Proceedings of GLOGIFT 12
July 30 – August 1, 2012
University of Vienna, Austria
pp. 750-757

Quantification of Critical Success Factors of Total Quality Management Principles: An Application of Fourier Series Analysis

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Abstract

The aim of this paper is to identify and quantify the key factors in successful implementation of Total quality management (TQM) practices in Indian oil and gas industry. The Critical success factors (CSFs) considered in this study are identified through literature review and opinion of expert from industry and academia. Fourier series analysis (FSA) is employed to compute the relative significance of the CSFs of TQM implementation in oil and gas industry. FSA highlights the importance of CSFs and helps the top management to decide the areas of critical concern. It can be seen that Fourier analysis is more powerful tool as it goes one step further and considers the relationship of CSFs with magnitude and type of effect.

Keywords: *Total Quality Management; Critical Success Factors; Fourier series Analysis*

Introduction

TQM is an integrative management philosophy aimed at continuously improving the quality of products and processes to achieve customer satisfaction (Joseph et al., 1999). It mandates the participation of individuals at all levels and functions of an organization (Pfau, 1989) and affirms a management philosophy based on process improvement through use of relevant data. TQM focuses on customer orientation, comprehensive quality monitoring, and supportive management systems (Smith et al., 1989). It makes itself evident through an organization-wide shared belief in total customer satisfaction (Hall, 2004).

To be competitive in this world, organizations need a higher level of effectiveness across all functions and processes and Total quality management (TQM) has emerged as a strategy to achieve a niche in the market (Baidoun, 2003). Implementation of TQM has results in improved productivity, enhanced quality, increased customer satisfaction, reduced costs and increased competitive advantage (Hasan and Kerr, 2003). A number of companies have revitalized their businesses and have thereby restored their market shares and profits by adopting TQM principles (Samson and Terziovski, 1999).

A survey (cited in Singh, 1991) conducted by National Productivity Council revealed that quality improvement is vital for the achieving competitiveness in Indian industrial environment. The

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challenge before the Indian supplying firms today is to update their total quality and supply activities in order to remain competitive at global level. To address this challenge the Indian supplying firms need to understand the factors that play critical role in implementation of TQM principles and their implications on strategic business objectives. This study provides a framework for knowing the relative importance of key success factors (CSF) that play major role in TQM implementation. Fourier series analysis (FSA) is employed to quantify the relative importance of CSFs.

The remainder of the paper is organized as follows: The next section briefly cover the TQM principles and relevant critical success factors. Then, Section 3 describes the research methodologies used in this study. Results are discussed in section 4. Finally, the concluding Section summarizes the findings of the study and suggests few directions for further research

Literature Survey

Although TQM is a proven approach for success in manufacturing, services and the public sector, several organizations failed in their campaigns because of many reasons like lack of top management commitment, ignoring customers etc. (Seetharaman et al., 2006). They reviewed the literature to identify the common problems that lead to the failure of TQM implementation. They argued that the understanding of the factors that cause failure to the TQM implementation can help companies in their long term continuous improvement efforts.

Total Quality Management Principles

TQM can be defined as a holistic management philosophy that strives for continuous improvement in all functions of an organization, and it can be achieved only if the total quality concept is utilized from the acquisition of resources to customer service after the sale (Kaynak, 2003). The TQM approach integrates the fundamental techniques and principles of quality function deployment, statistical control, and existing management tools in a structured manner. The aim of TQM is to reduce the errors produced during the supplying service process, enhance customer satisfaction, streamline supply chain operations, and have workers having the highest level of training.

CSFs of TQM Implementation

A critical success factor (CSF) is an element that is necessary for an organization to achieve its goal. According to Boynlon and Zumud (1984), CSFs are those few things that must go well to ensure current and future success of current operating activities. These factors represent those managerial or enterprise issues that must be given special and continual attention to bring about high performance. Karuppusami and Gandhinathan (2006) examined 37 TQM empirical studies and compiled 56 CSFs. They analyzed and sorted the CSFs in descending order according to the frequency of occurrences using Pareto analysis. Eid (2009) identified a comprehensive set of factors influencing the successful implementation of TQM in Egyptian supplying firms and classified them into two categories: strategic and tactical success factors. Since the number of such factors is large, each capable of influencing the most of others to a varying degree, it is very difficult, if not impossible, to consider them all. The selection involves a decision making team comprising of experts from industry and academia. Based on the literature survey and outcome of the brainstorming session involving team of experts from industry and academia, eight most CSFs influencing TQM practices were identified as: Customers focus, Leadership commitment, Continual improvement, Team work, Human resource focus, Organisation structure, Quality control tools. These are briefly discussed in the following subsections.

Customer's Focus

Increasingly, organizations are using customer satisfaction as the measure of quality. Customer's focus is one of the most generally-accepted precepts of quality management. Malcolm Baldridge National Quality Award qualification assigns 300 out of the total 1000 points to customer satisfaction. This factor addresses the organization's capability to determines current and future customer requirements and expectations, provides effective customer relationship management, and determines customer satisfaction (Evans and Lindsay, 1995). TQM proponents have also argued that an organization should not be conceived as a closed, self-contained system but rather as open, including for example, both suppliers and customers (Bowen and Waldman, 1999).

Leadership Commitment

Leadership commitment is considered as the major force of TQM which involves defining the need for change, creating new frameworks to mobilize commitment to those vision frameworks for thinking about strategy, structure and people (Aalbregtse, 1991). This requires management to actively participate in quality transformation. They have to outline the quality goals, quality policies and quality plans so that employees are constantly reminded that the customer, not the product, is the top priority (Besterfield, 1995). Some principles and practices of TQM may differ among firms and industries, but there is unanimous agreement as to the importance of leadership by top management when implementing TQM.

Continual Improvement

Continuous improvement of all systems and processes in an organization is essential for TQM success. It is a business management strategy originally developed by Motorola USA in 1981. It is is now widely recognized as a business strategy that employs statistical and non-statistical tools and techniques, change management techniques, project management skills, team-working skills and a powerful roadmap to maximize an organization's return on investment (ROI) through the elimination of defects in processes (Atkinson,2006). A continuous improvement system gears the organization toward attainment of the vision (Richardson, 1997). The improvement system must not only be continuously applied, but also consistently, throughout the organization. This requires a disciplined continuous improvement system based on trust, with everyone in the organization striving to improve the system (Crosby, 1979).

Team Work

Teamwork in TQM often takes forms of quality circles, quality improvement teams, and cross-functional teams. Effective teamwork can motivate employees and improve employee performance and self-efficacy. This improved motivation and self-efficacy via teamwork can be a source of employee autonomy, meaningfulness, bonding with team members, and satisfaction (Denison and Hart, 1996). For example, Rahman and Bullock (2005) found from their surveys of manufacturing companies in Australia and New Zealand that the use of teams has a significantly positive relationship with employee morale.

Customer Relationship Management

Customer relationship management (CRM) is the overall process of building and maintaining profitable customer relationships by delivering superior customer value and satisfaction (Sen and Sinha, 2011). The most important expected outcomes of CRM can be listed as: improvements in efficiency, cost reduction, improved profitability and increase in sales, enhanced customer value, customer satisfaction and improved customer loyalty (Öztays, et al., 2011). CRM as tool in today's business paradigm includes people, cross-functional processes, and technological

aspects associated with marketing, sales and service. In order to maintain a high-quality service for customers, CRM typically streamlines processes and automates the process of gathering a huge amount of data and information about customers and uses it for effective communication and delivery of products, services, information, and solutions.

Human Resource Focus

Many studies have identified human resources as one of the critical factors of total quality management (Ruggieri and Merli, 1997). Human resource focus aims to generate improved individual and organizational performance and to help employees reach certain personal goals by empowering them to participate in the decision-making process, inspect their own jobs, and find and fix problems. Recent studies identified employee empowerment as a critical factor of TQM implementation (Baidoun, 2003). Sila and Ebrahimpour (2003) divide this factor in to nine sub categories: Human resource management, Training, Workforce commitment to quality, Employee involvement, Employee empowerment, Employee fulfillment, Teamwork, Employee performance appraisal, rewards and recognition and Communication.

Management Structure

The structure defines the power relationships and institutionalises the pattern of interpersonal interaction and information flows (Hall, 1987). The organizations embarking on TQM path should have the requisite structural characteristics to deal with problems of complexity, interdependence and uncertainty during implementation of various programs. The horizontal organic structures designed around processes are ideal ones from the TQM implementation point of view.

Quality Tools

Yusof and Aspinwall (1999) considered improvement tools and technique as CSF in their study. This factor includes QC tools (Cause and effect diagram, check sheet, control charts, histogram, Pareto charts, Scatter diagram and Stratification), SPC, quality control and problem solving technique. Proper application of these tools helps in successful implementation of TQM.

Research Methodology

The objectives of this paper are to examine the relationship among various CSFs of TQM practices and to rank them with reference to various performance measures. Here, the FSA is used for examining the magnitude of TQM principles so that top management can adjust its focus accordingly.

Pilot Survey

A pilot survey was conducted in ten oil and gas companies in India. More than 500 managers are contacted and data related to the problem was collected using a questionnaire designed for the purpose. A five-point Likert scale was utilized to seek the opinion of participants. The data thus collected has been used for FSA of the CSFs of TQM practices.

Ascertaining Significance of CSFs using FSA

Fourier series is basically used for calculating the coefficients of different harmonic presents in a particular signal. Once a person asked to give ranks to different parameters he has so many influential factors in his mind to give a rank to the parameters. Now ones, rank is given there are different statistical tools available to analyze the parameters dominance, statistics depends upon the data (rank given by the experts), but fails to recognize the real causes that force a person to give a particular rank to a parameter. As a person (experts) giving a signal (rank) to a parameter that rank as a signal has so many harmonics (causes).Fourier series coefficients

can help to find out those dominant harmonics (parameters or causes) and will be helpful to assign a magnitude to those causes or parameters .

Ranking of different TQM principles are done by industry experts. Ranks are basically a signal that is given by industry experts. This literature uses ranks of TQM Principles as the basic to find out Fourier series coefficients. Fourier series coefficients can be calculated using Matlab, coefficients of Fourier series gives the magnitude of the principles. Magnitude can be assigned to different TQM principles depends upon the average ranks that a particular principle has.

In this analysis eight CSFs of TQM are first ranked by different experts. These ranks are then fed as input signal in the Matlab program to calculate the harmonics of the signal, considering the eight CSFs as modes. The program output is in the form of the coefficients (Magnitude) and angles (phase) and is presented in Tables 1 and Table 2. Figure 1 shows the magnitude and phase of different TQM principles. The magnitude of Fourier coefficients represents the degree of dominance and phase of the coefficients represents the type of effect (Negative phase indicates Pull, Positive phase indicates Push and zero phase indicates constant effect).

Table 1: Magnitude of TQM Principles

TQM Principles	1	2	3	4	5	6	7	8
Magnitude	7.679688	0.19454	0.025271	0.044258	0.114709	0.105414	0.064853	0.305636

Table 2: Phase of TQM Principles

TQM Principles	1	2	3	4	5	6	7	8
Phase	0	0.414515	0.707472	-0.18417	-1.92937	-0.35648	-1.3422	-2.18194

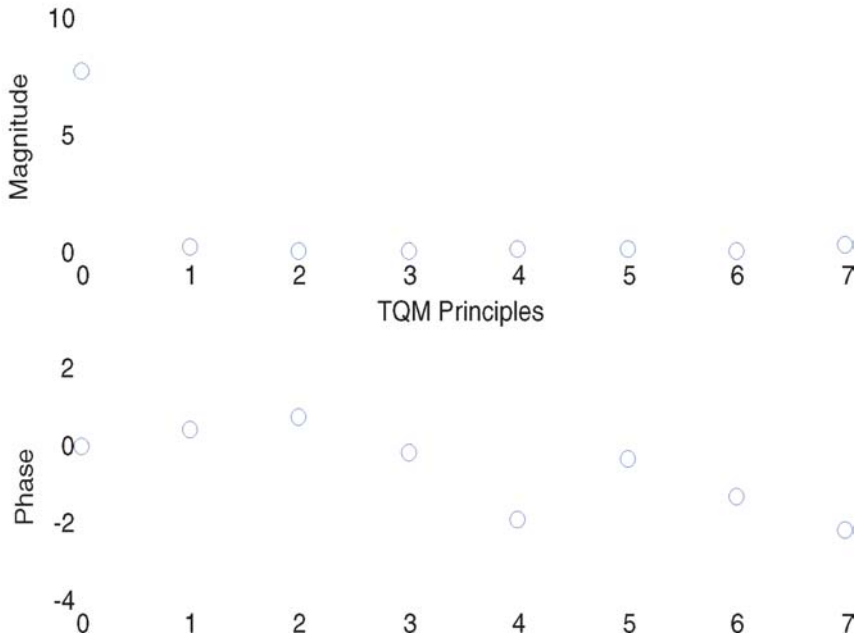

Figure1: Magnitude and Phase of Different TQM Principles

Table 3: Magnitude Assignment with the help of Average Rank of the TQM Principles

S.No	TQM Principles	Average Rank	Magnitude
1	**Customers focus**	4.235669	7.679688
2	**Leadership Commitment**	4.095541	0.305636
3	**Team work & empowerment**	3.974522	0.19454
4	**Quality tools**	3.888535	0.114709
5	**Management structure**	3.88535	0.105414
6	**Continual improvement**	3.843949	0.064853
7	**Supplier support**	3.821656	0.044258
8	**Human resource focus**	3.815287	0.025271

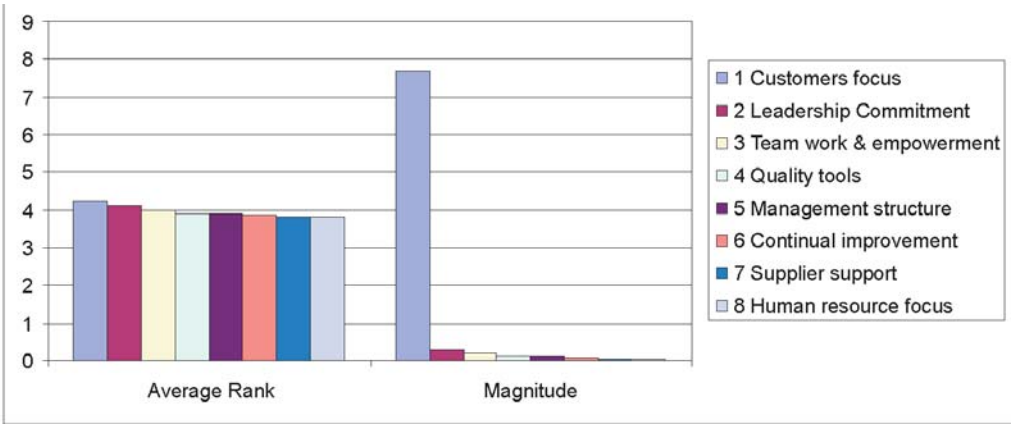

Figure 2: Average Ranks and Magnitude of Dominance of the TQM Principles

Results and Discussion

Major objectives of the paper were to analyze the relationships among the CSF of TQM principles and to rank them with respect to chosen performance areas using modeling approach .From Figure 2, it is clear that the ranks of the variance is less compared to the magnitude of the principles it indicates that ranking method does not give the clear picture of dominance as FSA does. The FSA revealed the magnitude of identified CSFs and helped to develop quantified values of TQM principles (Table 3). It also helped to identify the effect of TQM principles in terms of PUSH, PULL and CONSTANT.

FSA is very simple and takes into consideration the dynamicity of factors through time dependent functions. A FSA matrix needs to be square in nature. The contextual relationship among the variables always depends on the expert's knowledge about the firms and its operations. The bias of the person who is judging the variables might, therefore, influence the final result. And since the models used can differ from industry to industry, accuracy determination will be difficult without having any common base or context. FSA can only act as a tool for imposing order and direction on the complexity of relationships among the variables. It gives weighting and type of effect associated with the variables.

Conclusion

In this research paper we have tried to identify the major critical success factors (CSF's) which would facilitate successful implementation of TQM principles in India. The study gives a comprehensive perspective regarding CSFs of TQM principles and can act as ready reckoner

for the industry practitioners. The novel ranking model constructed using FSA could be handy in developing the dynamic ranking method, which other methods fails to incorporate. Moreover, the ranking obtained from these tools are also different from each other. This application of FSA helps in understanding the comparative evaluation of the methodologies, and able to assign the magnitude for different CFS's.

This paper will help the industry professionals in comparing ranking tools and choosing it according to their requirements. Moreover instead of using only one ranking process in industries, they can now use other ranking process in coordination of it.

This is one of the first studies that focus quantification of CSF's comparison has also been done with other tools available. Views of Industry and academia are also incorporated. These models can act as a tool for the management to understand the relative importance of CSF of TQM in industry.

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