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*Research Paper*

# SIX SIGMA – THE REVIVAL OF TQM

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This paper suggests that Total Quality Management (TQM) is undergoing a revival under a new name, six-sigma. Many organizations have discovered that such methodologies under appropriate leadership can be applied in such a way as to restore the strength of quality initiatives. The basic tenants of TQM include strong customer focus, elevated employee involvement, continuous improvement, enlightened leadership, and management by fact. There is concern, however, that TQM has lost its luster and has become less effective under the pressures of competing business priorities. Six-sigma provides a highly disciplined approach to quality improvement, assures follow-through using a five step process, and clearly assigns personnel responsibility. Specific customer oriented metrics are identified and tracked until a control system is in place to maintain the improved processes. All required features of TQM are found in the correct application of six-sigma. This paper examines the problems associated with total quality management and suggests a revival under a newer name, the rather odd reference to a statistical feature of the normal distribution known as 'six-sigma'.

Keywords: Total quality management, Involvement, Methodologies

## INTRODUCTION

Quality is not only a strategic weapon for competing in the current marketplace, but it also means pleasing consumers, not just protecting them from annoyances. Therefore, a company's specific advantage is to identify and then compete on one or more of the dimensions of quality (Kumar *et al.*, 2009).

Since the 1980s, several important quality management systems, or programs, such as ISO 9000, TQM, Six-Sigma program, Reengineering, and Toyota production system (or lean production), have been launched. Six Sigma and other concepts, have grown in popularity and many organizations have shifted their strategies and practices towards these concepts. That view is supported by Pande *et al.* (2000), who assert that "TQM is less visible now than in the early 1990s due to problems including lack of integration, leadership apathy, a fuzzy concept, unclear

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quality goals and a failure to break down internal barriers" and conclude that Six Sigma can overcome these deficiencies, stating that Six Sigma's expansion heralds a rebirth of the quality movement. Furthermore, Harry (2000) claims that "Six Sigma represents a new holistic, multidimensional systems approach to quality that replaces the form, fit and function specification of the past" and the financial Times wrote in October 1997 that "Six Sigma is a program aimed at the near elimination of defects from every product, process, and transaction".

Many organizations have come to realize that achieving zero-defect goods and services can lead not only to customer satisfaction but also to improved internal efficiency and reduced costs. According to recent figures, fewer than 10% of companies are adopting a Six Sigma program to the point where it is going to make any sort of significant difference to the bottom line in any meaningful period of time.

## The TQM Philosophy

Over the past decade, companies experienced dramatic changes in business environment characterized by such phenomenon as increasing consumer consciousness of quality, rapid technology transfer, globalization and low cost competition. After more than a year of continuous decline on international trade, the global economy begins to recover but this news can block the development and also can block policies adopted in order not to fall into a new crisis (Anagnoste and Agoston, 2009).

TQM is a systems approach to management that aims to enhance value to customer by designing and continually improving organizational processes and systems. It provides a new vision for management leadership. It places customers as principal focal point and redefines quality as customer satisfaction. TQM relies on fact based decision-making. TQM is a broad-based approach used by world class companies to achieve organizational excellence, the highest weighted category of all the quality and excellence awards (Oakland, 2001).

TQM implementation is based on three core elements:

- The TQM philosophy that comprises a set of TQM principles;
- The organizational culture—the present and desired state of culture that will be reached when the TQM philosophy is realized; and
- The implementation strategy—the approach to realizing the philosophy that will specifically include the activities to identify and offset TQM implementation barriers.

The Competing Value Framework (CVF) proposed and tested by Denison and Spreitzer (1991) has been selected to identify types of organizational culture and explore underlying dynamics of culture in terms of TQM practices being supported by type of culture.

## The Six Sigma Methodology

Six Sigma was started in Motorola by engineer Bill Smith in the late 1980s in order to address the company's chronic problems of meeting customer expectations in a cost-effective manner. Within improvement projects quality problems were systematically analyzed at the front end of the process and continued throughout the manufacturing process using four phases (Measure, Analyze, Improve, and

Control). Jack Welch, the CEO of GE applied this program across all of GE integrating training of Six Sigma into the promotion structure.

The primary objective of the Six Sigma methodology is the implementation of a measurement based strategy, which focuses on process and sub-processes improvement through the application of Six Sigma best practice such as DMAIC and DMADV.

Six Sigma is a statistical measure whereby it measures variation in process around its mean. It considers any data point that is beyond customer specified limit, as defect. The measure is quite proven and one could always assume that there will be 3.4 defects per million opportunities to have a process at Six Sigma levels.

## Problems Associated with TQM

TQM has been defined as 'managing the organization so that it excels in all dimensions of products and services that are important to the customer'. To be effective, it is generally agreed that TQM requires an organizational effort that includes continuous improvement, teamwork, and a customer focus. TQM has been a choice for managers and organizations for approximately two decades. Yet in the early and mid-1990s, articles began to appear that questioned the value and efficacy of TQM in a number of organizations. Chang (1993) referred to its failure in many companies as being due to the onset of 'excessive activity syndrome.' He argued that, too often, companies tended to implement a wide range of activities without focusing on the outcomes achieved.

Harari (1997) disclosed in an article originally published in 1993 that there are at least ten reasons why TQM doesn't work. 'Quality operations,' he stated, 'often become so cumbersome that they overshadow the real reason a company is in business'. Among the reasons cited for TQM failure are excessive bureaucracy, focus on internal processes, avoidance of genuine organizational reform, faddism, and lack of innovation within the corporate culture. Knights and McCabe (1999) suggested that hierarchical power structures and the pressures of capital accumulation restrict the operation of TQM. Kolesar (1995) referred to a gap between what TQM practitioners espoused and what was actually being implemented. He identified a number of shortcomings that left many firms practicing only partial quality management.Many of the perceived failures of TQM, it is believed, stem from the incorrect implementation of appropriate principles. TQM continues to be an elusive goal that leads to unrealistic organizational expectations, false promises, impatience, and the desire for immediate results. While several authors have signaled the demise of TQM, it is more likely that a natural evolution is occurring. Even under a variety of new names, the basic elements of TQM persist. With this concept in mind, the next section of this paper suggests a revival of TQM under a rather strange name with very practical results (Forrest, 2006).

## The Emergence of Six-Sigma

Six-sigma began as a process design or process improvement goal stated in terms of the properties of a normal distribution. Efforts were made to improve quality to such an extent that no more than 3.4 Defects Per Million Opportunities (DPMOs) would occur in a given process. When it became obvious that quality

was dependent on the involvement of multiple functional areas, six-sigma provided a common metric around which the efforts of other functions could be aligned. The natural limits of separate organizational functions, often characterized by different outlooks, agendas, and approaches, provided resistance to quality initiatives when organizational boundaries were crossed. Thus, over time, six-sigma expanded into a methodology or framework for assuring that cross-functional quality improvement efforts could be successful. In fact, business leaders today think of it as being a way to increase profits through improvements in current processes. 'Six-sigma is about helping the organization to make more money' (Pyzdek, 2000b).

How does six-sigma resolve the shortcomings and problems associated with TQM? Is it, in fact, a replacement for total quality management, or do its methods and approaches support the goals and activities that once made TQM a popular improvement methodology? To answer this question, it is helpful to examine the five major features of TQM and view each in terms of what six-sigma has done to capture the attention of major firms in the US and countries throughout the world.

### Strong Customer Focus

TQM places extraordinary emphasis on customer needs, both internal and external, seeking to determine what consumer's desire in products and services. Six-sigma formalizes this approach by specifically identifying Critical-To-Quality requirements (CTQs), which are characteristics that customers consider to have the most impact on quality. Such characteristics could be a key dimension in a part or product, the time to process a transaction, the ability to deliver a service, or the response to an internal process. A defect is then defined as any failure to meet the expected criteria, such that data can be collected to determine how many defects occur over a given number of opportunities. This constitutes the first step in a structured methodology that begins with 'define' to assure that customer needs and requirements are foremost. Achieving the goal of meeting customer expectations is further demonstrated by strict adherence to a five step process in which define is followed by measure, analyze, improve and control (DMAIC), all performed by a project team with the requisite training. One example of a six-sigma project resulting in greatly improved customer service was repairing roads in Fort Wayne, Indiana, where 98% of potholes were filled within 24 hours of being reported (Jones, 2002).

### Elevated Employee Involvement

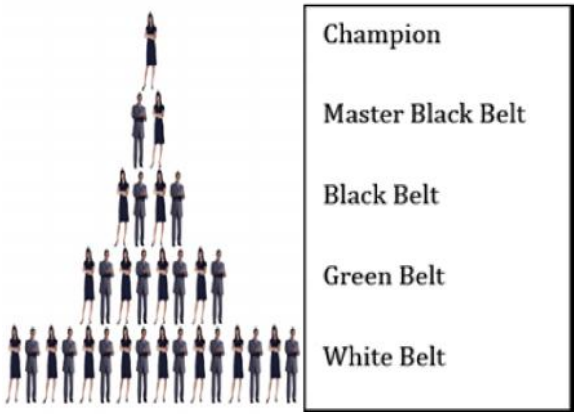
TQM seeks to expand the training and involvement of employees, often with the formation of self-directed work teams empowered to make changes and improvements in their work areas. Six-sigma formalizes this approach with the development of green-belt and black belt team leaders. Green belts typically receive one to two weeks of training and learn project management, quality management tools, meeting facilitation, problem solving, and exploratory data analysis. They serve on project teams and sometimes lead teams through the five DMAIC steps to completion. Black belts have more specialized training in statistical process control techniques, often five weeks or more, and usually possess a background in college

level mathematics such as statistics or engineering. They are typically assigned full-time to several projects a year, and also provide the training for green belts. Clearly, having black belt certified technicians on the staff constitutes a major investment for firms involved in six-sigma and assures that someone is capable of seeing projects through to completion (Pyzdek, 2000a).

While the usual ratio for black belts is one for every 100 employees, some firms exceed the 1% thumb rule. This may be considered extreme, but expectations are that each project headed by a black belt has the potential to contribute $150,000 or more in savings or increased earnings. Six-sigma projects are expected to realize bottom-line results. Two companies that are well known for their commitment to six-sigma and the investment in people required for success are Motorola and General Electric. Motorola predicted and achieved billions of dollars in savings over a five-year period. General Electric realized a return of $1.2 bn after investing $450 mn on six projects in one year. GE requires every employee to have black belt or green belt training before being considered for promotion. The design of specific roles and their effective operations are important factors of the GE-6ó program. Senior management is ultimately responsible for the success of the project through the provision of sufficient support, resources, and strong leadership. The implementation of GE-6σ is thus top–down. The chief executive officer (CEO) is usually the driving force who sets up the vision, develops the strategies, and drives the changes. Apart from the critical role of the CEO, other players also have their specific roles (Henderson and Evans, 2000):

- 'Champions' are usually the senior managers, who are the sponsors of the project and responsible for success of Six Sigma efforts, they are fully trained business leaders who promote and lead the deployment of Six-Sigma projects;
- 'Master Black Belts (MBBs)' are the full-time teachers and consultants, they are responsible for Six-Sigma strategy, deployment, training, mentoring, and results. A master Black Belt in Motorola has leaded as a Black Belt for about ten successful projects at least five years, and needs the recommendation of high managements;
- 'Black Belts (BBs)' have the key operational role in the program as full-time Six Sigma players; they are fully-trained Six-Sigma experts and lead the improvement teams. They are qualified as they successfully leaded at least two Six-Sigma projects;
- 'Green Belts (GBs)' are the process owners who, led by the BBs, work on Six Sigma projects while holding down their original job functions in the company.

Figure 1: The Roles Within Six Sigma




Source: Magnusson et al. (2007)

## Continuous Improvement

There have been many improvement models for process improvement or re-engineering. Most of their implementations are based on the steps introduced by W. Edwards Deming, which can be characterized as 'Plan', 'Do', 'Study', and 'Act' (PDSA) (Deming, 2001).

TQM brings about improvements in quality and process, typically by encouraging a series of relatively small gains that evolve into larger gains over time. Taken as a strategy, this has been described as 'a vague notion of improving everything we do forever'. Whereas six-sigma achieves its gains more by compartmentalizing the quality pie so that projects are selected with the overall goals of the organization in mind. Six-sigma, according to one author, is most successful when incorporated as a business strategy (Franco, 2001, p. 4). This is one of the reasons that six-sigma requires each project to follow the five-step DMAIC procedure and maintain the potential for financial improvement.

The last of the five steps assure that control methods are put in place to monitor the improvements that have been implemented. This step was not a clear requirement under TQM, which meant that some gains would be lost over time. Under six-sigma, institutionalizing the improvements may involve 'modifying compensation and incentive systems, policies, procedures, budgets, operating instruction and other management systems.

The Six-Sigma program has a five-phase cycle: 'Define,' 'Measure,' 'Analyze,' 'Improve,' and 'Control' (DMAIC) for process improvement that has become increasingly popular in Six Sigma organizations. There is another cycle characterized as 'Define,' 'Measure,' 'Analyze,' 'Design,' and 'Verify' (DMADV) for process design (and redesign) in (Pande *et al.*, 2000). Like other improvement models, the DMAIC (or DMADV) model is grounded in the original Deming PDCA cycle. Table 1 describes the specific tasks in each step, and the tools and techniques used in the DMAIC steps. The tasks and tools used in the DMADV steps are similar to those used in the DMAIC steps.

Table 1: DMAIC Steps and Tools Usage

| Step | Specific tasks | Tools and techniques employed |
|---|---|---|
| Define | • Analyze voice of customers (VOC)<br>• Identify improvement issues<br>• Organize project team<br>• Set-up improvement goal<br>• Estimate financial benefit | • Customer complaint analysis<br>• Cost of poor quality (COPQ)<br>• Brainstorming<br>• Run charts, control charts<br>• Benchmarking |
| Measure | • Map process and identify inputs and outputs<br>• Establish measurement system for inputs and outputs<br>• Understand the existing capability of process | • Process map (SIPOC)<br>• Cause and effect matrix<br>• Gauge R&R<br>• Control charts<br>• Process capability analysis<br>• Failure models and effects analysis (FMEA) |
| Analyze | • Identify sources of variation in process<br>• Identify potential critical inputs<br>• Discover the root causes<br>• Determine tools used in the improvement step | • Cause-and-effect diagram<br>• Pareto diagram<br>• Scatter diagram<br>• Brainstorming<br>• Analysis of variance (ANOVA) |
| Improve | • Create the strategic actions to eliminate the root causes<br>• Conduct improvement actions<br>• Use experiments<br>• Optimize critical inputs | • Design of experiment (DOE)<br>• Quality function deployment (QFD)<br>• Process capability analysis<br>• Control charts |
| Control | • Standardize the process<br>• Maintain critical inputs in the optimal area<br>• Verify long-term capability<br>• Evaluate the results of improvement projects | • Standard operation procedure<br>• Process capability analysis<br>• Fool-proofing (Poka Yoke)<br>• Run charts<br>• Failure models and effects analysis (FMEA) |

*Source: Aized (2012)*

## Enlightened Leadership

TQM calls for a style of management that is committed, participative, and capable of creating a climate for cultural change. Managers are expected to be resource people, motivators, and leaders who can engender trust within and among the people in the organization. Under six-sigma, the CEO is usually the driving force, and a champion

for each project is selected from an executive management team. A champion is responsible for the success of the project and helps by providing resources and bridging the gap between functional interests. Typically, a portion of the champion's compensation depends on the successful achievement of six-sigma objectives. Upper management is heavily involved in project selection and has a stake in the outcomes. The important point here is that management actions are focused, strategic goals are considered, compensation is involved, and the duties of a champion are clearly delineated.

### Fact-Based Decision Making

TQM makes use of several quality control tools and various statistical methods for evaluating and improving quality. Key Performance Indicators (KPIs) are required to assure that quality improvement initiatives are sustained. It is in this area that TQM often breaks down. Alternatively, six-sigma is unquestionably data oriented. Every project requires the selection of one or more key process output variables as primary project metrics. The measure step in six-sigma makes it essential that key variables are tracked over time. This leads to the step in which various statistical techniques are applied to analyze which factors are causing a process to vary in quality. Ultimately, the improve step calls for deciding what may be done to reduce variability and promise consistent results in the future.

Throughout these three steps and others in the DMAIC process, a number of tools are used by the green belts and black belts in charge. In the measure step, tools may include cause and effect diagrams, process maps, Pareto charts, capability ratios, and histograms. During the analyze step, methods of analysis include t-test, F-test, chi square, multi-variance, regression, interactive plots, Kruskal-Wallis, Mood's median, and Mann-Whitney. The improve step may well include process modeling, design-of-experiment, response surface diagram, main effects plot, process capability, and mistake proofing. Not every tool is used on every project, but to choose and apply the right tools, the level of training for those on the project team must be extensive.

It often happens that the steps applied in actual practice are not linear, and cycling back to earlier phases may be necessary. A firm making non-fiber textile products in Virginia tracked the amount of scheduled time and the amount of raw material lost in lot cleaning on one line. After proceeding somewhat intermittently through the structured process and applying several of the tools mentioned above, the reduction in cleaning time and material loss ultimately achieved an annualized cost reduction of $104,000 and a one day per year capacity gain. This was a rather typical application in a mid-sized company and demonstrates the value of using factual analysis throughout the process.

## CONCLUSION

What the six-sigma process brings to TQM is a methodology for disciplined quality management. Many companies found that when six-sigma is integrated into their current business system, almost all of the elements of TQM are in place. Six-sigma strengthens TQM efforts through a strategic approach that emphasizes strong executive involvement, bottom-line accountability, extensive practical

training, and personnel devoted to getting worthwhile improvement projects carried out. The requirement for high-level champions, black-belt project leaders, green-belt team members, and a ûve-step solution process puts these elements together. It becomes a comprehensive system with the structure and discipline needed to assure focus and accountability.

Six Sigma DMAIC methodologies are beneficial to improve productivity and quality of the organization. The DMAIC methodology is applicable in both, manufacturing and non-manufacturing sectors. Six Sigma is a new strategic paradigm of management invention for an organization to survive in this 21st century.

The list of companies implementing six-sigma is long and growing longer, despite the cost and resources devoted to deployment. Military contractors, government agencies, hospitals, package delivery firms, food processors, and many others have found six-sigma to be cost effective and worthwhile. Various black belts interviewed for portions of this research invariably reported that even when some projects did not realize the potential predicted, there were qualitative improvements that had a positive effect at one point or another. TQM is not dead; it has merely re-surfaced in another form, arguably better and more likely to produce the results anticipated.

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