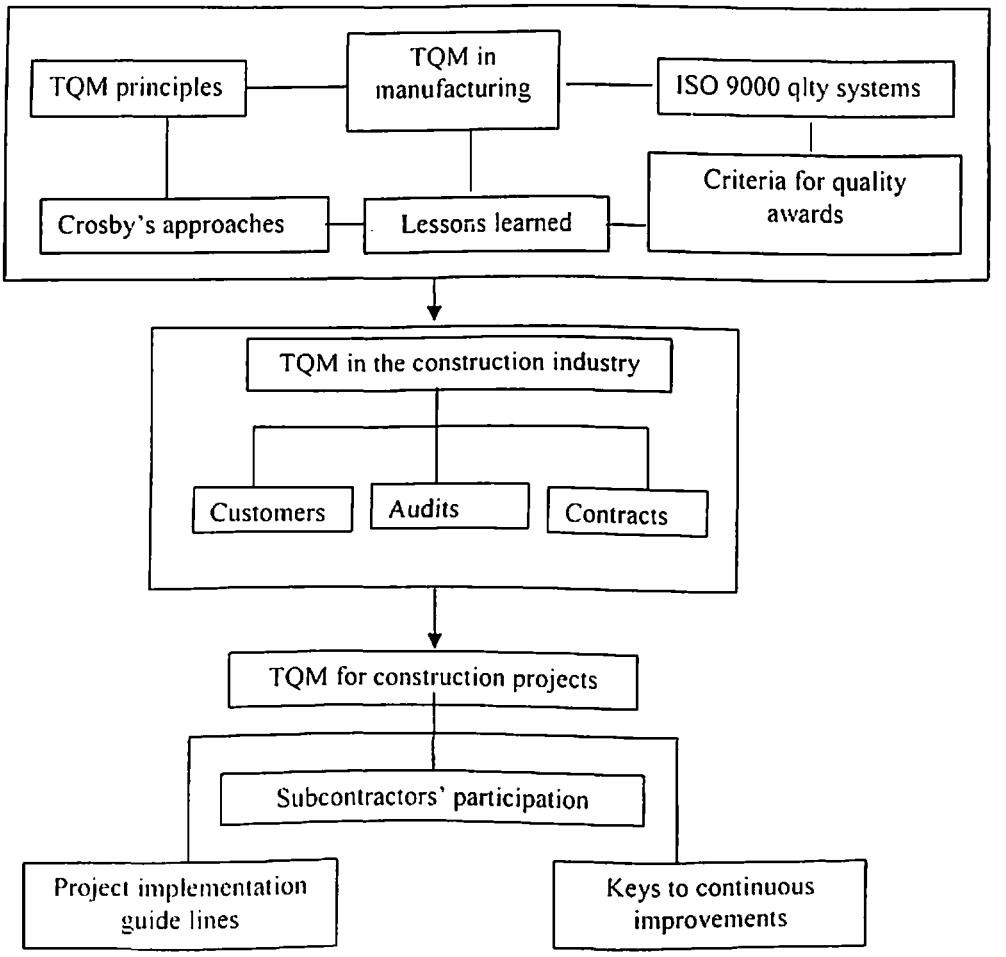

Figure 3.5 Pheng and Wei Model

Table 3.6 CSFs of Ang et al. Model

1. Leadership
2. Strategic planning process
3. Out put quality assurance
4. Important innovations
5. Information and analysis
6. Human resource utilization
7. Customer satisfaction
8. Quality results

3.2.12 Zhang et al. Model

Zhang et al (2000), from an extensive review of the literature in the field of TQM, identified 11 CSFs of TQM implementation (Table 3.7). A model measuring these CSFs was developed. The reliability and validity of the model were tested and validated using data from 212 Chinese manufacturing companies. Various methods were employed for this test and validation. Comparisons between this model and the three other quality management models (viz. Saraph et al., 1989; Flynn et al., 1994; and Ahire et al., 1996) were made.

Table 3.7 CSFs of Zhang et al. Model

1. Leadership
2. Supplier quality management
3. Vision and plan statement
4. Evaluation
5. Process control improvement
6. Product design
7. Quality system improvement
8. Employee participation
9. Recognition and reward
10. Education/ training
11. Customer focus

3.2.13 Nwabueze Model

Nwabueze (2001) considers the abstract requirements of an implementational model of TQM and the implementational models which are currently available, by offering a new model that accord with the philosophy underpinning TQM. In the final analysis, by using an empirical example of an attempt to implement TQM in the NHS in England, He further revealed that many of the barriers to implementation can best be removed through adherence to the new model rather than by following the prescriptions of the quality gurus. Table 3.8 gives the holistic TQM model of Nwabueze.

Table 3.8 CSFs of Nwabueze Model

1. Vision and mission
2. Strategy
3. Customer satisfaction
4. Prevention
5. Quality measurement
6. Management commitment
7. Internal and external customers
8. Team work
9. Quality on all agenda
10. Continuous improvement
11. Aligned system
12. Every one participates

3.2.14 Thiagarajan et al. Model

Thiagarajan et al (2001) based on quality gurus philosophies and findings representing the experiences of TQM organizations in Malaysia developed critical categories for organizational excellence (Table 3.9). These categories are distilled from the critical quality factors of various TQM scholars.

3.2.15 Westerveld Model

Westerveld (2002) adapted the Project Excellence Model from the EFQM-model and is a concept developed to link the project success factors and critical success factors for

Table 3.9 CSFs of Thiagarajan et al. Model

1. Customer satisfaction
2. Internal stakeholder involvement
3. Customer driven processes
4. Continuous improvement
5. Leadership

projects. The model consists of six result areas covering project success criteria and six organizational areas covering critical success factors. Model is shown in the Figure 3.6.

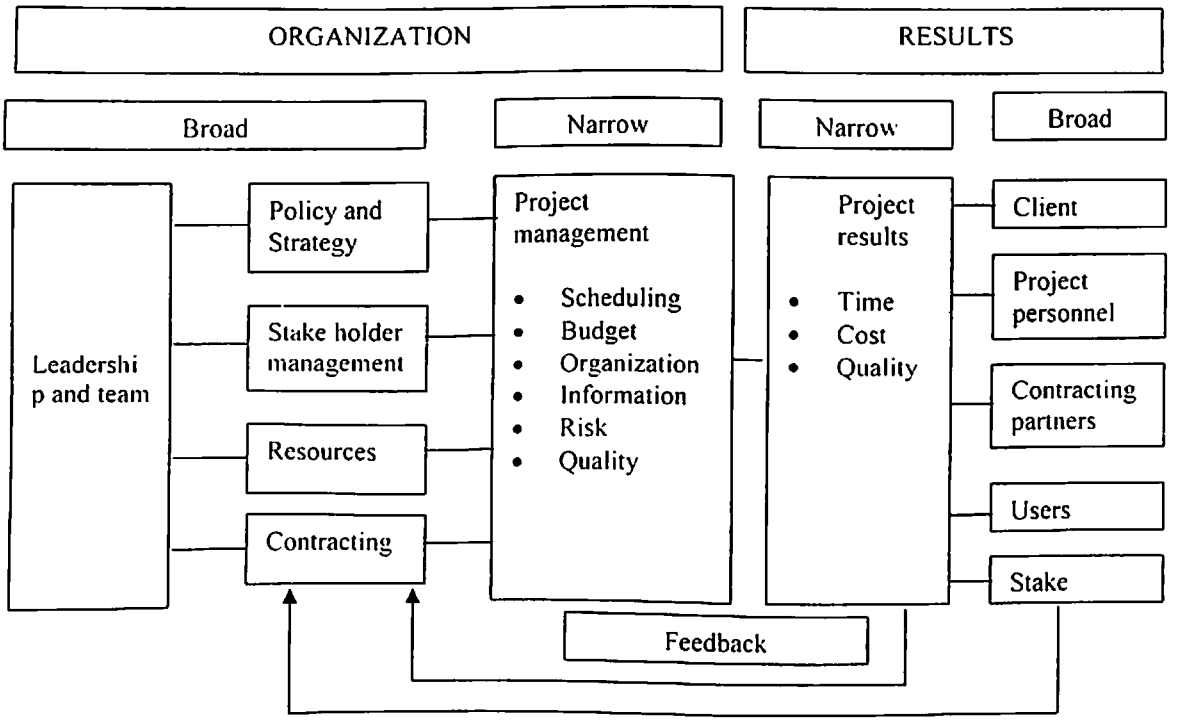

Figure 3.6 Westerveld Model

3.3 Critical Analysis of TQM Models

Though hundreds of quality award models are in existence (Calingo, 2001), most of these models are derived from either the Deming prize, MBNQA or EQA. Hence these three quality award models are only considered along with the other 12 TQM models suggested by various scholars, for the purpose of critical analysis.

In an effort towards obtaining a comprehensive analysis of the TQM models and to compare with each other, a detailed analysis of the selected models with respect to CSFs and other inherent quality factors is carried out. Various models use different approaches regarding CSFs. Some focus on the technical properties of TQM, while others look at the general management philosophy. Keeping this in mind, it is necessary to study and critically analyze and interpret the various TQM models available to overcome the possible flaws or weak points.

The Deming prize (2004) has six evaluation items (viz. management policies and their deployment, new product development and work process innovation, maintenance and improvement, management of systems, information and analysis and utilization of IT, human resource development). Deming prize does not consider customer satisfaction as a separate CSF.

The MBNQA (2004) has seven criteria (viz., leadership, strategic planning, customer and market focus, measurement/analysis and knowledge management, human resource focus, process management and business results). Information and analysis is the basis of MBNQA model, which confirms the core value of the management by fact. Achieving excellent results is also highlighted in this model. The MBNQA lacks stress on comprehensive integration. Every part of the company engaged in the process goes about trying to improve its performance independently of the others (Roth, 2001). Interaction is less, action is more. The highest priority given to business results may lead to co-operational results, like manipulation of balance sheet and other result areas in favour of spurious outcomes which indicate false improvements (e.g. recent failures like WorldCom, Enron, and Global Trust Bank etc.).

EQA (2004) criteria viz., leadership, policy and strategy, people, partnership and resources, processes, customer results, people results, society results, and key performance results are divided into Enablers (things to be done) and Results (caused by enablers). The results cover all aspects of the organization including business results. The

EQA model includes environmental impact (society results) as one of the CSF which is not found in Deming prize and MBNQA as an independent CSF. But like other business excellence models it lacks integration and comprehensive planning.

Saraph et al. (1989) model is based on a thorough review and synthesis of quality literature identified eight CSFs viz. role of top management and quality policy, role of quality department, training, product/service design, supplier quality management, process management, quality data/reporting, and employee relations of managerial planning and action to achieve effective quality management in a business unit. This model derives CSFs from prescriptions of quality gurus, including Deming, Juran, and Crosby. The major strength of Saraph et al. model is the high level of acceptability; since both manufacturing and service industries were included in the sample (Ahire et al., 1996; Zhang et al., 2000).This model is primarily based on the quality prescriptions of quality gurus. In this model, important CSF, customer focus, is not included.

Oakland (1993), using the MBNQA categories and supplemented with EQA additional category of impact on society (community) has built a TQM model with eight CSFs viz. leadership and behaviour, strategic planning, techniques and continuous improvement, people, quality assurance, quality and business assurance, customer satisfaction, and community against which an organization can measure itself. The Oakland model is a fusion of MBNQA and EQA model. It is an improved version of MBNQA, with community (social responsibility) as an additional CSF.

The Flynn et al. (1994) model is built on the Saraph et al. (1989) study focuses on a plant and utilizes the views and perceptions of operative and executive level employees. Eight CSFs (viz. top management support, quality information, process management, product design, workforce management, supplier involvement, employee involvement and customer involvement) of quality management are identified in this study from the empirical and practitioner literature. Flynn et al. model indicates a direct relationship between top management leadership and process management. The concept of learning is

not explicitly emphasized. Also this model omits empowerment of employees and benchmarking (Ahire et al., 1996).

Babbar and Aspelin (1994) propose sequential steps to a successful TQM journey. It has drawn the attention that managerial commitment, empathy, use of personal power, management by example and fairness provide the foundation for a structure that enables the organization's TQM-driven climb to the top. The Babbar and Aspelin model though claims to be holistic, it is too generic and CSFs are overlapping and creates confusion in the minds of the practitioners.

Ahire et al. (1994) model identifies, validates, and tests CSFs of integrated quality management viz. top management commitment, internal quality information usage, design quality management, employee training, supplier quality management, employee involvement, employee empowerment, customer focus, SPC usage and bench marking through an empirical survey of manufacturing firms. This model is based on a thorough review of the conceptual and empirical literature on TQM. In Ahire et al. model, the CSFs, product quality and supplier evaluation indicate TQM outcomes than strategies. This model considers SPC tool as a separate CSF which is misleading.

Black and Porter (1996) model is based on the MBNQA model and prevailing literature. The ten CSFs are corporate quality culture, strategic quality management, quality improvement measurement systems, people and customer management, operational quality planning, external interface management, supplier partnerships, teamwork structures, customer satisfaction orientation, communication of improvement information. All the CSFs generated by this empirical analysis are consistent with the factors proposed by studies of Saraph et al. (1989), Flynn et al. (1994) and Ahire et al. (1996). Black and Porter (1996) model is based on the MBNQA model and recognized quality literature. It focuses on corporate culture which is not found in other models. However, process management CSF is missing in this model.

The Pheng and Wei (1996) model is based on TQM principles, Crosby philosophy, manufacturing practices of TQM and ISO 9000 practices. Pheng and Wei model refers to construction projects exclusively. It promotes the TQM philosophy for the construction industry, explains the rationale for TQM in construction, discusses the factors which affect construction quality; and proposed a model for implementing TQM in the construction industry as well as at the project level in construction. The important CSF top management commitment and leadership is missing.

In Ang et al. (1999) model, the CSFs are derived from a process involving identification and synthesis of the requirements for TQM that have been prescribed by quality practitioners and academics. This model has eight CSFs viz. leadership, strategic planning process, output quality assurance process, important innovations, information and analysis, human resource utilization, customer satisfaction and quality results, which are much in common with the MBNQA model. The only modification made is to divide the scope of the process management category in the MBNQA model into two: output quality assurance and important innovations. The Ang et al. model focuses on the quality processes than quality performances. The only modification made was to divide the scope of the process management category in the MBNQA model into output quality assurance and important innovations.

Zhang et al. (2000) model from an extensive review of the literature in the field of TQM identifies eleven CSFs viz. leadership, supplier quality management, vision and plan statement, evaluation, process control and improvement, product design, quality system improvement, employee participation, recognition and reward, education/training and customer focus. It includes recognition/reward, vision/ plan statement and the model is based on MBNQA. Comparisons between this model and the three other quality management models (Saraph et al., 1989; Flynn et al., 1994; and Ahire et al., 1996) is made. In this model, two CSFs of Ahire et al. (1996) model, namely product quality and supplier performance are not included. The role of the quality department in the Saraph et al. model is excluded. The benchmarking and internal quality information usage in the Ahire et al. model is integrated to form the CSF of evaluation. This model includes two

more CSFs, namely, quality system improvement and vision and plan statement. This model lacks focus on empowerment of people.

Nwabueze (2001) model considers the abstract requirements of TQM, by offering a new model that is in accord with the philosophy underpinning TQM. It has fourteen CSFs viz. vision and mission, management commitment, quality strategy, quality measurement, quality on all agenda, continuous improvement, aligned system, teamwork, customer satisfaction, measurement, prevention, internal and external customers, all work is process and quality through people from various models with continuous improvement as separate CSF. Nwabueze model has tried to overcome the difficulties in putting into practice the essential elements of quality guru philosophies. This model does not clearly demark CSFs and generic suggestions.

Thiagarajan et al. (2001) model is based on an empirical study of TQM in the Malaysian industrial context and identifies quality factors that are effective and critical for TQM to flourish. The outcomes from this research show leadership, customer satisfaction, customer driven processes, continuous improvement and internal stakeholders' involvement leads towards organizational excellence. In Thiagarajan et al. model, the focus is more on the increase of the degree of effectiveness of TQM. It lacks in detailing and analysis of CSFs.

Westerveld (2002) adapted the Project Excellence Model from the EFQM-model and is a concept developed to link the project success factors and critical success factors for projects. The model consists of six result areas covering project success criteria and six organizational areas covering critical success factors. The Westerveld model clearly differentiates company (parent organization) and project phases, which is unique to construction organizations. The policies of an organization (higher level) how percolate into project (lower level) with reference to different aspects of a project is very clear. At organizational level, leadership, policy and strategy, stakeholder management, resources, contracting, project personnel, contracting partners, users are highlighted and at project

level, project management and project results are highlighted. In this model the stress is more results.

3.3 Inference

This study gives an overview of the quality awards, scholarly TQM models their contents. The description and diagrams provides a base to critically analyse them, with respect their CSFs and inherent factors.

The critical analysis provides the evidence which suggests that the models of TQM have provided prescriptions as a guide without providing an adequate integrated model within which tenets of TQM can be operationalized. Despite TQM's perceived importance, the overview and critical analysis reveals that little attention is devoted to examining the TQM implementation process.

Much of the focus of studies was on the hard aspects, such as tools, techniques and systems. Most TQM writers emphasize the importance of cultural change in TQM implementation. This work demonstrates the need to identify relevant CSFs for successfully putting TQM models into practice.

CHAPTER 4

DEVELOPMENT OF TQM MODEL

This chapter deals with the development of TQM model. As a first step it identifies the CSFs from different TQM models with their frequency of appearance, which helps to understand the priority of CSFs. After identifying CSFs and based on critical analysis from prescriptive, conceptual, practitioner, and empirical literature (from chapter 3) a model is proposed. The CSFs of the proposed model are corroborated. In the next step, sub criteria of the CSFs of proposed model are identified based on frequency analysis.

4.1 Introduction

The contemporary manufacturing quality management literature is quite encyclopaedic. Many researchers do articulate different theories and versions on the CSFs of TQM, the concept of TQM, and the influence of contextual factors on TQM. Over the past two decades, TQM has emerged as an important field of study in quality management. Although, the criticality of the features of TQM has been emphasized in TQM models and individually, it appears that no research work, as yet, has collectively taken all these features into consideration.

As TQM programmes become universally implemented and sophisticated, it is indeed true that aspects of the TQM philosophy can also be applied to construction. But, the results and findings of the studies done in manufacturing cannot be applied directly to the construction sector due to certain well-known inherent discrepancies and contradictions between manufacturing and non-manufacturing organizations (Culp et al., 1993). The systems by which these goods and services are produced and marketed will also vary. To put everything in a nutshell, the CSFs of TQM vary in their characteristics and dynamics when applied to non-manufacturing sector like construction, as the different characteristics of these organizations call for some judicious organizing principles, which means that construction management warrants a different system by which services can be produced and marketed as opposed to the production and marketing of manufacturing goods.

Therefore, there is an obvious need for the researchers to first identify CSFs of TQM before developing a model for TQM implementation process for construction.

4.2 Identification of CSFs

This section deals with identification of the CSFs that focused on TQM. Literature search is carried out for frequency analysis of the CSFs. A total of 71 of the 231 studies analyzed contained TQM factors and most of them based on factor analysis and/or judgmental process. However, 15 studies among these 71 articles are exclusive TQM models. Remaining 56 articles did not use a model or a holistic approach. These 15 models were analyzed, which identified 15 CSFs of TQM (Table 4.1). Other than scholarly models, the TQM literature also provides CSFs of TQM. The Table 4.2 provides details of CSFs within TQM literature.

Frequency Analysis of TQM models

Using 15 identified CSFs each TQM model was analyzed to determine whether or not the 15 CSFs are covered. The analysis of each model was carried out similar to the above analysis. According to this analysis (Table 4.1), issues related to Customer satisfaction (14) and Process quality management (14), Education and training (14) had the highest coverage, followed by issues related to Top management commitment (13), Information and Analysis (13), Supplier quality management (12), Empowerment and involvement (12), Design quality management (9), Strategic quality management (9). Impact on society (4), Business results (4), and Resources (2), Benchmarking (1), SPC usage (1) received low coverage, surprisingly organizational culture (1) element which is the key to the success of remaining CSFs is mentioned among the least.

Frequency analysis of TQM literature and CSFs

In TQM literature analysis (Table 4.2), the issues related to top management commitment (24) received the highest coverage in the TQM survey literature analyzed here. Without this any quality project is bound to fail in any business. Training and education (23), empowerment (20) were the next high coverage CSFs, indicating critical role of human resource management in TQM. Furthermore, the importance of customer satisfaction

Table 4.1 Analysis of TQM Models to Identify CSFs

CSFs → / TQM MODELS	i	ii	iii	iv	v	vi	vii	viii	ix	x	xi	xii	xiii	xiv	xv
1. Deming (2004)	x	x	x	x	x	x		x						x	x
2. MBNQA (2004)	x		x	x	x	x		x			x	x		x	x
3. EQA (2004)	x	x	x	x	x	x		x		x	x	x		x	x
4. Saraph et al. (1989)	x	x		x	x	x		x						x	x
5. Oakland (1993)	x	x	x		x	x		x			x	x			x
6. Flynn et al. (1994)	x	x	x	x	x	x		x							
7. Babbar & Aspelin (1994)	x		x					x							x
8. Ahire et al. (1996)	x	x	x	x	x	x	x	x					x	x	x
9. Black & Porter (1996)		x	x	x	x	x		x	x					x	x
10. Pheng and Wei (1996)		x		x	x										
11. Ang et al. (1999)	x	x	x		x	x		x						x	x
12. Zhang et al. (2000)	x	x	x	x	x	x		x							x
13. Nwabueze (2001)	x	x	x	x	x	x		x						x	x
14. Thiagarajan et al., (2001)	x		x		x			x							x
15. Westerveld (2003)	x	x	x		x	x		x		x	x	x		x	
Frequency	**13**	**12**	**14**	**9**	**14**	**13**	**1**	**14**	**1**	**2**	**4**	**4**	**1**	**9**	**12**

Identified CSFs

i = Top management commitment; ii = Supplier quality management; iii = Customer focus;

iv = Design quality management; v = Process quality management; vi = Information and Analysis;

vii = Benchmarking; viii= Education and Training ix =Organizational culture; x = Resources; xi = impact on society;

xii = Business results; xiii= SPC usage; xiv = Strategic quality management; xv = Empowerment and involvement

Table 4.2 Analysis of TQM Literature and CSFs

CSFs → / Author(s)	i	ii	iii	iv	v	vi	vii	viii	ix	x	xi	xii	xiii	xiv	xv
1. Ahire and Ravichandran (2001)	x	x	x	x	x	x		x	x				x		
2. Ahmed and Kangari (1995)			x												
3. Ambroz (2004)									x						x
4. Amsden et al. (1996)	x		x												x
5. Baidoun (2003)	x	x	x		x		x	x					x		
6. Belle (2000)						x									
7. Burati et al. (1992)	x	x	x					x					x		x
8. Butch and Rivers (2001)	x								x						
9. Caddick and Dale (1998)		x													
10. Cardy and Dobbins (1996)								x							
11. Carpinetti et al. (1998)	x		x					x							
12. Chan et al. (2003)		x													
13. Chan and Tse (2003)									x						
14. Cheng and Li (2002)		x													
15. Cheung et al. (2002)		x													
16. Conti and Kleiner (1997)							x								x
17. Culp et al. (1993)	x					x		x							x
18. Edgeman (2003)	x														x
19. Fisher et al. (1995)							x								
20. Forza and Filippini (1998)		x	x		x	x		x							x
21. Galperin and Lituchi (1999)								x							

Table 4.2 Analysis of TQM Literature and CSFs (continued)

CSFs → / Author(s)	i	ii	iii	iv	v	vi	vii	viii	ix	x	xi	xii	xiii	xiv	xv
22. Ghobadian and Gallear (2001)					x			x						x	x
23. Hart (1992)	x	x	x	x	x	x		x							
24. Hides et al. (2000)	x							x						x	x
25. Ho and Fung (1995)	x		x		x			x							x
26. Holt et al. (2000)								x							x
27. Holt and Rowe (2000)	x														
28. Humphreys et al. (2003)		x													
29. Huq and Stolen (1998)	x	x	x		x	x		x					x		x
30. Ingram (1997)								x							x
31. Irani et al. (2003)												x			
32. Jabnoun and Anwar (2002)									x						
33. Jenner et al. (1998)									x						
34. Josephson et al. (2002)							x								
35. Kruger (1998)															x
36. Khan (2003)			x												x
37. Lagrosen and Lewis (2002)											x				
38. Laszlo (1998)	x								x						x
39. Lewis (1996b)									x						
40. Li et al. (2003)	x	x	x	x	x	x	x	x					x	x	x
41. Love et al. (2004)			x												

Table 4.2 Analysis of TQM Literature and CSFs (continued)

CSFs → / Author(s)	i	ii	iii	iv	v	vi	vii	viii	ix	x	xi	xii	xiii	xiv	xv
42. Manley (1998)									x						
43. Mathews et al. (2000)								x							
44. Nwankwo et al. (2002)		x													
45. Perry (1997)	x	x	x		x	x			x						
46. Pheng and Teo (2004)	x	x	x		x			x						x	
47. Puffer and McCarthy (1996)	x														
48. Riley and Clare-Brown									x						
49. Roney (1997)									x						
50. Sinclair and Collins (1994)									x						
51. Sureshchandar et al. (2001)	x		x	x	x	x	x	x			x				x
52. Thiagarajan and Zairi (1997)	x							x							x
53. Ugboro & Obeng (2000)	x		x												x
54. Waldman &Gopalakrishnan (1996)	x	x		x	x	x		x	x						
55. Youssef and Zairi (1995)	x		x					x	x				x		
56. Zairi (1994)	x														
Frequency	**24**	**17**	**17**	**5**	**12**	**9**	**6**	**23**	**18**	**0**	**1**	**0**	**6**	**3**	**20**

Note:

i = Top management commitment; ii = Supplier quality management; iii = Customer focus; iv = Design quality management; v = Process quality management; vi = Information and Analysis; vii = Benchmarking; viii= Education and Training ix =Organizational culture; x = Resources; xi = impact on society; xii = Business results; xiii= SPC usage; xiv = Strategic quality management; xv = Empowerment and involvement

(17), supplier quality management (17), Process quality management (12), Information and Analysis (9), and organizational culture (18) in TQM implementation is also indisputable and studies analyzed here reflect the same opinion. The CSFs that received relatively low coverage by these studies include Design quality management (5), Strategic quality management (4),Benchmarking (6), SPC usage (6), Impact on society (0), Business results (0), and Resources (0) and were not mentioned as much as the other factors.

4.3 Proposed TQM Model

Above analysis revealed that most of the models have nine CSFs in common viz., top management commitment, strategic quality management, design quality management, process quality management, supplier quality management, education and Training, empowerment and involvement, information and analysis, customer satisfaction are considered as most important CSFs. Only four models have business results as CSF. Benchmarking Statistical process control, resources and culture are represented as a CSF in one model each. four models have impact on society and environment as a CSF. The present study, therefore, recognises the above mentioned nine common important CSFs for the evolution of the new model.

The two CSFs, namely, product quality and supplier performance in the Ahire et al. model, were not included in this model since they represent TQM outcomes. Role of quality department in the Saraph et al. model was excluded in this model since every department in any organization is involved in quality management. Benchmarking, SPC being quality tracking strategies, but not quality management strategies are integrated with process management CSF. The CSFs resources and impact on society are considered as part of top management commitment. Business results CSF being out come of implementation of remaining CSFs is not considered as a separate CSF

All other models, except Black and Porter model, have not considered organizational culture as an independent CSF. Quality awards like MBNQA and other models like Ang et al., discussed culture as an item under different CSFs like leadership and education and

training. However, the major literature reveals that culture as one of the important criteria for the success of TQM. Also, it is well known fact that culture influences all the above CSFs of TQM. Therefore it is necessary to add culture as a separate CSF of TQM. Ample literature evidence is available to consider culture as CSF as shown in Table 4.2. Using the culture and already recognised nine important CSFs a new TQM model is developed. The proposed model is represented in Figure 4.1. This model has the following ten CSFs:

1. Top Management Commitment
2. Supplier Quality Management
3. Customer Satisfaction
4. Design Quality Management
5. Process Quality Management
6. Information and Analysis
7. Education and Training
8. Organizational Culture
9. Strategic Quality Planning
10. Employee Empowerment and Involvement

The group of CSFs education and training, empowerment and involvement, supplier quality management, and customer satisfaction represent the focus more on human aspects. The group of CSFs strategic quality management, design quality management, and process quality management focus more on tools, techniques and methods. The CSF, organizational culture is positioned at the centre to reflect the influence of culture over quality management system. The CSF top management commitment is placed at the top indicate the importance of leadership which works as enabler to achieve remaining CSFs. The placing of CSF, Information and Analysis indicates it as a foundation for the effective quality management system. The bi-directional arrows drive home the point that TQM is an integrated approach where there is a lot of synergy among the various CSFs and indicate the importance of feedback at each and every stage.

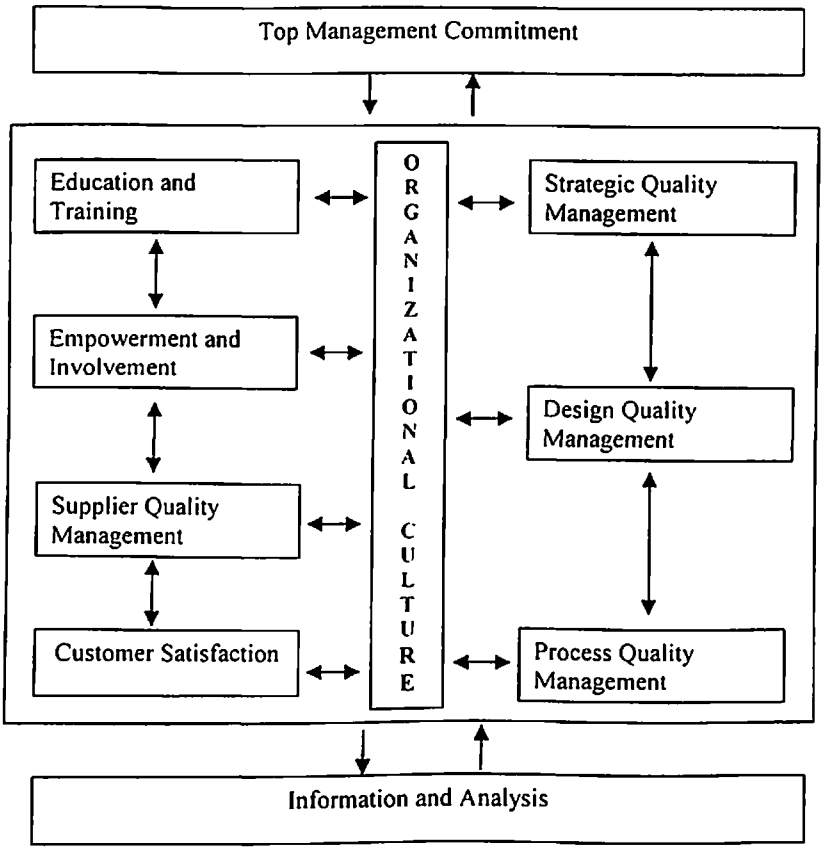

Figure 4.1 Proposed TQM Model

4.4 Description of the Proposed TQM Model

4.4.1 Top Management Commitment

Top management commitment has been identified as one of the major determinants of successful TQM implementation (Baidoun, 2003; Ho and Fung, 1995). While implementing TQM commitment by the management is an essential one. Without it, there is no need to go further (Culp et al., 1993). The critical role of top management in providing leadership has been illustrated in the literature for several diverse organizations, such as, Ford and Motorola (Ahire et al., 1996). TQM adoption typically starts with the senior management in the organization and is driven by their commitment and leadership. Top managers propel TQM by creating values, goals, and systems that lead to satisfied customers and improved organizational performance. The clarity of quality goals in an organization determines the effectiveness of the quality efforts. A top management team committed to quality conveys the philosophy that quality receives

priority over cost and schedule and that in the long run, superior and consistent quality leads to improvements in cost and delivery performance. Upper management not only gives quality the highest priority possible but also demonstrates its commitment to quality by providing adequate resources for implementing quality management. In particular, this is accomplished through investments in human and technical resources (Ahire and Ravichandran, 2001; Nesan and Holt, 2002).

TQM is a culture and philosophy that must permeate an organization as the method of management. It can only thrive under a senior management that is genuinely considered with long term health of the company and that establishes TQM as a top priority (Burati et al., 1992; Babbar and Aspelin, 1994; Ho and Fung, 1995; Oakland 1993; Youssef and Zairi, 1995). The study of Youssef and Zairi (1995) demonstrates that, for TQM to be introduced successfully there has to be top management commitment and this is to be demonstrated through active involvement, setting clear goals and a vision for the organization and integrating TQM into the strategic quality planning process.

According to Laszlo (1998), one of the prime prerequisites for successful implementation for any major initiative within an organization is commitment from the top. It is the responsibility of management to establish the strategies toward the objectives of the organization as well as to set priorities to attain its goals. It must be recognized that no matter how noble a cause may be, unless management includes it into its strategic plans and sets goals toward its attainment, all efforts which are not sanctioned by management are considered to be distractions from other priorities. Indeed, resources committed to other causes are actually wasteful as far as the management of the organization is concerned.

Top management commitment is prerequisite for effective and successful TQM implementation. Visionary leadership pertains to the formulation of a long range vision for the development of the organization, propagating the vision throughout the organization, devising and developing a plan of action and finally stimulating the entire organization towards the accomplishment of the vision. Leadership and corporate quality strategy means a united senior management team which is committed to customer

satisfaction and communicating the "vision" in such a way as to mobilize all employees towards its attainment (Li et al., 2003; Thiagaragan et al., 2001.). Without management commitment in a TQM programme, it will lack the foundation to build on. Total commitment by management can bring out powerful emotions that can spur employees to accomplish things they thought impossible (Huq and Stolen, 1998).

The critical role of top management and their leadership in quality management is emphasized over and over again in the literature covering implementation case studies and the writings of quality gurus. Top management commitment to the quality process and their leadership in fostering an environment where quality is a way of life sets the foundation for the implementation of TQM in an organization. Deming calls for managers to institute leadership to usher the transformation process. Feigenbaum views senior executives' commitment as the means for promoting organizational commitment. Kano talks about senior executives' commitment as a (more) important factor of TQM, and their doubt as the greatest enemy. Crosby places management commitment on top of the essentials of TQM implementation. Juran attributes the quality excellence of the Japanese companies to senior managers' commitment to quality (Amsden et al., 1996, Butch and Rivers, 2001; Thiagarajan and Zairi., 1997).

Few would argue about the important role which senior executives play in TQM. Their grasp of its purpose and intent is indicative of the amount of time they have given to its consideration, and by implication therefore, their level of involvement. Understanding also influences the levels of resources being committed to TQM and the amount of time which will be given to it before a 'bottom line' return on investment becomes a prerequisite for its continuance (Taylor, 1997).

Lack of top management commitment is one of the reasons for failure of TQM efforts (Zhang, et al., 2000; Fok and Hartman, 2001; Al-Khalifa and Aspinwall, 2000). It is estimated that approximately 80 per cent of UK TQM initiatives fail to fulfil their potential due to lack of senior management commitment to the quality process. This is thought to derive from the fact that many senior managers do not view themselves as part

of the quality problem, but view it as a worker motivation issue (Cooper and Phillips, 1995).

Lack of competent management, lack of effective leadership, having too many chiefs with conflicting agendas, result in a lack of focus while implementing TQM (Nwabueze, 2001; Salaheldin, 2003). Lack of understanding of principles of TQM by top managers is another obstacle (Taylor and Wright, 2003). Management problems which are barriers for TQM are ineffective supervision, conflicting and unrealistic goals, poor planning and organizing, lack of resources, lack of interest and lack of top management support (Longnecker and Scazzero, 1996, Carpinetti et al., 1998). Laszlo (1998) recognized that no matter how noble a cause may be, unless management includes it into its strategic plans and sets goals toward its attainment, all efforts which are not sanctioned by management are considered to be distractions from other priorities. Indeed, resources committed to other causes are actually wasteful as far as the management of the organization is concerned. It is argued that the major problems associated with the TQM adoption have been lack of understanding about the degree of organisational commitment required (Irani et al., 2003).

It is not surprising that issues related to top management commitment received the very high coverage in the TQM literature survey and analysis. Among the 15 TQM models analyzed, 13 put top management commitment as the foundation for success of TQM (Table 4.1). Out of 56 TQM related works, 24 stressed the importance of it and it is the highest among all the CSFs (Table 4.2).

4.4.2 Suppler Quality Management

The supplier is now regarded more as a partner in the supply chain, with an enhanced relationship, rather than as a participant in an adversarial war of attrition, typical of the spot market. This has stimulated the need for a change in the culture of purchasing/supplying personnel. This is epitomized by the referred supplier status, which is appointed following exhaustive evaluation and drawn subsequently into the regular

mutual monitoring process (Caddick and Dale, 1998; Shi and Halpin, 2003; Sonmez et al., 2002; Steane and Walker, 2000).

Saraph et al., (1989) studied philosophies of Deming, Juran, Crosby and other quality experts and arrived at the opinion, supplier quality management as one of the key critical factors of quality management. This includes fewer dependable suppliers, reliance on suppliers process control, strong inter dependence of supplier and customer, purchasing policy, emphasizing quality rather than price, supplier quality control and supplier assistance in quality development. Successful projects in the future are likely to be decided based on quality and supplier responsiveness, which can only be achieved through partnership relationships. These relationships will involve fewer suppliers, and they will be based on mutual trust (Burati et al., 1992).

Suppliers play a well recognized key role in quality management and they have a clear influence on several quality CSFs. Once it is recognized that the materials and the components purchased are the main cause of quality problems and that the blame for this can often be placed on incorrect relations with suppliers, the logical conclusion is that, in order to get adequate quality control of critical inputs, companies must invest more in their relations with their suppliers (Forza and Filippini, 1998).

An organization must ensure quality at all stages of construction. As such an effective quality management approach should form the basis for procuring quality material. The suppliers' role is critical in many ways. First the quality of incoming material from supplier determines the level of inspection efforts of a buyer organization and to an extent, determines the final product quality. Also suppliers' capability to react to a buyer firm's needs, determines buyer's flexibility in responding to customers needs (Ahire et al., 1996). The literature is replete with the role of suppliers in quality management initiatives (Huq and Stolen, 1998; Nwankwo et al., 2002; Baidoun, 2003). They provide guidelines to ensure quality and recommends extensive long term partnership with suppliers.

Ahire and Ravichandran (2001) studies revealed that organizations do not operate as isolated entities. They depend on and constantly interact with their environment. This dependence necessitates integration of external entities such as suppliers within organizational processes for successful execution of these processes. Since suppliers play a key role in determining the product quality, their cooperation is indicative of productive supplier relations. Thus organizations committed to improving quality cultivate long term supplier development and elicit consistent cooperation from them in terms of supply quality and punctuality of deliveries.

Supplier quality management is an important aspect of TQM since materials and purchased components are often a major source of quality problems. Many organizations that manufacture the highest quality products have purchasing departments that rank quality rather than cost minimization as their major objective. Conversely, in organizations with the lowest quality performance, the primary objective of the purchasing department is to obtain the lowest price for technically acceptable components. If organizations wants to pursue good supplier quality management, they should establish long-term co-operative relations with their suppliers, often participate in supplier quality activities, have detailed information concerning supplier performance, give feedback on the performance of suppliers' products, regularly conduct supplier quality audits, and regard product quality as the most important factor for selecting suppliers (Zhang et al.,2000). Many authors including Thiagarajan et al (2001), Baidoun (2003) advocate that companies must establish supply chain partnerships to motivate suppliers to provide materials needed to meet customer expectations (Jabnoun, 2000). Other recent studies support these findings.

Crosby, Deming, and Ishikawa stress heavily on supplier development and this is also consequential to the quality of the products and services provided by companies (Huq and Stolen, 1998). Barriers, such as poor communication must be removed through reductions in the number of suppliers and developing a long term relationship with them. Nothing is a more potent change agent than a buyer getting a supplier to initiate a process of quality improvement. Also poor quality of supplier products results in extra costs for

the purchaser: e.g. for one appliance manufacturer, 75 percent of all warranty claims were traced to purchased components for the appliances (Zhang et al., 2000)

In today's business world, the way in which supplier quality need to be perceived, structured and managed has changed remarkably. Effective integration and management of suppliers' value chain is central to a company's very competitiveness. The key to an effective supplier quality integration lies in creating competitive agility by building and managing scalable networks of suppliers that can work together to bolster a company's pursuit of quality excellence. By sharing knowledge and resources, such value networks are able to leverage their (suppliers') collective competencies into clearly targeted quality goals (Nwankwo et al., 2002).

For construction projects, there is a problem on construction sites of developing an integrated material supply particularly due to the use of large number of subcontractors (Riley and Clare-Brown, 2001). The implication of research findings of Torbica and Stroh, (1999) is that there is a gap between the importance that supplier quality management has in affecting buyer satisfaction and the current level of industry practice of that factor. This is the area with greatest potential for competitive advantage. Construction industry should pay more attention and focus their improvement effort towards practicing supplier quality management

The TQM literature survey and analysis indicates, among the 15 TQM models analyzed, 12 put partnering/supplier quality management as the CSF for success of TQM (Table 4.1). Out of 56 TQM related works, 17 stressed the importance of it very highly among all the CSFs (Table 4.2).

4.4.3 Customer Satisfaction

One of the TQM principles for successful implementation of TQM is total customer satisfaction (Ho et al., 1995; Tang et al., 2003). To achieve quality firms must understand customers' needs and develop products facilities and services appropriately (Metri, 2003). Without customer focus the TQM programme will lack the foundation to build on

(Huq and Stolen, 1998). One can produce a beautiful product very efficiently, but may be out of business if it does not meet the customer needs (Culp et al., 1993). Based on Amsden et al. (1996) studies and understanding of TQM, organizations and systems adopting this style of managing generally focus on satisfying customers, both internal and external, consider a holistic, balanced, and integrated system for their needs, and manage the system holistically so as to continuously improve the customer satisfaction.

All activities of an organization must be planned and executed to improve processes that lead to manufacturing quality products. However, quality must be incorporated into these activities with a clear customer focus. Despite the use of latest process improvement techniques and capable management, a firm's neglect of its customers may lead to a disaster (Ahire et al., 1996). The pressure to revitalize manufacturing has been rooted in customers demand for a greater variety of reliable products with short time leads. The importance of customer focus is also evident from the fact that it is assigned the highest weight among MBNQA criteria. Customer expectations are dynamic in nature. Hence an organization needs to assess them regularly and adjust its operations accordingly. An organization's long terms success is tied to customer retention efforts. Organization may out perform their competition by being able to anticipate and respond quickly to customers' demands with new ideas and technologies and to produce products that satisfy or exceed customers' expectations (Ahire et al., 1996; Burati et al., 1992).

To achieve quality, it is essential to know what customers want and to provide products or services that meet their requirements. A successful organization recognizes the need to put the customer first in every decision made. The 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 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 inputs at every stage of the process so that there is less likelihood of quality problems once full production begins. The ultimate measure of company performance is customer satisfaction, which may very well predict the future success or failure of an organization. In order to improve customer satisfaction, customer

complaints should therefore be treated with top priority. Warranty on sold products should also be provided. Methods that can be used for customer focus efforts include collections of customer complaint information, market investigations, and customer satisfaction surveys (Zhang et al. 2000).

The customer is the reason for a firm's existence. If a company wants to be in business to remain profitable and to grow, it has to give the customer the absolute best product. One has to understand the competition, and continually add real value to your product (Babbar and Aspelin, 1994, Ho and Fung, 1994). Study of Youssef and Zairi (1995) in UK, Middle East, Malaysia, and Singapore revealed the importance of customer satisfaction, which was next to top management commitment.

One of the main barriers to implementation of TQM is lack of customer awareness (Nwabueze, 2001). Customer focus is critical for survival in a competitive market. It seems, however, that TQM firms exhibit a stronger commitment to achieve this focus through more rigorous implementation of the other implementation CSFs (Ahire et al., 1996). Customer focus and satisfaction is such an important component of the TQM movement because organizations can outscore their competitors by effectively addressing customers' needs and demands, and anticipate and respond to their evolving interests and wants. This can be achieved by the use of technology which will produce products that consist of such attributes of quality as conformance to requirements, conformance to specifications, reliability, durability, absence of variation, fitness for use, etc. (Sureshchandar, 2001).

Because customer satisfaction and market share are the long-term goals of TQM, the entire organization must adapt its attitude to making the customer the focus of all quality efforts. Listening to customer opinions helps keep quality efforts relevant and cost effective because these interactions can lead to better products and services.

Dynamic customer expectations should be tracked and quality efforts adjusted accordingly. Customer focus is reflected in a firm's efforts to receive customer feedback,

to transmit the feedback to people in charge of effecting product and process changes, and to execute changes based on the customer feedback (Ahire and Ravichandran, 2001). Also Irani et al., (2003) studies showed the importance of customer commitment to obtain a cultural change. Managing by customer-driven processes for value means the organization conducting its business and implementing its quality goals (Thiagarajan and Zairi, 2001).

Customers are an economic asset, they are not on the balance sheet, but they should be. This statement of many quality gurus shows the emphasis on customer satisfaction or customer-driven quality is considered by them and writers as a major success of the quality management effort (Baidoun, 2003). In quality management, it is essential to maintain very close links with customers, in order both to identify their needs and to receive the feedback necessary to the company, if it is both to understand to what extent it has succeeded in satisfying those requirements and thus to initiate the relevant improvement activities (Forza and Filippini, 1998). Customer focus of an organization is usually assed by the frequency and rigor of customer satisfaction surveys. However, mere execution of such surveys is not useful unless the results are made available to functional areas. Further, these results should be used in improving the product quality (Ahire et al., 1996).

The TQM literature survey and analysis, among the 15 TQM models analyzed, 14 put customer satisfaction, the highest number, as the CSF for success of TQM (Table 4.1). Out of 56 TQM related works, 17 stressed the importance of it very highly among all the CSFs (Table 4.2).

4.4.4 Design Quality Management

A comprehensive approach to designing quality into products reflects organizations strategic quality planning capabilities. Today's complex products cannot be designed by design engineers alone. An interdisciplinary approach to designs (wherein other functions such as production, materials planning and engineering get involved in the early stages of the product design) is essential. Also marketing and manufacturing experiences of the

design team members enhance their ability to design quality products (Ahire et al., 1996; Kuprenas, 2002). Saraph et al., (1989) while developing critical factors of quality management. high lighted the importance of product and service design which includes involvement of all affected departments in design reviews, clarity of specifications and avoidance of frequent redesigns.

Several researchers argue that design management efforts are as important as the efforts to assure quality during production. Although only about 10% of the total production cost is actually spent at the design stage, it is at this stage that the management commits to the remaining 90% of the actual production cost. Superior product designs result in distinct competitive capabilities such as fast delivery and manufacturing flexibility. Thus the design process management is an important aspect of TQM (Ahire and Ravichandran, 2001). A study conducted by The American Quality Foundation and Ernst and Young suggested that high quality performance firms invested more efforts in design management while low quality performance firms focused on inspections. Product design is an important CSF of quality management. For complex products, errors during product development cause about 50 percent of fitness for use problems. Sound product design meets or exceeds the requirements and expectations of customers better than the competitors, leading to an increased market share (Zhang et al., 2000).

Design quality management/ Design of service are an important CSF of quality management. Sound and reliable service design is vital as it meets or exceeds the needs, expectations and desires of customers, ultimately leading to enhanced business performance. The ability to design services systematically is as important as designing products. Sureshchandar et al., (2001) findings revealed two quality strategies that must be adopted right from the design stage: (1) prevention, (2) zero fault strategy. Designing quality into service insists on combining the precision of the engineer, the integral attitude of the architect, and the customer-orientation of the marketer. It concluded that in order to effectively design quality into a service, one not only needs to comprehend the wants and passions of the customer, but also needs to understand the intricacies of the service.

Good design quality management results in excellent quality of core service with features that positively influence customer perceptions of quality. Thus Product design is an important CSF of quality management; good or bad product design will directly impact on product success. Sound product design meets the requirements and expectations of customers (Li et al., 2003, Zhang et al., 2000).

For construction project, traditionally it is believed that design checking and engineering inspections significantly increase the structural reliability but in reality it is not the case, since during utilization phase owner of the facility will make certain additions/ alterations or necessary changes if his actual requirements are not fully met. Thus, the present engineering design practice is inadequate since it will not take into account the customer requirements and expectations fully (Srividya and Metri, 2000). Neither architect nor engineer routinely places great emphasis on customer driven goals unless they are directly aligned with aesthetics and performance (Mallon and Mulligan, 1993).

Most of the construction firms consider factors that affect process quality at construction stage of the project. On contrary it has to be considered in all the three phases of the lifecycle of a construction project, design phase being the foremost one, by degree of importance. A quality program may fail in the design phase itself due to lack of cooperation of all suppliers (e.g., owners, regulatory agencies etc.) and customers (e.g., contractors, sub contractors, material vendors etc.) involved in the design phase (Arditi and Gunaydin, 1998). Designing quality into products impact quality, yet, few studies have touched upon the relative importance of this phase of quality management.

The TQM literature survey and analysis indicates, among the 15 TQM models analyzed, 7 put design quality management as the CSF for success of TQM (Table 4.1). Out of 56 TQM related works, 5 stressed the importance of it (Table 4.2).

4.4.5 Process Quality Management

When products are being produced, variations in the construction / manufacturing process (variables like material quality, worker skills etc.) contribute to variation in product

quality. The role of process control/management is as critical as design quality management. It is necessary to detect assignable causes contributing to variation in quality to provide useful information to product design and to investigate critical areas where improvement needed. Saraph et al., (1989) synthesized quality literature and arrived at the opinion, process management as one of the critical factor for quality management. This provides clarity of ownership and less reliance on inspection.

A key part of any total quality strategy is the management of processes. Process refers to some unique combinations of machines, tools, methods, materials, and people engaged in production. Process management focuses on managing the manufacturing process so that it operates as expected, without breakdowns, missing materials, fixtures, tools, etc., and despite workforce variability. One important matter in process management is to ensure that process capability can meet production requirements (Zhang, 2000). Process quality directly contributes to the cost of production and the extent of waste, such as rework and scrap. It also affects productivity because of mis-specification of processing parameters (Ahire and Ravichandran, 2001). Clearly this has impact on quality, hence a critical factor of quality management.

To achieve customer satisfaction, Oakland (2000) emphasizes the importance of managing the internal-supplier relationship as the first step to support the process management. Through a process of translating the customer-supplier chain at all levels, better focus can be achieved and ultimately all work carried out will be of value (Baidoun, 2003). Process management of key business processes is vital for effective quality improvement. The big winnings in a quality revolution can only come from restructured and metamorphosed business processes. Process management essentially refers to the procedures, systems and technology that are required to streamline the delivery. The TQM approach places a great deal of importance on the maintenance of process control; in other words, it tries to ensure that these processes do not only behave as expected but also that the behaviour of these processes does not create problems for the future. Thus, greater attention is paid to the control of the behaviour of the processes that generate the products than to product conformity control (Forza and Filippini, 1998).

In essence, quality philosophies advocate concentration on continuously improving both the "process" and the "people" which when properly managed, results in organisational changes and improvements able to deliver high productivity and better quality. A process is a series of activities that produces an output of value to the customer by the use of various kinds of input. Combined, these two elements are linked to productivity, such that the improvement of productivity lies in the structure of the process itself. Every employee has significant potential to improve not only his/her own processes, but also to co-operate for improvements in others' processes. Authorizing employees to be responsible for their own work makes them simultaneously an inspector and processor. Consequently, this approach greatly reduces and/or eliminates unnecessary non-value added procedures and enables individuals to be involved in the improvement of their own business (Nesan and Holt, 2002).

The TQM literature survey and analysis carried out by the author indicates, among the 15 TQM models analyzed, 14 put process quality management as the CSF, which is the highest number, for success of TQM (Table 4.1). Out of 56 TQM related works, 12 stressed the importance of it (Table 4.2).

4.4.6 Information and Analysis

If there is inferior dissemination of the generated information, quality techniques like benchmarking and SPC tools which allow monitoring quality internal processes, will be rendered ineffective. To maintain a true customer focus, an organization must ensure prompt feedback of customer survey results to appropriate functional areas for effective actions. Juran advocates the determination of cost of quality for all process components and wide dissemination of this information within the organization. The MBNQA recognizes the importance of making timely, adequate, and relevant quality data available to concerned department and employees (Ahire et al., 1996). Measures of costs of prevention, appraisal, internal failure, and external failure are crucial for determining the health of a TQM programme. Determination of causes of quality variation is one important step for launching a quality improvement programme (Huq and Stolen, 1998).

Saraph et al., (1989) in their studies stressed the use of timely quality measurement, availability of quality data, evaluation of managers and employees based on quality performance as an important factor towards achieving quality. Flynn et al., model suggested that specific quality improvement practices such as statistical control and feedback are antecedents of process quality. An on going internal knowledge compilation of internal processes/product quality information like rework, scrap, cost of quality allows the organization to gauge its progress vis-à-vis its quality improvement targets. External knowledge compilation to track where the firms' processes and products stand in vis-à-vis those of other firms (competitors and non competitors) involved in similar processes and products. Rigor and consistency of these external knowledge compilation efforts indicate the extent of acceptance of the management's quality improvement initiative by employees and their voluntary. These efforts also ensure that quality efforts are focused on the needs and desires of customers. Furthermore, external product benchmarks ensure that quality improvement efforts are targeted at improving products in a competitive manner (Ahire and Ravichandran, 2001).

An organization's TQM movement will be rendered futile if there is inadequate/ ineffective dissemination of general information. In order that TQM be effective, conventional information systems focusing on cost and financial accounting activities, sales, marketing, purchasing and scheduling will not be adequate in construction organizations. They may not be able to provide quality service to customers (as services, unlike goods, cannot be inventoried and used in times of emergency or demand). This can only be achieved by equipping the employees with information regarding the process and the customers. Organizations instituting TQM require enhanced communications to espouse the improvement process. In a TQM ambience people need to communicate across organizational levels, functions, product lines, locations to work out current problems and implement change

Measurement activities (like service deficiencies; skill improvement; customer and supplier satisfaction; productivity; cycle times; and training effects), Job performance evaluation (like Continuous evaluation of the performance of employees, including:

product/service deficiencies; skill improvement; and productivity), Benchmarking (a formal process of measuring and comparing the company's product, process or service against those of the top performing companies), Self-assessment of performance (individuals or teams are empowered to assess the quality of their own performance in respect of their functions) are the cornerstone for monitoring continuous improvement in an organization (Nesan and Holt, 2002). TQM systems problems include ineffective corrective action procedures, people not aware that quality problems exist (ineffective feedback mechanisms), ineffective measurement procedures, unrealistic quality standards, and technology/ equipment problems (Longnecker and Scazzero, 1996). Culp et al., (1993) cited reason for failing of many TQM efforts as the lack of clearly defined, measurable goals that are aligned with firm's overall objectives.

TQM embodies the importance of constant feedback at every stage of the building cycle. In construction, not only must all requirements be carefully decomposed into systematically and clearly identifiable parts, special attention must be given to measure the conformance of every particular identifiable component. Various sub-processes must be checked for their conformance to plans. Attempts must be made to measure the identifiable parts according to an established method of measurement so that when the job progresses downstream, the measurements reflect clearly the difference between planned targets versus actual results forming a basis for review and audit (Pheng and Wei, 1996).

From above it is clear that information and analysis/quality data reporting makes important step towards assessing and gauging quality level of an organization. The TQM literature survey and analysis indicates, among the 15 TQM models analyzed, 13 put process quality management as the CSF, which is the very high, for success of TQM (Table 4.1). Out of 56 TQM related works, 9 stressed the importance of it (Table 4.2).

4.4.7 Education and Training

Many organizations tend to become more eager and enthusiastic for economic development to the extent that they are inclined to place greater emphasis on technology,

completely overlooking the fact that it is the human resource that makes the capital, technology and other resources productive. But, if the technological advances lure the organization to consider technology as a substitute for human beings, instead of using it as a tool, it may prove disastrous for them (Sureschandar et al., 2001).

TQM cannot simply continue to refine the effectiveness of its traditional functions. To remain viable in a TQM environment requires the issues of managing people, from the perspective of adding value to the customer. This change in orientation is brought by education and training of the people in the organization. The differences between TQM and non-TQM organizations demonstrate the magnitude of change which is necessary if TQM is to be integrated into organizations. Failure to make such a shift will prevent TQM from providing value to organizations (Ahire et al.1996). TQM can become a driving force behind companies as they fight to compete in a-global market place.

An influential problem that team members deal with is their own lack of training. Lack of training is one of the most common reasons why groups fail. Achieving cohesive teamwork requires specific learned and inherent skills. Learning the skills necessary and understanding the important characteristics of cohesion can facilitate a group's positive work experience (Conti and Kleiner, 1997).

Quality-related training has also been emphasized in the literature as a key human resource element of TQM, as well as related forms of advanced manufacturing technologies. Indeed, large expenditures have been invested into such training including the construction of elaborate corporate quality training facilities characterized a TQM firm as a "learning organization". To this extent, TQM makes strong demands on employees to not only possess adequate knowledge and skills to perform their jobs, but also to possess specific values, knowledge, and skills associated with TQM activities (Murray and Donegan, 2003; Sharma and Sharma, 2003;Waldman and Gopalakrishnan, 1996).

A study of Kruger (1998) revealed that every employee in a business organization has a

potential which should be fully developed by management. Such a valuing of the individual's potential does not only generate personal benefits for the employee but also benefits for the work organizations. Improving workers' skills and quality consciousness through enhancing training programs is important for TQM implementation (Salaheldin, 2003). It has been long recognized that well focused quality oriented job training is essential to better quality management. Employees will be motivated to engage in quality oriented behaviour when their roles and the relevance of their training to overall quality goals are clarified (Ahire et al., 1996; Ahire and Ravichandran, 2001; Carpinetti et al., 1998; Ghobadian and Gallear, 2001; Hides et al., 2000; Ho and Fung, 1995).

Many research results reveal that education and training are one of the most important elements in a successful implementation of TQM. Investment in education and training is vitally important for TQM success (Zhang et al., 2000). Education and training, also seems a reasonable indicator of the depth and pervasion of a quality philosophy within the organization. At the very least, it indicates a measure of commitment to the development of quality (Li et al., 2003). TQM introduction is heavily reliant on employee involvement and participation and TQ-based performance is dependent on people productivity. As such, investment in people through education and training is fundamental to the success of TQM implementation (Youssef and Zairi, 1995).

A study conducted by Longnecker and Scazzero (1996) on causes of ongoing quality problems, revealed that eight out of fifteen reasons cited were related to people problems like individuals not effectively performing their jobs, communication breakdowns, ineffective supervision, lack of team work, poorly trained workers and lack of worker input/involvement. Also, studies revealed the organizational non-alliance with functional areas like analysis of jobs and training leads to unfruitful implementation of quality programmes in Brazil (Carpinetti et al., 1998).

Most of the TQM training courses designed are from manufacturers' perspective and not specifically designed for construction projects (Culp et al., 1993). It is argued that the transient construction workforce is quite different from the relatively stable

manufacturing workforce. The transient nature may make it more difficult to train workers, particularly craft labour (Burati et al., 1992). But in spite of change of location, processes are similar in construction projects also and training can be imparted.

Successful implementation of a TQM program must include a recalibration of organization-wide thinking as well as training in quality assurance methods (Laszlo, 1998). Employee empowerment and involvement is not effective unless employees have received formal, systematic training in quality management. Only when employees are trained in the quality concepts and tools can they understand quality related issues (Carpinetti, et al., 1998). Education and training is one of the keys of any meaningful quality improvement. Employees will understand the theory of quality only when they are properly trained in the quality concepts and tools. Training also helps organizations to send powerful messages about an organization's priorities. With the growing interest in TQM, attitudinal training has received greater attention than ever before, but a comprehensive approach to training at all levels is essential. Elements of the training programme include the following:

- Organization awareness training
- Apprenticeship orientation course / New employee induction course
- People handling skills for supervisors
- Quality service concepts for managers, executives and supervisors
- Management development programs
- Interpersonal and communication skills
- Technical training / Safety and hazard recognition
- Economics of the construction industry / Marketing, customer service
- Continuous process improvement

The TQM literature survey and analysis indicates, among the 15 TQM models analyzed, 13 put education and training as the CSF, which is the very high, for success of TQM (Table 4.1). Out of 56 TQM related works, 23 stressed the importance of it, which is also

very high (Table 4.2). Contribution of this CSF to TQM stands in par with top management commitment.

4.4.8 Organizational Culture

Culture is defined here as a set of shared meanings (beliefs and values) held by members of a group that affects their perceptions and interpretations of events and their actions. Certain common values and beliefs may be crucial to an organization attempting to foster total quality behaviour and outcomes (Waldman and Gopalakrishnan, 1996). The role of organizational culture in understanding how firms work has received considerable attention in the TQM and innovation literature. Empirical studies tend to focus on the articulation of TQM practices and not TQM culture. While this does not indicate the ignorance or abandonment of the importance of defining TQM-type culture, it may be that the result of the imprecise boundary between TQM as management practices and TQM as an organizational culture is not well defined. Therefore, many TQM elements contain CSFs that could be classified as reflecting organizational culture (Prajogo and Sohal, 2001). Prajogo and Sohal (2001) hypothesized relationship between organizational culture and organizational strategy, organizational culture and TQM practices. Also a case study of Velden engineering company in a UK firm by Irani et al., (2003) confirmed the fact; a strong organisational culture enables the smooth flow of information and nurtures harmony among its members.

Many studies have argued that the culture of enterprises must first be transformed before they can implement TQM and related management techniques (Jenner et al., 1998; Recht and Wilderom, 1998). Regarding organizational culture, it is found that organizations successful at implementing TQM tend to have cultures which are conducive to learning about problems, sharing information, and have a holistic approach toward problem solving. This is in contrast to organizational cultures which promote finding quick fixes to problems, misuse of information (where information becomes a source of power and is not readily shared), and a segmented or functional approach toward problem-solving (Waldman and Gopalakrishnan, 1996).

National culture may contribute to the failure of a TQM implementation process. Therefore, when attempting to implement business practices, such as TQM, in different countries, it is necessary to comprehend the value and attitudinal model of the cultures in question (Galperin and Lituchi, 1999). People of different nations have different values or norms that influence their attitudes and priorities on issues relevant to organizations. Perry (1997) studies in Africa regarding TQM implementation disclosed multinational companies cannot simply transplant Western management techniques and processes into African enterprises because of cultural, organisational and infrastructure differences. The empirical results from UK, Middle East, Malaysia and Singapore reflected the fact; TQM is long term and can only succeed if there is a serious attempt at changing methods, ways of working, ideas, technologies etc. In a sense it requires a fundamentally new culture (Youssef and Zairi, 1995).

One of the primary reasons cited for the failure of the TQM includes, failure to develop and sustain a quality oriented culture (Fok and Hartman, 2001). The failures of TQM have been attributed to the pre-existence of factors that conflict with TQM philosophy and practice, also disregard for contextual factors. One of the reasons for failure to implement a quality program includes a mismatch of organizational culture. People dominated by an individualistic culture may not fit well into the group-orientation aspects of management practices (Galperin and Lituchi, 1999).

Any organization that seeks to have employees look for ways of doing things better needs to possess a culture that deals effectively with changes. Two fundamental roadblocks to such an approach are the so-called NIH syndrome ("not invented here" – hence not good for us) and the old adage, "if it ain't broke, don't fix it" (sometimes stated as "we always did it this way!"). These ideas and the TQM philosophy are not only diametrically opposite, but they are mutually exclusive any attempt to implement TQM in the presence of such ideas is futile (Laszlo, 1998). In Europe and USA, majority of TQM initiatives either did not work at all or fell away after achieving some successes. One of the reasons for this is the lack of appropriate cultural policies (Irani et al., 2003; Kumar et al., 2002).

The construction industry, however, by and large has failed to use the potential of the TQM approach, apparently due to mismatch commonly seen between the participative, long term, people building process of TQM and the hostile environment of the construction industry, which features instability, temporary employment, and an ever-changing work setting (Rosenfeld et al., 1992). On contrary, quality management is usually seen as a uniform concept to be used in the same way regardless of the context in which the company operates (Lagrosen, 2002). Culture existing in construction has significant differences to that found within the manufacturing industries. It will not be possible to transfer management tools from one industrial sector to the other without substantiate redesign. The culture within the construction is found to be a project culture in comparison to manufacturing, which is found to be a company culture (Riley and Clare- Brown, 2001). Also it is clear that the challenge of changing the culture is daunting. It is important for all companies to nurture and manage a culture that is appropriate to their ambitions and business environments.

The TQM literature survey and analysis indicates, among the 56 TQM related works, very high number of 18 stressed the importance of it (Table 4.2). This shows the importance of critical role to culture in the implementation of TQM.

4.4.9 Strategic Quality Management

Strategic quality management provides the environment that encourages the development of strategic concepts. However, these concepts are to be put into practice through strategic planning models, which provide specific instructions for approaching, executing, and evaluating the development of strategic concepts. These include internal issues like development of a roadmap for organizational development, resources, long term plans, vision statement, incorporation of the core competencies concept into the organization, move toward new technology, long term education. External issues being response of the organization to the economic swings in the industry, the impact of new market opportunities on existing business practices and protecting against competitors (Chinowsky and Meredith, 2000)

In order to realize a vision statement, an organization must make plan statements which support the realization of the vision. These plans are strategic quality plans, comprising detailed business plan, a quality policy, a quality goal, and a quality improvement plan. These plans and statements should be well communicated to the employees of organizations and in return employees will be encouraged in their commitment to quality. In order to make these plans and statements, employees from different levels should be involved (Zhang et al. 2000)

Price and Newson (2003) findings disclosed the fact that, the long time survival of an organization depends on effective strategic management based on sound strategic planning. Taylor and Wright (2003) in their studies hypothesized that deriving success from TQM has been significantly associated with the inclusion of quality objectives in the strategic planning process also argued that TQM was likely to achieve more if it was treated as a key strategic business issue rather than merely an operational one. In their survey, all 113 respondents claimed that the management of quality was a strategic issue for their organizations. Some 96% ranked quality in the top three strategic issues, and over one-fifth stated that it was the prime strategic concern. In the latest data, most respondents (86%) again reported having documented strategic business plans. Almost the same number (85%) also reported that these business plans contained specific quality plans and objectives.

Longnecker and Scazzero (1996) conducted a survey of 137 upper level managers, they strongly believe that TQM improves quality, but it is necessary to adopt TQM principles fully into their overall management philosophy and strategy.

Strategic management in the context of the construction industry comprises the following areas; vision, mission and goals, core competencies, knowledge resources, education and markets competencies. These strategy elements combine to focus a construction organization in a particular direction for a particular planning period. A strategic plan is required to outline the goals, objectives, mile posts, and evaluation criteria that must be achieved to follow the developed strategy (Crowe and Cheng, 1996; Dikmen and

Birgonul, 2003). How ever, while translating a strategy into a series of tasks that can be accomplished by individual department is challenging. The time required to focus on broadening client bases, or examining new revenue streams, is often overridden by demands by projects for attention to budget, schedule, or personnel matters. Given this conflict for attention, a specific set of instructions is required to ensure that an organization remains focused on organization level concerns. This set of instructions is the strategic plan. Encompassed within this plan are the measurable outcomes that both division and organizational level managers can evaluate for progress and final achievement.

The traditional philosophy of management, both in academia and industry, places great emphasis on the ability to plan and execute projects. In contrast, a similar emphasis on strategic management has received less attention in the construction industry. In this focus there is a need to address the strategic management challenges of operating a construction organization as opposed to individual project. Specifically, existing literature and research reports provide far fewer avenues for constructional professionals to obtain strategic management knowledge (Chinowsky and Meredith, 2000)

The TQM literature survey and analysis indicates, among the 15 TQM models analyzed, 9 put strategic quality management as the CSF, which is the high, for success of TQM (Table 4.1). Out of 56 TQM related works, 3 stressed the importance of it (Table 4.2). But its contribution to TQM is more crucial to the success of remaining CSFs.

4.4.10 Empowerment and Involvement

The importance of empowerment in TQM is underlined by so many authors that it can be identified as one of the fundamental CSFs in TQM. A case study of BET NHS Trust, one of the largest trust hospitals in England which employs over 3,000 people demonstrated, other essential elements of TQM include involvement of employees and must be people led (Nwabueze, 2001).

Empowerment is an important ingredient that will benefit the area of company wide employee involvement in both TQM and project management implementation efforts

(Ahire et al., 1996, Galperin and Lituchi, 1999).In short, empowerment is a result of effective and sustained training that enhances the individual's self-esteem and his/her capability to solve problems and to make low-risk decisions. The aim of empowerment as defined through Deming's theory of management is to increase joy in work and pride in the outcome for all employees (Hides et al., 2000).

Empowerment also leads to increased employee participating in the quality improvement efforts, due to the heightened awareness of responsibility and equity among people at various levels (Carpinetti et al., 1998).Employee empowerment is a critical cornerstone for creating a total quality organization. Worker motivation, responsibility, and accountability are generic concepts that can benefit any business organization (Huq and Stolen, 1998). Ugboro and Obeng (2000) hypothesized and tested that, employee empowerment and job satisfaction are positively associated with customer satisfaction.

Involvement plays key role in successful implementation is involvement (Ahire et al., 1996; Ghobadian and Gallear, 2001; Hides et al., 2000; Ho et al., 1995). By personally participating in quality improvement activities, employees acquire new knowledge, see the benefits of the quality disciplines, and obtain a sense of accomplishment by solving quality problems. The participation leads to lasting changes in behaviour. Participation is decisive in inspiring action on quality improvement (Zhang et al., 2000). Taylor and Wright (2003) explored the percentage of employees involved in each TQM initiatives and hypothesized an effective involvement of employees' leads to success of TQM.

A study conducted by Longnecker and Scazzero (1996) on causes of ongoing quality problems, revealed people problems like individuals not effectively performing their jobs, lack of team work and lack of worker involvement.

Thiagarajan et al (2001) studies showed succeeds only with employees' involvement in the TQM process and their commitment to its goals, The critical importance of employees' involvement in the quality process of an organization is based on the belief that the best process innovation ideas come from the people actually doing the job. The quality reputation of Japanese companies is mainly credited to their great success in this

area. Also 60 per cent to 90 per cent of the costs of total quality are difficult to control by management alone. When workers themselves are committed to delivering quality, they take greater initiative towards meeting product and process specifications; detecting and eliminating bottlenecks; improving product and process designs and setting realistic yet challenging performance targets (Khan, 2003).

One of the organizational barriers which represent ongoing quality struggles for many TQM organizations is *People problem* which include individuals not performing their jobs effectively, communication breakdowns, lack of teamwork lack of worker input and involvement, lack of employee cooperation and motivation (Al-Khalifa and Aspinwall, 2000; Carpinetti et al., 1998; Fok and Hartman, 2001, Ho et al. 1995; Longnecker and Scazzero, 1996; Salaheldin, 2003). Taylor and Wright (2003) hypothesized that firms that have been unable to facilitate or motivate the majority of their employees to become involved in TQM are also less likely to perceive TQM as having been successful. In Europe and USA, majority of TQM initiatives either did not work at all or fell away after achieving some successes. One of the reasons for this is the lack of appropriate people policies in (Al-Khalifa and Aspinwall, 2000; Irani et al., 2003) which lacked involvement.

The TQM literature survey and analysis carried out by the author indicates, among the 15 TQM models analyzed, 12 put empowerment and involvement as the CSF, which is the very high, for success of TQM (Table 4.1). Out of 56 TQM related works, 20 stressed the importance of it, which is an also very high (Table 4.2) .This show that the literature on the TQM studies assign critical role to empowerment and involvement in the implementation of TQM.

4.5 Identification of Sub Criteria of the CSFs

Next, to examine the literature on the sub criteria for each of the CSF identified, more than 137 sub criteria synthesized from various secondary sources are presented. Looking at the practical difficulties, these sub criteria were reduced to 55 using frequency analysis without sacrificing the importance.

After identifying the 15 CSFs of TQM (Table 4.1), the next step in developing a TQM model would be to further investigate into the detail of each of the CSFs to know the sub criteria contents and importance of each sub criteria, which will be used in making decisions regarding CSFs while proposing the new TQM frame work. The analysis of each of the CSFs was carried out with respect to the questionnaire items in the appendix of each article of the scholarly TQM models referred. If not provided, results sections, literature review section are analysed. According to this analysis, issues related to top management commitment had 20, supplier quality management 15, customer satisfaction 13, design quality management 12, process quality management 16, information and analysis 14, education and training 10, organizational culture 8, strategic quality management 13, empowerment and involvement 16 sub criteria, (Tables 4.3 to 4.12).

4.6 Selection Process of the Sub Criteria

The identified 137 sub criteria of the CSFs of the proposed TQM model have to be prioritized and reduced to feasible number (63) of items to make it comprehensive and usable by clubbing similar items and prioritizing on descending hierarchy of frequency. Details are given in the below in the Tables 4.13 to 4.23 which are self explanatory. Also abbreviations used in this context are given below.

D = Deming prize; M = MBNQA; E = EQA; S = Saraph et al.; O = Oakland; F = Flynn et al.; B = Babbar and Aspelin; A = Ahire et al.; BP = Black and Porter; PW = Pheng and Wei; AN = Ang et al.; Z = Zhang et al.; N = Nwabueze; T = Thiagarajan et al.; W = Westerveld: Q = Frequency.

4.7 Conclusion

The findings reveal presence of 15 CSFs in this investigation and share most of the values covered by the key principles espoused by the TQM works. A TQM model is proposed based on the results of analysis of the frequency of the CSFs. The CSFs are corroborated for literature evidence. Also 167 sub criteria of the CSFs are identified in detail. The identified sub criteria are reduced to feasible number (63) of sub criteria.

Table 4.3 Top Management Commitment Sub Criteria

1. Active participation and leadership	10. Evaluation depends quality
2. Learns quality concepts	11. Clear quality vision and goals
3. Encourages learning and involvement	12. Ownership/responsibility for quality
4. Empowers employees for continuous improvement	13. Department heads responsibility for quality
5. Allocates resources for quality training and development	14. Top management evaluation
6. Quality issues/reviews in top management meetings	15. Specificity of quality goals
7. Product quality than yields.	16. Comprehensiveness quality goal settings
8. Pursues long-term business success	17. Communication of quality values
9. Quality over costs, schedules and yields	18. Supportive corporate culture
	19. Recruitment policy
	20. Involvement with customers and suppliers

Table 4.4 Supplier Quality Management Sub Criteria

1. Long-term relations/ partnership	9. Amount of education to supplier
2. Quality based selection than price	10. Involving supplier in product development
3. Participation in supplier quality activities	11. Clarity of specifications
4. Communication and feedback to suppliers	12. Supplier quality programs and systems
5. Supplier performance information	13. Making purchasing deptt responsible
6. Technical assistance to suppliers	14. Assurance of supply quality
7. Reliance on few dependable suppliers	15. Responsiveness of suppliers for quality
8. Thoroughness of supplier rating system	

Table 4.5 Customer Satisfaction Sub Criteria

1. Collection of information and complaint 2. Top priority to customer complaints 3. Assessing customer needs (CS Surveys) 4. Market research for improvements 5. Warranties on products 6. Customer need focused 7. Awareness of CS surveys (among staff) 8. Summary of complaints (to managers)	9. Comparison with competitors 10. Determination of improvements in CS 11. Determination of customer future requirements 12. Management of internal and external customers 13. Satisfied partners (suppliers/clients/customers)

Table 4.6 Design Quality Management Sub Criteria

1. Designers require experiences (practical and marketing) 2. Customer needs are thoroughly analyzed 3. Product design based on Customer needs 4. Functional departments' participation 5. Designs reviewed before production 6. Cost is emphasized in the product design	7. Producibility and experimental designs 8. Use of QFD in designs 9. Use prevention techniques 10. Clarity of product / service specifications 11. Quality emphasis by functional personnel 12. Integration of design process (customer and operational requirement)

Table 4.7 Process Quality Management Sub Criteria

1. Cleanliness 2. Process capability meets production needs 3. Maintenance of equipment 4. Implementation of inspections (incoming materials/processes/final products) 5. Use of QC tools and technique (SPC /PDCA etc.) 6. Uses of benchmarking and sampling 7. Amount of automation (inspection. review checking)	8. Self inspection 9. Stability of schedule 10. Clarity of work 11. Documented traceable system 12. Focus on quality standards 13. Conformance to set standards (specification and drawings) 14. Incorporating from customers 15. reducing variability 16. Innovation and creativity

Table 4.8 Information and Analysis Sub Criteria

1. Audits of policies and strategies. 2. Regularly conducts quality audits 3. Uses compliance / benchmarking 4. Availability and extent of quality related data (Errors /scrap / rework) 5. Availability of cost of quality data 6. Evaluation with quality related data (Performance of management, deptt, employees) 7. Communication of defects 8. Product quality measures (tools)	9. Supplier quality system / performance measure 10. Timeliness of quality data 11. Determination of quality costs 12. Assessment (needs for quality training, improvement, services) 13. Effective management of data/information (staff, customers, suppliers, processes) 14. Procedures / system (reliability/improvement of data gathering)

Table 4.9 Education and Training Sub Criteria

1. Assessing / encouraging employees 2. Resources allocation 3. Development and education 4. Employees trained in quality management methods /tools (cause and effect diagrams, pareto analysis, quality circle/statistical techniques, continuous improvement)	5. Specific work-skill training 6. Regarding employees long-term resources 7. Training as an on going process (not a fad) 8. Communication / team building 9. Use of specific organizational structures 10. Use of techniques to identify key processes customers and suppliers

Table 4.10 Organizational Culture Sub Criteria

1. Consideration of performances
2. Company-wide quality culture(strategic / executive / operative)
3. Continuous improvement policy
4. Cultural policies / attitudes Correction (not checking) / Problem solving (not finding fault)/ Improvement (not criticism) / sharing quality information)
5. Collectivistic behaviour (adaptability / cooperation)
6. Structure of the organization (development, decentralization)
7. Job security / Climate of fairness / open communication
8. Financial control by employees (employee control over I/E financial aspects

Table 4.11 Strategic Quality Management Sub Criteria

1. Clear quality policy
2. Detailed quality goal
3. Effective quality plan
4. Communication of policies and plans
5. Employee involvement (in making policies / plans)
6. Focus on critical processes (in accordance with design)
7. Active leadership/ involvement (managers)
8. Employee well being consideration
9. Identification/ Analysis of Strategic issues
10. Analysis of performance and cost data
11. Development /deployment of quality strategies
12. Consideration of performance requirements
13. Document strategic planning

Table 4.12 Empowerment and Involvement Sub Criteria

Empowerment 1. Employees inspect /fix problems of own work 2. Resources / technical assistance (provided to correct quality problems) 3. Problem solving network 4. Promoting empowerment /open behavior 5. Building self esteem and confidence *Employee involvement / participation /teamwork* 6. Presence of cross-functional teams 7. Active (quality) involvement programmes (like QC circles,)	8. Implementation of suggestions 9. Encouragement to report / share problems 10. Degree of employee participation (in quality decisions) 11. Amount of feedback provided to employee (on their quality performance) 12. Effectiveness of supervisors (in solving the problems / issues) *Recognition and reward (Motivation)* 13. Quality improvement efforts recognized. 14. Career development based on quality 15. Reward system (for suggestions) 16. Human resource management(in line with quality performance plans

Table 4.13 Details and Selection of Sub Criteria of Top Management Commitment

Sub criteria	i D	ii M	iii E	iv S	v O	vi F	vii B	viii A	ix BP	x P	xi AN	xii Z	xiii N	xiv T	xv W	Q
1. **Active participation / leadership**	x	x	x	x	x	x	x				x	x	x	x	x	12*
2. Learns quality concepts/					x						x					2
3. **Encourages learning / involvement**	x	x	x		x	x	x				x	x		x		9*
4. **Empowers employees for CI**		x	x				x				x	x				5*
5. **Allocates resources for quality, T and D**								x	x				x			3*
6. **Quality issues/reviews in top mgmt meetings**					x				x				x			3*
7. Product quality than yields.												x				1
8. Pursues long-term business success												x				1
9. Quality over costs / schedules/ yield				x				x								2
10. Evaluation depends quality								x								1
11. **Clear quality vision / goals**	x		x		x		x	x						x		7*
12. **Ownership/responsibility for quality**				x			x							x		3*
13. Dept heads responsibility for quality				x												1
14. Top mgmt evaluation		x		x												2
15. Specificity of quality goals				x										x		1
16. Comprehensiveness quality goal setting				x			x									2
17. **Communication of quality values**	x	x	x		x	x	x				x			x		8*
18. **Supportive corporate culture**			x		x	x	x									4*
19. Reward and recognition			x												x	1
20. Involvement with customers /suppliers			x													1

Selected sub criteria

1. Active participation and leadership
2. Encourages learning and involvement
3. Empowers employees for CI
4. Allocates resources for quality, T and D
5. Quality issues/reviews in top mgmt meetings
6. Clear quality vision and goals
7. Ownership/responsibility for quality
8. Communication of quality values
9. Supportive corporate culture

Table 4.14 Details and Selection of Sub Criteria of Supplier Quality Management

Sub criteria	i D	ii M	iii E	iv S	v O	vi F	vii B	viii A	ix BP	x PW	xi AN	xii Z	xiii N	xiv T	xv W	Q
1. **Long-term relations/ partnership**	x	x	x	x		x	x	x				x	x		x	10*
2. **Quality based selection than price**				x		x		x				x				4*
3. **Participates in supplier quality activities**							x			x		x				3*
4. Communication / feedback to suppliers										x		x				2
5. **Supplier performance information / audit**		x	x							x	x	x	x			6*
6. Technical assistance to suppliers								x				x				2
7. Reliance on few dependable suppliers				x		x										2
8. Thoroughness of supplier rating system				x				x								2
9. Amount of education to supplier				x												1
10. **Involving supplier in product development**		x		x		x										3*
11. Clarity of specifications				x												1
12. Supplier quality programs /systems				x				x								2
13. Making purchasing deptt responsible				x												1
14. Assurance of supply quality									x							2
15. Responsiveness of suppliers for quality									x							1

Selected sub criteria

1. Long-term relations and partnership
2. Quality based selection than price
3. Participates in supplier quality activities
4. Supplier performance information and audit
5. Involving supplier in product development

Table 4.15 Details and Selection of Sub Criteria of Customer Satisfaction

Sub criteria	i D	ii M	iii E	iv S	v O	vi F	vii B	viii A	ix BP	x PW	xi AN	xii Z	xiii N	xiv T	xv W	Q
1. **Collection of complaint / information**	x	x	x									x				4*
2. **Top priority to customer complaints**		x				x						x				3*
3. **Asses / measure customer needs**	x	x	x			x					x	x	x	x		8*
4. **Market research for improving products**		x						x				x				3*
5. Warranties on products								x				x				2
6. **Customer / need focused** .	x	x	x			x		x			x	x	x			8*
7. Awareness of CS surveys (among staff)								x								1
8. Summary of complaints (to managers)									x							1
9. Comparison with competitors									x							1
10. Detn of improvements in CS									x							1
11. Detn of customer future requirements					x				x							2
12. **Mgmt of intnl / extnl customers relationship**	x	x	x		x						x					5*
13. **Partnerships with suppliers /clients**	x	x	x			x				x			x			6*

Selected sub criteria

1. Collection of complaint and information
2. Top priority to customer complaints
3. Asses and measure customer needs
4. Market research for improving products
5. Customer need focused
6. Management of internal and external customers relationship
7. Partnerships with suppliers and clients

Table 4.16 Details and Selection of Sub Criteria of Design Quality Management

Sub criteria	i D	ii M	iii E	iv S	v O	vi F	vii B	viii A	ix BP	x PW	xi AN	xii Z	xiii N	xiv T	xv W	Q
1. Designers require practical experiences								x				x				2
2. **Customer needs are thoroughly analyzed**						x		x				x				3*
3. **Product design based on Customer needs**	x	x	x	x								x				5*
4. **Functional departments' participation**	x	x		x		x		x		x	x	x	x			9*
5. **Designs reviewed before production**				x		x						x				3*
6. Cost is emphasized in the product design												x				1
7. **Producibility / experimental designs**				x		x						x				3*
8. Use of QFD in designs								x				x				2
9. Use prevention techniques								x								1
10. Clarity of product / service specifications				x												1
11. Quality emphasis by functional personnel				x												1
12. Integration of design process (customer and opnl requirement						x	x									2

Selected sub criteria

1. Customer needs are thoroughly analyzed
2. Product design based on Customer needs
3. Functional departments' participation
4. Designs reviewed before production
5. Producibility and experimental designs

Table 4.17 Details and Selection of Sub Criteria of Process Quality Management

Sub criteria	i D	ii M	iii E	iv S	v O	vi F	vii B	viii A	ix BP	x PW	xi AN	xii Z	xiii N	xiv T	xv W	Q
1. Cleanliness and organization						x						x				2
2. Process capability meets prodn needs												x	x			2
3. **Maintenance of equipment**				x		x						x				3*
4. **Implementation of inspections** (incoming materials/processes/final products)	x	x	x	x								x				5*
5. **Use of Quality tools / methodologies**	x	x	x	x							x	x		x		7*
6. **Uses of benchmarking /sampling**		x		x										x		3*
7. Amount of automation (inspection, review checking)				x												1
8. Self inspection				x												1
9. Stability of schedule				x												1
10. Clarity of work				x												1
11. Documented traceable system					x						x					2
12. **Focus on (setup quality standards/ foolproof)**	x	x		x		x					x	x	x			5*
13. **Conformance to set standards** (specification and drawings)	x									x	x		x			4*
14. **Incorporating from customers (I/E)**	x	x	x													3*
15. **Reducing variability / complaints**	x	x	x	x												4*
16. Innovation and creativity	x	x	x		x			x			x					6*

Selected sub criteria

1. Maintenance of equipment
2. Use of Quality tools and methodologies
3. Uses of benchmarking /sampling
4. Focus on setting up quality standards/ foolproof
5. Conformance to set standards
6. Incorporating from customers (I/E)
7. Implementation of inspections
8. Reducing variability and complaints
9. Innovation and creativity

Table 4.18 Details and Selection of Sub Criteria of Information and Analysis

Sub criteria	i D	ii M	iii E	iv S	v O	vi F	vii B	viii A	ix BP	x PW	xi AN	xii Z	xiii N	xiv T	xv W	Q
1. Audits of policies and strategies												x				1
2. Regularly conducts quality audits												x				1
3. **Uses compliance / benchmarking**	x	x								x		x				4*
4. **Availability /extent of quality related data** Information / feedback(Errors /scrap / rework)	x	x		x				x			x	x				6*
5. **Availability of cost of quality data**		x						x				x				3*
6. **Evaluation with quality related data** (Performance of mgmt, deptt, employees)	x	x	x	x		x					x	x				7*
7. Communication of defects				x				x								2
8. Product quality measures (tools)									x		x					2
9. Supplier quality system / performance measure				x						x						2
10. Timeliness of quality data				x							x					2
11. Determination of quality costs									x							2
12. Assessment of needs (trg, product, service)									x	x						2
13. **Effective management of data/information** (staff, customers, suppliers, processes)	x	x	x		x				x		x					6*
14. **Procedures / system** (Reliability/improvement of data gathering)	x	x			x	x										4*

Selected sub criteria

1. Uses compliance and benchmarking
2. Availability and extent of quality related data
3. Availability of cost of quality data
4. Evaluation with quality related data
5. Effective management of data and information
6. Procedures and system

Table 4.19 Details and Selection of Sub Criteria of Education and Training

Sub criteria	i D	ii M	iii E	iv S	v O	vi F	vii B	viii A	ix BP	x PW	xi AN	xii Z	xiii N	xiv T	xv W	Q
1. **Assessing / Encouraging employees**				x	x		x					x		x		5*
2. Resources allocation .				x				x								2
3. **Quality development and education**	x	x	x	x		x						x				6*
4. **Trained in quality mgmt methods /tools** (cause and effect, pareto, QCC/SPC, CI)	x			x		x	x	x			x	x		x		8*
5. **Specific work-skill training**				x							x	x		x		4*
6. Regarding employees long-term resources																1
7. Training as an on going process (not a fad)								x								1
8. **Communication / Team building group dynamics**	x	x	x	x			x							x		6*
9. Use of specific organizational structures									x							1
10. Use of techniques to identify key processes, customers and suppliers									x							1

Selected sub criteria

1. Assessing / Encouraging employees
2. Quality development and education
3. Trained in quality mgmt methods /tools
4. Specific work-skill training
5. Communication / Team building group dynamics

Table 4.20 Details and Selection of Sub Criteria of Organizational Culture

Sub criteria	i D	ii M	iii E	iv S	v O	vi F	vii B	viii A	ix BP	x PW	xi AN	xii Z	xiii N	xiv T	xv W	Q
1. Consideration of performances								x	x							1
2. **Company-wide quality culture** (strategic / executive / operative)		x							x							3*
3. **Continuous improvement policy**	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15*
4. **Cultural policies / attitudes** (Correction not checking / Problem solving (not finding fault / Improvement (not criticism / sharing quality information)																P
5. **Collectivistic behaviour** (adaptability / cooperation)																P
6. **Structure of the organization** (development, delegation, decentralization)																P
7. Job security / Climate of fairness / open communication																
8. **Financial control by employees** (employee control over I/E financial aspects)																P

Selected sub criteria

1. Company-wide quality culture
2. Continuous improvement policy
3. Cultural policies and attitudes
4. Collectivistic behaviour
5. Structure of the organizations
6. Financial control by employees

Table 4.21 Details and Selection of Sub Criteria of Strategic Quality Management

Sub criteria	i D	ii M	iii E	iv S	v O	vi F	vii B	viii A	ix BP	x PW	xi AN	xii Z	xiii N	xiv T	xv W	Q
1. **Clear quality policy.**	x	x	x		x							x				5*
2. **Detailed quality goal**		x			x							x				3*
3. Effective quality plan.												x				1
4. **Communication of policies and plans**	x	x	x		x							x				5*
5. Employee involvement (in making policies / plans)							x									1
6. Focus on critical processes (in accordance with design									x							1
7. Active leadership/ involvement (by managers)					x				x							1
8. Employee well being consideration									x							1
9. Identification/ Analysis of Strategic issues											x					1
10. Analysis of performance and cost data									x							1
11. **Develpt /deployment quality strategies**	x	x	x			x				x		x			x	7*
12. Consideration of performance requirements (in developments short tern goals)									x							1
13. Document strategic planning											x					1

Selected sub criteria

1. Clear quality policy
2. Detailed quality goal
3. Communication of policies and plans
4. Development/deployment quality strategies

Table 4.22 Details and Selection of Sub Criteria of Empowerment and Involvement

Sub criteria	i D	ii M	iii E	'v S	v O	vi F	vii B	viii A	ix BP	x PW	xi AN	xii Z	xiii N	xiv T	xv W	Q
Empowerment																
1. Inspection / fixing problems of their own work								x								1
2. Resources / technical assistance								x								1
3. Problem solving network						x		x								2
4. Promoting empowerment /open behaviour	x	x	x		x											4*
5. Building self esteem and confidence					x											1
Employee involvement participation //teamwork																
6. **Presence of cross-functional teams**								x			x	x				3*
7. **Active (quality) involvement programmes (like QC circles)**				x	x	x	x	x			x	x	x			8*
8. **Implementation of suggestions**								x			x	x				3*
9. Encouragement to report / share problems											x	x				2
10. Degree of employee participation (in quality decisions)				x		x										2
11. Amount of feedback provided to employee (on their quality performance				x							x					2
12. Effectiveness of supervisors (in solving the problems / issues)				x												1
Recognition and reward (Motivation)																
13. **Quality improvement efforts recognized.**				x	x	x	x	x			x	x		x		8*
14. Career development based on quality					x							x				2
15. **Reward system (for suggestions)**					x			x				x				3*
16. **Human resource management** (in line with quality performance plans	x	x	x		x	x										5*

Selected sub criteria

1. Presence of cross-functional teams
2. Promoting empowerment / open behaviour
3. Active (quality) involvement programme
4. Implementation of suggestions
5. Quality improvement efforts recognized
6. Reward system (for suggestions)
7. Human resource management

Table 4.23 Proposed model CSFs and sub criteria

Top management commitment

1. Active participation and leadership
2. Encourages learning and involvement
3. Empowers employees for CI
4. Allocates resources for quality, T and D
5. Quality issues/reviews in top mgmt meetings
6. Clear quality vision and goals
7. Ownership/responsibility for quality
8. Communication of quality values
9. Supportive corporate culture

Supplier quality management

1. Long-term relations and partnership
2. Quality based selection than price
3. Participates in supplier quality activities
4. Supplier performance information and audit
5. Involving supplier in product development

Customer satisfaction

1. Collection of complaint and information
2. Top priority to customer complaints
3. Asses and measure customer needs
4. Market research for improving products
5. Customer need focused
6. Management of internal and external customers relationship
7. Partnerships with suppliers and clients

Design quality management

1. Customer needs are thoroughly analyzed
2. Product design based on Customer needs
3. Functional departments' participation
4. Designs reviewed before production
5. Producibility and experimental designs

Process quality management

1. Maintenance of equipment
2. Use of Quality tools and methodologies
3. Uses of benchmarking /sampling
4. Focus on setting up quality standards/ foolproof
5. Conformance to set standards
6. Incorporating from customers (I/E)
7. Implementation of inspections
8. Reducing variability and complaints
9. Innovation and creativity

Information and analysis

1. Uses compliance and benchmarking
2. Availability and extent of quality related data
3. Availability of cost of quality data
4. Evaluation with quality related data
5. Effective management of data and information
6. Procedures and system

Education and training

1. Assessing / Encouraging employees
2. Quality development and education
3. Trained in quality mgmt methods /tools
4. Specific work-skill training
5. Communication / Team building group dynamics

Organizational culture

1. Company-wide quality culture
2. Continuous improvement policy
3. Cultural policies and attitudes
4. Collectivistic behaviour
5. Structure of the organizations
6. Financial control by employees

Strategic quality management

1. Clear quality policy
2. Detailed quality goal
3. Communication of policies and plans
4. Development/deployment quality strategies

Empowerment and involvement

1. Presence of cross-functional teams
2. Promoting empowerment / open behaviour
3. Active (quality) involvement programme
4. Implementation of suggestions
5. Quality improvement efforts recognized
6. Reward system (for suggestions)
7. Human resource management

CHAPTER 5

JUSTIFICATION OF THE PROPOSED TQM MODEL

5.1 Introduction

The proposed model has to be justified to know the relevance of its contents. Criterium decision plus (CDP) software (www.Infoharvest.com) which is based on Analytical hierarchy process (AHP) is used to compare the proposed model with established international TQM awards (models). This is done to know the position of the proposed model with respect to quality awards. Though hundreds of quality awards are available, most of them are derived from Deming prize, MBNQA and EQA (Calingo, 2002). For this reason the proposed model is compared with these TQM awards.

5.1.1 The CDP process

The CDP allows structuring the problem hierarchically through a sequence of pairwise comparison. The different phases include, setting up the hierarchy, comparison of characteristics or CSFs, comparison of alternatives, and obtaining overall ranking. A brief description is given below.

Setting up the hierarchy

The problem is structured into a hierarchy or levels. The first level denotes the overall goal of the decision-maker. The second level consists of CSFs that contribute to this goal. The third level consists of alternative TQM models, which are to be evaluated in terms of 10 CSFs.

Comparison of CSFs

The CSFs from the second level of the hierarchy are compared with each other, to determine the relative importance of each CSF in accomplishing the overall goal.

Comparison of alternatives

The alternatives are compared with respect to how much better one is than the other in satisfying the CSFs from the second level.

Obtaining the overall ranking

The last step in the process is to obtain the overall ranking of the four alternatives in the form of decision scores.

5.2 Arriving at Weightages of CSFs

The process of application of CDP needs a uniform base to compare different models (alternatives). The goal being best model and criteria are CSFs. The Deming prize has a total score of 100 points, MBNQA has 1000, points and EQA has 100 percent.

The proposed model has total weightage 100 based on frequency analysis (average of general TQM works and TQM models). All of these are transformed to a uniform scale of 100 and then compared. The weightages for quality awards are available from the literature. A weightage if 1 unit is allotted for CSFs without representation of weightages in a particular model, recognising the presence of it implicitly and deducting the same from relevant CSF. For example, unit 1 is allotted to CSF culture in Deming prize, at the same time unit 1 is deducted from the top management commitment, indicating responsibility for it. In MBNQA unit 1 is allotted to Supplier quality management and unit 1 is deducted from Design quality management. Similarly the business results weightages are allotted uniformly to remaining CSFs. Resource and impact on society weightages are added to top management commitment. Similar process is followed with all models. This is shown in Table 5.1.

5.3 Prioritization of Importance of CSFs

To prioritize the importance of CSFs, a scale of 1 – 20 is followed indicating unimportant (UI) important (I), very important (VI) and critical (C). The average weightage of CSFs of quality awards and proposed model is taken as best CSF values for comparison purpose, as it is robust, because of averaged opinion. Based on these values prioritization is done among the models compared (Table 5.2).

The application of Criterium decision plus software and its results are shown below through Figures 5.1- 5.3

Table 5.1 Arriving at Weightages of CSFs

	TCM	SUPLQ	CUST	DISGQ	PROCEQ	INFO	BENCH	EDU/TRG	CULTUR	RESOUR	SOCTY	BUSINE	SPC	STRATGQ	EMPO
DP	10 (-)1cult	10	10	10	10	15		10	(+)1					10	15 5
(R)DP	**9**	**10**	**10**	**10**	**10**	**15**		**10**	**1**					**10**	**15**
MBNQA	7 (+)5 soc (+)5.62 br (-)1 cult		4.5 (+)5.62 br	4 (+)5.62 br (-)1 supl	8.5 (+)5.62 br	9 (+)5.62 br		2.5 (+)5.62 br			5	45		8.5 (+)5.62 br	6 (+)5.62 br
(R)MBNQA	**16.62**	**1**	**10.12**	**8.6**	**14.12**	**14.62**		**8.12**	**1**					**14.12**	**11.62**
EQA	10 (+) 6 soc (+)1.66 br (+) 5.5 res (-) 1 cult	1.8 (+)1.66 br	20 (+)1.66 br	7 (+)1.66 br	7 (+)1.66 br	1.8 (+)1.66 br		9 (+) 1.66		5.4	6	15		8 (+) 1.66	9 (+) 1.66
(R)EQA	**22.16**	**3.48**	**21.66**	**8.66**	**8.66**	**3.46**		**10.66**	**1**					**9.66**	**10.66**
SCHOLAR	10.98	10.98	12.08	6.59	12.08	10.98	1.09	10.98	1.01	1.01	2.19	2.19	1.09	6.59	9.89
GENERAL	14.9	10.55	10.55	3.1	7.45	5.59	3.72	14.28	11.8		0.62		3.72	1.86	12.42
PROPMOD	12.94 (+)1.4 soc (+) 0.05 br (+)1.01res	10.76 (+) 0.05 br	11.31 (+) 0.05 br	4.84 (+) 0.05 br	9.76 (+) 0.05 br (+)2.4 spc (+)2.4 bm	8.28 (+) 0.05 br	2.4	12.63 (+) 0.05 br	6.09 (+) 0.05 br	1.01	1.4	0.54	2.4	4.22 (+) 0.05 br	11.15 (+) 0.05 br
(R)PROPM	**15.4**	**10.81**	**11.36**	**4.89**	**14.61**	**8.33**		**12.68**	**6.14**					**4.27**	**11.2**

Note:
TCM = Top management commitment; SUPLYQ = Supplier quality management; CUST = Customer focus; DISGQ = Design quality management; PROCEQ = Process quality management; INFO/ANA = Information and analysis; EDU/TRG = Education and Training; CULTUR = Organizational culture; STRATGQ = Strategic quality management; EMPOW = Empowerment and involvement; (R)= Revised; DP = Deming prize, MBNQA = Baldrige award, EQA = European quality award, PROPMOD = Proposed model; SCHOLAR = Scholarly models; GENERAL = TQM literature; PROPMOD = Proposed model ; br = Business results; cult =Culture; soc = Social responsibility; res = Resources; bm = Benchmarking; supl = Supplier management; SPC = Statistical process control

Table 5.2 Prioritization of CSFs

CSFs >	TCM	SUPLYQ	CUST	DISGQ	PROCEQ	INFO/ANA	EDU/TRG	CULTUR	STRATGQ	EMPOW
DP	9	10	10	10	10	15	10	1	10	15
MBNQA	16 62	1	10 12	8 6	14.12	14 62	8 12	1	14 12	11.62
EQA	22 16	3 48	21 66	8 66	8 66	3 46	10.66	1	9 66	10.66
PROPM	15 4	10.81	11.36	4.89	14.61	8.33	12 68	6 14	4 27	11.2
AGGRE	15 79	6.32	13.28	7 53	11.89	10.35	10.36	2.28	9 53	12.17

Scale / priority 0 - 5 = UI >5 - 10 = I >10-15=VI > 15 = C

DP = Deming prize. MBNQA = Baldrige award. EQA = European quality award. PROPM = Proposed model
TCM = Top management commitment. SUPLYQ = Supplier quality management. CUST = Customer focus.
DISGQ = Design quality management. PROCEQ = Process quality management. INFO/ANA = Information and analysis.
EDU/TRG = Education and Training. CULTUR = Organizational culture. STRATGQ = Strategic quality management.
EMPOW = Empowerment and involvement

5.4 Conclusion

The comparative analysis of TQM works of scholars made by the author reveals the uniform opinion among them regarding top management commitment, strategic planning, process quality management, design quality, education and training, supplier quality management, information and analysis and customer satisfaction. But their views considerably differ, rather there is no unanimity regarding business results, resources, impact on environment and others. Although some the authors do a skimming through cultural fact and none of them deeply consider culture to be worth as a CSF of TQM frame work.

The results of application of CDP based on AHP is an evidence that the proposed model is an improved one over the quality awards Deming prize, MBNQA and EQA. This model includes one unique CSF namely, organizational culture which is not found in

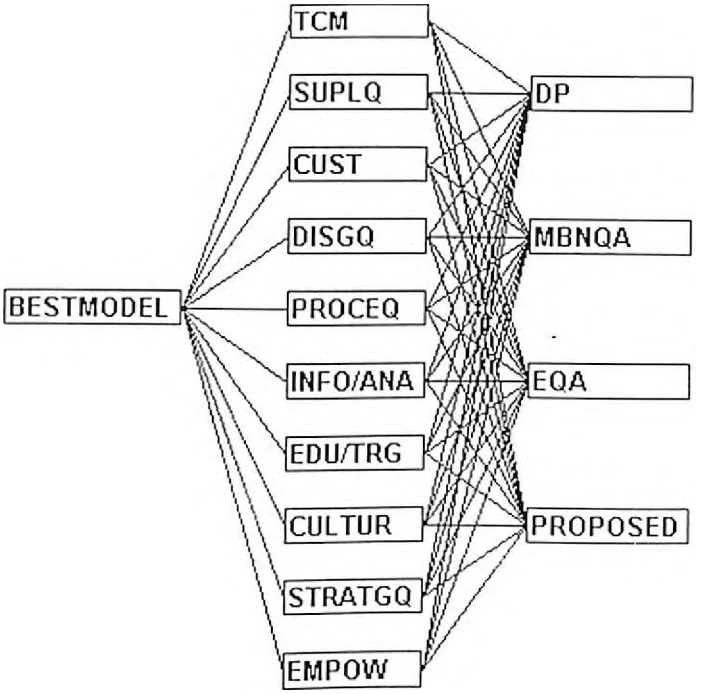

Figure 5.1 CDP/AHP Hierarchy Diagram

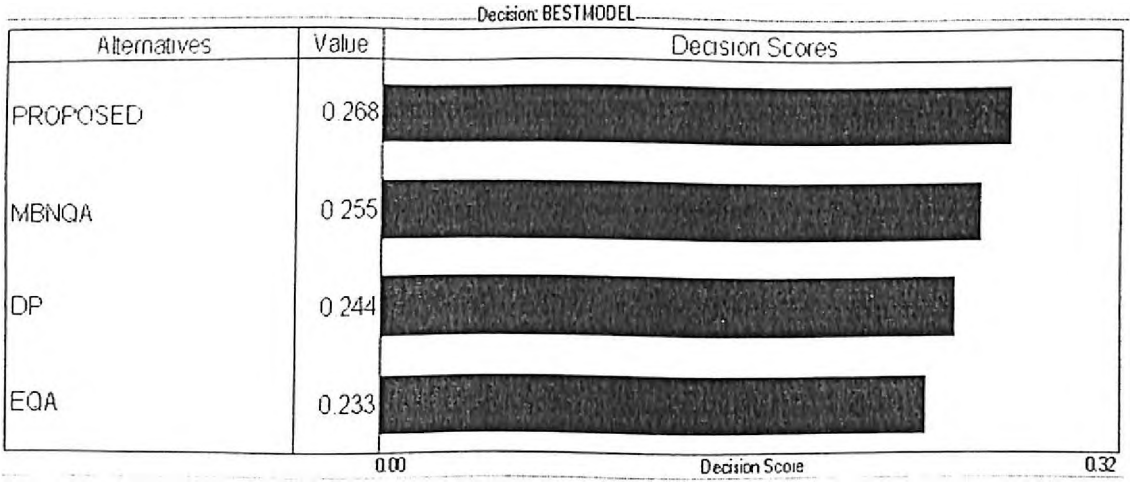

Figure 5.2 Comparison of Proposed Model and Quality Awards

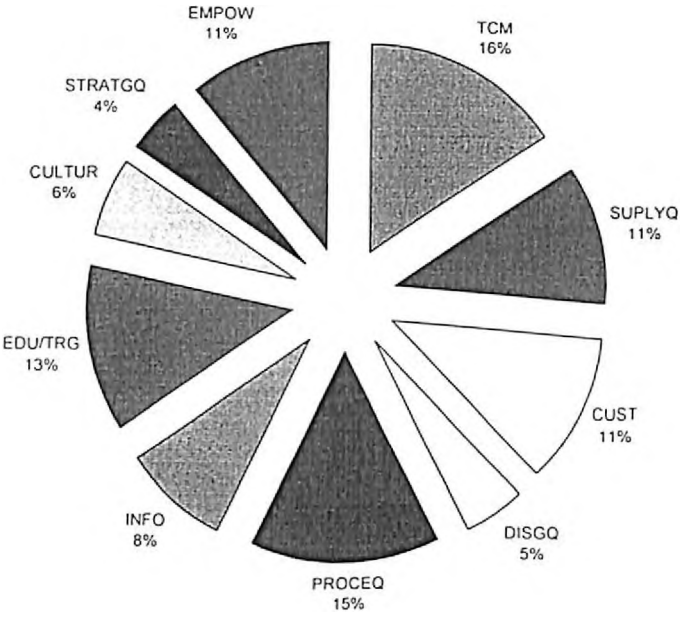

Figure 5.3 Contribution of each CSF to the proposed TQM Model

models Deming, MBNQA, and EQA models. Though some of the models do discuss about it, none of them made it a major CSF. This model therefore covers a broader scope of TQM. The specific characteristics of culture of companies were taken into account in developing this model. Since the aim of this research is to develop a TQM model for Construction industry, it had to be suitable for use in Construction organizations. Thus, specific characteristics of Construction companies had to be taken into account when developing this model. For example, Construction companies unlike manufacturing companies have both company and project cultures which make them unique. Also in this era of global opportunities culture of a country plays crucial role in the success of TQM implementation.

CHAPTER 6

THE TQM IMPLEMENTATION PROCESS MODEL

6.1 Introduction

In this chapter, based on a review of the conceptual, empirical literature and, prescriptive view, a model for implementation process of TQM with specific reference to the construction organization is developed. Also, different phases of TQM implementation are illustrated. The present research work offers a model, which helps construction professionals and organizations in implementing TQM.

6.2 Necessity of Implementation Process Model

Currently, the elements of a TQM policy and its application are manufacturing oriented. Among non manufacturing, this has led to a range of perceptions of what TQM is and different methods of implementation. Methods of implementation can vary from individual application of Deming, Juran, and Crosby philosophies to organizational approaches based on quality awards It is no surprise that construction companies experience more problems due to lack of implementation process models, barring a few like Pheng and Wei (1996) and Westerveld (2003), when deciding on the approach that fits their organization. Unsuccessful TQM implementation attempts are not uncommon (Babbar and Aspelin, 1994). The lack of clear guidelines and implementation methods and no adequate explanation of how to operationalize TQM in organization have contributed to the failure of TQM (Nwabueze, 2001; Thiagarajan et al., 2000). Over laying a TQM model (worked so well in manufacturing) to a construction organization without modification will fail because of differences in customer relationships and nature of service (Culp et al., 1993).

Given the importance of quality in today's market, the TQM philosophy can contribute to the success and profitability of businesses. TQM practices, however, have not always been successful nor profitable (Galperin and Lituchi, 1999). The literature on TQM has described the various concepts, philosophies benefits, needs value, and experiences associated with TQM. However little has been offered regarding implementation

processes so necessary to make TQM work (Hensey, 1993). Many TQM efforts have failed due to lack of proper foundation and focus. Perceiving TQM as a narrowly a set of tools and techniques (i.e. hard aspects) and ignorance of TQM culture (i.e. soft aspects) has proven to be one of the primary reason for failure of TQM. Also the failure of TQM is attributed to piece meal implementation or starting training system without understanding their quality and lack of directions. It is argued that when TQM has failed, it is not because there was a basic flaw in the principles of TQM, but because an effective (implementation) system was not created to execute TQM principles properly (Ghobadian & Gallear 2001).

Thus an implementation process is important for number of reasons and central for the TQM to take root successfully in the long term. Against this background, in an effort to provide guidelines for construction organizations, on the basis of investigating into the philosophy and critical success factors (CSF) of TQM models, this chapter suggests a systematic TQM implementation process for construction organization.

6.3 Prior Research

The study of the literature provided information on TQM models, majority of which is manufacturing oriented. The focus on construction industry is very less. In addition, detailed plans of implementation process are almost not available for construction.The processes of stable manufacturing firms can be applicable to construction (Kiwus and Williams, 2001; Pheng and Wei, 1996), the logic behind this is, though construction firms are of shifting type (once the project is completed), the processes are repetitive type irrespective of project location barring few qualities like culture. Construction projects have both company culture and project culture, where as manufacturing has only company culture (Riley and Clare-Brown, 2001).

The literature survey findings indicate presence of very few implementation process models. The chosen few for development of TQM implementation process model are Ahire and Ravichandran (2001), Dean and Helms (1996), Pun et al. (2000), Thiagarajan

et al. (2001), and Witcher and Butterworth (1999). The steps proposed in these models are shown in Table 6.1.

Table 6.1 TQM Implementation Process Models

Author	*Phases / Stages / Levels suggested*
1. Ahire and Ravichandran (2001)	Adoption of TQM strategy /Organizational adaptation (transformation)/ Organizational acceptance of quality strategy/Use of Quality oriented techniques /Impact on plant level quality outcomes
2. Dean and Helms (1996)	Structural Changes/Quality Plans and Assessments /Training /Empowerment of Employees/Supplier and Customer Focus
3. Pun et al. (2000)	Quality Strategy Development/Quality Strategy Deployment
4. Thiagarajan et al. (2001)	Institute Leadership/Maximizing Stakeholders Involvement /Manage by Customer Driven Process/ Adopt Continuous Improvement
5. Witcher and Butterworth (1999)	Focus and Priorities/Alignment and Deployment/ Integration and Daily Management/Review and Self Assessment

All these models are manufacturing oriented. Although they offer useful information to carry out TQM implementation, no model suggests detailed step by step implementation methodology and they are too generic. For example Ahire and Ravichandran (2001) and Pun et al., (2000) focus on strategy, Dean and Helms (1996) focus on structural changes, Witcher and Butterworth (1999) focus on alignment and integration, Thiagarajan et al. (2001) focus on leadership. They do not clearly specify the goals and activities involved in each steps.

6.4 Development of TQM Implementation Process Model

Based on the proposed TQM model study, TQM principles, techniques and tools, an implementation process with 22 steps model was developed by integrating TQM principles with QFD technique (Figure 6.1). Different stages of a construction project like planning, designing, processing, partnering and construction operations (project management) were brought under the purview of QFD process (Eldin and Hikle, 2003; Govers, 2001; Hongen and Xianwei, 1996) and fused with TQM practices of the organization. As any construction organization is made of company (manufacturing) culture and project (construction) culture, the TQM principles application has been done in two levels and integrated into the proposed implementation process model for construction organization. The implementation of TQM is carried out in three phases viz. planning phase, implementation phase and modification phase, and at two levels viz. organizational level and project level. The steps are briefly explained in the subsequent paragraphs.

6.5 Description Of TQM Implementation Process Model

After examining the contents of implementation process, phasing of the implementation initiatives was chosen with sequential introduction of initiatives one by one. This is the approach prescribed in the TQM literature. From literature, six interpretations of (viz. Ahire and Ravichandran, 2001; Dean and Helms, 1996; Pun et al., 2000; Thiagarajan et al., 2001; Witcher and Butterworth, 1999) change process phases were identified.

Each interpretation was compared against each of the implementation plan and commonalities among implementation plans were identified. This iterative process suggested that the majority of the implementation plans followed a four phase implementation approach: adoption (start-up), adaptation (transition), acceptance (consolidation), modification (re-focusing). These four phases were clearly visible, in the majority of implementation plans. However, each phase was not independent but coexists with each other along implementation path. The phases are with varying degree of focus and many a times overlapping. The present work has chosen three phases viz. planning phase, implementation phase, review phase, keeping in view critical management and

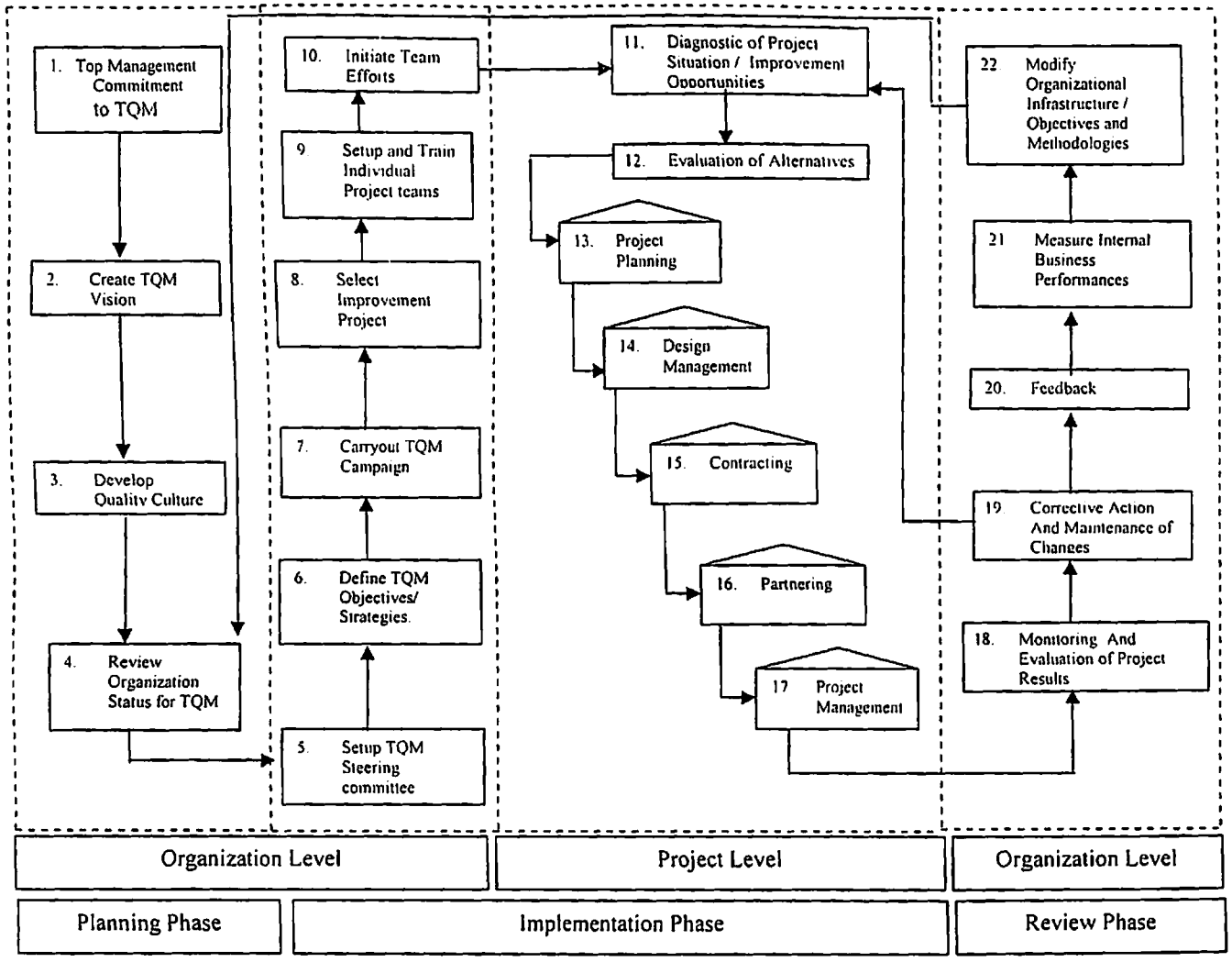

Fig.6.1 The TQM Implementation Process Model

operation processes. The presence of TQM elements in each phase can be seen.The subsequent paragraphs give the details of implementation phases.

6.5.1 Planning Phase

This is the initial phase prior to the development of the main operational features of TQM implementation plan. Suitable base is created in this phase for implementation of TQM plan. Awareness, identification / preparation, and intentions are features of this phase facilitating adoption of TQM

6.5.1.1 Organizational level

At this level of the planning phase, the top management commits itself to TQM principles and practices. It should allocate time and organizational resources for implementing TQM. Prior to the adoption of TQM, an organizational review has to be conducted to know the present status of concepts, and system of quality management practices in the construction organization. There must be a clear TQM vision and mission statement(s) that indicates company objectives for performance improvement (Ahire and Ravichandran, 2001). An organization-wide education and training programme to promote awareness and introduction of TQM culture and practices is required. The logic here is that, only if the employees are treated as valuable resources and worth of investing in education and training on them by their employers, in turn employees treat their customers as valuable (Sureshchandar et al. 2001). This programme has to convey the quality management concepts, team practices and tools not only to employees but to top management and senior executives also. This helps top management to understand and fix the degree of responsibilities / authority to different levels of personnel in the organization. Continuous improvement, companywide quality, collectivistic behaviours, flattened organizational structure, empowerment and involvement of employees, efficient and rewarding human resource management and degree of ownership of the company by employees brings out best talents of employees, are the base of quality culture change. The steps involved in planning phase at organization level are briefly explained below.

Step 1 Top Management Commitment to TQM

Top management has to commit and allocate time and organizational resources for implementing TQM. They have to take the initiative to identify areas that need improvement in the construction organization and to develop an employee-led process for improvement. Table 6.2 depicts methodology to implement step 1: *Top Management Commitment*

Table 6.2 Methodology to Implement Step 1: *Top Management Commitment*

Goal:

Confirmation of top management commitment to TQM

Participants:

Top management and Senior executives

Activities:

- Commit time and organizational resources for adopting TQM
- Initiate to identify areas for improvement throughout the organization
- Obtain agreements from all parties involved regarding the scope/objectives of improvement efforts
- Provide vision and mission
- Make commitment to quality visible to staff
- Create quality as a way of life within agency
- Communicate quality values to staff
- Facilitate communication between top management and other staff (flat organization)
- Encourage staff involvement to improve work processes and quality management
- Empower staff for continuous improvement and to solve quality problems
- Actively participate in quality management and improvement process
- Learn quality-related concepts
- Arrange adequate resources for employee education and training
- Discuss quality-related issues in top management meetings
- Focus on product quality rather than yields

Step 2 Create TQM Vision

There must be a clear TQM vision and mission statement(s) that indicates construction organization objectives for performance improvement. The vision has to be translated

into quality goals and strategies, and communicated to all involved. Table 6.3 depicts methodology to implement step 2: *Create TQM Vision*

Table 6.3 Methodology to Implement Step 2: *Create TQM Vision*

Goal:

Creating and developing TQM vision

Participants:

Top management, Senior executives, project managers and key employees.

Activities:

- Create a clear long-term vision statement. It should effectively encourage employees' commitment to quality improvement and indicate company objectives for performance improvement (The design elements like quality programme, documentation, personnel, organization structure, facility, customer satisfaction, Training, technical support constitute the development of the strategic vision and service design for the company)
- Translate vision into clear quality goals and strategies (mission), and communicate to employees, customers, suppliers and other stakeholders by the use of company newsletters, periodicals, and other media.

Methodologies/Tools

- Organize quality campaign programs
- Involve key employees from different levels in making policies and plans
- Take up modernization of company facilities
- Understanding and improving of users' needs

Step 3 Develop Quality Culture

Prior to the adoption of TQM, the construction organization should be exposed to TQM concepts and principles to bring in a new quality culture and explore specific needs for organization structure. The necessity of the adoption of TQM practices is to be made aware of. A company-wide education and training programme to promote awareness and introduction of TQM practices is required. The programme has to convey the quality management concepts, team practices and tools. Table 6.4 depicts methodology to implement step 3: *Develop Quality Culture*

Table 6.4 Methodology to Implement Step 3: *Develop Quality Culture*

Goal:

Development of quality culture

Participants:

Top management, chief executives (project managers), engineers, contractors, suppliers and all employees

Activities:

- Organizing workshops and seminars
- Determine the strategic quality needs of the organization
- Quality awareness education is given to participants
- Make information available to participants for carrying out their responsibilities
- Formation of work teams or quality improving groups to solve problems / share information
- Involve participants in quality improvement and solicit suggestions from participants
- Appraise and provide feedback to participants on quality performance
- Plan participants training needs and train on quality-related skills, methods and tools
- Recognize participants and their contribution to quality improvement
- Encouraging employees (resources provided) to accept education and training
- Regard participants as valuable, long-term resources worthy of receiving education and training throughout their career.
- Decide degree of ownership of the company with employees

Methodologies/Tools

- Workshops
- Quality consultant service
- Deputation
- Team building,
- Training in quality tools (e.g. quality function deployment (QFD), deming cycle (PDCA), quality control circles, SPC etc.).

Step 4 Review of Organization's Status for TQM Adoption

A review has to be conducted to know the present status of concepts, and system of quality management practices in the construction organization. Senior management has to investigate the elements and critical processes of TQM adoption. Present situation of the

company and the environment in which it functions is examined. Table 6.5 Methodology to implement step 4: *Review Of Organization's Status for TQM Adoption*

Table 6.5 Methodology to Implement Step 4: *Review of Organization's Status for TQM Adoption*

Goal:

Review of present organizational processes

Participants:

Senior executives and project managers

Activities:

Review the current status of the quality management practices like

- Quality programme /documentation
- Personnel management / Education and training / facility / safety
- Communication / technical support
- Organization structure
- Critical processes of TQM adoption that cover the design, planning, operations, delivery, maintenance, control and monitoring functions
- Comprehensive analysis of operational performance against the business plan
- Users' needs and customer satisfaction levels
- Employee feedback on the provision of company services
- Assessing the strengths and weaknesses
- Determining the opportunities for improvements
- Exploring the threats being faced by the organization.

Methodologies/Tools

- Survey instruments
- Audit reports / Expert analysis

Outcome of the Planning phase

The out come of the project phase reflects degree of commitment from top management, culture change among people in the organization and the preparedness of the organization for TQM implementation.

A top management team committed to quality conveys the philosophy that quality receives priority over cost and schedule and that in the long run, superior and consistent

quality leads to improvements in cost and delivery performance. Upper management not only gives quality the highest priority possible but also demonstrates its commitment to quality by providing adequate human and technical resources for implementing quality management. Quality training is given in technical skills such as the use of statistical process control tools and behavioural skills such as teamwork and group problem solving. Organizational values and norms change to reflect a commitment to satisfy customer needs. Senior management focus on customer satisfaction and ensures that this focus permeates organizational activities. Employees in the organization are prepared to understand and participate in the quality initiatives. Suppliers are encouraged to participate in the organization's quality initiatives. Thus, planning phase should result in organizational adaptation along CSFs, like increased customer focus in all activities comprehensive employee training and implementation of supplier quality management strategies that ensure supplier adaptation to conform to higher quality standards.

6.5.2 Implementation Phase

In this phase, necessary actions are taken to initiate the combining of TQM and normal construction processes into one whole. This is characterized by increasing participation, mobilization, delegation of authority, transformation, business alignment and organization for continuous improvement.

Organizational level

At this level of implementation phase, for introduction and development of TQM, a steering committee has to be established and TQM vision has to be translated into a set of strategic quality objectives, operating principles and action plans. Senior management has to communicate with employees regarding their roles and needs in the TQM efforts. TQM vision, principles and objectives has to be publicized effectively through a TQM campaign. An implementation plan for continuous improvement activities needs to be developed in line with the TQM model, namely organizing, systems and techniques, measurement and feedback, and changing the culture (Thiagarajan et al. 2001). Pilot improvement projects are to be selected to ensure that the quality improvement projects, that are supportive of the TQM vision and objectives (Chase and Federley, 1992; Culp et

al., 1993). For facilitating the project work, it is necessary to establish strong team infrastructure viz. employees/designers/contractors/suppliers/participants (Pheng and Wei, 1996). These teams and task forces are formed according to their skills and different operational requirements. These work as process improvement teams. To initiate (activate) the programme, motivation and morale support should be from the top. The senior management needs to delegate authority and deploy resources to empower teams and task forces. Further steps involved in implementation phase at organization level are briefly explained below.

Step 5 Setup TQM Steering Committee

For introduction and development of TQM, a steering committee has to be established. The committee should comprise top management, chief executives, project managers, construction managers, and engineers. The main function is to design, plan, assess and monitor the entire process of TQM adoption. Table 6.6 depicts methodology to implement step 5: *Setup TQM Steering Committee*

Step 6 Define TQM Objectives and Strategies

TQM vision has to be translated into a set of TQM objectives, operating principles and action plans. This will help to activate a company-wide strategic quality planning, and help to formulate sub-strategies and prepare quality plans with the divisions and appropriate personnel. Table 6.7 depicts methodology to implement step 6: *Define TQM Objectives and Strategies*

Step 7 Carryout TQM Campaign

Senior management has to communicate with employees regarding their roles and needs in the TQM campaign. TQM vision, principles and objectives has to be publicized effectively, by steering committee in an effective way. Performance criteria has to be more specific to fit the construction organization's situation and within the context of the construction operations. Table 6.8 depicts methodology to implement step 7: *Carryout TQM Campaign*

Table 6.6 Methodology to Implement Step 5: *Setup TQM Steering Committee*

Goal:

Formation of TQM steering committee and defining its functions

Participants:

President, project managers, top technical staff, engineers from functional departments, corporate trainer and TQM coordinator, operations executive, frontline staff

Activities:

- Establishment of committee comprising of strategic level (president), executive level (project manager) and front level (engineering) personnel.
- Training of facilitators and steering committee
- Selection of a program coordinator
- Identification of improvement goals and priorities for project selection
- Selecting two to three quality improvement projects and teams
- Identification of any blockages
- Developing a statement of organizations mission and guiding principles
- Developing an action plan for implementing the TQM program
- Providing guidance to project teams
- Deciding the need of special support
- Reviewing of team recommendation and integrating them into the quality system
- Promptly distributing news of success stories from inside and of the organization
- Establishing a system to get accurate feedback on the program success
- Being visible and available to all employees and ask right questions

Step 8 Select Improvement Projects

This is to ensure that the quality improvement projects are supportive of the TQM vision and objectives. Detailed action plans should be developed with consensus and support from all functional areas concerned. Appropriate operation procedures should be prepared and work instructions revised in line with users' and customers' feedback and requirements. Table 6.9 depicts methodology to implement step 8: *Select Improvement Projects*

Step 9 Setup and Train Individual Project Teams

Table 6.7 Methodology to Implement Step 6: *Define TQM Objectives and Strategies*

Goal:

Formulation of TQM objectives and strategies and planning for implementation

Participants:

Senior managers and steering committee members, senior executives (project managers), senior managers (construction managers), design engineers, construction engineers, suppliers and employees

Activities:

- Measuring the daily management performance of companies using critical process and critical success metrics
- Identification of critical processes, align the improvement efforts and measures how well the vision is being realized
- Analyzing the gaps between its current and desired future performance of company programs and services based on the comments from users
- Examination the causal issues by comparing individual vision elements
- Identification and analysis of strategic issues
- Formulation of and documentation of strategic plans
- Implementation of quality plans and assessment
- Identification of the milestones and monitoring of the plan.
- Encouragement of co-ordination and co-operation among various functional areas (e.g. design, operations, marketing, and maintenance)
- Establishing an agreed pay/rewards and recognition scheme for promoting TQM adoption

Methodologies/Tools

- SPC tools, bar chart, tally chart, histogram, scatter diagram
- Radar chart to analyze the gaps
- Interrelationship diagraph to examine causal issues
- Tree diagram for development of strategies

For facilitating the project work, it is necessary to establish a strong team infrastructure. These teams and task forces are formed according to their skills and different operational requirements. Adopting TQM should include training in applying practical skills, tools and techniques in job-related (estimating and costing, surveying, planning, designing,

Table 6.8 Methodology to Implement Step 7: *Carryout TQM Campaign*

Goal:

To Carryout TQM campaign

Participants:

Steering committee, senior executives, project managers, design engineers, construction engineers, suppliers and employees

Activities:

- Monthly/annual business meetings
- Informal gatherings
- Departmental meetings
- Company newsletters.

Methodologies / Tools

- Lectures/seminars
- Presentations
- Bulletins
- Film shows

construction methods, etc) and project specific (housing, irrigation, power, bridge etc) areas. Table 6.10 depicts methodology to implement step 9: *Setup and Train Individual Project Teams*

Step 10 Initiate Team Efforts

To activate the programme, motivation and morale support should be initiated from the top, and then deployed to the different departments and/or divisions of the organization. Table 6.11 Methodology to implement step 10: *Initiate Team Efforts*

Project level

At the project level, a diagnostic of present situation of the project is carried out. Construction waste, management and organizational deficiencies, possible causes of waste and deficiencies are identified (Serpell and Alarcon, 1998). Various problem solving tools are introduced at this phase. After selecting most promising improvement opportunities or a new product, a set of improvement strategies and actions is identified

Table 6.9 Methodology to Implement Step 8: *Select Improvement Projects*

Goal:

Choosing of improvement projects

Participants:

Steering committee members, senior executives, project managers, construction manager

Activities:

- Improvement and problematic areas are segregated
- Determine whether *Kaizen* type improvements or *breakthrough* actions and or both are required
- Assign initial projects that have a high probability of success
- Develop detailed action plans with consensus/support from functional areas concerned. Prepare appropriate operation procedures
- Revise work instructions in line with users' and customers' feedback and requirements

for the selected project.

The vast majority of construction project activities occur in this phase. This is the core level of the implementation phase, which involves application of the improvement strategy QFD to any construction project. It normally involves four stages viz. planning, designing, contracting and construction. The present work considers supplier management or partnering as a separate stage to provide a more specific approach.

Project planning involves with the development of first stage QFD (house of quality matrix).It starts with knowing of customer requirement using customer satisfaction surveys and mandatory social and environmental requirements. Voice of customer is translated into design requirements and quantifiable measures to be executed. The second stage QFD is developed for design management. Outputs from first stage QFD are the inputs for this stage. It involves preparation of detailed structural designs and drawings, detailed schedules, estimation and costing. The main objective is to produce a set of contract documents for the contractor to follow during construction of project. The third stage QFD is for contracting process and inputs are from design stage QFD outputs. The

Table 6.10 Methodology to Implement Step 9: *Setup and Train Individual Project Teams*

Goal:

To compose project teams and to provide training in project specific areas

Participants:

Senior executives, project managers, trainers, engineers of functional departments, supervisors and employees

Activities:

- Formation of departmental improvement teams
- Formation of process improvement teams
- Formation of cross-functional teams
- Formation of *ad hoc* task forces
- Appointment of team leaders
- Selection members who are committed to teamwork
- Developing clear operating guidelines for the teams
- Providing training in job related skills (estimating and costing, surveying, planning, designing, construction methods etc.) and project specific (housing, irrigation, power, bridge etc) areas

Methodologies / Tools

- Problem solving techniques
- Quality control tools
- Conformity requirements of quality standards
- Cascaded training
- Training by designated in-house trainers
- Training by external consultants and/or quality professionals.

processes in a construction project involve analysis and selection of budgets, technologies, suppliers and materials contract forms, drawing and specifications and technology involved. The fourth stage QFD is for partnering. Partner or supplier management involves managing contractors, sub contractors and material suppliers in an efficient manner to reduce/avoid future delays and related problems. The last and fifth stage QFD is for project management (construction operations). This is the actual stage of a construction project which involves managing money men, machine, material and time. The output is a constructed facility (Ahmed et al., 2003; Eldin and Hikle, 2003; Mallon

Table 6.11 Methodology to Implement Step 10: *Initiate Team Efforts*

Goal:

Activation of team efforts

Participants:

Senior management, steering committee and teams

Activities:

- Teams and task forces activated with formal team meetings
- Encourage teams to initiate projects and plans regarding the improvements of processes, operations and procedures in their work places
- Delegate suitable authority
- Deploy resources to teams and task forces, for execution of improvement tasks

Steering committee should

- Provide a clear project scope and objectives
- Arrange for trained facilitators to direct the improvement efforts of individual teams
- Setup cross-functional teams
- Setup several QC circles (within one function)
- Involve employees actively in quality-related Activities:
- Implement employees' suggestion Activities: extensively after an evaluation.
- Make employees committed to the success of company
- Encourage employees to fix problems they find and to report work problems in company

and Mulligan, 1993). Further steps involved in implementation phase at project level are briefly explained below

Step 11 Diagnostic of Project Situation and Identification of Improvement Opportunities

It is carried out with the observation, data gathering, and data processing of a construction project, which includes resources and information flows, management flows and conversion processes. Construction waste, management and organizational deficiencies, and possible causes of deficiencies are identified. Analysis is done to find out cost effective improvement opportunities (that can be applied to reduce waste, deficiencies, rework etc) or development of a new product .The feasible and profitable strategies and actions are selected for implementation. Table 6.12 depicts methodology to

Table 6.12 Methodology To Implement Step 11: *Diagnostic of Project Situation/ Improvement Opportunities*

Goal:

To obtain accurate picture of what is happening in the project and to obtain a list of improvement opportunities

Participants

Senior executives / different functional teams

Activities

- Construction project problem identification
- Study of construction processes
- Study of jobsite organization
- Project organization and management study
- Study of resource procurement systems
- Study of quality and quality system
- Study of equipment utilization system

Methodologies/Tools

- Problem identification survey – to obtain people's perception about project problems and types of wastes that are occurring in the site and identification of their possible causes (viz. lack of planning, unclear information, resources quality problem, late information, lack of control, resources missed, information quality problems)
- Work sampling – to obtain information about labour utilization
- Delay survey – to identify the causes of delays
- Construction process analysis - processes observation to obtain information about construction methods, resources utilization, processes performance and safety, etc.
- Statistical data analysis
- Crew balance charts
- Procurement, storage, and resources delivery system analysis
- Labour satisfaction survey
- Client satisfaction survey
- Quality surveys
- Equipment utilization sampling
- Teamwork and brain storming

implement step 11: *Diagnostic of Project Situation and Identification of Improvement Opportunities*

Step 12 Evaluations of Improvement Strategies and Actions

After selecting most promising improvement opportunities, a set of improvement strategies and actions is identified for each one. An initial selection is performed to reduce the number of alternative solutions. The feasible and profitable strategies and actions are selected for implementation. Table 6.13 depicts methodology to implement step 12: *Definition and Evaluation of Improvement Strategies and Actions*

Table 6.13 Methodology to Implement Step 12: *Evaluation of Improvement Strategies and Actions*

Goal:

Choosing improvement strategies

Participants:

Senior executives, technical team, financial officer and project manager

Activities:

- Technical feasibility
- Economic feasibility
- Time feasibility
- Cost of implementation
- Benefits of implementation

Methodologies/Tools:

- Teamwork and brain storming
- Economic evaluation methodologies
- Cost estimating
- Planning tools
- Teamwork

Step 13 Project Planning

It starts with knowing of customer requirement or opportunities for improvement. Voice of customer is translated into design requirements and quantifiable measures to be executed. The objective is to develop a clear definition of the end product a client looking for or an expected improvement. The deliverables of this stage includes project planning report. Table 6.14 depicts methodology to implement step 13: *Project Planning*

Table 6.14 Methodology to Implement Step 13: *Project Planning*

Goal:

Identification of QFD parameters for planning stage of a construction project.

Participants:

Owners, project managers, labour department, engineers (planning, design, construction, environmental) contractors, and advocates.

Activities identified:

- Identifying project owner requirement
- Gaining knowledge of manpower codes and standards
- Gaining knowledge of environmental requirement
- Knowing process flow requirements
- *Product technical planning*
- *Facility scope planning*
- *Project execution planning*
- *Contract strategy planning*

Methodologies/tools

- Owner interview reports
- Manpower agencies reports
- Environmental agency reports
- Legal consultation
- Technical personnel / department report

Step 14 Design Management

The main objective is to produce a set of contract documents for the contractor to follow during construction of project. Table 6.15 depicts methodology to implement step 14: *Design Management*

Step 15 Contracting

The processes in a construction project involve analysis and selection of budgets, technologies, suppliers, materials and equipment. Table 6.16 depicts methodology to implement step 15: *Contracting*

Table 6.15 Methodology to Implement Step 14: *Design Management*

Goal:

Identification of QFD parameters for design stage of a construction project.

Participants:

Owners, Engineers, Project managers, Contractors

Activities identified:

- Project specification
- Design operations
- Communication with owner
- Constructability
- Design budget
- Feedback system
- Codes and standards
- Drafting practices
- *Detailed cost estimate*
- *Detailed schedule*
- *Detailed design*
- *Preparing of work package*

Methodologies and tools

- Design drawing and schematics
- Construction drawing and schematics
- Bill of materials
- Specifications for procurement of materials/equipments
- Bid package document

Step 16 Partnering

This involves managing contractors, sub contractors and material suppliers in an efficient manner to reduce/avoid future delays and related problems. Educating and making them stakeholders is the important feature of this step. Table 6.17 depicts methodology to implement step 16: *Partnering*

Step 17 Project Management

This is the actual execution stage of a construction project which involves managing

Table 6.16 Methodology to Implement Step 15: *Contracting*

Goal:

Identification of QFD parameters for contracting stage of a construction project

Participants:

Technical teams, Legal experts, Supervisors, Contractors (fromdifferent trades) and Suppliers,

Activities identified:

- Analysis of construction budget
- Analysis of management budget
- Selection of contractors (from different trades)
- Selection of technology used
- Personnel coordination
- Selection of supplier
- *Management of bulk commodities/ Fabricated items*
- *Management of standard engineering equipment / Field equipment*
- *Management of Specialized engineered equipment*
- *Field management*
- *Services (General contractor and Subcontractors)*
- *Documentation*

Methodologies and tools

- Contract management (tendering, bidding)
- Drawings and specifications
- Inventory management

money, men, machine, material and time. The final outcome of any construction project is dependent on this crucial stage, which reflects the quality efforts involved in the whole project and immediate perception of customer satisfaction. Table 6.18 depicts methodology to implement step 17: *Project Management*

Outcome of the implementation phase

At project level of the implementation phase, the present situation of the project is analysed and opportunities for improvement are identified. Different stages of a construction project and corresponding activities are identified, analyzed, implemented.

Table 6.17 Methodology to Implement Step 16: *Partnering*

Goal:

Identification of QFD parameters for partnering stage of a construction project.

Participants:

Project manager, general contractor, electrical contractor, equipment contractor, material contractor, construction manager, testing and equipment organization

Activities:

- Educating people in the project
- Educating suppliers and sub contractors
- Arranging partnering workshops
- Developing evaluation workshops
- Periodic review
- Final evaluation

Methodologies/Tools

- Workshops
- Seminars
- Education and training by experts

The outcome of the implementation phase at organizational level reflects the actual start of the execution of TQM implementation efforts. A steering committee is formed, TQM objectives and strategies are defined and TQM campaign is carried out. A project with high success rate is selected. Different functional teams are selected and trained in respective areas and team efforts are initiated.

The ability of the employees to execute actual product/process improvement activities is improved by quality training. Appropriate training, incentives for participation, and rewards for effective participation in quality efforts are setup. Investment is made in training employees at all levels. Construction project specific skills and functional department skills are taught. Employees are motivated to engage in quality-oriented behaviour when their roles and the relevance of their training to overall quality goals are clarified. The knowledge-sharing among employees for quality problem solving develops

Table 6.18 Methodology to Implement Step 17: *Project Management*

Goal:

To identify QFD parameters for project management stage of a construction project

Participants:

Project manager, general contractor, electrical contractor, equipment contractor, material contractor, construction manager, testing and equipment organization

Activities:

- Planning
- Scheduling
- Controlling
- Budgeting
- Costing
- *Demobilizing*

Methodologies/Tools

- PERT/CPM
- Bar chart
- Resource levelling
- Estimating and costing methods
- Budgeting techniques
- Tender documents
- Various agreements and documents

A technically and psychologically mentored workforce works as a team with the common goal of improving quality. The cooperative attitude of workers is reflected in their internal associations among peers. It is also demonstrated in their interactions with suppliers. Concurrent to the changed work behaviour, workers also are motivated to learn about the current status and possible improvements of organizational processes that could lead to quality outcomes. Both quality circles and cross-functional team approaches is implemented, which increases the extent of internal cooperation among employees.

6.5.3 Review Phase

This is the refocusing and maturity phase of TQM implementation. The experienced and

competent TQM practitioners and technical experts of construction and management monitor and /or adjust strategies in response to outcomes of implementation or wider changes of business requirements. It is characterized by necessary activities and new initiatives with revised or new targets and critical examinations

Organizational level

In this level of modification phase, results obtained from implementation phase are determined. Feedback from teams, customers and employees is taken. This facilitates to reward the teams and guides management to show appreciation of team efforts in achieving predetermined targets of improvement performance. Deviations from the predetermined objectives should be explained. Competitive benchmarking of operations and processes with the best-in-class performers and competitors in industry should be performed. Corrections are under taken.

The progress of improvement plans and the corrective actions undertaken should be reviewed and modified. In addition, the creation and transfer of good practices should be facilitated, and continuous improvement procedures properly established, documented and monitored. Further steps involved in implementation phase at project level are briefly explained below

Step 18 Monitoring and Evaluation of Project Results

Results obtained from implementation are determined. Decisions at this stage should be made based on the results obtained and the analysis of the implementation process. Table 6.19 depicts methodology to implement step 18: *Monitoring and Evaluation of Project Results*

Step 19 Corrective Actions and Maintenance of Changes

According to results obtained in the previous stage, corrective actions are considered to make the implementation more effective. After making changes, again the situation of the project is diagnosed to identify improvement opportunities. In case of not coming across any further improvement opportunities, feed back step is followed. Table 6.20 depicts

Table 6.19 Methodology to Implement Step 18: *Monitoring and Evaluation of Project Results*

Goal:

To review actual improvements achieved by implementation, difficulties faced during implementation and reasons that reduced expected gains.

Participants:

Senior executives and project managers, construction managers

Activities:

- Measurement of project results
- Identifying causes of failures
- Identification of corrective actions
- Deciding about improvement process
- Gathering of lessons learned

Methodologies/Tools

- Performance gathering tools
- Statistical data analysis
- Cost measurements
- Construction process analysis

methodology to implement step 19: *Corrective Actions and Maintenance of Changes*

Table 6.20 Methodology to Implement Step 19: *Corrective Actions and Maintenance of Changes*

Goal:

Effective implementation and maintenance of corrective actions and changes made.

Participants:

Project manager, general contractor, electrical contractor, equipment contractor, material contractor, construction manager, testing and equipment organization

Activities:

- Implementing corrective actions
- Maintaining effective changes

Step 20 Feedback

The feedback and requirements acquired from users/customers would help prioritize the identified areas of continuous improvement, along with the time and resource constraints, as well as other organizational concerns (e.g. environmental, safety and social responsibilities). Employees' views should be sought on their attitude and comments towards TQM implementation by all possible means. Positive recognition and feedback of quality efforts are both important for organizational learning and as a stimulus to create structured, planned and continual improvement activities in the organization. Table 6.21 depicts methodology to implement step 20: *Feedback*

Step 21 Measure Internal Performance

Internal assessment is an effective means to audit the performance of internal operations by comparison with internal standards and organizational goals. All positive changes and improvements should be evaluated in line with the corporate mission and operational objectives. Deviations from the predetermined objectives should be explained. Competitive benchmarking of operations and processes with the best-in-class performers and competitors in industry should be performed. Table 6.22 depicts methodology to implement step 21: *Measure Internal Performance*

Step 22 Modify Organizational Infrastructure, Methodologies and Objectives

The progress of improvement plans and the corrective actions undertaken should be reviewed and modified. The adaptation of TQM practices requires comprehensive organizational changes and human integration into every aspect of the business. The variables and factors that affect the progress of quality projects and programmes are to be reviewed. The scope, objectives and methodologies of these factors are to be refined. The organization status for TQM implementation is again reviewed. Table 6.23 depicts methodology to implement step 22: *Modify Organizational Infrastructure, Methodologies and Objectives*

Outcome of the review phase

The outcome of review phase includes evaluated project results and corrective actions

Table 6.21 Methodology to Implement Step 20: *Feedback*

Goal:

To obtain customers' feedback / employees' feedback / teams' feedback

Participants:

Steering committee and teams

Senior executives, senior managers and customers (internal and external)

Senior executives, senior managers and employees

Activities:

The steering committee should acquire the teams' feedback of project progress and final outcomes through

- standard feedback channels / regular progress reports / performance assessment
- audit sheets

Collect customers' feedback through

- customer satisfaction surveys / customer visits / customer complaints
- marketing research / user groups / customer panels / customer-supplier meetings

Collect employees feedback through

- employee satisfaction surveys
- employee performance appraisal
- departmental meetings

taken. The feedback records of the employees, teams and customers are obtained. The internal business measure (performance) data analysis results are generated. Modified organizational infrastructure, methodologies and objectives are seen.

6.6 Relationships

Proposed TQM model is an integrated approach where there is interdependence among 10 TQM CSFs, 22 implementation steps (Table 6.24) and sub-criteria. In view of the above it has been decided to portray relationships between these and among CSFs. Figure 6.2 indicates the CSFs and the major steps derived from them.

6.6.1 Relationships between CSFs, Implementation Steps and Sub-Criteria

The top management commitment CSF is characterized by personal commitment through

Table 6.22 Methodology to Implement Step 21: *Measure Internal Performance*

Goal:

Assessing internal performance and conducting competitive benchmarking

Participants:

Senior executives and senior managers

Activities:

- Collection data about staff, customers, suppliers and work processes
- Providing timely, relevant, comprehensive information for different levels of need
- Accessing of accurate and consistent information to staff for decision making.
- Regular conduct of audit of policies, strategies and quality.
- Maintaining detailed databases of quality related data (such as measure service quality, measure productivity, measure reductions in operational costs, measure of waste such as waiting, re-do work, and damage to equipment, employee satisfaction, defect rates and scraps) and display quality-related information
- Evaluation of the management of company / performance of all departments, employees using quality related data
- Use of benchmarking extensively (internal and external) to compare performance of organization operations/processes / relevant standards/specifications/methods employed
- Performing benchmarking against other competitors of world-class performance
- performing self-assessment of progress against the excellence model criteria (like MBNQA, EQA)

visionary leadership towards developing quality culture. As an important step towards implementation and supervision of TQM, steering committee is formed by top management. The partnering with different firms of strategic importance in improving the quality is the sole decision of top management. Also modifying the organizational infrastructure, objectives, and methodologies involves commitment of resources and time from the top management. These indicate active participation of leadership with clear quality visions and supportive quality culture.

The supplier quality management CSF is reflected by the organizations quality culture, which treats suppliers as part of it and stakeholders. They are taken into confidence while planning a project, contracting and partnering. These indicate long-term interest and

Table 6.23 Methodology to Implement Step 22: *Modify Infrastructure, Methodologies and Objectives*

Goal:

To Modify and refine organizational infrastructure, project scope, objectives and methodologies

Participants:

Top management, senior executives, project managers

Activities:

- Review of completion dates / owners of implementation items and those actually executing the strategy and plan
- Checking of duplications / inconsistencies / Organizational / resource shortages / any possible financial constraints / equipment condition
- Checking and modifying time spent on training, employee resistance / communication between departments
- Checking and modifying conflicting interpretations of policies and other decisions
- Checking for modification of the existing organizational infrastructure and/or structure
- Changing of the procedures and processes / Impact of changes
- Reviewing management commitment
- Changing rewards and recognition systems
- Identification and elimination any implementation roadblocks.
- Checking and aligning with customer satisfaction results

Table 6.24 TQM Implementation Process Steps (S1 to S22)

S1 = Top management commitment	S9 = Setup/train individual teams	S18 = Monitoring / evaluation of results
S2 = Create TQM vision	S10 = Initiate team efforts	S19 = Corrective action/ maintenance of results
S3 = Develop quality culture	S11 = Diagnostic of current opportunities	S20 = Obtain customers / employees / teams feedback
S4 = Review organization status for TQM	S12 = Evaluation of opportunities	S21 = Measure internal business performance
S5 = Setup steering committee	S13 = Project planning	S22 = Modify organizational Infrastructure/objectives /methodologies
S6 = Define TQM objectives	S14 = Design management	
S7 = Carryout TQM campaign	S15 = Contracting	
S8 = Select improvement projects	S16 = Partnering	
	S17 = Project management	

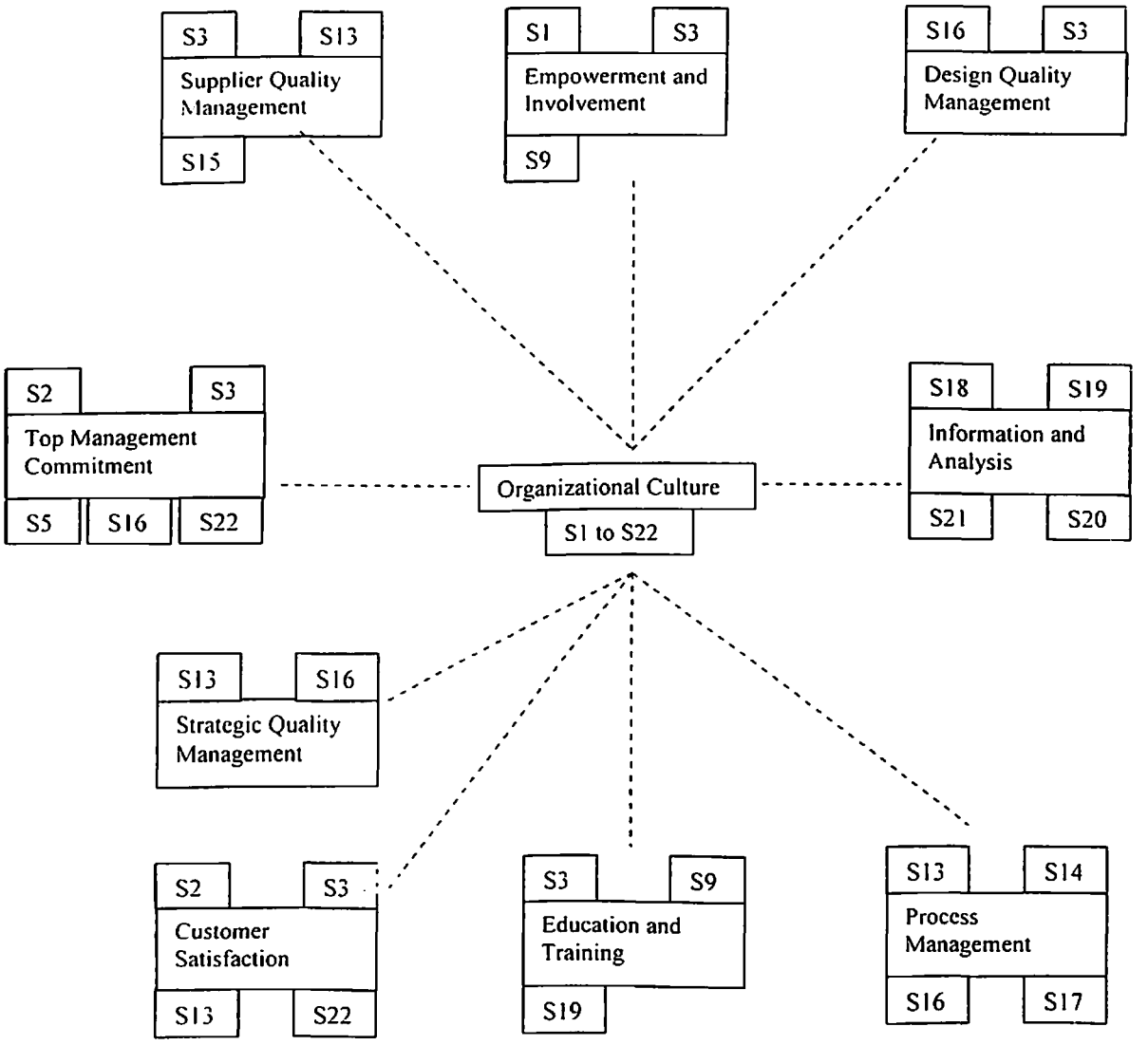

Fig. 6.2 Relationship between CSFs and Major Implementation Steps

involvement of suppliers and treating them as partners in product development

The characteristics of customer satisfaction CSF are reflected in creating customer oriented visions, objective and obtaining and implementing the feedback from the customers and employees.

The characteristics of design quality management CSF are reflected in design management which involves application of QFD to design products and services, where

customer needs are thoroughly analysed. Also, the partnering step is influenced by design quality management, which builds quality into products before construction or production starts by involving suppliers and functional departments.

The characteristics of process management CSF are reflected in construction project processes viz. project planning, design management, contracting, and partnering and project management. Quality tools and methodologies are used to measure conformance to set standards, which are used to reduce variability and complaints.

The characteristics of Information and analysis CSF are reflected in monitoring and evaluation of results, obtaining of customer/employees/teams feedback, measuring internal performances. Effective management of data and information is carried out with the help of compliance reports and bench marking, measured with standard procedures and systems.

The characteristics of education and training CSF are reflected in developing quality culture, setting up and training individual teams, and educating partners. Employees are assessed for development and required education, to impart specific work skill training and team building characters. Also retaining and maintaining of developed skills and knowledge requires education and training.

The characteristics of organizational culture CSF are reflected in developing quality culture, defining quality objectives, and training of teams, partnering with suppliers and making employees as partners in the company, and obtaining customer and employee feedback. Modifying organizational objectives in line with customer requirement and investing in improving the infrastructure is the core effect of CSF organizational culture. Companywide quality culture is induced by cultural policies and attitudes, leading to collectivistic behaviour. Structure of the organization is modified to reflect delegation of authorities and amount of financial control of employees over the company.

The characteristics of strategic quality management CSF are reflected in project planning, contracting and partnering. Quality strategies for partnering, design management are

developed regarding nature of the product and alliances. Clear quality policies with detailed quality goals are provided.

The characteristics of empowerment and involvement CSF are reflected in developing quality culture, initiating team efforts with delegation of responsibility with required authority. Promoting of problem solving network, authorising to inspect and fix problems of their own work, creating cross functional teams, and recognising quality improvement efforts are main features in this step.

6.6.2 Relationship among CSFs

While top management acts as driver for progressive TQM, its commitment must be translated to a set of strategies and their effective implementation. These strategies must be implemented with a clear focus on three critical stakeholders in an organization's operations: customers, suppliers, and employees. Thus CSF top management commitment is related with strategic management CSF.

Several scholars argue that TQM needs to be implemented in a suitable organizational culture in order to be successfully beneficial for the organization. This means that it is the organizational culture that will determine the results of TQM implementation. As such, there is a relationship between organizational culture and all other TQM CSFs.

Regarding organizational culture, it is found that organizations successful at implementing TQM tend to have cultures which are conducive to learning about problems, sharing information, and have a holistic approach toward problem solving.
The implementation of CSFs associated with TQM (i.e. top management commitment and quality culture, product design, supplier quality management, process quality management, and quality data and reporting, quality-related training and employee empowerment and involvement) is positively related to external customer perceptions of quality. Thus all the CSFs are related to CSF customer satisfaction (Waldman and Gopalakrishnan, 1996).

The essence of strategic quality management is to design a strategy that makes the most effective use of the core resources and capabilities. In this respect, strategic management scholars have considered organizational culture as intangible resources (Ghobadian and Gallear (2001)), meaning that organizational culture does influence the strategic choices.

The strategies that allow a firm to produce high quality product / service are; designing quality into products, assuring in-process quality through process management, judicious use of internal (quality reports, etc.) and external (customer feedback, benchmarking) quality information. However education and training is a key link in successful implementation of these TQM CSFs. It shapes the TQM environment through empowering the employees to make decisions related to quality. It ensures a supportive infrastructure for full employee involvement (participation) and training employees in technical and managerial aspect of their role in TQM.

Relationship between Top management commitment and education and training, empowerment and involvement, supplier quality management, and customer focus:
Top management *adopts* the TQM philosophy and demonstrates its commitment. Top management commitment directs TQM efforts. Senior executives design and structure policies and make them customer focused. They educate, train and empower and focus employees to achieve the vision of TQM efforts and customer needs. Clearly, these roles establish the relation between the top management commitment with employee management, supplier quality management, and customer focus.

Relationship between information and analysis with education and training, empowerment, supplier quality management, and customer focus:
Firms must interact with internal / external factors to accomplish their goals. Thus, the information and analysis (continuous compilation, analysis, use of quality information) of external (suppliers and customers) and internal (education and training, empowerment) cooperation, with customers, employees, suppliers, are related.

Relationships between information and analysis, team based quality efforts and design quality management:

TQM encompasses actual quality design, management, and improvement practices forming the core of TQM implementation. The actual practices implemented by successful firms attest to the precedence of quality information usage and team work with respect design management. Thus, information and analysis, cooperation and learning are drivers to effective execution of the design quality management core in successful firms.

Relationship between design quality management and process quality management

Effective use of cross functional design techniques leads to development of superior products. Tracking of in-process quality data monitoring helps to identify process deviations beyond control limits and aids in the adjustment of process parameters for ensuring consistent process and product quality. Also, quality improvement has been associated with the use of error-prevention and problem-solving techniques like QFD. Thus, an emphasis on CSF of design quality management results in improved product quality and process quality (TQM outcomes).

6.7 Testing of TQM Implementation Process Model

The TQM implementation process model developed, though its intention is to improve the quality of the construction organizations, it has to be tested for its usefulness viz. can it be used in practice and usability viz. do practitioners see it as being of real benefit to them, by construction management and quality experts (Voss et al., 1994). As the implementation process model is developed to address the universal quality needs of construction organization, testing the model, where it is likely to be used becomes important. Users of the model from diverse construction organizations are likely to interpret and understand the model differently. The broad categories of the users are quality directors, project managers, engineers, contractors and consultants in the construction industry.

Testing for Usability and Usefulness

Usability testing involved individual meeting with the experts and analysis by the experts. Questionnaire was designed to test the understanding of the model and its

terminology. As might be expected from a model developed by academics, there were a considerable number of areas where the experts stated that they did not understand the language or the concepts. All of these comments were taken and a considerably revised model was produced. In addition, the experts commented on areas that they thought were missing.

For usefulness testing, explicit question was asked of each of the participating experts in the organizations. The responses were very positive. All experts stated in various ways that they found the models challenging and useful.

The testing process reveals the opinion of the actual users of the implementation process model. It reflects the usefulness (acceptance) and usability (applicability) of the model in the construction industry. Also, strong and weak points of-the models are highlighted, which are used for refining the model, if found suitable. Being stakeholders of the proposed implementation process model, the quality experts and construction organizations, were convinced about the importance of testing and their feedback for positively designing the implementation process.

The responses captured and the suggestions given were analysed for relevance before introducing any changes into the model. The qualitative evaluation of the implementation process model through company survey questionnaire was carried out to know the importance of implementation process model and to identify the acceptance and weak points in the model.

Objectives of testing

Testing is conducted to find out whether the implementation process model is

- easy to interpret and understand
- communicating precise message
- ambiguous and confusing
- comprehensive or not
- the weak and strong points

- logical relation of implementation steps

Also one can capitalize on the feedback captured by questionnaire to

- Observe the characteristics of response received from quality experts in construction organizations
- Analyse and incorporate suggestions to improvise the model (steps)

Methodology

A structured questionnaire with open ended questions is used for testing. The questions designed were oriented towards usefulness and usability of the model. The features of the questionnaire are given in the Table 6.25.

The survey was conducted during March – April 2005 for testing of the model. The perceptions regarding usability of the model on various aspects are obtained. The sampling companies were identified at Bangalore. Bangalore being the silicon valley of India has become centre for major national and international software companies. Large scale construction activities including infrastructure development and multi-storeyed structures have increased to very high proportions. Major national construction companies have made their presence in Bangalore. Also, it was personally convenient for author to develop contacts with companies and quality experts in construction field. The target quality experts were identified through yellow pages of the telephone directory and personal contacts. Prior appointment was taken with experts. Questionnaire was personally distributed. After a gap of one week questionnaires were collected back after having a formal interview with the expert. Normally the duration for interviewing was anywhere between 30 minutes to 2 hours.

For evaluation purpose construction management and quality experts were identified based on experience of minimum ten years in different fields of construction, to know their perceptions about the implementation process model. 48 experts from different companies were consulted, out of which 24 responded. The main aim is to receive feedback regarding usefulness, usability of the model and appropriateness of implementation steps involved, communication of quality message, easiness in

Table 6.25 Structured Questionnaire for Testing the Implementation Process Model

Questionnaire

Profile of the company and quality expert

I. Name of the Company

II. Turnover of Company

III. Name of the Quality In-charge

IV. Designation (Project Manager / Quality Manager / Quality Director etc.)

V. Experience in years

Questions

1. Does the model communicate precise message
2. Is the model easy to interpret and understand
3. Are details of the model are sharply defined
4. Does the model focus on usability
5. Does the model focus on the important functionalities of construction industry
6. Are all the steps logically connected to each other
7. Does the model evolve clear understanding
8. Is the model ambiguous and confusing
9. Is the representation of the model comprehensible (holistic) to users
10. What are the constraints (weak points) of the model
11. What are the strong points of the model
12. What factors of the model can be compromised with
13. Additional comments you wish to make

interpretation and understanding, focus on functionalities, comprehensiveness and opportunities for improvement of the implementation process model. The questionnaire was intended to get the information on companies profile in terms of name, turnover, and number of employees. The details of quality experts' name, designation, experience are also captured.

The consolidated diagnostic report of the companies responded, is shown in the Table 6.26 below. For purpose of analysis companies with annual turnover above 500 crore are graded as A, between100 to 500 crore graded as B and 50 to 100 are graded as C category companies. Analysis of responses is given in Table 6.27.

All the experts accepted the model and found it of immense help while competing for international contracts, but expressed doubts over the suitability of the model for small companies. This is unfound as the implementation process remains same irrespective of the size of the company. Some suggested increasing number of steps in the model to make it more understandable by adding material management as an extra step. The suggestion though useful, it is already taken care in partnering step, which makes material contractors as stakeholders and participants in TQM implementation. Another suggestion was the necessity of include input from related mechanical and electrical disciplines. It was already embedded in partnering step as involving suppliers and sub contactors. One more suggestion was to stress more the cost factor in the model. Keeping in view the fact. that. the out comes of TQM implementation increases the quality, leads to improved business results and makes the company competitive in the field, it is decided not to consider the suggestion as relevant, as the more stress on cost factor leads to decrease in quality practices. Also, it is established that one of the reason for failure of TQM is too much focus on cost factors and ROI. Many were of the opinion that, quality assurance should be a separate step. Since whole TQM process is oriented towards developing and assuring quality, the idea of separate step for quality assurance was discarded. Some felt, only project level feedback necessary (step 19). Since results of the project affect both project and organization, feedback from only project level is not adequate. Feedback loop at both levels is important. An executive director who also owned the company argued partnering with suppliers, and providing stakeholders status as not practicable. As motive behind making suppliers as partners is to involve them genuinely in TQM implementation process and it is also one of the prime factors in developing quality culture, this suggestion was un acceptable. Lack of stress on top management authority in the model was highlighted by some task masters. But basic principle of TQM being involving and sharing of authority and responsibility, this suggestion was discarded.

Out of 24 experts responded, 14 experts accepted the model and its usability in construction without suggesting any modification. The remaining 10 experts suggested modifications which were clarified. Overall the entire model was welcomed by

Table 6.26 Company Profiles and Suggestions

Organization/Company	Grade	No. of Employees	Modification suggested
1. BRIGADE GROUP	A	800	Not suitable for small companies
2. CONTINENTAL CONTRACTORS	C	150	Increase number of steps
3. COSMOS	C	100	More steps needed
4. ECCI	B	400	Nil
5. ENGINEERS INDIA	A	1200	Add inputs from mechanical, electrical fields
6. ETA	A	900	Nil
7. HM CONSTRUCTIONS	B	300	Nil
8. JAIPRAKASH ASSOCIATES	A	1500	Needs more stress on cost of the project
9. L & T	A	1500	Add quality assurance as separate step
10. MYCON	B	500	Nil
11. MFAR CONSTRUCTIONS	C	150	Nil
12. NAGARJUNA CONSTRUCTIONS	A	800	Nil
13. NBCC	A	1200	Nil
14. PRESTIGE GROUP	A	800	Only project level feedback necessary
15. PURAVANKARA PROJECTS	A	700	Making suppliers as partners not practicable
16. RAHEJA GROUP	B	300	Nil
17. RANKA AND RANKA	B	300	Nil
18. SHIRKE GROUP	A	800	Stress on top management authority
19. SIMPLEX PILES	A	900	Nil
20. SJR INFRASTRUCTURES	B	200	Nil
21. SKYLINE CONSTRUCTIONS	B	400	Nil
22. SOBHA DEVELOPERS	B	500	Nil
23. STUP CONSULTANTS	C	100	Nil
24. UNITECH	B	300	Nil

Table 6.27 Analysis of Responses

Quality experts contacted	Responses received	Responses suggesting modifications	Responses not suggesting modifications
48	24 (50%)	10 (20.83%)	14 (29.17%)

quality experts viz., directors, project managers, consultants, engineers and contractors.

6.8 Conclusion

A comprehensive TQM implementation process model is developed from the perspective of the construction organization, addressing all the facets of TQM in construction organizations such as planning, designing, processing, partnering, project management (construction operations), in addition to generic TQM principles and practices. The model, especially in the light of scarcity of TQM implementation process models in TQM literature for construction provides a detailed approach. It was tested for usefulness and usability with quality experts and found to be an innovative one. It was accepted by different sections of experts in construction field. The TQM implementation model can be effectively used by consultants, contractors to implement TQM in the various construction organizations. Times overrun, cost overrun, rescheduling, rework, redesign, and other serious problems faced by the construction organization are overcome or reduced by following this methodology.This would offer key information on the different quality management practices that have to be amalgamated in order to enhance the business performance with respect to quality.

All of the relationships between CSFs and implementation steps, and between the various CSFs among themselves do have relations and mutually not exclusive. These relationships have favourable effect of each affecting CSF on the affected CSF.TQM can only be effective if these CSFs and implementation steps operate in an environment that embraces TQM culture as a philosophy of quality management; i.e. the success of any

TQM movement would largely depend on how synergically the various CSFs are espoused in an ambience of organizational culture.

The research work attempts to add to the scarce literature (when compared to literature available on manufacturing) available on total quality management with respect to construction. Such studies help researchers and practitioners to better understand the intricacies and relevance of the various aspects of TQM across different construction organizations. Thus, from an application standpoint, this implementation process model is aimed at increasing the degree of effectiveness in implementation by assisting construction consultants, construction managers and contractors to develop a step-wise TQM implementation roadmap.

CHAPTER 7

CONCLUSION

In the light of global business environment construction companies should align with manufacturing companies in terms of implementing TQM. The success of construction companies can no longer be seen in isolation. Rather, they have to redesign their business processes to create better quality management systems. The real challenge is to overcome from the traditional quality control to TQM. All companies will eventually face significant change in their competitive environments from dramatic breakthroughs in techniques, changes in customer demand, or rise of new competitors. Making the change initiatives is important, but the change must align with the core competencies. The companies have to shift to knowledge base. Knowledge management, learning organization and higher adaptability are the key strategic issues.

Based on the above premise, the present research work has developed TQM implementation process model that could be very useful for construction organizations, which are attempting to implement TQM and to identify those characteristics that may provide an opportunity to improve productivity and cost efficiency. Organizations can use this model to assess the current stages, assign responsibilities and resources within the organization and monitor the progress for achieving company-wide improvements.

This work focuses on building quality organization along with project quality. Quality is built at the time of planning and execution of various functions like top management commitment, strategic planning, education and training, design, procurement, construction etc. The approach followed helps to align construction process to TQM process. The CSFs are aligned with organizational and project requirements. These requirements include elements like organizational vision, customer satisfaction, and partnership with suppliers etc.

Various implementation steps were identified from the angle of CSFs of TQM. These steps bring focus on organization as well as project and could be seen more objectively

from the angle of building quality. The developed implementation process model is more system oriented than product inspection, reflecting the concept of TQM making quality every ones responsibility and activity. Analogous to this, the conclusions of the present research work and further scope work is presented below.

7.1 Specific Contributions

1. After the review of literature related to TQM it became evident that research dealing with TQM framework for construction has been conducted. In addition no research has been systematically conducted for developing TQM implementation process model for construction industry to improve their TQM implementation efforts.

2. The extensive literature study also revealed that the lack of sufficient guidelines to assist construction firms has lead to a number of unsuccessful TQM implementation throughout the world.

3. A TQM model for construction has been proposed based on extensive review of existing TQM frameworks and other TQM literature.

4. The application of CDP tool based on AHP reveals that, the proposed TQM model is found comparable and better than business excellence models.

5. The extensive review of TQM literature revealed, the large number of failures of TQM initiatives is due to negligence of organizational culture.

6. The proposed model unlike others has included culture as an important element of TQM.

7. Using the elements of proposed TQM model, a 3 phase, 22 steps implementation process model of TQM has been developed for construction organizations as presented in the Fig. 6.1

8. This model has been tested by industry professional for its usefulness and usability. This model can be used by construction firms to improve their TQM implementation efforts. Through using this model firms can quickly identify areas which urgently need improvement to satisfy customers. Thus resources can be allocated more wisely and more effective implementation plans can be formulated.

9. It is important to note the difference between the implementation process models studied in the research while identifying implementation steps. The outcome of this research, i.e. implementation process model for construction, which involves QFD as major technique is not found in any TQM implementation models. The output of this research is not a generic model of TQM implementation process, but a specific model with detailed step by step approach.

10. The developed comprehensive TQM implementation process model from the perspective of the construction organization, address different facets of TQM in construction organizations such as planning, designing, processing, partnering, project management, in addition to generic TQM principles and practices.

11. The TQM implementation model can be effectively used by consultants, contractors to implement TQM in the various construction organizations to enhance the business performance and quality.

12. Times overrun, cost overrun, rescheduling, rework, redesign, and other serious problems faced by the construction organization are overcome or reduced by following this methodology.

13. The research work help researchers and practitioners to better understand the intricacies and relevance of the various aspects of TQM across construction organizations.

14. This implementation process model could be used by construction organizations to identify goal issues, participants, activities and address the alignment of TQM.

7.2 Further Scope for Research

1. In order to continuously improve TQM implementation process model, more structured interviews would be conducted in different kinds of national and international construction firms in different countries.

2. In depth case studies would be conducted, to gain more insight into using this implementation process model in practice.

3. Further the influence of external environment could be studied in order to explore how external environment affects construction firms TQM implementation initiatives.

4. The construction sector includes large to small organizations. There are large numbers of small organizations which are unorganized. The testing of the implementation process model with big companies does not necessarily reflect universal acceptance of the model. There is a need to test the model for its relevance with small organizations with proper feedback from them.

5. TQM awareness in construction industry is still catching up. Case studies are not available in Indian scenario. There is need to investigate reasons for low awareness of TQM and its implementation by construction organizations.

6. Testing for usability and application of the research findings is limited to group of companies considered for testing. Present work has been tested with only 24 numbers of companies. There is a necessity to test with large number of companies.

7. Definition of large, medium, small companies differ from country to country. In order to assess similarity in TQM implementation, it is necessary that a comparative study be made in this aspect.

It is hoped that this research work will help to implement TQM practices in Indian construction industry. The research intends to establish TQM firmly in construction industry. This should be able to support TQM implementation process and realise the potential of TQM. It is hoped that this detailed TQM implementation process model for construction industry would support to achieve world class performance.

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Appendix I Manual Database Journals Search

Names of the Journals
1. Civil Engineering and Construction Review
2. IEEE Transactions on Engineering Management
3. IEEE Transactions on Engineering Management Review
4. Indian Concrete Journal
5. Indian Construction
6. Industrial Engineering
7. Journal Construction Engineering and Management
8. Journal of Architectural Engineering
9. Journal of Management In Engineering
10. Leadership and Management In Engineering
11. Performance of Constructed Facilities
12. Practice Periodical on SD and C
13. Practice Periodical on Structural Design and Construction
14. Productivity

Appendix II Online Database Journals Search

Names of the Journals
1. Applied Ergonomics
2. Automation in Construction
3. Benchmarking for Quality Management and Technology
4. Business Horizons
5. Business Process Management Journal
6. Computers and Industrial. Engineering
7. Decision Sciences
8. European Business Review
9. European Industrial Training
10. European Journal of Purchasing and Supply Management
11. European Management Journal
12. Facilities
13. Futures
14. Industrial Management and Data Systems
15. Information Management
16. Integrated Manufacturing Systems
17. International Journal of Project Management
18. International Journal of Quality And Reliability Management
19. International Business Review
20. International Journal Service Industry Management
21. International Journal Applied Quality In Management
22. International Journal Information Management
23. International Journal of Management Science
24. International journal of Quality Management
25. International Journal Operations and Production Management
26. International Journal Production Economics
27. International Journal Public Sector Management
28. International of Quality Management
29. International Journal Supply Chain Management
30. International Journal Team Performance Management
31. Journal of Operations Management
32. Journal of Organization Change Management

Appendix II Online Database Journals Search (continued)

Names of the Journals
33. Journal of World Business
34. Leadership And Management In Engineering
35. Leadership and Organization Development Journal
36. Logistics Information Management
37. Long Range Planning
38. Management Research news
39. Managerial and Auditing Journal
40. Managing Service Quality
41. Marketing Intelligence and Planning
42. Omega
43. Supply Chain Management Journal
44. Technovation
45. The Learning Organization
46. The TQM Magazine
47. Training For Quality
48. Work Study

Appendix III Categorisation of TQM Related Quality Articles

Group	Author
I. TQM models (25)	Ang et al. (2000); Ahire et al. (1996a);Babbar and Aspelin (1994); Baidoun (2003); Black and Porter (1996) Davies and Isaac (1998) Deming prize (2004); EQA (2004); Flynn et al. (1994);Hart and Bogan (1992); Ho and Fung (1994); Ho and Fung (1995); Ho (1995); Kanda (2002); MBNQA (2004); Motwani (2001); Nwabueze (2001); Oakland (1993); Prajogo and Sohal (2001); Pheng and Wei (1996); Saraph et al. (1989); Ugboro and Obeng (2000); Westerveld (2003); Youssef and Zairi (1995); Zhang et al. (2000).
II. TQM related works (32)	Aua and Choib (1999); Al-Ghamdi (1998); Ahire and Ravichandran (2001); Chase and Federley (1992); Chin and Pun (2002); Culp et al. (1993); Dean and Helms (1996); Ghobadian and Gallear (2001); Galperin and Lituchy (1999); Hongen and Xianwei (1996);Kiwus and Williams (2001); Khanna et al. (2002); Laszlo (1998);Leavitt and Nunn (1995);Lemak and Reed (2000);Li et al. (2003);McCambridge and Tucker (1998);Perry (1997);Peters (1994);Pheng and Teo (2004); Plenert (1996); Pun et al. (2000); Salaheldin (2003); Sharma and Hoque (2002); Shrivastava et al. (2004); Sureshchandar et al. (2001); Taylor and Wilson (1996); Taylor and Wright (2003); Thiagarajan (2001); Wiklund and Wiklund (1999); Witcher and Butterworth (1999); Zhang et al. (2005).
III. TQM and Culture (14)	Ambroz (2004); Butch and Rivers (2001); Chan and Tse (2003); Irani et al. (2003); Jenner et al. (1998); Jabnoun and Anwar (2002); Lagrosen (2002); Lewis (1996a); Lewis (1996b); Recht and Wilderom (1998); Riley and Clare-Brown (2001); Roney (1997); Sinclair and Collins (1994); Vranesevic et al. (2002).
IV. TQM and Leadership (7)	Butch and Rivers (2001); Edgeman (1998); Khuntia and Suar (2003); Politis (2003); Puffer and McCarthy (1996); Taylor (1997); Zairi (1994).

Appendix III Categorisation of TQM Related Quality Articles (continued)

Group	Author
V. TQM and Quality Function Deployment (8)	Ahmed et al. (2003); Crowe and Cheng (1996); Eldin and Hikle (2003); Franceschini and Terzago (1998); Govers (2001); Mallon, and Mulligan (1993); Metri (2003); Srividya and Metri (May 2000).
VI. TQM and Education and Training, Empowerment (16)	Cardy and Dobbins (1996); Carpinetti et al. (1998); Conti and Kleiner (1997); Dainty et al. (2002); Deadrick and Gardner (1999); Holt et al. (2000); Ingram et al. (1997); Kassicieh and Yourstone (1998); Kjellberg and Svensson (1998); Mathew et al. (2001); Maloney (2003); Nesan and Holt (2002); Price et al. (2004); Sharma and Sharma (2003) Smither (2003); Soltani et al. (2003).
VII. General Quality and TQM works (49)	Aggarwal and Rezaee (1996); Ahire and Dreyfus (2000); Ahire et al. (1996b); Al-khalifa and Aspinwall (2000); Amsden et al. (1996); Backford (2002); Chini and Valdez (2003); Chang and Tsai (2003); Curkovic and Pagell (1999); Chan et al. (2003); Chin et al. (2002); Cox et al. (2003); Cooper and Phillips (1995); Currie (1999); Cua et al. (2001); Chua et al. (2003); Dikmen and Birgonul (2003); Escanciano et al. (2002); Folk et al. (2001); Formoso and Revelo (1999); Forza and Filippini (1998); Hensey (1993); Hides et al. (2000); Humphreys et al. (2003); Huq and Stolen (1998); Kaynak (2003); Khan (2003); Kruger (1998); Kumar et al. (2002); Kumar and Garg (2002); Longnecker and Scazzero (1996); Lima (2000); Macomber (2003); McCarthy and Keefe (1999); Miller (1996); Nasierowski (2000); Page and Curry (2000); Price and Newson (2003); Roth (2001); Rungtusanatham et al. (2003); Samson and Terziovsk (1999); Sousa and Voss (2002); Sriparavastu and Guptha : (1997); Taveiraa (2003); Thiagarajan and Zairi (1997); Thomas and Napolitan (1995); Torbica and Stroh (1999); Waldman and Gopalakrishnan (1996); Zeng et al. (2003).

Appendix III Categorisation of TQM Related Quality Articles (continued)

VIII. Construction quality related works (delays, obstacles, disputes, wastes etc.) (80)	Abdul-malak et al. (2002); Abd. Majid, and McCaffer (1998); Ahmed and Kangari (1995); Arditi and Patel (1989); Arditi and Gunayadin (1998); Al-Hammad and Assaf (1996); Anderson and Tucker (1994);Assaf et al. (1995); Back and Moreau (1998); Battikha (2003); Belle (2000); Bhasin (2005); Blackmon and Gramopadhye (1995); Bossink (2002); Bossink and Brouwers (1996); Bryd (1997); Bubshait and Al-Musaid (1992); Burati Jr. et al. (1992a); Burati et al. (1992b); Burleson (1998); Caddick and Dale (1998); Chan and Larn (2002); Chang 2002); Cheng and Li (2002); Cheung et al. (2002); Chin and Choi (2003); Chinowsky and Meredith (2000); Construction vision 2000 (1997); Desai (2003a); Desai (2003b); Elinwa and Buba (1993); Federle and Chase (1993); Fisher et al (1995); Formoso et al. (2002); Goucha and Connor (1996); Guptha (1998); Harman and Kinley (2005); Holt and Rowe (2000); Iyer and Devkar (2005); Josephson et al. (2002); Kadkade (2003); Kharb (2003); Kometa and Olomolaiye (1997); Kraiem and Diekman (1987); Love et al. (2000); Maloney (2002); Matthews et al. (2000); Mejje and Punia (2005); Mitropoulos and Tatum (1999); Molenar and Johnson (2003); Narayan (1997); Oakland and Aldridge (1995); Okpala and Aniekwu (1998); Ock and Han (2003); Odusami (2002); Pheng (1999); Pheng and Hwa (1994); Pheng and Pong (2003); Proverbs et al. (1999); Rahman and Kumaraswamy (2004a); Rahman and Kumaraswamy (2004b); Ramirez et al. (2004); Rojas and Aramvareekul (2003); Rosenfed et al. (1992); Sahad (2005); Santos et al. (2000); Saram et al. (2004); Santos et al. (2002); Serpell Alarcon (1998); Shirke (2003); Shi and Halpin (2003); Samuellson and Grans (2004); Sonmez et al.(2002); Steane and Walker (2000); Tan and Lu (1995); Tang et al. (2003); Uhlik and (Lores (1998); Vaid (2005); Zutshi and Mohanty (2003); Zutshi (2003)

Appendix IV List of Publications

Conferences / Work Shops Participated

1. Faculty development programme.18 - 27 March 2002. sponsored by EMI, Jaipur, DST, Govt. of India and BITS, Pilani, held at BITS, Pilani, Rajasthan
2. National conference on 'Infrastructure management: emerging issues', 16 – 18, May, 2003, sponsored by AICTE, organized by Manipal Institute of Management, Manipal, Karnataka.
3. National conference on strategic imperatives for Indian corporations, 14 – 15, February, 2004 organized by The Technological Institute of Textile and Sciences, Bhiwani. Haryana.
4. National seminar on Challenges posed by IPR regimes, 15 – 16, September, 2004, organized by BITS, Pilani, Rajasthan.

Papers Presented

1. 'Development of quality highway infrastructure in India using BOT system', National conference on 'Infrastructure management: emerging issues', May 16 – 18, 2003, sponsored by AICTE, organized by Manipal Institute of Management, Manipal, Karnataka.
2. 'TQM in construction industry: an emerging operational paradigm becomes a strategic imperative', National conference on strategic imperatives for Indian corporations, February 14 – 15, 2004, organized by The Technological Institute of Textile and Sciences, Bhiwani. Haryana.

Papers Communicated

1. Shivaprakash, C. K., and Bhimaraya, A. Metri. (2005). 'An overview of TQM models and evolution of a new model' South African Journal of Industrial Engineering
2. Shivaprakash, C. K., and Bhimaraya, A. Metri. (2005). 'A TQM implementation framework for construction organizations' Indian Concrete Journal
3. Shivaprakash, C. K., and Bhimaraya, A. Metri. (2005). 'A TQM framework for construction industry' Journal of Construction Management.

Appendix V Bio-Data of Supervisor

Dr. Bhimaraya A. Metri obtained his Ph.D. degree from IIT-Bombay, Mumbai in the area of quality management. He obtained M. E. degree from Shivaji University, Kolhapur specializing in construction and management. He did his B. E (Civil) from Govt. College of Engineering, Karad. His experience spans over 16 years in academics. His research interest lies in the areas of quality management, supply chain management, world class manufacturing and project management. He is having over 45 publications to his credit in refereed journals and conference proceedings. He has also worked as consultant and trainer for PMGSY, NTPC, Autoloite (India) Ltd., Nippon Dendro Ispat Ltd., BSES Ltd., Bank of Rajasthan, and Hindustan Zinc Ltd. Dr. Metri is a life member of ISTE, New Delhi and IETE, New Delhi. He also worked as Assistant Professor in Management Group at BITS, Pilani. Presently he is working as Associate Professor of operations management at MDI, Gurgaon.

Appendix VI Bio-Data of Candidate

Mr. Shivaprakash C.K. obtained his M. Tech degree in construction engineering and management from MIT Manipal. He did his B.E (Civil) from MCE, Hassan, Mysore University. His teaching career spans over 21 years, He has worked as lecturer for about 8 years and as Assistant Professor for about 13 years. His research areas are quality management, operations research and project management. Mr. Shivaprakash has worked with various academic and examination bodies of Bangalore University, Mangalore University, Karnataka University and Visweswaraiah Technological University. He is also a life member of ISTE, New Delhi. Mr. Shivaprakash is a full time Research Scholar of BITS, Pilani.