

# Lean, Six Sigma and TQM: An overview

Valmik B. Nawale<sup>1</sup>, Nilesh P. Ghongade<sup>2</sup>

<sup>1</sup>PG Student, Mechanical Engineering Dept., Saraswati college of Engineering, NaviMumbai - India

<sup>2</sup>Associate Professor, Mechanical Engineering Dept., MHSSCOE, Mumbai - India

**Abstract:** During the last decades, the quality concepts, including lean, Six sigma and total quality management (TQM), have been applied by many organizations. Although the most of the work already documented regarding lean, six sigma and TQM, a number of questions remain concerning the applicability of these concepts in various organization. Hence the purpose of this paper is to describe the similarities and differences between the concepts including evaluation and criticism of each concept by using literature review methodology.

**Key words:** Quality management; Lean; Six Sigma; Total Quality Management.

## INTRODUCTION

Quality management can be described as a management revolution, a revolutionary philosophy of management, a new way of thinking about the management of organizations, a paradigm shift, a comprehensive way to improve total organizational performance, an alternative to management by control or as a framework for competitive management [(Foley, 2004)].

Although considerable progress has been made in the field of quality management in general and in lean, six sigma and TQM in particular, many important issues remain unexplored concerning the similarities and differences between these concepts. Hence, the purpose of this paper is to describe similarities and differences between lean, six sigma and TQM. In specific, similarities and differences concerning areas such as the methodologies, tools, effects and criticism are illuminated in this paper.

## QUALITY MANAGEMENT CONCEPTS

According to Dale (1999), Quality has been an important issue for organizations for many years. The early focus on quality evolved from inspection to quality control and later to quality assurance. During the 1990s, TQM evolved as a common term among organizations. Different definitions of TQM have been presented over the years. Dahlgaard et al. (1998) view TQM as a corporate culture characterized by increased customer satisfaction through continuous improvement, in which all employees in the firm actively participate. Shiba et al. (1993), argued that TQM is 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) define TQM as a continuously evolving management system consisting of values, methodologies and tools, the aim of which is to increase external and internal customer satisfaction with a reduced amount of resources.

**Methodologies and tools:** Hellsten and Klefsjo (2000) argue that methodologies are “ways to work within the organisation to reach the values”. Hellsten and Klefsjo (2000), opined that the methodology is nothing but “consists of a number of activities performed in a certain way”.

Hellsten and Klefsjo (2000) define tools as: . . . rather concrete and well-defined tools, which sometimes have a statistical basis, to support decision-making or facilitate analysis of data. Tools mentioned in TQM literature include the seven quality control tools, see Shewhart (1980) and Ishikawa (1985), and seven management tools, see Mizuno (1988). The improvement cycle is also a common methodology in order to improve the business, according to Evans and Lindsay (1996). The improvement cycle is composed of four stages: plan, do, study and act (P-D-S-A). There are many different approaches to evaluate the benefits of TQM. Historically, one of the most common ways to quantify the benefits of quality has been to estimate the costs of poor quality, see, for example, Juran (1989) and So`rqvist (1998). Vokurka et al. (2000) argue that, with customers demanding quality and competitors responding to such demands, business turned to TQM as the key to enhance overall performance. Lemak and Reed (1997) also claim that TQM leads to an improved profit margin, after studying 60 companies that had demonstrated a commitment to TQM for a period of at least five years.

**Criticism:** The failures of TQM implementation have been well documented, [Brown et al. (1994), Eskildson (1994), Harari (1997), Cao et al. (2000), Nwabueze (2001) and Foley (2004)]. In more detail, Harari (1997) states that, after studying all the independent research conducted by consulting firms, the conclusion is that only few of the TQM programs in the US and Europe have achieved significant improvement in terms of quality, productivity and competitiveness. Pyzdek (1999) states, after summarizing some criticism against TQM, that TQM professionals constantly need to seek to improve the knowledge of quality and the methodologies for attaining it in order to manage the changing concept of TQM.

**Six Sigma:** Rancour and McCracken, (2000) examined that the Motorola was the first company to launch a six sigma programme in the mid-1980s. In 1988, Motorola received the Malcolm Baldrige National Quality Award, which led to an increased interest of six sigma in other organisations, see Pyzdek (2001). Today, every organizations have developed six sigma programmes of their own and now it is established in every organization.

**Six sigma is defined** as a business process that allows companies to drastically improve 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, see Magnusson et al. (2003). Six sigma could also be described as an improvement programmes 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 of a million customers should be unsatisfied, [Magnusson et al. (2003)].

**Methodologies and tools:** Henderson and Evans (2000) claim that the major components for a successful six sigma implementation are management involvement, organization, infrastructure, training and statistical tools. Eckes (2001) also points out the importance of having an infrastructure before starting an improvement programme, like six sigma, and further claims that “successful organisations use a model for improvement” rather than working ad hoc without a model. One of the most important issues of the infrastructure is the involvement of the management, [Eckes (2001)]. Sanders and Hild (2000) claim that six sigma organisations often have standardized training courses, ranging from comprehensive courses for Black Belts to basic courses for White Belts. There are two major improvement methodologies in Six Sigma, one for already existing processes and one for new processes. The first methodology used to improve an existing process can be divided into five phases, see Pyzdek (2003) and Magnusson et al. (2003). These are:

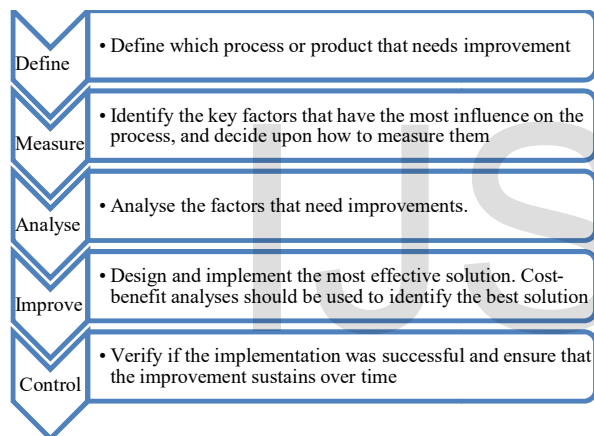


Fig 1: Six Sigma DMAIC methodology

The second methodology is often used when the existing processes do not satisfy the customers or are not able to achieve strategic business objectives, (Eckes, 2001). This methodology can also be divided into five phases; define, measure, analyze, design, verify, according to Magnusson et al. (2003). In summary, the two different methodologies have obvious similarities.

There are usually many different improvement tools used in a six sigma programme. Magnusson et al. (2003) document that the six sigma toolbox contains the seven design tools, the seven statistical tools, the seven project tools, the seven lean tools, the seven customer tools, the seven quality control tools and the seven management tools. The tools are often easy to use in both ongoing and breakthrough improvement projects, but there are also some more advanced statistical tools in the toolbox.

**Effects.** Much of the increased interest in six sigma programmes is due to the positive financial impact some companies claim that the programmes have. For example, Volvo Cars in Sweden claims that the six sigma programme has contributed with over 55 million euro to the bottom line during 2000 and 2002, (Magnusson et al. 2003).

**Criticism.** There has not been published much criticism against six sigma, according to the belief of the present authors. Klefsjö et al. (2001) claim, however, that Six Sigma has the same common features as TQM and that six sigma does not, in principle, contain anything new.

**Lean:**

The concept was introduced at a larger scale by Toyota in the 1950s, but not labeled lean manufacturing until the now famous book about the automobile appeared in 1990 (Womack et al., 1990). Lean is about controlling the resources in accordance with the customers’ needs and to reduce unnecessary waste. While there are many formal definitions of the lean concept, it is generally understood to represent a systematic approach to identifying and eliminating elements not adding value to the process. A systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection (NIST, 2000). Methodologies and tools: Lean principles are fundamentally customer value driven, which makes them appropriate for many manufacturing and distribution situations. Five basic principles of lean manufacturing are generally acknowledged:

1. Understanding customer value: Only what the customers perceive as value is important.
2. Value stream analysis: Having understood the value for the customers, the next step is to analyse the business processes to determine which ones actually add value. If an action does not add value, it should be modified or eliminated from the process.
3. Flow: Focus on organizing a continuous flow through the production or supply chain rather than moving commodities in large batches.
4. Pull: Demand chain management prevents from producing commodities to stock, i.e. customer demand pulls finished products through the system. No work is carried out unless the result of it is required downstream.
5. Perfection: The elimination of non-value-adding elements (waste) is a process of continuous improvement. “There is no end to reducing time, cost, space, mistakes, and effort” (McCurry and McIvor, 2001).

Lean principles do not always apply, however, when customer demand is unstable and unpredictable. The main elements contributing to the elimination of non-value-added activities are the following: excess production, excess processing, delays, transport, inventory, defects and movement. A variety of approaches are available for reducing or eliminating waste. These approaches include value stream analysis, total productive maintenance, Kaizen and cost analysis, engineering and change management, and document management. Tools used include Kanban cards for pull through the supply chain and the closely related JIT system for inventory reduction.

**Effects:** There are many reasons to introduce lean techniques in an organization, as it may contribute substantially to cutting costs and providing competitive advantages. Lean benefits include reduced work-in-process, increased inventory turns, increased capacity, cycle-time reduction and improved customer satisfaction.

**Criticism:** Despite the several success stories associated with the lean concept, it has some shortcomings. Examples of shortcomings which can be found in the literature on the subject are the following:

- The lean organisation may become very susceptible to the impact of changes. The leanness in itself leads to reduced flexibility and less ability to react to new conditions and circumstances (Dove, 1999).
- JIT deliveries cause congestion in the supply chain, leading to delays, pollution, shortage of workers, etc. (Cusumano, 1994).

**Similarities and differences:**

In this section, some similarities and differences between TQM, six sigma and lean are presented. The overall similarities and differences between the concepts, regarding origin, theory, process view, approach, methodology, tools, mottoes and criticism, are also presented in Table 1.

**Table 1:** Similarities and difference between lean, six sigma and TQM (Roy Andersson et al. 2006)

Concepts	Lean	Six Sigma	TQM
Origin	This concept was evolved in Japan and Toyota	This concept was evolved in Japan and Motorola	This concept was evolved in Japan
Focus	Waste reduction	Defects reduction	Customer's satisfaction
Process view	Processes flow improvement	Process improvement through variation reduction	Processes improvement & uniformity
Approach	Project management	Project management	Everyone committed
Methodology	Understanding customer value, value Stream mapping, Flow	Define, measure, analyze, improve (or design), control (or verify)	Plan, do, check, act (PDCA)
Tools	Analytical tools	Advanced statistical and analytical tools	Analytical and statistical tools
Primary motto	Saving money	Lead time reduction	Increase customer satisfaction
Secondary motto	Reduces inventory, increases productivity and customer satisfaction	Achieves business goals and improves financial performance	Achieves customer loyalty and improves performance
Criticism	Reduces flexibility, not applicable in all types of industries	Does not involve everybody, does not improve customer satisfaction	Intangible improvement

**Origin and theory**

Even though TQM, six sigma and lean have the same origin (the quality evolution in Japan), the concepts have developed differently. TQM became a very popular notion in the beginning of the 1990s among researchers and practitioners

in order to describe how organisations should work to obtain better performance and customer satisfaction.

The success with six sigma at Motorola and with lean at Toyota is a main reason for these concepts to spread to other organisations. George et al. (2004) claim that the main difference between six sigma and lean is that the previous focuses more on accomplishing no defects, while the latter is a better choice when one wants to improve process flow and eliminate waste. TQM also has elements of accomplishing no defects and eliminate waste, but with the main objectives to increase external and internal customer satisfaction with a reduced amount of resources, (Hellsten and Klefsjo, 2000).

**Process view and approach:**

According to Magnusson et al. (2003), the improvement projects in a six sigma programme are conducted in a wide range of areas and at different levels of complexity in order to reduce variation. Six Sigma programmes talk the top managers' language in terms of the economical gains of the improvement. Lean, on the other hand, is a discipline that focuses on process speed and efficiency, or the flow, in order to increase the customer value; (George et al. 2004). six sigma and lean focus on performing improvements mainly through projects, TQM has sometimes a different approach. TQM emphasizes the commitment and involvement of all employees, (Bergman and Klefsjo, 2003). In TQM, there is also, like six sigma and lean, a strong focus on processes.

**Methodologies:**

Hellsten and Klefsjo (2000) argue that TQM contains a number of methodologies. However, the improvement cycle is one of the most widespread methodologies in TQM, according to Evans and Lindsay (1996). The improvement cycle is composed of four stages: P-D-S-A. In six sigma there are two major improvement methodologies, one for already existing processes and one for new processes. The lean principles could in this context be regarded as a methodology. The principles of lean are: understanding customer value, value stream, analysis, flow, pull and perfection. There are many similarities between the improvement cycle in TQM and the methodologies of Six Sigma.

The lean principles are different compared to the methodologies in TQM and Six Sigma, as they are not cyclical in nature and are not focused on how to perform improvements.

**Tools:**

According to Deming about 96 % of the problems are built into the system and that individual employees can only control about 4 %. The purpose of most improvement efforts is to use data in a proper way in order to find out what is wrong with the system and hence improve the system. In six sigma, lean and TQM, there are many different tools that could be used in order to find out what is wrong with the system. TQM normally consists of tools that have either a statistical or an analytical base. Among others, the seven quality control tools and the seven management tools are frequently applied in TQM. six sigma programmes have successfully emphasised the statistical part in quality management. In summary, the tools in the lean concept are more analytical in nature compared to the more statistical tools used in TQM and six sigma.

**Effects:**

The main objective with TQM is to increase the customer satisfaction, see Hellsten and Klefsjo (2000). Eklof et al. (1999) have also shown that there is a positive correlation

between customer satisfaction and the financial results of companies. On the other hand, Ingle and Roe (2001) argue that in a six sigma programme, the projects are selected in such a way that they are closely tied to the business goals or objectives. The company's business goals are normally set in such a way that customers' needs will be satisfied. six sigma programme primarily emphasizes the economical savings and secondly the customer satisfaction. This view was supported by Ericsson in Boras. When starting a lean project with the objectives to reduce the lead time of a process, one first analyses the customer's demands of the process. Hence, the objective of the improvement, besides reducing the lead time, is also to increase customer satisfaction. In addition, increased productivity and an inventory reduction are common effects of successful lean projects.

#### **Criticism:**

The main criticism against TQM is that there is a widespread confusion concerning what TQM really means, [Boaden (1997) and Hellsten and Klefsjo (2000)]. In addition, a number of failures of organizations trying to implement TQM have been documented. According to Magnusson et al. (2003), there is a difficulty in six sigma programmes to exceed the customer's needs and hence increase the customer satisfaction. To avoid this problem some companies use voice of the customer tools in their define phase. Klefsjo et al. (2001) claim that six sigma programmes fail to create conditions in order to involve everyone, which is more emphasised in the TQM literature.

The main criticism against lean is the lack of flexibility the concept offers, [Dove (1999)], and that the concept actually can lead to delays for the customers, [Cusumano (1994)]. There is also a discussion going on whether lean, which was developed for manufacturing and distribution situations, is applicable in all industries. Mast (2004), on the other hand, argues that six sigma can be applied in a wide range of areas, including both manufacturing and service industries.

#### **DISCUSSION**

The presented concepts show many similarities, especially six sigma and TQM. However, the package of quality tools, the attention to financial result, the sustaining of the gains, and the focus of the problem solving methods of projects are new approaches in six sigma compared to other concepts in quality management. Klefsjo et al. (2001) argue that six sigma should be regarded as a methodology within the larger framework of TQM. One reason for this is due to the fact that six sigma supports all the six values in TQM, [Klefsjo et al. (2001)]. Dahlgaard and Dahlgaard (2001) also state that there is not any contradiction between the objectives in lean and TQM. Dahlgaard and Dahlgaard (2001) mean that six sigma and lean have clear road-maps in order to achieve business excellence.

Magnusson et al. (2003) also state that many companies have merged six sigma and lean manufacturing practices. George et al. (2004) claim that: Lean Six Sigma helps companies flourish in a new world where customers expect no defects and fast delivery at the minimal cost.

#### **CONCLUSION**

The purpose of this paper is to describe similarities and differences between lean, six sigma and TQM. The three presented concepts have many similarities, especially concerning origin, methodologies, tools and effects. Comparing the different quality management concepts, TQM and six sigma shows many similarities, while the lean concept is slightly different compared to the previous two.

However, it recommended that there is a lot to gain if organizations are able to combine these three concepts. Indeed, the concepts are complementary; especially six sigma and lean are excellent road-maps, which could be used one by one or combined, in order to strengthen the values of TQM within an organization. However, organizations continuously need to work with customer-orientated activities in order to survive; irrespective of how these activities are labeled today and in the future.

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