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# Similarities and differences between TQM, six sigma and lean

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## Abstract

**Purpose** – During the last decades, different quality management concepts, including total quality management (TQM), six sigma and lean, have been applied by many different organisations. Although much important work has been documented regarding TQM, six sigma and lean, a number of questions remain concerning the applicability of these concepts in various organisations and contexts. Hence, the purpose of this paper is to describe the similarities and differences between the concepts, including an evaluation and criticism of each concept.

**Design/methodology/approach** – Within a case study, a literature review and face-to-face interviews in typical TQM, six sigma and lean organisations have been carried out.

**Findings** – While TQM, six sigma and lean have many similarities, especially concerning origin, methodologies, tools and effects, they differ in some areas, in particular concerning the main theory, approach and the main criticism. The lean concept is slightly different from TQM and six sigma. However, there is a lot to gain if organisations are able to combine these three concepts, as they are complementary. Six sigma and lean are excellent road-maps, which could be used one by one or combined, together with the values in TQM.

**Originality/value** – The paper provides guidance to organisations regarding the applicability and properties of quality concepts. Organisations need to work continuously with customer-orientated activities in order to survive; irrespective of how these activities are labelled. The paper will also serve as a basis for further research in this area, focusing on practical experience of these concepts.

**Keywords** Quality management, Six sigma, Total quality management, Lean production, Quality improvement

**Paper type** Research paper

## Introduction

While management is considered as relatively immature compared to other social sciences, the field has been bombarded with “fads” see, for example, Carson *et al.* (1999). In summary, the different management theories presented over the years, of which some could be argued to be management fads, have been criticised for having four major defects. These major defects of the management theory are the following:

- (1) it is constitutionally incapable of self-criticism;
- (2) its terminology and industry-specific jargon rather confuse than inform;
- (3) it rarely rises above common sense; and
- (4) it is replete with fads and plagued with contradictions that would be intolerable in other scientific disciplines (Carson *et al.*, 1999).



During the last decades, quality management has been put forward by a number of its promoters as a new management theory, see, for example, Foley (2004). However, the description of what quality management is differs. Quality management can be described as a management revolution, a revolutionary philosophy of management, a new way of thinking about the management of organisations, a paradigm shift, a comprehensive way to improve total organisational performance, an alternative to management by control or as a framework for competitive management (Foley, 2004). Despite the high aims of promoters of quality management, the failures of organisations trying to implement a successful quality management programme have been well documented, see Brown *et al.* (1994), Eskildson (1994), Harari (1997), Cao *et al.* (2000) or Nwabueze (2001). These failures have led some authors to question whether some concepts in the area of quality management are fads, see, for example, van der Wiele *et al.* (2000).

John Godfrey Saxe's famous fable "The Blind Men and the Elephant" in which six blind men attempt, and ultimately fail, to describe an elephant could actually be a good description of quality management. In this well written story, each blind man touches only a part of the elephant. They go on to describe what the elephant feels like. For example: one blind man says "the elephant feels like a wall" another blind man describes it as "the elephant feels like a snake". In much the same way as each blind man forms a vision of the whole by examining a part, promoters of quality management have written books and articles and presented seminars about different concepts, which either are about the parts or are visions of the whole drawn from the knowledge of one or a few parts, see Foley (2004). Concepts that have been presented and promoted are, for instance, total quality management (TQM), six sigma, lean manufacturing, business process re-engineering, just-in-time (JIT), Kaizen and Business Excellence.

However, the description and definition of these different quality management concepts differ. For example, TQM is sometimes defined:

... 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, see Hellsten and Klefsjö (2000).

Six sigma, on the other hand, 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 minimise waste and resources while increasing customer satisfaction by some of its proponents, see Magnusson *et al.* (2003).

NIST (2000) defines lean:

... as a systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection.

While the definitions of TQM, six sigma and lean differ, the aim of the different concepts seems to be similar; through improvements minimising waste and resources while improving customer satisfaction and financial results. These concepts also have the same origin, the quality evolution in Japan after the World War II, see Dahlgaard and Dahlgaard (2001).

With parallels to the fable described above, one could argue that different promoters in the field of quality management (the six blind men), who each describes different quality management concepts (the wall, snake, etc.), are trying to describe a part or a vision about the whole; the area of quality management (the elephant). However, the parts or the visions about the whole differ, according to the definitions contributed of TQM, six sigma and lean (which also was the case for the six blind men). Furthermore, the way to achieve these objectives seems to differ between the different concepts. On the other hand, and as shown above, there are also many similarities, for example, with respect to the overall aim and origin. Therefore, one could also argue that the different promoters (the six blind men) in some areas are able to describe a similar vision of the whole (a similar picture of the elephant). Hence, and in summary, this paper sets out to describe if the vision of the different promoters of quality management concepts (TQM, six sigma and lean) is the same or if it differs.

Although considerable progress has been made in the field of quality management in general and in TQM, six sigma and lean 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 TQM, six sigma and lean. In specific, similarities and differences concerning areas such as the methodologies, tools, effects and criticism are illuminated in this paper. Furthermore, an overall description of each concept is contributed in this paper. Moreover, different management theories have been criticised for having four major defects, see above. Hence, the intention with this paper is also to present criticism of each concept (point 1) and inform, rather than confuse the reader about the similarities and differences of each concept (point 2), see Carson *et al.* (1999).

### **Quality management concepts**

#### *Total quality management (TQM)*

Quality has been an important issue for organisations for many years. The early focus on quality evolved from inspection to quality control and later to quality assurance, according to Dale (1999). During the 1990s, TQM evolved as a common term among organisations. Different definitions of TQM have been presented over the years. Dahlgaard *et al.* (1998) view TQM as:

... a corporate culture characterised by increased customer satisfaction through continuous improvement, in which all employees in the firm actively participate.

Shiba *et al.* (1993), on the other hand, argue 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 Klefsjö (2000) support the view that TQM is an evolving system. Hellsten and Klefsjö (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 Klefsjö (2000) argue that methodologies are “ways to work within the organisation to reach the values”. A methodology, according

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to Hellsten and Klefsjö (2000), “consists of a number of activities performed in a certain way”. Hellsten and Klefsjö (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 that are frequently mentioned in the TQM literature include the seven quality control tools, see Shewhart (1980) and Ishikawa (1985), and the 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 (PDSA).

*Effects.* 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. There are many different approaches to evaluating the possible 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 Sörqvist (1998). In recent years, research has also shown that one of the goals of TQM, customer satisfaction, has a significant positive impact on market value as well as accounting returns, see, for example, Andersson and Fornell (1994) and Eklöf *et al.* (1999).

The General Accounting Office (GAO) study was one of the first studies trying to establish a link between TQM practices and the performance of companies, see GAO (1991). In this study, Malcolm Baldrige recipients and companies that had received a site-visit (i.e. companies that in a sense were close to receiving an award) were evaluated. The main conclusion from the GAO study was that the companies investigated had improved their operating results. Moreover, better employee relations and improved operating procedures had been achieved, greater customer satisfaction had been accomplished, and an increased market share and profitability had been gained.

Hendricks and Singhal (1997) and Eriksson and Hansson (2003) compare recipients of quality awards with different control companies. The main conclusions from their research are that companies that have received a quality award outperform the control companies concerning operating income-based measures and other indicators during a period that follows the announcement. For instance, the growth in operating income for recipients averaged 91 per cent during a period that followed the award announcement, in contrast to a 43 per cent average growth for the control groups, see Hendricks and Singhal (1997). 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, see, for example, 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 about one-fifth, or at best one-third, of the TQM programmes in the US and Europe have achieved significant or even tangible improvements in quality, productivity, competitiveness or financial results.

As shown above, and described in Boaden (1997) and Hellsten and Klefsjö (2000), opinions differ about what TQM really is. Boaden (1997) claims in particular that:

... attempting to define TQM is like shooting at a moving target. As it is more widely practised, and other initiatives emerge, the emphasis on different aspects change.

The different opinions concerning what TQM is lead to different opinions about what TQM should result in. In particular, Eskildson (1994) states, on the basis of survey results, that many organisations do not succeed in their TQM efforts due to a vague definition of TQM. As a solution to this problem, Pyzdek (1999) states, after summarising 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.

Moreover, van der Wiele *et al.* (2000) discuss whether TQM is a fad, fashion, or fit. A fit of TQM into normal management practice means that the original fad will have affected the normal way of working within the whole organisation and not just a small part, such as would be the case in the adoption of a mere fashion. The fieldwork from van der Wiele *et al.* (2000) shows that a change to a fit of TQM to other management theories will only occur when there is a strong internal motivation for and emotional involvement in the implementation of TQM.

#### *Six sigma*

Motorola was the first company to launch a six sigma programme in the mid-1980s (Rancour and McCracken, 2000). 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, a number of global organisations have developed six sigma programmes of their own and six sigma is now established in almost every industry.

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 minimise 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 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 of a million customers should be unsatisfied, see 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, organisation, 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, see Eckes (2001). Panda *et al.* (2000) mean that the organisation also must clarify the different roles required and their different areas of responsibility in order to be successful with a six sigma programme. According to Magnusson *et al.* (2003), the hierarchy of responsibilities and the roles are: Champions and Sponsors, Master Black Belts,

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Black Belt, Green Belt, White Belt. Sanders and Hild (2000) claim that six sigma organisations often have standardised 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:

- (1) *Define*. Define which process or product that needs improvement. Define the most suitable team members to work with the improvement. Define the customers of the process, their needs and requirements, and create a map of the process that should be improved.
- (2) *Measure*. Identify the key factors that have the most influence on the process, and decide upon how to measure them.
- (3) *Analyse*. Analyse the factors that need improvements.
- (4) *Improve*. Design and implement the most effective solution. Cost-benefit analyses should be used to identify the best solution.
- (5) *Control*. Verify if the implementation was successful and ensure that the improvement sustains over time.

The second methodology is often used when the existing processes do not satisfy the customers or are not able to achieve strategic business objectives, see 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, see Magnusson *et al.* (2003).

Another company that has been successful with their six sigma programme is the Business Unit of Transmission & Transportation Networks at Ericsson located in Borås, Sweden. Ericsson in Borås have about 1,100 employees. According to Peter Häyhänen, a promoter and educator at Ericsson, they started their six sigma programme in 1997. At Ericsson, six sigma was first defined as a methodology for solving problems. Today, they rather see six sigma as a business excellence model for concrete areas and as a methodology in order to reach business goals. At Ericsson in Borås, approximately 50 Black Belt projects and 200 Yellow Belt projects have been executed between 1997 and 2004, with total savings of approximately 200-300 million euro between 1997 and 2003. (The company admits it is very difficult to estimate the savings due to the fact that they do not measure the total savings anymore.)

*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. In more detail, they state that six sigma is a highly disciplined, data-oriented, top-down approach, which typically includes four stages (measure, analyse, improve and control) and the use of statistical decision tools. The new thing concerning six sigma is the explicit linking of the tactical and the strategic, according to Klefsjö *et al.* (2001). For example, statistical techniques are used in a systematic way to reduce variation and improve processes, and there is a stronger focus on results, including customer needs. Klefsjö *et al.* (2001) see six sigma rather as a methodology within the larger framework of TQM.

#### *Lean*

Among the several quality management concepts that have been developed, the lean concept, as in lean manufacturing, lean production, etc. is one of the more wide-spread and successful attempts. Briefly, lean is about controlling the resources in accordance with the customers' needs and to reduce unnecessary waste (including the waste of time). The concept was introduced at a larger scale by Toyota in the 1950s, but not labelled lean manufacturing until the now famous book about the automobile appeared in 1990 (Womack *et al.*, 1990).

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. Consequences of this are striving for perfection and a customer-driven pull of the process. Thus, the definition of NIST is relevant:

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 organising 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 costing 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 organisation, 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. According to a recent survey, see NIST (2003), of 40 companies that had adopted lean manufacturing, typical improvements are visible in three areas. These improvement areas include: operational improvements (reduction of lead time, increase in productivity, reduction in work-in-process inventory, etc.), administrative improvements (reduction in order processing errors, streamlining of customer service functions so that customers are no longer placed on hold, etc.) and strategic improvements (reduced costs, etc.).

*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).

To summarise, lean requires a stable platform, where scale efficiency can be maximised. Highly dynamic conditions cannot be dealt with, as there is no room for flexibility due to the focus on perfection, which is always a function of particular market conditions at a certain period of time.

### 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, methodologies, tools, effects and criticism, are also presented in Table I.

#### *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. TQM is often associated with the prominent figures within the field of quality management, for example, Deming and Juran, but they have in general not used the term TQM. In particular, Deming (1994) has stated that:



**Table I.**  
The table shows the authors' view concerning the similarities and differences between TQM, six sigma and lean

Concepts	TQM	Six sigma	Lean
Origin	The quality evolution in Japan	The quality evolution in Japan and Motorola	The quality evolution in Japan and Toyota
Theory	Focus on customers	No defects	Remove waste
Process view	Improve and uniform processes	Reduce variation and improve processes	Improve flow in processes
Approach	Let everybody be committed	Project management	Project management
Methodologies	Plan, do, study, act	Define, measure, analyse, improve (or design), control (or verify)	Understanding customer value, value stream, analysis, flow, pull, perfection
Tools	Analytical and statistical tools	Advanced statistical and analytical tools	Analytical tools
Primary effects	Increase customer satisfaction	Save money	Reduce lead time
Secondary effects	Achieves customer loyalty and improves performance	Achieves business goals and improves financial performance	Reduces inventory, increases productivity and customer satisfaction
Criticism	No tangible improvements, resource-demanding, unclear notion	Does not involve everybody, does not improve customer satisfaction, does not have a system view	Reduces flexibility, causes congestion in the supply chain, not applicable in all industries

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... the trouble with TQM, the failure of TQM, you can call it, is that there is no such thing. It is a buzzword. I have never used the term, as it carries no meaning, see Romano (1994).

The success with six sigma at Motorola and with lean at Toyota is a main reason for these concepts to spread to other organisations. In contrast to six sigma and lean, no organisation was the origin to the term TQM (there is ongoing discussion on who really labelled TQM). A notable difference between six sigma and lean is that Motorola labelled six sigma, see Rancour and McCracken (2000), while authors in the field, Womack *et al.* (1990), labelled the lean concept. 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, see Hellsten and Klefsjö (2000).

#### *Process view and approach*

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, see Magnusson *et al.* (2003). When the project members have reduced the variation in a process, and hence achieved the business goals, increased the profit or lowered the cost, this improvement is visualised to the top managers at the company. Often some of the top managers are also involved in the performed improvement projects. As a result, the six sigma programme receives necessary support from the top managers at the company, as the managers recognise the economical impact of it. This could be one explanation for the documented successes of six sigma compared with TQM, i.e. six sigma programmes talk the top managers' language (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; see George *et al.* (2004). In lean manufacturing, project groups are usually the approach to perform the necessary improvements. While six sigma and lean focus on performing improvements mainly through projects, TQM has sometimes a different approach. TQM emphasises the commitment and involvement of all employees, see, for example, Bergman and Klefsjö (2003). In TQM, there is also, like six sigma and lean, a strong focus on processes. It is the authors' opinion that the main objectives of the process work within TQM are to alternatively improve and uniform the processes.

#### *Methodologies*

Hellsten and Klefsjö (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: PDSA. In six sigma there are two major improvement methodologies, one for already existing processes and one for new processes, see above. 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; i.e. the methodologies are cyclical and consist of similar phases. One could argue that the methodologies in six sigma are a further development of the

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improvement cycle, which first was developed by Shewhart and Deming. 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.

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#### *Tools*

Deming stated that about 96 per cent of the problems are built into the system and that individual employees can only control about 4 per cent. 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. In general, six sigma programmes have been successful at integrating advanced improvement tools with the methodologies. The tools range from design tools to management tools and from very simple tools to more advanced statistical tools. During the training programmes in six sigma, one learns how to choose the most appropriate tool and how it should be applied. In addition, one must verify the selection in order to assure that the appropriate tool was chosen. In general, six sigma programmes have successfully emphasised the statistical part in quality management. In lean, a variety of tools are available for reducing or eliminating waste, see above. 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 Klefsjö (2000). Eklöf *et al.* (1999) have also shown that there is a positive correlation between customer satisfaction and the financial results of companies. Furthermore, there is strong correlation between customer satisfaction and customer loyalty, see Söderlund (2001). Moreover, it has been shown that organisations that have successfully implemented TQM outperform similar organisations regarding a number of financial indicators, see Hendricks and Singhal (1997) and Eriksson and Hansson (2003). 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. Before starting a six sigma project, one must prove that the improvement will result in economical savings for the company. This results in the fact that all improvements in a six sigma programme are economically justified. However, it is the authors' opinion that six sigma does not necessarily improve customer satisfaction to the same extent as a successful TQM programme. The reason is that a six sigma programme primarily emphasises the economical savings and secondly the customer satisfaction. This view was supported by Ericsson in Borås. 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 objectives 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.

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### Criticism

The main criticism against TQM is that there is a widespread confusion concerning what TQM really means, see Boaden (1997) and Hellsten and Klefsjö (2000). In addition, a number of failures of organisations trying to implement TQM have been documented. In more detail, a number of organisations have put a large amount of resources on implementing TQM, but with no tangible improvements achieved, see, among others, Harari (1997). 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. Klefsjö *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. Furthermore, in six sigma training programmes one can only start a project which gives a certain amount of savings. This project is often executed in the department of the project members. The project normally leads to an improvement in the department of the project members, but due to the performed change another department can experience deterioration. As a result, six sigma is sometimes accused for not having a system view. The main criticism against lean is the lack of flexibility the concept offers, see Dove (1999), and that the concept actually can lead to delays for the customers, see 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.

### Discussions

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. Klefsjö *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, see Klefsjö *et al.* (2001). Dahlgaard and Dahlgaard (2001) also state that there is not any contradiction between the objectives in lean and TQM. They support the view presented by Klefsjö *et al.* (2001) above, and argue that six sigma and lean should rather be seen as a collection of concepts and tools, which support the overall principles and aims of TQM. Dahlgaard and Dahlgaard (2001) mean that six sigma and lean have clear road-maps in order to achieve business excellence, but it is important in order to be successful to stress the corporate culture and human factor in these concepts. TQM is often accused for being blur and unclear, and it is, therefore, the authors' opinion that six sigma and lean can be appropriate approaches for organisations in order to make important progress in the field of quality management.

Recently, the term lean six sigma has been put forward by, for example, George *et al.* (2004) and Martichenko (2004). In specific, 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.

Magnusson *et al.* (2003) also state that many companies have merged six sigma and lean manufacturing practices. The merger can be traced back to early developments at General Electrics where they realised that the two concepts complemented each other

very well, i.e. lean manufacturing addresses process flow and waste whereas six sigma addresses variation and design.

This paper has focused on a theoretical description and comparison of three quality management concepts. Further research in this area will need to focus on the practical experience of these concepts, and contribute to a better understanding concerning which concept is most appropriate in different situations. Furthermore, a more detailed description of how these concepts can be combined needs to be presented in order to facilitate for organisations to meet and exceed the demands of future customers and survive in an even more competitive environment.

### Conclusions

The purpose of this paper is to describe similarities and differences between TQM, six sigma and lean. With parallels to the fable described above, one could argue that the blind men's visions about the whole are very similar; the three presented concepts have many similarities, especially concerning origin, methodologies, tools and effects. However, the blind men's vision about the whole also differs slightly in some areas; especially concerning the main theory, approach and the main criticism. Comparing the different quality management concepts, TQM and six sigma show many similarities, while the lean concept is slightly different compared to the previous two. However, it is the authors' recommendation that there is a lot to gain if organisations 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 organisation. Even if some of the presented concepts have been accused for being management fads, see above, it is the authors' opinion that organisations continuously need to work with customer-orientated activities in order to survive; irrespective of how these activities are labelled today and in the future.

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#### Further reading

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