Article

Interrelationship between Total Quality Management and Six Sigma: A Review

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Abstract

The purpose of this study was to explore the dimensions of total quality management (TQM) and Six Sigma methodology through an extensive literature review and to understand the similarities and differences between the two. The present study identified a set of 13 TQM and 11 Six Sigma practices. The authors also compared the two methodologies with respect to their mutual similarities and differences. Though a considerable number of studies are available on TQM and Six Sigma individually, only limited literature is available regarding their integration. This study systematically reviews and reports about a set of 36 and 31 scholarly articles for TQM and Six Sigma, respectively. Only a few authors (such as, Revere & Black, 2003; Yang, 2004; Zu, Fredendall & Douglas, 2008) have focused on the integration perspective of TQM and Six Sigma.

The literature survey revealed that TQM and Six Sigma are two different concepts that share similarities, but also have significant disparities. Six Sigma emerges as significantly superior to TQM in some aspects. However, both TQM and Six Sigma should be integrated to produce a synergistic effect on quality performance, which, in turn, may increase business performance. The outcome of this study will help provide a better understanding of the identified TQM and Six Sigma philosophies that will help managers and future researchers understand effective implementation of quality management strategies in improving business performance.

Keywords

Total quality management (TQM), Six Sigma, quality management, literature review, comparison

Introduction

In today's globalized economy, companies are trying very hard to satisfy the ever-increasing demands of the customer by improving their quality of products and services, and business success is being viewed in terms of better financial results. Eriksson and Hansson (2002) advocated that quality award recipients exhibit better financial results than comparable average companies do. Continuous improvement in total business activities and focus on customers is the need of the hour. Therefore, quality management is the only way by which companies can survive in the increasingly aggressive markets and take on

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a competitive edge (Dale, 1999). According to Juran (1989), quality is not an obligation of any one individual but is the responsibility of each employee in the organization; it is an integrated effort that results in building quality products, processes and services.

Considering the above facts, one sees that a large number of organizations are increasingly adapting total quality management (TQM) as a business strategy to minimize management costs and improve customer satisfaction rather than just restricting it to administering product quality and service level. Total quality management came to be used somewhere in the early 1980s, and became popular quite rapidly, as can be deduced from a 1993 *Industrial Weekly* article that stated 'In ten short years, TQM has become as pervasive a part of business thinking as quarterly financial results'. Total quality management has now been promoted to achieve competitiveness, better financial results and overall business performance. Contemporary insights provided by Brun (2011) reaffirm TQM as an integrated practice where all departments, namely, marketing, finance, design, manufacturing, purchase, engineering and human resources (HR), come together to accomplish organization goals and objectives and to meet customer requirements. It is also observed that every organization tries to make continuous efforts to improve product, process and services by using knowledge and experience of the workforce in the organization.

However, TQM has also come in for its fair share of criticisms. Pyzdek (2003) reported that the low probability of success of quality initiatives deterred many organizations from implementing TQM. Total quality management offers a broad set of philosophical procedures and no means to prove that one had accomplished their quality goals (Pyzdek, 2006). Also, Brun (2011) pointed out that TQM offered not specific, but merely a general set of guidelines for implementation leading to worldwide criticism. Harari (1997) criticized TQM for the long time it takes to get appreciable results.

Six Sigma practices were implemented for the first time by Motorola in 1986, and the same has been accepted as an exceptional and recognized methodology for measuring quality and a global standard as well (Antony & Ricardo, 2002). Well-established organizations, such as, Texas Instruments, Honeywell, Kodak, General Electric (GE) and Sony, have exhibited substantial financial returns because of the adoption of Six Sigma methodology for various business processes. Six Sigma practices, particularly espoused by GE, have become a popular management tool in the business world (Yang, 2004). Implementing Six Sigma can lead to quality improvements, enhanced productivity and reduced costs (Cheng, 2009). Further, Six Sigma methods have been treated as a project-driven management methodology and a business approach, which advance an organization's products, services and processes by continually eliminating defects and reducing variations. This has resulted in improvising the understanding of customer requirements, business systems, productivity and financial performance (Kwak & Anbari, 2006).

Though Six Sigma is a meticulously focused and highly efficient implementation of proven quality principles and techniques, some pitfalls related to these practices have been put forth. Stamatis (2000) stated that Six Sigma is merely the repackaging of TQM. Later, Kwak and Anbari (2006) opined that Six Sigma is not an immediate one-stop solution that resolves all business problems. Organizations need to evaluate their strong and weak points properly before implementing Six Sigma methodology. In the light of this, the present review attempts to examine the contents and practices of TQM and Six Sigma, and explores the interrelationship between them.

Review Methodology

The present review of literature is a concerted effort to study TQM, Six Sigma practices and their integration perspectives with each other and with other quality management tools and techniques; the review particularly aims at identifying certain gaps in the current research scenario. Several peer-reviewed articles were explored through keywords, such as, 'Total Quality Management (TQM)', 'Six Sigma' and 'Integration of TQM and Six Sigma', in December 2012 (Figure 1). A structured review was

Figure 1. List of Journals Referred

Source: Authors' own.

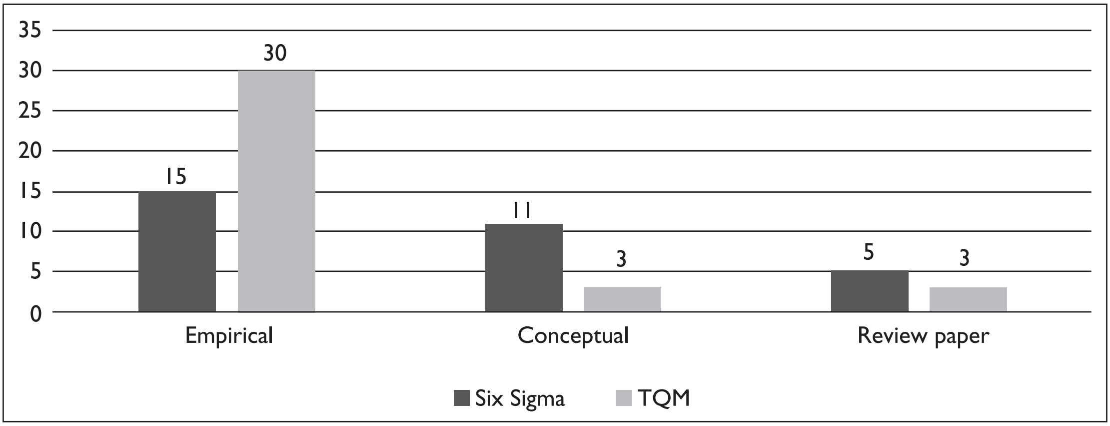

Figure 2. Distribution of Articles Related to TQM and Six Sigma as per Type of Study

Source: Authors' own.

conducted after collecting scholarly research articles published in business-allied journals from databases, such as, EBASCO, *ScienceDirect*, *Emerald* and ABI/Inform Global (ProQuest Direct), which are available in research institute libraries; the studies from conferences and books have also been included in the present review. Considerable volumes of literature related to TQM and Six Sigma are available. For an organized meta-analysis, the collated research articles were arranged as per the type of the study, the geographical region of the study, the year of the study and the industry type to which the study pertained to.

Figure 2 depicts the type of TQM- and Six Sigma-related studies published in scholarly articles. The figure illustrates that in the case of TQM, a considerable number of empirical studies have been conducted, whereas Six Sigma is a relatively new idea still in the conceptual stage requiring the thrust of more empirical studies.

Figure 3 shows the comparison of Six Sigma- and TQM-related research with respect to the type of industry. The figure illustrates that a larger number of studies pertaining to the manufacturing industry have been conducted in the case of TQM than Six Sigma.

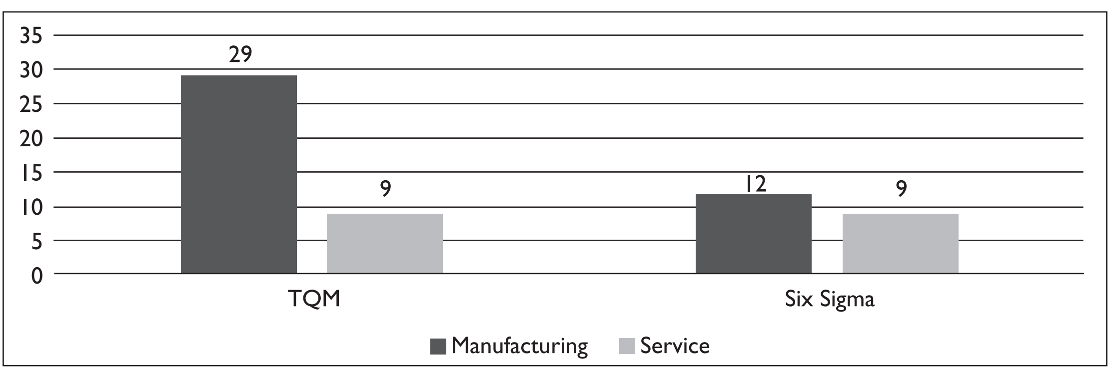

Figure 3. Industry-wise Distribution of TQM and Six Sigma Studies

Source: Authors' own.

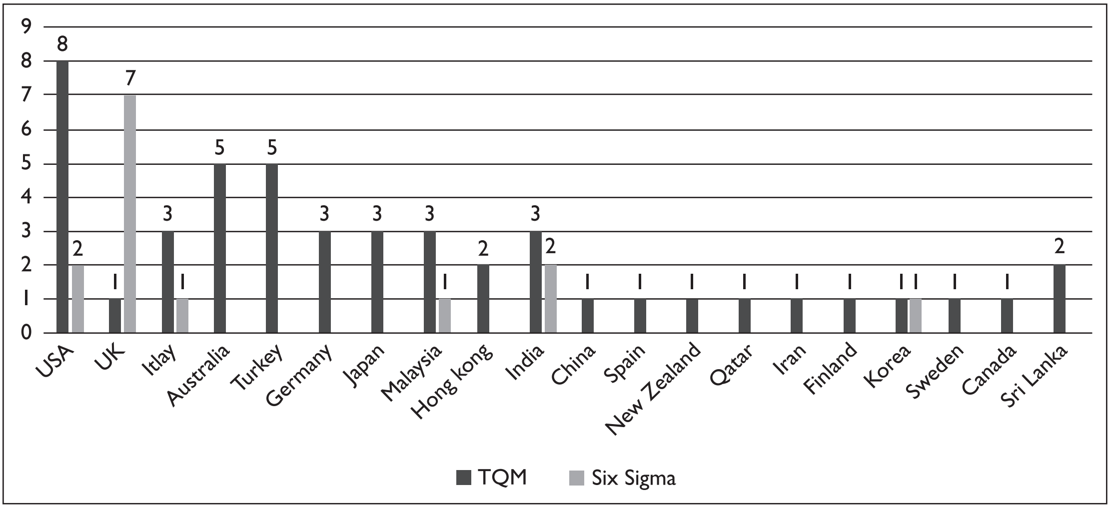

Figure 4. Country-wise Distribution of TQM and Six Sigma Studies

Source: Authors' own.

Figure 4 outlines the comparison of Six Sigma and TQM with respect to the countries where the same were implemented. The figure demonstrates that almost all developed (USA, UK, Australia, Japan, Canada, New Zealand, etc.) and developing countries (India, Malaysia, Hong Kong, China, Korea and Sri Lanka) have implemented TQM. However, Six Sigma is a relatively new concept and has been popularized in countries, such as, the USA and the UK.

Figure 5 displays the comparison of TQM and Six Sigma based on the number of years of research that have gone into both. The figure shows that TQM-related empirical studies started since 1989 and concerted research is still on as of 2012. However, the concept of Six Sigma is relatively novel and related empirical studies emerged only from 2004 onwards. To date, there is a significant dearth of relevant empirical studies with respect to Six Sigma.

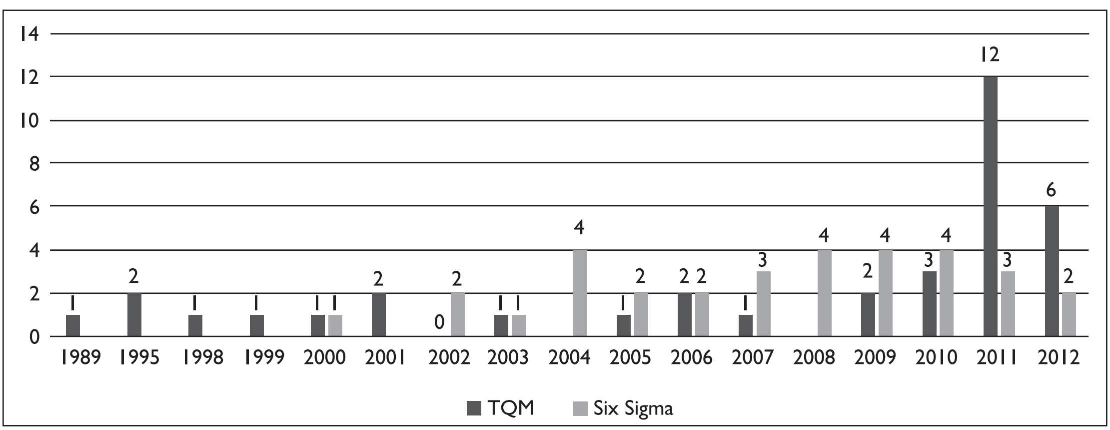

Figure 5. Year-wise Distribution of Research Articles Related to TQM and Six Sigma

Source: Authors' own.

The present review attempts to explore the relationship between TQM and Six Sigma. To understand these theories, scholarly articles related to both the practices were identified and studied. Further, papers related to integration perspective of TQM and Six Sigma were referred. This review is organized as follows: The third section starts with the theoretical background of TQM and Six Sigma, which includes definitions, methodologies, tools, practices and criticisms. The fourth section presents a thorough comparison between TQM and Six Sigma. The fifth section discusses about the integration perspective of TQM and Six Sigma. Finally, the 'Discussion and Conclusion' section is followed by a summing up of the research gaps identified from the present review.

Theoretical Background

Lenka, Suar and Mohapatra (2010) reported that quality management philosophy is based on the theory of competitive advantage (Porter, 1985), resource-based theory of the firm (Prahalad & Hamel, 1990) and the systems theory of work performance (Waldman, 1994). Supporters of all these theories contended that the success of an organization's competitive strategy hinges on demands in the target market. In the 'resource-based theory', internal resources of firms, such as, technology and people, provide a competitive edge. This theory accentuates the significance of internal resources of organizations that help create a superior market position. Resources comprise physical capital, human capital and organizational capital where human and organizational capitals are the main drivers of competitive advantage. On the other hand, the 'systems theory' inspects work performance. Internal aspects of an organization's environment are the key components of its actions and responses. 'Quality management practices' are deployed as a means of creating competencies in organizations. These three theories recommend that organizations must articulate their strategies according to market demands.

Quality management can be viewed as a management revolution, a revolutionary philosophy of management, a novel thought process for managing organizations, a paradigm shift, an inclusive way to amplify total organizational performance, a substitute to management by control or as a framework for competitive management (Foley, 2004). Further, Kroslid (1999) believes that there are two schools of thought related to quality management—the deterministic and the continuous improvement school. The former is elaborated as '(the) deterministic sight of reality with a belief in the existence of one best way', that is, conformance to specifications is a paramount way to congregate customer requirements. On the other hand, the latter may be put forth as '(the) real world is full of variation, with an awareness of improvement potential in every aspect of (the) work', or in other words, continuous improvements are used to reduce the impact of environmental changes and other variations.

About TQM

In the past years, quality has been a significant issue for almost every organization. As per Dale (1999), the initial focus on quality gradually shifted from inspection to quality control, and then to quality assurance. Waldman (1994) reports that TQM practices owe their origin to the manufacturing sector wherein statistical quality control measures were first employed to reduce product defects during the mid-1980s. By the 1990s, TQM evolved as a common term among organizations. In this period, TQM was the prevailing paradigm for quality management, which incorporated many of the elements supported by leading quality thinkers, such as, Deming, Juran and Crosby (Dale, 1999). Today, TQM is a well-accepted twentieth-century management philosophy in operation management (Ahire & Ravichandran, 2001).

Competition on a global scale has caused several businesses to invest sizeable resources in taking up and implementing TQM strategies (Demirbag et al., 2006). Organizations are keen to utilize this methodical quality improvement approach to achieve business performance in terms of quality outcomes (Dow, Samson & Ford, 1999).

TQM Definitions

Different definitions of TQM have been presented over the years. Dahlgaard, Kristensen and Kanji (1998) view TQM as a corporate culture characterized by improved customer satisfaction through continuous improvement, in which all employees in the firm actively participate. Shiba, Graham and Walden (1993) describe TQM as an evolving system of practices, tools and training methods for managing companies to provide customer satisfaction in a rapidly changing world. Hellsten and Klefsjo (2000) defined TQM as a continuously evolving management system consisting of values, methodologies and tools. According to Besterfield et al. (2008), TQM is *Total:* Made up of entire; *Quality:* extent of superiority a product or process offers; *Management:* act, art or manner of handling, controlling, directing. Alternatively, TQM is defined as the philosophy and set of guiding principles that represent the foundation of a continuously improving organization. The International Organization for Standardization (ISO) defines TQM as a management approach for an organization centred on quality, based on the participation of all its members, aiming at long-term success through customer satisfaction and benefits all members of the organization and the society at large.

Methodologies and Tools

Melsa (2009) mentioned that there is no specific tool best suited for every application. Also he reported a comprehensive list of tools, namely, Process Maps, Poke-Yoke, Statistical Tools, Force Field analysis, Root Cause analysis (Five Why's), Fishbone analysis (Ishikawa Diagram), plan–do–check–act or plan–do–check–act (PDCA) cycle, Affinity Diagram, Interrelationship Digraphs, Tree Diagram, Priority Matrix and Activity Network diagram. The aim of values, tools and methodologies is to diminish significantly the dependence on resources and to enhance external and internal customer satisfaction. The methodologies and tools should be chosen accordingly and continuously to maintain the values to be part of the organizational culture (Hellsten & Klefsjo, 2000). The three units, values, tools and methodologies together form TQM as a complete management system. These three elements have been presented in Figure 6.

Anderson et al. (1995) mentioned that tools commonly reported in the TQM-related literature consist of seven tools each of quality control (Ishikawa, 1985; Shewhart, 1980) and management (Mizuno, 1988). The improvement cycle is a shared methodology in order to improve the business (Evans & Lindsay, 1996). The improvement cycle consists of four stages: plan, do, study and act (PDSA).

TQM Practices

Several authors have studied the effect of TQM practices on business performance. TQM practices are directly related to final product quality and customer satisfaction (Gotzamani, Theodorakioglou & Tsiotras, 2006). Table 1 presents 13 TQM practices identified from previous studies; these practices have a significant effect on operational and organizational performance.

Top Management Leadership

Various authors have mentioned that the foundation of TQM practices is laid by the top management. According to Parast et al. (2011), top management support is a significant variable in explaining the variability of operational performance of an organization. Leaders play a critical role as drivers of

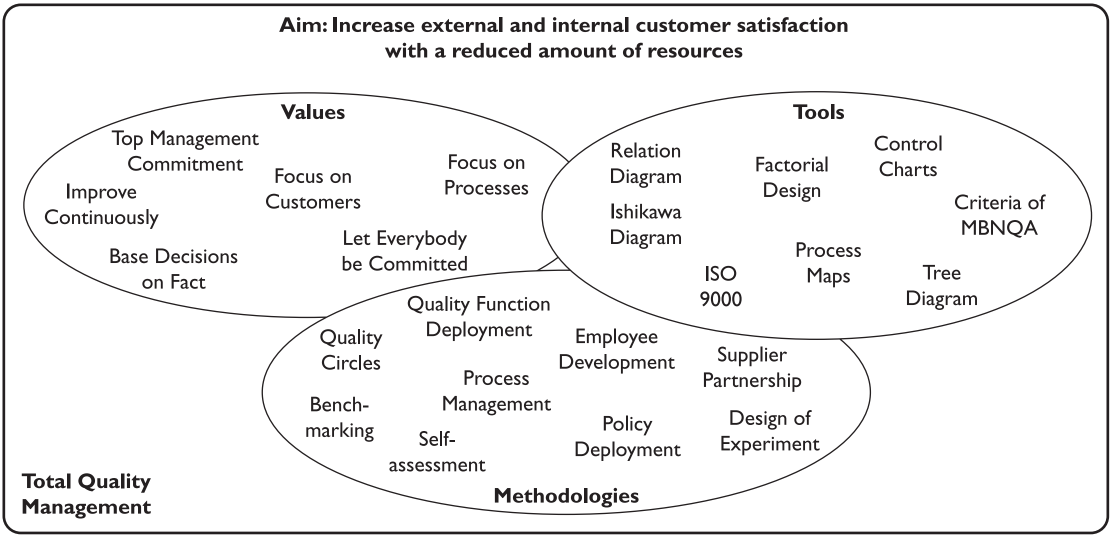

Figure 6. TQM as a Management System Consisting of Values, Methodologies and Tools

Source: Hellsten and Klefsjo (2000).

Table 1. List of TQM Practices

Sl. No.	Major TQM Practices	Supporting References
1	**Top Management Leadership**	Saraph, Benson and Schroeder (1989), Anderson et al. (1995), Flynn, Schroeder and Sakakibara (1995), Dow et al. (1999), Kaynak (2003), Yeung and Cheng (2005), Parast et al. (2006), Tarí, Molina and Castejon (2007), Zu et al. (2008), Kumar, Garg and Garg (2009, 2011), Salaheldin (2009), Khanna, Laroiya and Sharma (2010), Sadikoglu and Zehir (2010), Zu, Robbins, & Fredendall (2010), Parast, Adams and Jones (2011), Chin and Sofian (2011), Phan, Abdallah and Matsui (2011), Talib, Rahman and Qureshi (2011), Zehir et al. (2012), Mensah, Copuroglu and Fening (2012), Wickramasinghe (2012), Lam et al. (2012), Ooi et al. (2012), Kim, Kumar and Kumar (2012).
2	**Role of Quality Department**	Saraph et al. (1989), Tarí et al. (2007), Khanna et al. (2010), Mensah et al. (2012), Wickramasinghe (2012), Lam et al. (2012).
3	**Training and Learning**	Saraph et al. (1989), Anderson et al. (1995), Dow et al. (1999), Das et al. (2000), Ho (2010), Kaynak (2003), Tarí et al. (2007), Salaheldin (2009), Khanna et al. (2010), Sadikoglu and Zehir (2010), Parast et al. (2011), Phan et al. (2011), Talib et al. (2011), Kumar et al. (2011), Ooi et al. (2012), Kim et al. (2012).
4	**Supplier Quality Management**	Saraph et al. (1989), Flynn et al. (1995), Forza and Filippini (1998), Dow et al. (1999), Das et al. (2000), Ho (2010), Cua, Mckone and Schroeder (2001), Kaynak (2003), Parast et al. (2006, 2011), Tarí et al. (2007), Zu et al. (2008), Kumar et al. (2009), Salaheldin (2009), Khanna et al. (2010), Sadikoglu and Zehir (2010), Zu et al. (2010), Chin and Sofian (2011), Phan et al. (2011), Agus and Hassan (2011), Baird, Hu and Reeve (2011), Talib et al. (2011), Zehir et al. (2012), Mensah et al. (2012), Wickramasinghe (2012), Kim et al. (2012).

Sl. No.	Major TQM Practices	Supporting References
5	**Product/Service Design**	Saraph et al. (1989), Flynn et al. (1995), Cua et al. (2001), Kaynak (2003), Zu et al. (2008, 2010), Salaheldin (2009), Khanna et al. (2010), Parast et al. (2011), Baird et al. (2011), Phan et al. (2011), Gunday et al. (2011), Kim et al. (2012).
6	**Process Management**	Saraph et al. (1989), Anderson et al. (1995), Flynn et al. (1995), Forza and Filippini (1998), Cua et al. (2001), Kaynak, (2003),Yeung and Cheng (2005),Tarí et al. (2007), Zu et al. (2008, 2010), Salaheldin (2009), Khanna et al. (2010), Sadikoglu and Zehir (2010), Zhang, Linderman and Schroeder (2011a), Baird et al. (2011), Chin and Sofian (2011), Phan et al. (2011), Gunday et al. (2011), Zehir et al. (2012), Mensah et al. (2012), Lam et al. (2012), Kim et al. (2012).
7	**Quality Data Reporting**	Saraph et al. (1989), Flynn et al. (1995), Das et al. (2000), Ho (2010), Kaynak (2003), Parast et al. (2006), Tarí et al. (2007), Kumar et al. (2009, 2011), Khanna et al. (2010), Agus and Hassan (2011), Parast et al. (2011), Zhang et al. (2011a), Baird et al. (2011), Phan et al. (2011), Kim et al. (2012), Zehir et al. (2012).
8	**Employee Relations**	Saraph et al. (1989), Anderson et al. (1995), Flynn et al. (1995), Dow et al. (1999), Ho (2010), Kaynak, (2003), Parast et al. (2006, 2011), Tarí et al. (2007), Zu et al. (2008), Kumar et al. (2009), Salaheldin, (2009), Khanna et al. (2010), Zu et al. (2010), Sadikoglu and Zehir (2010), Zhang et al. (2011a), Baird et al. (2011), Chin and Sofian (2011), Phan et al. (2011), Talib et al. (2011), Zehir et al. (2012), Mensah et al. (2012), Wickramasinghe (2012), Lam et al. (2012), Ooi et al. (2012), Kim et al. (2012).
9	**Customer Satisfaction**	Flynn et al. (1995), Forza and Filippini (1998), Dow et al. (1999), Das et al. (2000), Cua et al. (2001), Tarí et al. (2007), Zu et al. (2008), Kumar et al. (2009, 2011), Salaheldin (2009), Khanna et al. (2010), Sadikoglu and Zehir (2010), Zu et al. (2010), Parast et al. (2011), Zhang et al. (2011), Chin and Sofian (2011), Phan et al. (2011), Talib et al. (2011), Zehir et al. (2012), Mensah et al. (2012), Wickramasinghe (2012), Lam et al. (2012), Ooi et al. (2012), Kim et al. (2012).
10	**Continuous Improvement and Innovation**	Anderson et al. (1995), Tarí et al. (2007), Salaheldin (2009), Khanna et al. (2010), Sadikoglu and Zehir (2010), Agus and Hassan (2011), Baird et al. (2011), Gunday et al. (2011), Talib et al. (2011), Kumar et al. (2011), Zehir et al. (2012).
11	**Benchmarking**	Dow et al. (1999), Salaheldin (2009), Agus and Hassan (2011), Parast et al. (2011).
12	**Culture**	Yeung and Cheng (2005), Salaheldin (2009), Khanna et al. (2010), Baird et al. (2011), Ooi et al. (2012).
13	**Information & Analysis**	Zu et al. (2008), Salaheldin (2009), Sadikoglu and Zehir (2010), Zu et al. (2010), Parast et al. (2011), Chin and Sofian (2011), Mensah et al. (2012), Wickramasinghe (2012), Lam et al. (2012).

Source: Authors' own.

TQM (Tarí et al., 2007) and improve performance by influencing other TQM practices (Anderson et al., 1995; Flynn et al., 1995). Earlier studies related to quality management show that strategic planning and management leadership are key factors for achieving higher product quality and creating an environment for continuous improvement (Anderson et al., 1995; Das et al., 2000; Flynn et al., 1995; Kaynak, 2003). According to Sadikoglu and Zehir (2010), the TQM theory holds complete assurance to a total quality setting where leaders can categorize and synergize people's actions to achieve the common goals of an organization.

Role of Quality Department

Saraph et al. (1989) highlighted the attributes of the quality department including visibility and autonomy, consultation, coordination with other departments and overall efficient running of the machinery. According to Zhang, Hill and Gilbreath (2011b), quality exploitation practices provide the best performance outcomes in steady environments, while in a dynamic setting, quality exploration practices with an organic organizational structure give the best results as quality data have a positive impact on financial and market performance (Kaynak, 2003).

Training and Learning

The role of training and learning has been discussed as a key element in TQM practices as employee training has a significant effect on operational performance (Parast et al., 2011). Bell and Burnham (1989) mentioned that employee education and training is an important element of workforce management, while executing changes in an organization is a significant factor for producing quality products and services. According to Flynn et al. (1995), skill enhancement training for employees, employee suggestion and participation of employees in continuous improvement help the workforce imbibe a commitment with quality and skills. This leads to better product quality which is mediated through quality data and reporting (Ho, 2010). Forza and Filippini (1998) highlighted the significance of the personnel for a firm as organizational success is positively correlated with the level of commitment employees have with their jobs.

Supplier Quality Management

The long-term cooperative relationships with few suppliers result in efficient supplier quality management. Supplier relations increase the performance of both suppliers and buyers, and this is particularly true when quality and delivery are the buyer's priority (Flynn et al., 1995). A positive relationship with customers and suppliers on performance was reported in many empirical studies (Baird et al., 2011; Cua et al., 2001; Flynn et al., 1995; Kaynak, 2003; Parast et al., 2006; Yeung & Cheng, 2005). These studies recommended that managers should focus on customer and supplier involvement since it would permit organizations to enhance quality performance, which ultimately leads to customer satisfaction.

Product/Service Design

Flynn et al. (1995) discussed two aims of product/service design, that is, designing manufacturable products and designing quality into the products. They concluded that the product and service design process reduces process complexity and process variance thereby improving the manufacturing processes. Forza and Flippini (1998) found that quality problems can be reduced by including customers' requirements in new product/service design reviews prior to production. Further, Kayank (2003) concluded that there is a direct effect of product/service design on process management, which significantly contributes towards quality performance.

Process Management

Process management employs preventive and proactive techniques to quality management, such as, the decline in process variance reduction and foolproofing, which improve the quality of products in the production stage (Baird et al., 2011; Cua et al., 2001; Flynn et al., 1995; Saraph et al., 1989). Process management influences continuous improvement, which, in turn, can impact quality outcomes (Tarí et al., 2007). Additionally, the empirical findings by Forza and Filippini (1998) show that the reduced process variation results in improved output uniformity and simultaneously reduces rework and waste due to the timely detection and rectification of quality problems in the production process.

Quality Data and Reporting

This TQM practice ascertains the degree to which quality data is collected, scrutinized and used for quality improvement purposes (Gotzamani & Tsiotras, 2001). Supplier quality can be sustained by incorporating a supplier performance measurement database to retain a comprehensive record of material quality, parts' defects rates and supplier responsiveness (Forza & Filippini, 1998; Krause, 1998), with tools, such as, control charts often used in accordance with the database. Organizations implementing TQM give eminence to quality integration into the product rather than inspecting quality of the finished product and removing defective products (Ahire & O'Shaughnessy, 1998; Flynn et al., 1995; Handfield, Jayaram & Ghosh, 1999; Tan, 2001). As product design entails an extensive range of information, design teams are comprise people from purchasing, designing, production, suppliers and customers (Flynn et al., 1995; Lockamy, 1998).

Also, quality data and reporting directly affects process management by instantaneous notification to workers about loopholes in processes so they can take corrective actions before defective products are produced (Ahire & Dreyfus, 2000; Baird et al., 2011; Flynn et al., 1995; Handfield, Ghosh & Fawcett, 1998).

Employee Relations

This pertains to both the interdepartmental relationship between employees and the improved interaction between the organizational management and the workforce.

Empirical outcomes support the claim that employee relations are directly related to quality data and reporting (Flynn et al., 1995; Ho, 2010). Sadikoglu and Zehir (2010) reported that in research, design, sales and production, people have to work interdependently as a team across conventional organizational structures, in spite of working independently within their functions, as employee fulfilment has a significant effect on customer satisfaction (Anderson et al., 1995). In order to improve operational performance, better HR management practices are essential (Parast et al., 2011).

Customer Satisfaction

Customers are involved in quality improvement as their needs and expectations related to quality are measured (Zu et al., 2008) as open communication with key customers; this allows companies to recognize quickly the customers' requirements and to determine whether necessary conditions are being met (Flynn et al., 1995). An organization must attain the necessary information for the identification of customer needs as the constant appraisal and fulfilment of customer's necessities leads to continuous improvement. This aids in improving the system by maintaining the basic process of conversion of inputs into outputs (Sadikoglu & Zehir, 2010).

The improvement of products and service quality can be evaluated with the help of customer's feedback. Forza and Filippini (1998) view the degree of improvement in terms of customer satisfaction, which is indicated by the number of customer compliments, number of repeat customers and the customer retention rate.

Continuous Improvement and Innovation

Ortiz, Benito and Galende (2010) discussed innovation related to total quality practice and mentioned that not every business practice integrated with total quality has a positive significant effect on innovation. Total quality practices associated with HR management do exhibit a positive effect on technological innovation. Further, Gunday et al. (2011) conducted their study in Turkey on 184 manufacturing firms for measuring innovation performance and they confirmed the positive effects of innovations on firm performance, especially in manufacturing industries.

Benchmarking

As per Parast et al. (2011), benchmarking is not statistically significant in explaining variability in external quality results; yet it is being extensively adopted by many organizations. The rationale behind adopting benchmarking is improvement in organizational performance, as an organization can be transformed to world-class grade. The association between benchmarking and TQM improves performance based on best organizational practices and may openly contribute towards meeting customer requirements (Yusuf, Gunasekaran & Dan, 2007).

Culture

An empirical study conducted by Baird et al. (2011) reports that cultural dimension, that is, teamwork and respect for people is the most essential factor in enhancing the use of TQM practices. The study covered 145 Australian manufacturing and service companies. Similarly, the impact of culture has been studied by Yeung and Cheng (2005) in the context of Hong Kong and China. The empirical evidence of the study based on 225 electronics firms clearly illustrates that quality management is context dependent and that the cultural elements create a series of chain effects on organizational performance.

Information and Analysis

The results of empirical studies conducted by Flynn et al. (1995), Kaynak (2003) and Yeung and Cheng (2005) underline the key role of information and analysis in decisions taken by the top management and in TQM practices. Sadikoglu and Zehir (2010) report that relevant information helps organizations to define and achieve short-term and long-term goals and to cope up with internal and/or external changes. Quality charts, graphs and tables are commonly used sources of information on shop floors, which enhance quality awareness of the employees.

Criticism of TQM

According to Glover (1993), many TQM practices failed because of conceptual weakness, design flaws and ineffective implementation. Additionally, Sebastianelli and Nabil (2003) have given five barriers to TQM implementation, namely, unsatisfactory development and management of HR, lack of planning for quality, lack of leadership for quality, inadequate resources for TQM and absence of customer focus.

The failures of TQM implementation have been well documented by authors, such as, Brown, Hitchcock and Willard (1994), Eskildson (1994), Harari (1997), Cao, Clarke and Lehaney (2000), Nwabueze (2001) and Foley (2004). Harari (1997), after studying all the independent research conducted by consulting firms, elaborates that only about 20–30 per cent of US- and Europe-based TQM programmes can lay claim to significant or even tangible improvements in quality, productivity, competitiveness or financial results. Eskildson (1994) states, on the basis of survey results, that many organizations do not succeed in their TQM efforts due to an ambiguous definition of TQM. As a solution to this problem, Pyzdek (2003) states that TQM professionals should prioritize achieving perfection in their knowledge of quality and in the methodologies for attaining it to manage the changing concept of TQM.

About Six Sigma

Motorola Incorporation, under the leadership of Chief Executive Officer (CEO) Bob Galvin, pioneered the Six Sigma philosophy in the 1980s, which went on to become a quality revolution. With Six Sigma, Motorola emerged as a leader in quality and financial one-upmanship, and demonstrated its potential by winning the Malcolm Baldrige National Quality Award in 1988 (Pyzdek, 2003). Six Sigma projects can increase the level of improvements and decrease the performance variability of projects, and boost the morale of the employees and their commitment level towards quality (Linderman et al., 2003). De Mast (2007) pointed that the Six Sigma programme brings competitive advantages to companies that implement it. Six Sigma projects improve operational effectiveness and efficiency.

The origin of Six Sigma has two major perspectives, namely, the statistical and the business viewpoints (Kwak & Anabari, 2006). The statistical viewpoint encompasses a business performance improvement strategy aiming at reduction in the number of mistakes or defects to as low as 3.4 occasions per million opportunities or a success rate of 99.9997 per cent (Antony & Banuelas, 2002). This accentuates the fact that the Six Sigma philosophy has its roots in statistics. Sigma, 'σ', is a letter in the Greek alphabet used by statisticians to measure the variability in any process. Further, performances are measured by the Sigma level of their business processes (Pyzdek, 2003). For instance, if a business achieves a success rate of 93 per cent, it is operating at the three-Sigma level (Kwak & Anbari, 2006).

On the other hand, the business viewpoint states that Six Sigma is a 'business strategy used to improve business profitability, to improve the effectiveness and efficiency of all operations to meet or exceed customer's needs and expectations' (Antony & Banuelas, 2001).

Six Sigma Definitions

Six Sigma has been defined as a business process that allows companies to improve drastically their bottom line by designing and monitoring everyday business activities in ways that minimize waste and resources while increasing customer satisfaction by some of its proponents (Magnusson, Kroslid & Bergman, 2003). Six Sigma may also be described as an improvement programme for reducing variation, which focuses on continuous and breakthrough improvements. Improvement projects are driven in a wide range of areas and at different levels of complexity, in order to reduce variation. The main purpose of reducing variation on a product or a service is to satisfy customers. The goal of Six Sigma is that only 3.4 out of a million customers should be dissatisfied (Magnusson et al., 2003). The American Society for Quality (ASQ) describes Six Sigma as a fact-based, data-driven philosophy of quality improvement that values defect prevention over defect detection. It drives customer satisfaction and bottom line results by reducing variation and waste, thereby promoting a competitive advantage. Additionally, Linderman et al. (2003) described Six Sigma as an organized, systematic method for strategic process improvement and new product/service development that relies on statistical and scientific methods to make dramatic reductions in customer defined defect rates. Six Sigma is an organized, parallel 'meso' structure to reduce variation in organizational processes by using improvement specialists, a structured method and performance metrics with the aim of achieving strategic objectives (Schroeder et al., 2008).

Methodologies and Tools

Henderson and Evans (2000) reported that the successful Six Sigma implementation requires management involvement, organization, infrastructure, training and statistical tools. Also, Zhang et al. (2011b) highlighted five views for Six Sigma implementation, namely, philosophy view, programme view, project view, tool view and metric view. The *metric view* focuses on Sigma metric, process capability metric and high-level balance scorecard metric (Kalpan & Norton, 1996). On the other hand, the *tool view* emphasizes Six Sigma tools (statistical tools, causal mapping and process mapping). *Project view* stresses on project management skills and DMAIC (define, measure, analyze, improve and control). It should be noted here that for some organizations, the project view also includes kaizen events. *Program view* focuses on generating, selecting, resourcing, controlling and closing a portfolio of the project.

Philosophy view underlines the philosophies as they affect the values and culture. Additionally, Zhang et al. (2011b) have proposed five core elements of the Six Sigma philosophy: to wit, customer orientation, leadership engagement, dedicated improvement organization, structured method and metric focus. The description of each core element has been depicted in Table 2. Both the five views and five core elements define the domain of Six Sigma. Pande et al. (2000) stated that organizations should describe to their key personnel the multiple roles required and their different areas of responsibility in order to be successful with a Six Sigma programme. However, followers of Six Sigma need to adhere to the philosophy in its entirety rather than employ a few tools and techniques of quality improvement (Dale, 2000).

There are two chief improvement methodologies in Six Sigma: one for pre-existing processes and the other for new ones. These are DMAIC and DMADV (define, measure, analyze, design and verify)

Table 2. Five Core Elements of Six Sigma

Core Elements	Description
Customer Orientation	Deming (2000) and other quality gurus have consistently emphasized the importance of understading customer requirements. At the project level, Six Sigma project teams are strongly encourged to listen to the voice of the customer and to define the benefits of customer prespective. At the organizational level, customer orientation is used as a principle to select and priortize projects by the project selection committee (Eckes, 2000; Harry & Schroeder, 2000; Pande et al., 2000).
Leadership Engagement	The success of a process improvement programme requires strong management support. Six Sigma puts a systematic mechanism in place to ensure that the leadership team is engaged and Six Sigma stays on the organization's dashboard. In Six Sigma, senior executives act as champions, and they are directly involved in projects. This ensures that the right projects are selected and that they receive a buy-in for organizations. Black Belts are selected not only for their technical knowledge but also for their ledership skills (Schroeder et al., 2008).
Dedicated Improvement Organization	Six Sigma differs from tradional TQM programmes in that it requires organizations to use Black Belts and set up dedicated organizational structure for improvement of 'parallel meso' structure (Schroeder et al., 2008). This structure includes the role of Green Belts, Black Belts, Master Black Belts and Champions. It is the convention in Six Sigma to select one of the organization's best employeees to fill the Black Belt positions (Eckes, 2000; Harry & Schroeder, 2000; Pande et al., 2000). This dedication leads to effective improvement and also makes the effort easy to measure.
Structured Method	In comparison to the earlier quality programmes, Six Sigma is highly prescriptive in in that each project must follow DMAIC structured method. The method supports structured explorations of root causes and structural control of the process to produce the desired output. The emphasis on adhering to the standard method helps in creating a common language across an organization which benefits from knowledge creation and disssemination (Choo, Linderman & Schroeder, 2007a, 2007b).
Metric Focus	Six Sigma emphasizes metrics in either customer or financial terms. It also emphasizes rigorus tracking of metrics to ensure that the benfits are obtained from improvement projects. All Six Sigma projects must have clearly defined goals expressed in metrics, such as, critical to quality (CTQ) metrics (Linderman et al., 2003). Each project is carefully audited on its intended and realized benefits generally in finanacial terms and certified by the organization's financial department or the chief financial officer (CFO) (Eckes, 2000; Pande et al., 2000; Schroeder et al., 2008).

Source: Description Adapted from Zhang et al. (2011b).

Table 3. DMAIC: Description and Connotation

Define	• Define the project boundaries and goals of the improvement activity. • Define customer requirements/expectations.
Measure	• Measure the existing process. • Develop a data collection plan.
Analyze	• Analyze the system to identify defects and sources of variations. • Find out variations in the process.
Improve	• Improve the system to eliminate variation. • Build up an innovative alternative to implement improved plan.
Control	• Control the new system to meet customer expectations. • Establish an approach to monitor and control new system.

Source: Pyzdek (2003).

(Linderman et al., 2003). Using the Six Sigma DMAIC approach, the objectives of projects can be achieved by improving an existing product, process or service, whereas DMADV is used when the objective is to develop a new or radically redesigned product, process or service (Pyzdek, 2003). These approaches have been discussed in some detail in Tables 3 and 4, respectively. Six Sigma projects based on DMAIC make clear-cut measurements, identify particular problems and provide solutions that can be measured (sixsigmaonline.org, 2014). On the other hand, DMADV intends to create designs that are resource efficient, capable of very high yields regardless of complexity and volume, robust to process variability and deeply in sync with customer demands (Harry & Schroeder, 2000).

Six Sigma Practices

The philosophy of Six Sigma is a relatively new approach in quality management (Su Chiang, & Chang, 2006). Various authors reported that successful beginning and implementation of Six Sigma depended upon various key practices. A review of research and practitioner research studies on Six Sigma is synoptically presented in Table 5.

Based on reviews of several scholarly research articles and debates with Six Sigma leaders in organizations that implemented this methodology, the authors have identified 11 key practices for successful Six Sigma applications. The descriptions of these practices are as follows:

Management Involvement and Organizational Commitment

Six Sigma requires top management involvement and support to resources and efforts within an organization. For example, Jack Welch, GE's former CEO, had powerfully influenced and enabled the

Table 4. DMADV: Description and Connotation

Define	• Define objective of the desired activity. • What and why is it being designed?
Measure	• Measure CTQ metrics. • Transform customer requirements into project targets.
Analyze	• Analyze alternatives available for meeting objectives. • Determine performance of best in class design.
Design	• Design new products, services and process. • Use of simulation, prototypes to validate the concept usefulness in meeting objectives.
Verify	• Verify the design effectiveness in the real world.

Source: Pyzdek (2003).

Table 5. List of Six Sigma Practices

Sl. No.	Six Sigma Practices	Supporting References
1	**Management Involvement and Organizational Commitment**	Antony and Ricardo (2002), Coronado and Antony (2002), Antony and Fergusson (2004), Antony (2004, 2006), Antony, Kumar and Madu (2005), Kwak and Anbari (2006), Antony et al. (2007a), Chakrabarty and Tan (2007), Antony, Kumar and Labib (2007b), Hilton, Balla and Sohal (2008), Ho, Chang and Wang (2008), Zu et al., (2008), Antony and Desai (2009), Azis and Osada (2010), Brun (2011), Cho et al. (2011), Soti, Shankar and Kaushal (2010), Desai, Antony and Patel (2012), Shafer and Moeller (2012).
2	**Six Sigma Methodologies, Tools and Techniques**	Antony and Ricardo (2002), Coronado and Antony (2002), Antony and Fergusson (2004), Antony (2004), Antony et al. (2005, 2007a, 2007b), Hilton et al. (2008), Ho et al. (2008), Zu et al. (2008), Antony and Desai (2009), Azis and Osada (2010), Zu et al. (2010), Brun (2011), Cho et al. (2011), Soti et al. (2010), Desai et al. (2012).
3	**Linking Six Sigma to Business Strategy**	Antony and Ricardo (2002), Coronado and Antony (2002), Antony and Fergusson (2004), Antony (2004), Antony et al. (2005, 2007a, 2007b), Antony and Desai (2009), Azis and Osada (2010), Brun (2011), Cho et al. (2011), Soti et al. (2010), Desai et al. (2012), Cheng (2013), Anthony (2006).
4	**Linking Six Sigma to Customer**	Antony and Ricardo (2002), Coronado and Antony (2002), Antony and Fergusson (2004), Antony (2004, 2006), Antony et al. (2005, 2007a, 2007b), Chakrabarty and Tan (2007), Ho et al. (2008), Antony and Desai (2009), Azis and Osada (2010), Brun (2011), Soti et al. (2010), Desai et al. (2012).
5	**Linking Six Sigma to Suppliers**	Antony and Ricardo (2002), Coronado and Antony (2002), Antony (2004), Antony et al. (2005, 2007b), Antony and Desai (2009), Brun (2011), Soti et al. (2010), Desai et al. (2012).
6	**Linking Six Sigma to Employees**	Antony (2004), Antony et al. (2005, 2007a), Antony and Desai (2009), Brun (2011), Azis and Osada (2010), Soti et al. (2010), Desai et al. (2012).
7	**Project Selection, Management Tracking and Control Skills**	Antony and Ricardo (2002), Coronado and Antony (2002), Antony and Fergusson (2004), Antony (2004), Antony et al. (2005), Antony (2006), Kwak and Anbari (2006), Antony et al. (2007a), Antony et al. (2007b), Zu et al. (2008), Antony and Desai (2009), Azis and Osada (2010), Soti et al. (2010), Brun (2011), Cho et al. (2011), Desai et al. (2012).
8	**Six Sigma Organization/Role Structure**	Antony and Ricardo (2002), Coronado and Antony (2002), Antony and Fergusson (2004), Antony (2004), Antony et al. (2005, 2007a, 2007b), Hilton et al. (2008), Ho et al. (2008), Zu et al. (2008, 2010), Antony and Desai (2009), Brun (2011), Cho et al. (2011), Desai et al. (2012), Shafer and Moeller (2012).
9	**Cultural Change**	Antony and Ricardo (2002), Coronado and Antony (2002), Antony and Fergusson (2004), Antony (2004, 2006), Antony et al. (2005, 2007a, 2007b), Kwak and Anbari (2006), Chakrabarty and Tan (2007), Antony and Desai (2009), Brun (2011), Cho et al. (2011), Soti et al. (2010), Desai et al. (2012).
10	**Continuous Education and Training**	Antony and Ricardo (2002), Coronado and Antony (2002), Antony and Fergusson (2004), Antony (2004, 2006), Antony et al. (2005, 2007a, 2007b), Kwak and Anbari (2006), Chakrabarty and Tan (2007), Ho et al. (2008), Antony and Desai (2009), Azis and Osada (2010), Brun (2011), Cho et al. (2011), Soti et al. (2010), Desai et al. (2012).
11	**Six Sigma Focus on Performance Metrics**	Antony and Fergusson (2004), Antony (2004, 2006), Antony et al. (2007a), Chakrabarty and Tan (2007), Hilton et al. (2008), Zu et al. (2008, 2010), Azis and Osada (2010), Soti et al. (2010), Cho et al. (2011), Shafer and Moeller (2012).

Source: Authors' own.

rearrangement of the organization and transformed the attitude of the employees towards Six Sigma (Henderson & Evans, 2000). Organizational infrastructure needs to be established with well-trained individuals ready for action. Implementation of Six Sigma projects means the commitment of resources, time, money and the joint effort of the entire organization (Kwak & Anbari, 2006). With the lack of management support and commitment, the actual importance of the initiative shall remain doubtful (Pande et al., 2000).

Six Sigma Methodology, Tools and Techniques

Six Sigma applies a structured methodology for managing improvement activities, known as DMAIC used in process improvement and DMADV used in new product/service design improvement.

For several Six Sigma projects, mostly simple statistical or quality tools are sufficient to handle the problem, though for superior breakthrough, improvements in business processes, certain advanced statistical tools and techniques (design of experiments, statistical process control, regression analysis and analysis of variance) are desirable (Antony & Banuelas, 2002). Moreover, Feng and Antony (2009) believe that the use of quality management tools and statistical methods as per the Six Sigma philosophy are effective in eliminating defects. Six Sigma focuses on a systematic procedure in planning and conducting improvement or design projects (Zu et al., 2008).

Linking Six Sigma to Business Strategy

Harry and Schroeder (2000) pointed out that 61 per cent of topmost performing organizations link their rewards to their business strategies, while underperforming organizations make minimal linkage. Six Sigma improvement projects lead to variability reduction in project objectives and business strategies (Antony & Banuelas, 2002). It is essential to specify how Six Sigma projects and other activities link to customers, core processes and competitiveness (Pande et al., 2000). Antony (2004) mentioned that linking Six Sigma to business strategy leads to a breakthrough in profitability through quantum gains in service quality, product performance, productivity and customer satisfaction. Also, Cheng (2013) reported a model in which he linked the Six Sigma activities to the business strategy for fulfilling key customer requirements. Cheng (2013) further proposed that integrating business strategy with Six Sigma improvement action planning can produce competitive advantages (Cheng, 2013).

Linking Six Sigma to Customer

The most crucial component for successful Six Sigma programmes is the ability to link with customers. Customer requirement is most crucial for start-ups in any project (Harry & Schroeder, 2000). Antony and Fergusson (2004) highlight that customer involvement is most critical to the success of Six Sigma implementation within the software industry.

Customer satisfaction, in turn, requires copious background research and analysis. Pande et al. (2000) have pointed out that a good understanding of the organization and its linkage to various business activities were prerequisites for successfully meeting customer needs. Another important concern here is the selection of CTQ characteristics, which are key factors affecting the quality of a product or service so as to strongly impact customer satisfaction. An additional concept in this context is that of quality function deployment (QFD). Quality function deployment may be defined as '(a) method to transform user demands into design quality, to deploy the functions forming quality, and to deploy methods for achieving the design quality into subsystems and component parts, and ultimately to specific elements of the manufacturing process' (Akao, 1994). Quality function deployment is a powerful technique to understand the voice of customers, their needs and expectations and translate them into design or engineering requirements (Antony & Banuelas, 2002).

Linking Six Sigma to Suppliers

Several organizations that implemented Six Sigma found it favourable in extending the application of this methodology in their supply chain. Hendricks and Kelbaugh (1998) highlighted that a company cannot be Six Sigma until suppliers are participating towards cultural change. Further, as per the Six Sigma philosophies, one way to reduce variability is to have few suppliers with high Sigma performance capability levels (Pande et al., 2000).

Linking Six Sigma to Employees

Six Sigma involves a distinct hierarchical system among employees—there is a typical ranking of expertise recognized by the Belt system (Hoerl, 2001). Four different Belt levels (Master, Black, Green and Yellow) ensure that establishment and execution of Six Sigma projects are conducted flawlessly. Six Sigma constitutes important measures for management performance and compensation, which is a useful way to encourage selection and completion of the projects undertaken (Henderson & Evans, 2000). For instance, at GE, no employee is promoted without complete Six Sigma training and a finished project. This in itself is an impressive behaviour driver (Hendricks & Kelbaugh, 1998). Further, Jack Welch of GE needs his team of Black Belt employees managing the project to prove that the problems have been fixed permanently (Conlin, 1998).

Project Selection, Management, Tracking and Control Skills

A large number of Six Sigma projects do not succeed due to poor project management skills, failure in setting and keeping ground rules and determining employee responsibilities (Eckes, 2000). Therefore, Six Sigma projects have to be clearly reviewed, planned and selected to exploit the benefits of implementation. The project has to be feasible organizationally, financially beneficial and customer oriented (Kwak & Anbari, 2006). Besides, there ought to be periodic reviews to drive the projects to successful completion and closure. This review process also helps Black Belts and Green Belts to follow the Six Sigma methodology correctly (Antony & Banuelas, 2002). Moreover, the project must be well documented with special regard to project constraints, cost, schedule and scope of work (Kwak & Anbari, 2006).

Cultural Change

Caulcutt (2001) opines that Six Sigma involves radical readjustment of a firm's values and culture. Sometimes, considerable alterations in an organization's structure and infrastructure are required before the Six Sigma methodologies may be applied (Coronado & Antony, 2002). Individuals facing cultural change and challenges owing to the implementation of Six Sigma need to understand this requirement. In addition, a clear communication plan is desirable to inspire individuals to overcome resistance and to educate senior managers, employees and customers on the benefits of Six Sigma (Kwak & Anbari, 2006).

Continuous Education and Training

Training and education is the most important aspect of Six Sigma, which gives a clear picture for better understanding of tools and techniques. It is important to communicate the whys and hows and offer a chance to people to enhance their comfort level through training classes (Hendricks & Kelbaugh, 1998) before unleashing the employees into the world of Six Sigma. The curriculum is customized and needs identifying key roles and responsibilities of individuals implementing the projects (Antony & Banuelas, 2002). It is necessary for organizations to adapt the modern trends and techniques that are outside the Six Sigma domain, which can be useful to complement the approach (Kwak & Anbari, 2006).

Six Sigma Focus on Performance Metrics

Six Sigma focuses on numerous quantifiable metrics for acquiring breakthrough improvement; commonly used metrics are CTQ, defect measures and process Sigma level. Moreover, it also follows measures, such as, process capability, which is the same as the one adopted in TQM (Breyfogle, Cupello & Meadows, 2001; Dasgupta, 2003; Linderman et al., 2003; Pyzdek, 2003). Before the onset of any Six Sigma initiative, it is infinitely better to have a clear idea and agreement on the performance metrics to be used (Chakrabarty & Tan, 2007). Additionally, Six Sigma incorporates organizational-level performance, project metrics and processes in an organized manner, which can be helpful for managers to accomplish the organization goals quantitatively and to transform the business strategy into tactical tasks (Barney, 2002).

Six Sigma Organization/Role Structure

Six Sigma requires infrastructural support for effective deployment of its methodology. Six Sigma requires a group of specialists who are highly trained, have undergone rigorous statistical training and are capable of leading teams in identifying and managing Six Sigma projects (Antony & Banuelas, 2002; Henderson & Evans, 2000; Linderman et al., 2003). Six Sigma methodology follows a systematic hierarchical structure for quality improvement across multiple organizational levels (Sinha & VandeVen, 2005). For example, in most of the organizations, Six Sigma projects are headed by the CEO, who is also named as the Champion, followed by Master Black Belts, Black Belts' projects, Green Belts and other team members who are the part of a specific project's work under them (Harry & Schroeder, 2000).

Criticism of Six Sigma

According to Nave (2002), Six Sigma lacks system interaction and processes are improved independently. Klefsjo, Wiklund and Edgeman (2001) opined strongly that the Six Sigma philosophy lacked novelty and was, in essence, the same as TQM. These authors further asserted that the Six Sigma methodologies were rather a sub-part of TQM and functioned within the latter's larger framework. This view was shared by Catherwood (2002) and Stamatis (2000) who put forth that the Six Sigma philosophy was the mere repackaging of the traditional principles and techniques related to quality. Further, Kwak and Anbari (2006) declared that the Six Sigma philosophy required a detailed and time-taking research prior to its adoption by an organization and that it should not to be acquired hurriedly. They further stated that this was no panacea for all business problems and would fail to provide breakthrough improvement in the absence of a balanced assessment of strengths and weaknesses. Another major concern with Six Sigma practices is a radical change that must be brought about in the organizational culture. Organizations need to have a complete knowledge of obstacles and risks pertaining to Six Sigma projects to ensure successful implementation. Top management's commitment becomes a key element in this context.

Comparison of TQM and Six Sigma Philosophies

Six Sigma is similar to other process improvement programmes, especially TQM, and there is an ongoing debate as to how TQM differs from Six Sigma (Schroeder et al., 2008). Comparison between TQM and Six Sigma based on 12 dimensions, namely, development, principles, features, operation, focus, practices, techniques, leadership, rewards, training, change and culture, shows that there are several similarities between their quality concepts, leadership and culture (Yang, 2004). Further, Pyzdek (2003) presented similarities between TQM and Six Sigma and highlighted that TQM possessed management champions, improvement projects and sponsors, like Six Sigma. The only difference was that Six Sigma creates organizational infrastructure, that is, creation of more formally defined representative positions to ensure performance improvement activities. On the other hand, in TQM, the lack of infrastructure is the foremost reason for failure.

Similarities between TQM and Six Sigma

Similarities between TQM and Six Sigma have been discussed by Schroeder et al. (2008) and Shafer and Moeller (2012). These have been enlisted as follows:

- Involvement of top management leadership and commitment is essential for both TQM and Six Sigma.
- Employees' engagement is highlighted by both these management philosophies. Though there are notable differences between the levels of involvement of employees, Six Sigma relies on process improvement specialists, whereas TQM stresses on involving all employees.
- Both the philosophies highlight the requirement of customer satisfaction.
- Collecting and reporting quality data significance is recognized by both TQM and Six Sigma.
- The importance of customer feedback and use of voice of the customer (QFD) in product/service design is emphasized by both TQM and Six Sigma.
- Process ownership has been the point of focus in both the philosophies.

Significant Dissimilarities between TQM and Six Sigma Philosophies

Parsat et al. (2011) highlighted vital differences between Six Sigma and other process improvement programmes (such as, TQM, Lean and the Baldrige model). They pointed out the capability of Six Sigma in bringing an organizational context that facilitates problem solving and exploration across the organization. Further, Schroeder et al. (2008) advocated that Six Sigma creates a parallel 'meso' organizational structure not seen earlier in quality management. This structure helps reduce variation in the process with the help of a dedicated team consisting of Black Belts, Green belts, Master Black Belt and Champions. Schroeder et al. (2008) highlighted four aspects of Six Sigma that were not emphasized sufficiently in TQM. These points have been briefly summarized as follows:

- Six Sigma requires strong financial returns from projects; no Six Sigma project has been approved until bottom line impact has been identified. Thus, here, the financial focus is at the project level, whereas TQM and Baldrige Award focus on the organizational level.
- The Six Sigma approach requires permanent certified professionals, that is, Champions, Master Black Belts, Black Belts and Green Belts who lead, deploy and implement Six Sigma techniques. Total quality management does not require full-time specialists in supporting the quality management process.
- Six Sigma requires a specific metrics-based approach towards measurement and improvement. It also helps ensure process improvement. However, this was not evident in previous quality improvement efforts.
- Six Sigma follows a structured methodology with a degree of perseverance, that is, rigorous training of permanent specialists and integration of statistical and non-statistical techniques are unique, whereas in TQM teams are formed with minimal training, less emphasis on data and with no specific methodology.

Table 6. Advantages of Six Sigma Practices over TQM

TQM: Pitfalls		Six Sigma: Solution
Lack of integration	→	Links to business and personnel bottom line
Leadership apathy	→	Leadership at the vanguard
Fuzzy concept	→	A consistently repeated, simple message
Unclear goals	→	Setting a no-nonsense, ambitious goal
Purist attitude and technical Zealtory	→	Adapting tools and degree of rigour to circumstances
Failure to breakdown the internal Barriers	→	Priority on cross-functional process management
Incremental versus exponential change	→	Incremental exponential change
Ineffective training	→	Black Belts, Green Belts, Master Black Belts
Focus on product quality	→	Attention to all business processes

Source: Pande et al. (2000).

Major pitfalls of TQM and advantages Six Sigma reported previously (Pande et al., 2000) are presented in Table 6.

Cost Comparison between TQM and Six Sigma

Slack et al. (2001, p. 686) pinpointed a common cost model within today's TQM approaches. He claims 'TQM discards the optimum-quality level concept and attempts to reduce all known and unknown failure costs by preventing errors and failure taking place.' He mentioned that usually two of four cost categories are under managerial influence, that is, cost of prevention and cost of appraisal. The other two—'internal cost of failure and external cost of failure'—indicate the consequences of changes in the first two. This underlying assumption of TQM that prevention efforts have a 'significant, positive effect on internal failure costs, followed by reductions both in external failure costs and, once confidence has been firmly established, in appraisal costs' have been proven by more than a few studies (Wessel, 2002). However, the probability is very low, and no evidence has been found to support that these positive effects take place even if only a few defects occur in a process.

An improvement project could cost much more than the sum of all positive effects could compensate. As a result, this assumption is rejected by the Six Sigma approach, which is why the 'net-benefit' calculation is brought into play. Topfer (2000) highlighted that within the framework of TQM philosophy, Six Sigma methodology has a higher impact on the core value drivers of a company than traditional TQM. In addition, Six Sigma aids organizations in reducing operational costs by focusing on defect reduction, cycle time reduction and cost savings. It is different from conventional cost-cutting measures that may reduce value and quality. It focuses on identifying and eliminating costs that provide no value to customers, such as, costs incurred due to waste (Sixsigmaonline.org, 2014). Hence, Six Sigma may be accepted as a more cost-effective methodology in comparison with TQM.

Type and Size-effect Comparison between TQM and Six Sigma

Organizational size has been one of the best predictors of organizational structure and managerial behaviour in the history of organizational design and behavioural research (Drazin, 1995). Large organizations are more centralized and formalized than the smaller ones, and have more resources to deploy for the implementation of quality management programmes, be it TQM or Six Sigma. Therefore, the larger plants are likely to perform better than their smaller competitors (Cua et al., 2001) are. This view is supported by Terziovski and Samson (2000) who mentioned that larger, rather than smaller companies tend to gain greater benefits from TQM due to greater availability of resources and that the company size hinders the implementation of TQM. These findings are consistent with some previous reports (Fisher, 1993; GAO Study, 1991). Also, TQM tends to have a greater impact on reducing defect rates and warranty costs when implemented in larger firms than in smaller firms (Terziovski & Samson, 2000). Also, the size of the company (big or small), the company's adoption of TQM and the duration of a company's experience with TQM affect the rigour of implementation and the resulting level of quality performance (Brah, Tee & Rao, 2002).

According to Brah et al. (2002), the nature of the company, whether it is manufacturing or service, does not affect TQM implementation and quality performance. Brue (2006) opines the same about Six Sigma, '…Six Sigma may be implemented in any business, irrespective of what you do or how small you are, as Six Sigma is about problem-solving, and problems are everywhere. It doesn't matter what type or size of business this breakthrough methodology is applied to….' Contrastingly, Pantano, O'Kane and Smith (2006) mentioned that relative resource disparity served as a deterrent for smaller organizations from embracing Six Sigma methodology. Six Sigma deployment is best suited for organizations where initiatives are based on a pre-planned project charter that draws a skeleton of a project, financial targets, anticipated benefits and milestones. In comparison, organizations that have implemented TQM work without anticipating the financial gains.

Comparison between TQM and Six Sigma with Respect to Organizational Attributes

Six Sigma practises conventional methods apart from defining a clear road map to achieve total quality. However, Six Sigma's approach and deployment makes it distinguishable from other initiatives like TQM. Quality-critical organizational characteristic (QCOC) was used to describe a characteristic that influences the effectiveness of a quality activity (Mann & Kehoe, 1995). Further, he mentioned the following as organizational attributes: structure, process, management style, strategy and culture.

Organizational Structure

Mann and Kehoe (1995) reported that the organizational structure must include description (number of sites) as TQM is generally easier to implement within one site than in a number of sites. The larger the number of sites, the greater the difficulty of controlling its implementation. Stability of organizational structure is also a significant aspect. If the organizational structure is stable, then TQM will be easier to implement and integrate geographically. Organizations implementing TQM into sites geographically distanced from each other may find it difficult to implement an integrated TQM approach. Therefore, organizations should develop a TQM approach that complements their organizational structure.

On the other hand, Six Sigma requires a group of specialists which consists of highly trained personnel who undergo thorough and rigorous statistical training for leading teams in identifying and managing Six Sigma projects (Antony & Banuelas, 2002; Henderson & Evans, 2000; Linderman et al., 2003). Six Sigma methodology follows a systematic hierarchical structure for quality improvement across multiple organizational levels (Sinha & VandeVen, 2005).

Strategy

Calingo (1995) reported that integration of TQM with business strategy provides a valuable insight into maintaining competitive advantage. Also, for strategy integration, he proposed five sequential stages, namely, (i) annual budgeting, young organizations struggling to survive, (ii) long-range planning, an awareness of interconnections in the world climate and looking to build a place therein, (iii) strategic quality planning, the awareness that quality is the key to maintaining a place in world markets, (iv) management by policy, formally implementing quality as a competitive weapon and (v) strategic quality management, a customer-driven process approach to TQM. Leonard and McAdam (2002) argued about the strategic importance of TQM and mentioned that corporate strategy considered TQM as an inherent attribute. They went on to present some key issues between TQM and strategy.

First, the contradiction in TQM terminology, particularly TQM's integration with the strategic planning process, was highlighted. Second, TQM was underscored as a significant and effective means of accomplishing a target set at the strategic level. Finally, the results showed that TQM played a key role in strategy implementation, as distinct from strategic formulation, within the organizations.

On the contrary, Six Sigma is a business strategy that focuses on improving understanding of customer requirements, business systems, productivity and financial performance (Kwak & Anbari, 2006). Six Sigma has been deployed strategically to change the culture of organizations through inculcating process control discipline applied in manufacturing and non-manufacturing businesses. The issue is no longer whether Six Sigma should be considered or not, but a question of when and how. Quite emphatically, an organization cannot perform today's job with yesterday's methods (Thawani, 2004). The link between should be clearly identified in monetary terms, and in which way it may help business strategy (Banuelas & Antony, 2002). In addition, Six Sigma stresses that competencies, systematic and active problem solving and decision behaviour have the potential to be a source of competitive advantage, when integrated with a company's business strategy (De Mast, 2006).

Process

Both TQM and Six Sigma emphasize process ownership and possess clearly defined processes. Process management employs preventive and proactive techniques for TQM, such as, the decline in process variance reduction and foolproofing, which improve the quality of products in the production stage (Baird et al., 2011; Cua et al., 2001; Flynn et al., 1995; Saraph et al., 1989). Process management influences continuous improvement, which, in turn, can affect quality outcomes (Tarí et al., 2007). Additionally, the empirical findings by Forza and Filippini (1998) show that reduced process variation results in improved output.

On the other hand, Six Sigma utilizes a structured process improvement methodology called DMAIC for the existing process improvement in combination with a well-defined set of tools that are applied at various phases of the DMAIC methodology for breakthrough improvement (Shafer & Moeller, 2012).

Management Style

Numerous authors have discussed that the foundation of TQM practices is laid by the top management. Leaders play a critical role as drivers of TQM (Tarí et al., 2007) and improve performance by influencing other TQM practices (Anderson et al., 1995; Flynn et al., 1995). Earlier studies related to quality management have portrayed that strategic planning and management leadership are key factors for achieving higher product quality and creating an environment for continuous improvement (Anderson et al., 1995; Das et al., 2000; Flynn et al., 1995; Kaynak, 2003).

Relevant Six Sigma literature also highlights the importance of top management commitment and support to resources and efforts within an organization. For example, Jack Welch, GE's former CEO, had powerfully influenced and enabled the rearrangement of the organization, succeeding phenomenally in transforming the attitude of the employees towards Six Sigma (Henderson & Evans, 2000). Implementation of Six Sigma projects means commitment of resources, time, money and effort from entire the organization (Kwak & Anbari, 2006), resulting in amplified business performance.

Culture

Baird et al. (2011) report that the cultural dimensions, that is, teamwork and respect for people, are the most important factors in enhancing the use of TQM practices. Yeung and Cheng (2005) in their empirical study mentioned that quality management is context dependent and that cultural elements create a series of chain effects on organizational performance.

Six Sigma-related literatures also highlighted the importance of the cultural dimension. Six Sigma involves the readjustment of a firm's values and culture (Caulcutt, 2001). Individuals facing cultural change and challenges owing to the implementation of Six Sigma need to understand this requirement first. Besides, an appropriate communication network through defined channels is essential for the workforce to educate senior managers, employees and customers on the benefits of Six Sigma (Kwak & Anbari, 2006).

Comparison between TQM and Six Sigma with Respect to Performance Measures

Organizational success in the long term depends upon effective customer satisfaction on a constant basis. Therefore, TQM's success is determined by the adaptability of the organization and whether it uses customer satisfaction as a measure in assessing the success of its decisions and actions (Madu & Kuei, 1993). Agus and Hassan (2011) comment that TQM and its adoption has significant correlations with production performance and customer-related performance. Moreover, manufacturing companies should emphasize on quality measurement and greater degree of management support to ensure strategic sustainable competitive advantage. A continual improvement of operational effectiveness and efficiency is vital in order to avoid competitive disadvantage. In addition, Shafer and Moeller (2012) report that adopting Six Sigma positively influences organizational performance predominantly through the efficiency with which employees are deployed.

Integration Perspective

Klefsjo, Bergquist and Edgeman (2006) believe that for quality improvement, Six Sigma must be integrated with TQM. Both Six Sigma and TQM share the same goals of pursuing customer satisfaction and business profits. Therefore, integration of TQM and Six Sigma can produce synergistic effects (Yang, 2004). A recent study by Zhao et al. (2011) discussed supply chain internal integration and relationship commitment on external integration and advocated that internal integration and relationship commitment enhance external integration independently, and their interactive effect on external integration is not significant. Similarly, Simon, Karapetrovic and Marti (2012) argued that integration of standardized management systems, such as, ISO 9001 and ISO 14001, found that the majority of firms with more than one management system integrate them into a single system, producing a synergistic effect. Therefore, the next section describes TQM and Six Sigma integration with other quality tools and techniques.

According to Yizhong and Liping (2011), three major steps are involved in the integrated quality model. These steps consist of the implementation of ISO 9000, followed by implementation of TQM and Six Sigma. The implementation of ISO 9000 may lead to stability and consistency in the organization's work; implementation of TQM is likely to result in employee motivation and operational efficiency and implementation of Six Sigma may enhance organizational success and performance. The study of Prajogo and Sohal (2006) demonstrates the strong and positive correlation between TQM and technology/R&D management. TQM exhibits a strong predictive power against quality performance, but no significant relationship against innovation performance. Konecny and Thun (2011) mentioned the scarcity of HR for joint improvement of TQM and total productive maintenance (TPM) programmes and opined that a concurrent implementation of both concepts in integration does not necessarily lead to higher performance. The major findings of these studies have been presented in Table 7.

Shahin and Pourbahman (2011) advocated that the Six Sigma philosophy accentuates outputs, such as, improvement of products and services, leading to profitability. The European Foundation for Quality Management (EFQM) model was adapted to assess and improve performance. However, it is not clear how much its methodology is aligned with business performance. Hence, integration may help solve this problem by dividing Six Sigma into enablers and results. The criteria have been classified into two categories of enablers and results wherein enablers have a score of 795 and results have 205 out of 1,000. The proposed model includes nine major criteria similar to the EFQM model and 56 sub-criteria similar to the Six Sigma model. Further, Lin and Li (2010) integrated the frameworks of supply chain and Six Sigma which has three advantages over traditional practices as the framework can determine the overall performance of each dimension of a supply chain, and it evaluates the performance across the entire supply chain using Sigma metrics. Another advantage is the comparison of sigma level, which compares any two entities of supply chain or processes. Further, an organization can monitor its progress at any given point of time at each level within a supply chain; as a result, the organizations can keep a track of the records of its progress.

Arnheiter and Maleyeff (2005) refer to Lean Six Sigma as a combination of strengths of both lean management and Six Sigma and conclude that Lean Six Sigma organization includes three views of lean management. These are: first, maximize the value-added content of all operations, second, aim at global instead of local optimization and third, base management decision-making process on customer impact. Further, Salah, Rahim and Carretero (2010) advocated that integration of Six Sigma and lean management can be possible and, in fact, be beneficial by aiding companies to achieve quality improvement, zero defects and fast delivery at a low cost.

Wyper and Harrison (2000) articulated that the success of Six Sigma depends upon leadership, cost-effective HR practices that aid customer satisfaction (internal and external) and at the same time, increased motivation and job satisfaction of employees. Both Six Sigma and the HR team help achieve business results by appointing right people in the right place at the right time and at the right cost. Kulkarni et al. (2009) integrated Six Sigma with balance scorecard and concluded that it helps overcome the following barriers: vision barrier, people barrier, management barrier and resource barrier. Besides, joint implementation of Six Sigma and Capability Maturity Model (CMM) assists an organization to improve the marketplace and accomplish business objectives (Murugappan & Keeni, 2003). Six Sigma can provide an extraordinary framework to integrate these tools jointly (AlMishari & Suliman, 2008). However, it does not provide information about managing other types of process improvement problems, such as, workforce scheduling, resource planning and operations management. Therefore, integration of data envelopment analysis (DEA) into each phase of the DMAIC process provides an efficient way to handle such problems. Pfeifer, Reissiger, & Canales (2004) have given four advantages of systematic integration of Quality Management System and Six Sigma, i.e., i) identification of key areas, ii) selection of most efficient team for the project, iii) implementation of organization standard operating procedures and measures for all running projects, iv) structured documentation amenities that mayhelp in increased availabilities of project experiences. Six Sigma four stages, identification, characterization, optimization and institutionalization, combined with health care model, that is, structure, process and outcomes, form a new model with the help of existing resources and infrastructure to improve total quality effort (Revere, Black & Huq, 2004). The major findings of these studies are presented in Table 7.

Table 7. TQM and Six Sigma Integration with Other Quality Tools and Techniques

Authors/Year		Integration	Sector/Application	Major Findings
Yizhong and Liping (2011)	TQM	ISO and Six Sigma	Conceptual	Designed an integrated model for quality improvement, and identified five components for integrating quality management model, that is, leadership, integrated management system, culture, stakeholders and process.
Konecny and Thun (2011)		TPM (total productive maintenance)	Manufacturing Plants	TQM and TPM, supported by HR practices, have a significant potential to improve plant performance. Further, HR is identified as crucial element with respect to performance when implementing TQM and TPM simultaneously.
Moriones et al. (2011),		ISO 9000	Manufacturing and Services	EFQM engrosses an advance over ISO 9000 concerning the use of innovative work practices.
Ho (2010)		Lean	Conceptual	Lean management model has revealed some evidence to help organizations to hit the problems caused by the financial imbalances.
Prajogo and Sohal (2006)		Research and Development (R&D)	Manufacturing and Non-manufacturing	Technology/R&D management when integrated with TQM enhance business performance, specifically innovation.
Shahin and Pourbahman (2011)	Six Sigma	European Foundation for Quality Management (EFQM)	Conceptual	An integrated model of EFQM and Six Sigma is developed for assessing organizations towards excellence.
Feng and Antony (2009)		Data Envelopment Analysis (DEA)	Health Sector	Integration of quantitative techniques (DEA) with Six Sigma produces synergetic effect. Additionally, practitioners can analyze organizational or individual performance effectively.
Lin and Li (2010)		Supply Chain	Manufacturing Company/Case Study	An integrated framework will facilitate companies to determine and scrutinize supply chain performance effectively, which constitutes of team structure, process and output.
Salah et al. (2010)		Lean	Review paper	Six Sigma and lean are very powerful continuous improvement methodologies sharing a common platform in achieving customer satisfaction. Additionally, integration leads to achieve greater quality results.
Nachiappan, Anatharaman and Muthukumar (2009)			Manufacturing Industry	Six Sigma and lean are very powerful continuous improvement methodologies that shares common platform in achieving customer satisfaction. The integrated tools and techniques available in TPL Six Sigma would generate better quality products and services to customers.
AlMishari and Suliman (2008)		Reliability Improvements Method	Conceptual	Six Sigma integration with other reliability techniques can produce results that are far more objective and dependable.
Kulkarni et al. (2009)		Balance Scorecard (BSC)	Manufacturing Sector	Integration facilitates companies to use practices in synergy, which further improve the strategy execution process by surpassing barriers to strategy execution.

Arnheiter and Maleyeff (2005)	Lean Production	Manufacturing Sector	Joint implementation of both the programmes will result in a Lean Six Sigma organization to beat the restrictions of each programme when implemented in isolation.
Revere et al. (2004).	Continuous Quality Improvement (CQI)	Health care	Integration of Six Sigma with CQI reduces patient error rate and as a result, increases patient safety.
Pfeifer et al. (2004)	ISO 9000 QMS	Conceptual	Integration of Six Sigma and QMS is the next step towards TQM.
Murugappan and Keeni (2003)	Capability Maturity Model (CMM)	Service Sector	Integrating Six Sigma with Software CMM provides the agenda for process improvement and customer focus by aligning process-upgrading goals with customer expectations.
Revere and Black (2003)	TQM	Health care	Six Sigma can take TQM to the next level by focusing on process improvement, quality and service.
Wyper and Harrison (2000)	HRM	Engineering Sector/Case Study	Cost-effective HR practices help in improved business performance.

Source: Authors' own.

Several authors (Ferng & Price, 2005; Ricondo & Viles, 2005; Yang, 2004) suggest that Six Sigma can be integrated with TQM to produce synergy, that is, their combined effect is greater than the sum of their individual effects. Revere and Black (2003) designed a TQM and Six Sigma framework in the health care sector for reducing medication error and advocated that Six Sigma is to be included into an organization's TQM plan. This may lead to a detailed root cause analysis using a synchronized approach rather than a conventional approach of TQM. Revere and Black (2003) summarized that Six Sigma does not need to substitute TQM but needs to compliment and strengthen programmes; thus, integrating Six Sigma with TQM can improve quality without significantly increasing cost.

Discussion and Conclusion

Many firms all over the world have adopted TQM practices. After a systematic review of the literature, the present study reported about 13 TQM practices and 11 Six Sigma practices. Though a majority of the practices have been studied previously, only a few reported that practices, such as, innovation and culture, have been studied in various geographical contexts. For instance, Baird et al. (2011) studied culture and innovation practices pertaining to Australia. Similarly, Yeung and Cheng (2005) studied cultural practices in China and Hong Kong pertaining to the electronic industry. However, the results of these studies may not be generalized for the other geographical regions.

Successful implementation and ever-increasing organizational curiosity for the Six Sigma methodology have been reported in the last few years, and this management philosophy is emerging as a driving force for several technology project-driven organizations. In these organizations, two key approaches of Six Sigma (DMAIC and DMADV) have been implemented, resulting in a noteworthy improvement of overall business performance. A limited amount of literature has reported about implementation of Six Sigma practices in different organizational contexts. Moreover, only a few empirical studies related to Six Sigma have been published in the literature. Zu et al. (2008) identified three practices that are distinctively associated with Six Sigma, namely, Six Sigma role structure, Six Sigma structural improvement procedure and Six Sigma focus on metrics, and integrated these practices with seven traditional quality management practices, namely, top management commitment, customer relationship, supplier relationship, workforce management, quality information, product/service design and process management. Also, Zu et al. (2010) juxtaposed these three distinct Six Sigma practices with seven traditional quality management practices in the context of US manufacturing plants. The culture and business conditions of developing nations are different in comparison with developed countries considering which the results of this study cannot be generalized across other sectors and developing countries. The necessity of in-depth research to investigate how an organization's culture profile influences the pattern of TQM/Six Sigma implementation as well as the resulting effect on business performance is hence undeniable.

The authors have reviewed and examined the comparison of TQM and Six Sigma for better understanding, which has been outlined by way of similarities and differences between the two. Klefsjo et al. (2006) elaborated differences, such as, strict financial focus and massive training of key personnel, that made Six Sigma significant in comparison with TQM. While a decided focus on the finances is essential for organization improvement and growth, it should not be at the price of the well-being of employees and the trust of customers. Albeit it may be profitable in the short term to follow an unethical and ecologically unsustainable route, organizations have to pay back in the long term. On the other hand, large-scale senior manpower training programmes emphasized the importance of developing educational drive for key employees. However, this conservative approach results in lowering the morale of and isolating the staff members excluded from the training events.

Both TQM and Six Sigma have emphasized the importance of customer as well as the role of customer satisfaction in quality improvement. Customer satisfaction is considered one of the gold standards for measuring organizational performance. The customer plays an important role in assigning value of the product and hence it is essential to focus on customer needs. Quality improvement techniques, such as, TQM and Six Sigma, address issues related to long-term customer satisfaction and defect reduction, respectively. In this context, Harrington and Gupta (2014) debated that TQM sets error-free performance standards, focusing on the reliability of products, while Six Sigma is a metric-based approach, only suitable for companies aspiring to achieve industry leadership. This industry leadership could be achieved through rapid improvements in performance related to 'meeting customer requirements'. Six Sigma methodology (DMAIC) is the best-suited methodology for doing so (Harrington & Gupta, 2014).

Further, the review reported that there are numerous studies in literature in which integration of TQM and Six Sigma with other quality tools and techniques has been shown. However, a few studies related to quality integration reported that integration of TQM and Six Sigma practices helps facilitate organizations to produce a synergistic effect, which may further help in strategy execution process.

Scope for Further Research

Though the present review does not claim to be an exhaustive one, an attempt has been made to understand TQM and Six Sigma practices and potential benefits of their integration. The research gaps identified through the review have been presented below:

- Different organizations have different maturity levels of quality management implementation, and the strengths and weaknesses of their existing quality management systems vary from organization to organization. In the light of this, how Six Sigma practices are adopted needs to be studied.
- Very few studies have been conducted with special reference to both TQM and Six Sigma methodologies (e.g., Revere & Black, 2003; Yang, 2004; Zu et al., 2008). Hence, there is an immense scope for research with respect to integration of both these significant management philosophies.
- An inadequate number of studies have been reported in the literature related to empirical adequacy of Six Sigma (e.g., Antony & Desai, 2009; Desai et al., 2012) with respect to India. Further scope for research emerges in this geographical region.
- A dearth of studies on TQM considering the culture and innovation practices in India is apparent, and further studies may explore these dimensions in a more detailed manner.
- In TQM, the moderate effects of contextual factors, such as, firm size, firm type, scope of operations, degree of competition, environmental uncertainty and organizational structure (e.g., Lo et al., 2013; Zhang, Linderman, & Schroeder, 2012) can be studied to evaluate the complex relationships among these variables.
- The relationship between TQM practices and various performance measures has been determined for other geographical regions, but not India (e.g., Naor, Goldstein, Linderman, & Schroeder, 2008; Zu et al., 2008). Hence, there is immense scope to study indirect relationship between TQM practices and performance measures in the Indian context.

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