The challenges of six sigma in improving service quality

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Abstract

Purpose – The purpose of this paper is to critically evaluate the contributions of six sigma methodology to the improvement of service quality. Since its development in the late 1980s, six sigma has been extensively applied in manufacturing and quasi-manufacturing settings. This study aims to explore the challenges of six sigma in reaching a much wider field of application.

Design/methodology/approach – Utilizing the service quality framework, the authors assess the contributions of six sigma and explore its limitations when applied to services.

Findings – The relentless drive toward adopting six sigma to services has led both to a limited field of applications and to unrealistic expectations as to what six sigma is truly capable of achieving, particularly in knowledge-based environments.

Research limitations/implications – This research focuses on highlighting gaps in the six sigma as applied to services; further work is necessary to identify and develop new methods and to study their effectiveness.

Practical implications – The most immediate practical implication of this study is the call for the redesign of the curricula of six sigma black belts training programs; training in service quality is vital for the successful application of six sigma in service operations.

Originality/value – This study provides a fresh look into six sigma application to services by combining a thorough analysis of the service quality model with the in-depth understanding of six sigma statistical concepts.

Keywords Six sigma, Customer services quality, Consumer behaviour, Quality management

Paper type Research paper

Introduction

Service quality is an increasingly important priority for companies that wish to differentiate their services in a highly competitive and often cutthroat environment. Two trends are generally at work: in industrialized nations, the services have become the dominant sector of the economy, and, at the same time, products are being offered more and more as bundles of goods and services in response to a more comprehensive understanding of customer needs. Aided by innovative and pervasive communication technologies, even the old manufacturing facilities have largely turned into “service factories” (Chase and Garvin, 1989).

From an academic perspective, service quality continues to be a stimulating topic in contemporary management theory and practice. Researchers in the field of marketing have contributed significantly to our understanding of the nature of services and of the
nature of customer satisfaction (Ghobadian et al., 1994; Grönroos, 1982, 1984). The most consistent findings of three decades of service quality research are that:

- service quality is more difficult for the consumer to evaluate than product quality;
- service quality perceptions result from a comparison of consumer expectations with actual service performance; and
- quality evaluations are not based solely on the outcome of a service but also involve evaluation of the delivery process.

The challenges of service quality management are well captured in the words of Berry and Parasuraman (1997, p. 66):

The task of improving service in organizations is complex. It involves knowing what to do on multiple fronts, such as technology, service systems, employee selection, training and education, and reward systems. It involves knowing how to implement these actions and how to transform activity into sustainable improvement. Genuine service improvement requires an integrated strategy based on systematic listening. Unrelated, incomplete studies, outdated research, and findings about customers that are not shared provide insufficient support for improving service.

In services, the meaning of quality can be elusive and is often defined as a measure of how well the service level delivered meets customer expectations (Lewis and Booms, 1983). Rust et al. (1994) defined six levels of customer expectation as shown in Figure 1. According to this hierarchical framework, the will expectation is the average level of quality that is predicted based on all available information and represents the level of quality most expected by the customer; the should expectation represents the level of service the customer believes is deserving; and, the ideal expectation is what the customer believes is the best of circumstances. The minimally acceptable expectation is the threshold level of mere satisfaction, while the low-will expectation is the lowest level of quality expected by the customer and the worst possible is the worst service outcome that the customer can imagine.

![Figure 1. The hierarchy of customer expectations](image-url)
The concept of service quality is a technical term in the marketing literature that usually embodies a particular model relating service performance, customer perceptions of quality, customer expectations, and customer satisfaction. The seminal work in this area was presented by Parasuraman and his colleagues who developed a framework for assessing five dimensions of customer perceptions of service quality (Parasuraman et al. 1985, 1988, 1991, 1994; Zeithaml et al., 1988, 1996; Berry and Parasuraman, 1997). A number of studies have criticized and expanded the early stream of research and have proposed alternative models, which are reviewed in Seth et al. (2005).

Recently, a number of articles has focused on the importance of six sigma for services and the challenges of applying this quality improvement methodology to service operations (Biros, 2002; Patton, 2005; Hensley and Dobie, 2005; Antony, 2006; Chakrabarty and Tan, 2007; Antony et al. 2007; and Kumar et al., 2008). For example, Kumar et al. (2008) debunk the seven most common myths about six sigma that:

1. it is a fad;
2. it is all about statistics;
3. it is good only for manufacturing processes;
4. it is effective in large organizations;
5. it is the same as TQM;
6. it requires strong infrastructure and massive training; and
7. it is not cost effective.

Myth 3 is of special interest to us given the context of this study. What is the effectiveness of the six sigma methodology in improving the quality of services? What can be learned from the service quality literature that may inform the six sigma professionals and contribute to the effectiveness and to the range of applications of six sigma? This article first summarizes the growing literature of six-sigma applications in services, highlighting the potential and possible limitations of six sigma applications in service industry particularly in a knowledge-based environment. We then examine the theoretical contributions of six sigma to the quality field and compare it to total quality management (TQM). We present the main tenets of the service quality model, point to some deficiencies in the application of six sigma to services, and discuss the implications of those deficiencies to the continued expansion of this approach in service industries.

The six sigma wave in services
Since its development by Motorola in the late 1980s six sigma has gained considerable attention, especially since its adoption by high profile companies such as General Electric (GE) in the mid-1990s, six sigma has spread like “wildfire” (Caulcutt, 2001; Goh, 2002; Chakrabarty and Tan, 2007). Many organizations in manufacturing and services, public and private, large and small have joined the six sigma band wagon. In addition to Motorola and GE, many other Fortune 500 companies such as American Express, Boeing, Caterpillar, Fidelity Investments, Honeywell International, J.P. Morgan Chase, Johnson and Johnson, Kodak, Lockheed Martin, Maytag, Northrop Grumman, Sony, and Texas Instruments have applied six sigma to a myriad of projects. The six sigma wave has spread from the US to the European Union, Japan, Canada and is gradually becoming popular in India and other less developed countries.
in Asia, Middle East and Latin America (Thawani, 2004). Table I summarizes recent studies that report six sigma applications broken down by specific service industry or sectors. It includes examples from service industries as well as from service operations of manufacturing companies.

There is a growing number of descriptive and prescriptive articles, mostly authored by practitioners and consultants, that deal with six sigma applications in the service industry (e.g. Biolos, 2002; Hensley and Dobie, 2005; Patton, 2005; Antony, 2006; Chakrabarty and Tan, 2007; Antony et al., 2007). Some researchers employ conceptual models to investigate the organizational requirements for effective six sigma implementation. Hensley and Dobie (2005) propose a conceptual model for assessing organizational readiness for six sigma and utilize the model to analyze the readiness of a public transit company based on survey data. Chakrabarty and Tan (2007) examine the current state of six sigma application in services based on quantitative and qualitative analysis of the literature and identify critical success factors and key performance indicators as management guidelines for effective applications of six sigma in the service industry. Biolos (2002) prescribes ways how to effectively implement six sigma in service organizations. Some studies have investigated the success factors for implementing six sigma in world-class organizations (Eckes, 2000; Antony and Banuelas, 2002; Antony, 2006; Antony et al., 2007). Antony (2006) highlights the six sigma success factors: strong leadership and management commitment, organizational culture change, aligning six sigma projects to corporate business objectives, election of team members and teamwork, six sigma training, understanding the DMAIC methodology, tools, techniques and key metrics, selection of projects and project management skills, linking six sigma to customers, and accountability (tying results in financial terms to the bottom line). Wessel and Burcher (2004), Antony et al. (2005), and Fahmy (2006) discuss the application of six sigma in small and medium enterprises and what can be done to help them succeed. Antony et al. (2007) report on the benefits, challenges, and critical success factors of six sigma projects in service organizations. While the majority of articles pertain to six sigma applications in the USA, several studies focus on a variety of countries (Wessel and Burcher, 2004 – Germany; Ho and Chuang, 2006 – Taiwan; Kumi and Morrow, 2006; Antony et al., 2007 – UK; Kim, 2006 – S. Korea; Pheng and Hui, 2004 – Singapore).

While six sigma has been adopted by many organizations both in the United States and around the world, the main areas in the service industry where six sigma has seen the most work are banking and financial services, healthcare, construction, supply chain management, accounting, customer relations, public utilities, material procurement, education, libraries, order processing, the airline industry, safety and even the government and non-for-profits. Antony (2006) describes some of the potential areas in the service sector, which are prime for six sigma adoption. Edgeman et al. (2005) describe how the US government is using six sigma in order to increase the quality of service they are providing in this time of uncertainty. Furterer and Elshennawy (2005) explain how municipal finance departments are trying to increase their efficiency through lean six sigma initiatives. Reece (2006) describes how six sigma is aiding the US Department of Defense in managing budgetary constraints. Matchette (2006) on the other hand describes the various other ways that the US Department of Defense benefits from six sigma. Jenicke et al. (2008) propose a framework for applying six sigma in institutions of higher education.
<table>
<thead>
<tr>
<th>Sector</th>
<th>Examples of applications</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial services</td>
<td>Student Loan Marketing Association (Sallie Mae), Bank of America, Citibank, Fidelity Investments, J.P. Morgan Chase, American Express, GE Capital Corp., Sun Trust Banks, Inc., Credit Unions</td>
<td>Taghaboni-Dutta and Moreland, 2004; Biolos, 2002; Roberts, 2004; Carlivati, 2007; Antony, 2006; Chakrabarty and Tan, 2007; Hensley and Dobie, 2005</td>
</tr>
<tr>
<td>Non-manufacturing processes</td>
<td>GE, Honeywell, Maytag, Lockheed Martin, Northrop Grumman, AlliedSignal, Dow Chemical, Ford, Caterpillar, DuPont, Raytheon, 3M, Polaroid</td>
<td>Fahmy, 2006; Antony, 2006; Biolos, 2002; Hensley and Dobie, 2005; Chakrabarty and Tan, 2007; Taghaboni-Dutta and Moreland, 2004; Schlegel and Smith, 2005; Bandyopadhyay and Jenicke, 2007; Lanyon, 2003</td>
</tr>
<tr>
<td></td>
<td>Municipal Services</td>
<td>Furterer and Elshennawy, 2005 Matchette, 2006; Reece, 2006; Hensley and Dobie, 2005 Ho and Chuang, 2006</td>
</tr>
<tr>
<td></td>
<td>US Department of Defense</td>
<td>Juras et al., 2007</td>
</tr>
<tr>
<td>Healthcare</td>
<td>OSE Saint Francis Medical Center – University of Illinois College of Medicine</td>
<td>Simmons-Trau et al., 2004</td>
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<tr>
<td></td>
<td>Commonwealth Health Corp., Bowling Green, KY</td>
<td>Lazarus and Novicoff, 2004</td>
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<tr>
<td></td>
<td>Naval Medical Center, San Diego, CA</td>
<td>Johnstone et al., 2003</td>
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<tr>
<td></td>
<td>Wake Forest University Baptist Medical Center, NC</td>
<td>Porter, 2005</td>
</tr>
<tr>
<td></td>
<td>Radiology Film Library</td>
<td>Benedetto, 2003; Martin, 2007; James, 2005; D’Eredita, 2003</td>
</tr>
<tr>
<td>Education</td>
<td>Newcastle University Library Library Services, LibQUAL, South Korea</td>
<td>Kumi and Morrow, 2006</td>
</tr>
<tr>
<td></td>
<td>Institutions of Higher Education</td>
<td>Kim, 2006</td>
</tr>
<tr>
<td>Construction</td>
<td>Housing and Development Board, Singapore</td>
<td>Jenicke et al., 2008</td>
</tr>
<tr>
<td>Logistics and distribution</td>
<td>R.R. Donnelley Logistics</td>
<td>Cottrill, 2002</td>
</tr>
</tbody>
</table>

Table I. Applications of six sigma in services
The healthcare industry in particular is an area where there has been considerable research into six sigma applications. Benedetto (2003) examines the potential benefits and drawbacks of implementing six sigma in a radiology film library and how that environment compares to other areas in hospitals. D'Eredita (2003) describes ways to use six sigma in the healthcare industry in order to lower costs in non-core departments, while Johnstone et al. (2003) study the situation surrounding the implementation of six sigma into various areas of healthcare in order to save lives and reduce costs.

There are numerous manufacturing companies applying six sigma to their various non-manufacturing processes such as human resources, payroll, accounting, customer relations, supply chain management, safety and hazard engineering, and organization change and innovation. Lanyon (2003) describes how Raytheon Corporation is using six sigma to improve human resource management processes. Juras et al. (2007) describe how chief financial officers can apply six sigma in order to guarantee compliance with the Sarbanes-Oxley Act. Fleming et al. (2005) report how companies are applying six sigma to improve their customer relations processes.

Financial services are another area of the service sector where six sigma has been very popular in recent years. Taghaboni-Dutta and Moreland (2004) report how six sigma is applied to improve the process surrounding student loan refinancing, while Roberts (2004) reports how credit unions are benefiting from six sigma. Carlivati (2007) focuses on six sigma in the banking industry and how six sigma can be applied to various non-core divisions like marketing.

**Evaluation of six sigma applications**
Although the adoption of six sigma by such companies as GE led to an enormous expansion of this approach to the service operations of many large corporations, the service sector has been considerably slower in embracing six sigma than the manufacturing sector (Furterer and Elshennawy, 2005). Since its early days, however, the application of six sigma has not been without difficulties and challenges, especially with services (Biolo, 2002; Rylander and Provost, 2006; Antony, 2006; Matchette, 2006; James, 2005; Chakrabarty and Tan, 2007; Antony et al., 2007). In fact, an important part of the literature on six sigma applications regards the specific difficulties with, and provides useful advice for, its implementation in the service sector. Chakrabarty and Tan (2007, pp. 200-201) suggest several critical success factors to consider when applying six sigma:

- it is crucial that top management is committed to six sigma;
- employees must have adequate training in order to implement six sigma effectively;
- the company’s culture and values must adjust properly;
- the six sigma initiative must be focused on the customer;
- in order to do this, the company must have the proper metric;
- the company must be able to clearly show how six sigma financially benefits the company; and
- management must properly understand the company’s processes.

While these are all important considerations when implementing six sigma in any environment, there are specific difficulties in applying six sigma programs in the service sector. Hensley and Dobie (2005, p. 87) identify some of the problems that come about when implementing six sigma in the service sector:
it is harder to collect data in service industries;
• it is harder to measure due to various things that happen when customers and service providers interact;
• it may be more difficult to control and measure six sigma in the service industry due to the difficulties that arise from the various sub-processes;
• the data are not as reliable since the data are collected through more direct (“face to face”) means.

Biolos (2002, pp. 3-5) and Antony (2006, pp. 239-241) provide useful advice for consideration when applying six sigma to a service business:
• consider which processes can yield the most benefit from six sigma;
• the customer comes first so you must consider the impact on your customer;
• search relentlessly for the root causes;
• get to the root cause of the main problems plaguing your process;
• determine what is considered a service defect and how it will be measured;
• compare your company and your company’s capabilities before and after six sigma was implemented;
• do not forget this is no short time commitment;
• determine the risks that need to be considered with the project;
• identify the costs as well as benefits associated with each part of the project;
• clearly determine what everybody’s responsibilities are as well as any milestones.

With training costs up to US$50,000 per worker, the costs of implementing six sigma in an organization can be considerably high (Antony, 2006; Fahmy, 2006) and this has kept many small- and medium-sized companies from adopting six sigma (Wessel and Burcher, 2004; Antony, 2006; Fahmy, 2006). Wessel and Burcher (2004, p. 268-271) describe ten imperatives for small and medium companies implementing six sigma:
(1) all projects must benefit the company’s bottom line;
(2) track results for 12 months;
(3) small and medium companies must focus their six sigma program on the first two imperatives;
(4) incorporate a shorter training program that involves training the quality leaders but not incorporating the large green belt base;
(5) implement a one day training program to create awareness in the company;
(6) allow the quality leaders to handle the six sigma projects;
(7) design a corporate structure that supports a six sigma culture;
(8) small and medium companies must make sure they have the “fundamental elements of process management”;
(9) use consultants and trainers offering modular services;
(10) combine the efforts of six sigma and ISO 9000.
The literature on six sigma applications to services is vast and varied. However, something seems to be missing. While the importance of linking six sigma to customer satisfaction is often mentioned in this literature, there is little analysis of what customer satisfaction is and the role customer expectations may play in the evaluation of quality. There seems to be little room to incorporate, or even provide linkages to, the relevant research in the service quality literature. In none of the articles on six sigma applications to services that we investigated did we find the recognition of a service quality model or the development of a theoretical service framework; in only a few (e.g. Hensley and Dobie, 2005; Kim, 2006) there was a brief reference to the service quality model. It appears that the application of six sigma to services will be severely limited if there is no deep understanding of the nature of services and of how people judge quality in services.

Contributions of six sigma to quality

An excellent overview of six sigma’s assumptions, motivations, steps and tools can be found in de Koning and de Mast (2006). Two basic references which provide a comprehensive coverage of view of this approach are Pande et al. (2000) and Pyzdek (2001). In this section we identify and discuss four fundamental contributions of six sigma to the quality movement.

Six sigma as a philosophy: reducing process variability produces greater benefits than just controlling for the process average

A critical contribution of the six sigma philosophy is the realization that the variation of an operation impacts the rest of the process very significantly. This is due to the interrelated nature of most production processes and to the impact that a single defective may have across the entire process. Analytical studies show that the reliability of a process is multiplicative, and thus the probability of producing a defective item depends highly on the reliability of each operation. High variation of an operation leads to a higher proportion of defectives and thus impacts the entire process. An important assumption of the six sigma philosophy is that reducing the variation of a process leads to greater insights about how it functions than simply focusing on how to control its average. Associated with this assumption is the realization that in gaining an understanding of how to reduce variation, one also learns how to control the process average. These assumptions have totally replaced the focus on controlling the process average with little regard to variation, as it was common in traditional statistical process control (SPC) practices.

Six sigma as a quality standard

Six sigma can also be interpreted as a quality standard, in fact a rather stringent one. This critical contribution came from the realization that in real life there are commonly millions of incidences of an event, millions units of a product being used in the marketplace, and millions of services being delivered every day. Its origin goes back to early 1930s when Walter Shewhart (1931) introduced three sigma as a measure of variability in a process output. A standard of quality based on three standard deviations assumes an acceptance rate of 99.7 percent (based on the normal distribution) or 0.3 percent defective rate, or 2700 errors per million opportunities (EPMO). According to often-cited information reported by the Six Sigma Forum (Thawani, 2004, p. 657), a three-sigma quality level would result in:
In contrast, a six sigma standard would result in 68 wrong drug prescriptions each year, one short or long landing at major airports every five years, unsafe drinking water for one minute every seven months, and one hour without electricity every 34 years. The 3.4 EPMO associated with the six sigma standard reflects the sensibility that a three-sigma quality standard is not good enough. The much tougher six sigma standard reminds the organization that a seemingly low probability of error can be seen in a quite different way if one imagines millions of occurrences rather than the small number of units that the worker experiences directly. To illustrate this point, let us assume that an airline company loses 19 bags on a particular day. Considering that the airline transported 8,750 passengers that day, the ratio of lost bags per passenger of 0.2 percent seems rather small. If one factors in that passengers carry 1.6 bags per person (1.6 bpp) on average, the ratio of lost bags to total bags handled is “just” 0.136 percent. How bad can this be? The six sigma standard of 3.4 EPMO brings in a much tougher look at the same situation:

\[
\text{EPMO} = \frac{\text{No. of errors}}{\text{No. of opportunities}} \times 1,000,000.
\]

\[
= \frac{\text{No. of bags lost}}{\text{No. of passengers 1.6 bpp}} \times 1,000,000.
\]

\[
= \left( \frac{19}{14,000} \right) \times 1,000,000.
\]

\[
= 1,357 \text{ errors per million opportunities}.
\]

It quickly becomes apparent that losing 19 bags in one day is far from a six sigma level of performance. If the airline handles an average of 14,000 bags per day, the 3.4 EPMO standard means that the there should be only \( \frac{3.4}{1,000,000} \times 14,000 = 0.05 \) bags lost per day, which translates into the airline company running about 20 consecutive days without losing any bag.

The meaning of 3.4 EPMO and its relation with six standard deviations is worth clarifying. Suppose that a process adds a critical substance to a pharmaceutical compound. The specifications for this critical substance are 1,000 mg ± 6 mg. Let us further assume that the process is so finely tuned having an average of 1,000 mg and a standard deviation of 1 mg. The process is said to be six sigma capable, that is, the upper limit and the lower limit of specifications (ULS and LLS) are six standard deviations away from the process average. The probability of the process adding the critical substance below 994 mg or above 1,006 is only 0.0000001 percent, or 0.0001 times per million, that is, way below the 3.4 EPMO. Let us assume, however, that on a particular day that the process average is 1,001.5, that is, higher than what it should be by one and half standard deviations while the standard deviation is unchanged. What is the probability of the process adding more that 1,006 mg of the substance to the compound given that the process average is now 1.5 standard deviations higher? The
The answer is 

\[
P(x > 1,006) = P(z > (1,006 - 1,001.5)/1) = P(z > 4.5) = 0.0000034, \text{ or 3.4 times in a million.}
\]

Figure 2 illustrates six sigma’s 3.4 EPMO standard.

3. Six sigma as a continuous improvement methodology

When compared with TQM, six sigma has many differentiated characteristics: While TQM promotes employee empowerment and self-managed teams, six sigma is driven by organization’s champions; six sigma projects are more often cross-functional and strategic in nature than TQM department-based projects; TQM training is generally restricted to simple tools and statistical techniques (e.g. the Magnificent Seven), while six sigma focuses on more advanced statistical methods (such as experimental design, fault analysis, simulation); and six sigma projects are much more accountable in terms of return on investment than TQM projects ever were (Snee, 2000; Senapati, 2004; Antony, 2006; Green, 2006). A summary comparison between TQM and six sigma is presented in Table II.

The backbone of the six sigma methodology is the well-known five steps of the DMAIC process: Define (determine which processes to improve), Measure (collect all the necessary data), Analyze (identify the root of the problem), Improve (take actions to reduce the amount of defects), and Control (reduce defects via a change in the process). These five steps are very important to six sigma since they lay out the framework in which six sigma is applied (de Koning and de Mast, 2006). However, the critics of six sigma often claim that the DMAIC methodology of six sigma is not fundamentally different from those of other quality movements (Senapati, 2004).

Six sigma as an organizational change agent and motivational tool

Six sigma is a means to reduce process variation, but it is much more than that also. It is a philosophy that benefits everyone from the customers to the shareholders and even the suppliers and employees (Chakrabarty and Tan, 2007). Unlike lean management, which focuses on cost savings, six sigma is a means of saving both the company and the customer not only money but also all the problems that come along with poor quality. Chakrabarty and Tan (2007, p. 196) emphasize that six sigma is a “customer
<table>
<thead>
<tr>
<th>Feature</th>
<th>TQM</th>
<th>Six sigma</th>
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<tbody>
<tr>
<td>Emphasis</td>
<td>Customer satisfaction</td>
<td>Process reliability, reduction of process variation</td>
</tr>
<tr>
<td>Goal</td>
<td>Continuous improvement “improve everything forever”</td>
<td>Improve specific processes that are critical-to-quality</td>
</tr>
<tr>
<td>Competitive analysis</td>
<td>Benchmarking</td>
<td>Improvement driven internally by process data</td>
</tr>
<tr>
<td>Breadth</td>
<td>All phases of SIPOC value chain (suppliers, inputs, processes, outputs, and customers): Supplier partnerships, involvement Product/service design Process control, preventative management Employee relations, empowerment, teamwork Customer involvement, satisfaction Management’s quality awareness</td>
<td>Focus on manufacturing and service processes (only P of the SIPOC chain): Determine critical-to-quality variables Define appropriate metrics Measure process variation Design experiments to determine causal relationships Implement process improvements</td>
</tr>
<tr>
<td>Continuous improvement methodology</td>
<td>PDSA: plan-do-study-act</td>
<td>DMAIC: define-measure-analyze-improve-control</td>
</tr>
<tr>
<td>Training</td>
<td>Across the organization; more breadth than depth</td>
<td>Differentiated belt system: master black belts, black belts, and green belts; in depth statistics and data analysis</td>
</tr>
<tr>
<td>Statistical tools</td>
<td>“Magnificent 7”: Pareto charts Flow charts Check sheets Histograms Scattered diagrams Statistical process control charts Cause-effect diagrams</td>
<td>Failure mode and effects analysis Process mapping Process capability analysis Regression analysis Reliability Design of experiments Factorial designs Fractional factorials Block designs Response surface designs</td>
</tr>
<tr>
<td>Leadership</td>
<td>Top leadership, CEO</td>
<td>Project champions and master black belts</td>
</tr>
<tr>
<td>Rewards</td>
<td>Change in overall compensation systems Elimination of productivity-based ratings</td>
<td>Project champions incentives based on project’ success</td>
</tr>
<tr>
<td>Measure of success</td>
<td>Market share, overall financial performance</td>
<td>Project-focused Hard-dollar savings</td>
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</table>

Table II. Comparing TQM and six sigma

Six sigma in improving service quality
focused methodology that drives out waste, raises levels of quality, and improves the financial performance of organizations to breakthrough levels.”

Six sigma is not just a way of measuring the level of quality, it is a way of determining weaknesses; where the organization could do better; and how to serve the customer better (Edgeman et al., 2005; Antony, 2006; Antony et al., 2007). Six sigma is a way of instilling in the people in the organization a new perspective on what’s acceptable (Goh, 2002; Edgeman et al., 2005; Wessel and Burcher, 2004). While the major benefit of six sigma may be its impact on the bottom line, there are many other benefits such as increased customer satisfaction, higher understanding of problem solving, increased teamwork, and increased employee morale (Chakrabarty and Tan, 2007). However, as Hensley and Dobie (2005, p. 87) remind us, “six sigma works most successfully when it is adopted as a managerial philosophy not as a quick fix for a particular problem.”

Six sigma’s hierarchy of expertise is based on the belt system, which has been credited for fostering a culture of quality in which the ownership of quality is viewed as the responsibility of the entire organization and for providing a common purpose and language (Antony and Banuelas, 2002). The belt system is divided into five levels (Henderson and Evans, 2000):

1. champions (fully trained business leaders responsible for promoting and directing the six sigma strategy, selection of critical projects, and deployment);
2. master black belts (fully trained quality leaders responsible for six sigma implementation, training, mentoring, and results);
3. black belts (fully trained experts who are experienced in leading improvement teams);
4. green belts (fully trained experts in six sigma tools and methodologies deployed in six sigma project teams); and
5. team members (individuals supporting specific projects working in teams in their areas).


The service quality model
In the quality literature, five different perspectives in defining quality are commonly identified:

1. transcendental (only through experience, not definable);
2. product-based (performance, features, reliability, durability, serviceability, perceived quality);
3. user-based (fitness for use, defined by the customer);
4. manufacturing-base (conformance, defined by the producer); and
5. value-based (balancing conformance and performance with price) (Garvin, 1988; Haksever et al., 2000; Metters et al., 2006).
A complementary framework that brings a deeper understanding on how customers evaluate quality was proposed by Darby and Karni (1973) and Nelson (1974). These authors identify three types of attributes of goods and services:

1. Search attributes are those characteristics that are known prior to purchase or delivery of products or services;
2. Experience attributes are those characteristics that are knowable after purchase as the product is being used or the service is being delivered; and
3. Credence attributes are those characteristics that can only be known or evaluated long after the product is consumed or the service is delivered.

A number of researchers have attempted to define and model service quality. In their classic study, Parasuraman et al. (1985) identified ten service quality determinants, i.e. ten key criteria that customers use to evaluate quality regardless of the type of service: reliability, responsiveness, competence, access, courtesy, communication, credibility, security, understanding and knowing the customer, and tangibles. For Parasuraman et al. (1985) credibility and tangibles are search attributes; access, communication, courtesy, reliability, responsiveness, and understanding are experience attributes; and competence and security are credence attributes. Using factor analysis, these researchers later developed a service quality scale in which the ten original determinants of quality were collapsed into five dimensions (Parasuraman et al., 1988, 1991):

1. Reliability – consistency of performance and dependability; performs service right at the first time; honors its promises; keeps accurate records, correct billing, and performs services at the designated times;
2. Responsiveness – readiness to provide the service; timeliness; setting up appointments promptly;
3. Assurance – knowledge, competence and courtesy of employees; convey trust and confidence; has the required skills and knowledge; polite, respectful, considerate, friendly; trustworthiness, believability, honesty;
4. Empathy – caring; individualized attention, approachability, ease of contact; effort in understanding the customers’ needs; and
5. Tangibles – physical evidence of the service; physical facilities, tools and equipment; appearance of providers; appearance of other customers in the service facility.

For each dimension, the service quality scale provides a score for customer expectations (E) and a score for customer perceptions (P) of service quality. The differences between the two scores on each dimension are called gap scores. Service quality (SQ) is a function of the differences between perceived service (P) and expected service (E) for n service quality factors, i.e.

\[ SQ = \sum_{i=1}^{n} (P_i - E_i) = \text{Gap 5} \]

and the gap equation, \( SQ = P - E \), has become the \( e = mc^2 \) analog for service quality.
Parasuraman and his colleagues have proposed one of the most important models of service quality, known as ServQual or the Gap Model (Parasuraman et al., 1985, 1988, 1991, 1994; Zeithaml et al., 1988, 1996; Berry and Parasuraman, 1997). For these authors, satisfaction is based on the disconfirmation of consumer expectations: Satisfaction occurs when perceived performance meets or exceeds the customer expectations and dissatisfaction results when there is a negative gap between performance and expectations. The difference between perceived service and expected service (Gap 5) produces satisfaction or dissatisfaction and is primarily due to four organizational gaps, Gap 5 = f(Gap 1, Gap 2, Gap 3, Gap 4). The four organizational gaps, which fall under the responsibility of management, are:

1. difference between consumer expectations or quality determinants, and management’s perception of such consumer expectations;
2. difference between management’s perceived quality determinants and service specifications (i.e. the critical-to-quality specifications);
3. difference between quality specifications and actual service delivery; and
4. difference between actual service delivery and the company’s external communications about its services (e.g. word of mouth, past experience, promises, reputation, standard of care).

As shown in Figure 3, perceived service quality is the result of the consumer’s comparison of expected service with perceived service. The relative importance of the different criteria of evaluation and the impact of the different organizational factors in shaping customer expectations will differ from situation to situation. However, an important implication of the service quality model is that the gap between service performance and customers’ expectations may lead to customer dissatisfaction even when the service delivered meets the exact design specifications of the service provider. Other researchers have developed competing models of service quality. Ghobadian et al. (1994) provide an excellent overview of seven service quality models presented in the literature. Woodall (2001) reexamines the service quality dimensions proposed by Grönroos and discusses the implications of customer satisfaction and dissatisfaction to six sigma in services. Seth et al. (2005) review 19 service quality models that have emerged since the pioneering work of Grönroos in the early 1980s.
Six sigma and service quality

Differences between goods and services lead to service firms and goods-producing firms having different success factors (Ghobadian et al., 1994; Frei, 2008). To what extent does six sigma fulfill the service quality gaps, lead to the improvement of the service quality dimensions, and contribute to service quality management? The answers to these questions are not trivial since there are apparent challenges posed by the very nature and core premises of services: Is the reduction of variation always compatible with individual customer attention and service customization? Is measuring product attributes fundamentally different from measuring customer perceptions and expectations, especially given that the latter are not controllable by the provider? Do the inherent service characteristics of heterogeneity, intangibility, perishability, and inseparability pose unique challenges in the definition and measurement of quality?

In one way or another, these questions are relevant in all types of services but their answers depend on the type of industry and on the nature of the service being provided. For example, in process-based dominated service industries such as banking, auto registration, or telecommunications, services may be highly standardized. Whereas in knowledge-based services (e.g. legal services, interior and architectural design, health industry and software development) and in highly psychological industries (e.g. travel, lodging and entertainment) each customer’s expectations and needs play a much more critical role. We will examine these issues in terms of the six sigma contributions to service quality and in relation to the main service quality concepts presented above.

Six sigma’s contributions to service quality

- *Does six sigma make a significant contribution as a service quality philosophy?* The answer is yes. We suggest that the more the service provider understands the variation in customers, the better off it will be. Realizing the range of preferences, personalities, styles, cultures, and needs of customers contributes to the firm’s ability to understand what is common in different market segments, how to develop modular solutions, and how to build flexibility in its service delivery processes. However, inasmuch as six sigma is interpreted as a methodology to reduce all variation, the six sigma approach can be highly detrimental.

- *Does six sigma make a significant contribution as a service quality standard?* We believe the answer is no, at least in most situations. The 3.4 EPMO is too stringent and not realistic (or even desirable) in many situations. For example, let us compare the 19 lost bags mentioned in our earlier example with 19 complaints in one day at a 14,000-student university. In the latter case, it may not be possible, let alone desirable, to develop a management system at an institution of higher education in which complaints are rarely made. The voicing of customer complaints is often a necessary part in listening to and understanding the customer, learning how customer expectations are evolving, and it could be a part of the educational goals of such an institution.

- *Does six sigma make a significant contribution as a continuous improvement methodology for services?* The answer is that it may be possible, but the tools and the training that are available to champions, black belts, green belts and others need to be expanded. We strongly suggest that the six sigma toolkit be adapted.
and that new concepts and methods be developed for use in services. It is urgent that six sigma training and educational programs adapt their curricula to service operations.

- **Does six sigma make a significant contribution as a change agent for service organizations?** The answer is yes, but only if champions and black belts are trained specifically to introduce change in service industries. Developing six sigma curricula that focuses on the nature of services, how customers form expectations, and how they evaluate service quality is an area of great opportunity.

**Six sigma and service quality gaps**

What are the contributions of six sigma in terms of filling the five gaps of the service quality model?

- **Does six sigma adequately address the differences between customers’ expected services and perceived services (Gap 5)?** No. Six sigma is primarily focused on the delivery process; it measures the performance of service processes in physical terms (e.g., response time, processing time, and cost of delivery).

- **Does six sigma adequately address the differences between consumer expectations of quality and management’s perceptions of such consumer expectations (Gap 1)?** Not really. We believe that six sigma should put greater emphasis on quality function deployment (QFD), techniques for listening to customers, such as customer circles, focus groups, mystery shoppers (external or internal customers), as well as surveys of customers and non-customers as suggested by Peter Drucker (1964).

- **Does six sigma adequately address the differences between management’s perceived quality determinants and service specifications (Gap 2)?** Not really. Six sigma gives great importance to identifying critical-to-quality variables and to experimental designs that test different combinations of levels of these variables. However, all examples in the literature and training materials refer to manufacturing applications and physical measures. There should be greater emphasis on psychological variables and on studies of the factors that shape and affect perceptions.

- **Does six sigma adequately address the difference between service quality specifications and actual service delivery, the service performance gap (Gap 3)?** Yes, except when there are many different types of customers, since six sigma attempts to deliver a constant level of service. However, six sigma makes a superb contribution in identifying those service components and service delivery processes in which variation should be reduced, and provides effective tools to monitor and reduce variability.

- **Does six sigma adequately address the differences between actual service delivery and the company’s external communications about the service delivery (Gap 4)?** Six sigma does not typically address the communication messages that the organization releases about its services. This is an important area, which should receive greater attention since it has an enormous impact in shaping customer expectations. Service managers should monitor the consistency of their messages to the customer more closely, and six sigma can make important contributions in this area.
Six sigma and the service quality dimensions
According to the service quality model, service quality is defined in terms of five dimensions. What are the contributions of six sigma in improving each of these dimensions?

- **Does six sigma make significant contributions in terms of the reliability of service delivery (Dimension 1)?** This is the biggest strength and a critical contribution of six sigma to services. By concentrating on reducing the variability of the services delivered, a company can shape customers’ expectations especially if it monitors the consistency of the messages it conveys to current and potential customers. However, ensuring consistency of service delivery and consistency between service and messages is only half of the battle; management must also pay attention to changing customer expectations and the evolving standards of service in the industry.

- **Does six sigma make significant contributions in terms of the responsiveness of service delivery (Dimension 2)?** Yes. Consistent performance in responsiveness contributes to fulfilled customer expectations in all services, since improving timeliness, accessibility, time of service, and ability to deliver the service seem to be universally appreciated by customers.

- **Does six sigma make significant contributions in terms of the assurance of service delivery (Dimension 3)?** Yes. The key to less variation in service performance seems to be the knowledge and competence of service providers, facilitated by increasingly effective and cost-efficient information support systems. However, most applications of six sigma to services seem to emphasize the routine and technological aspects of service delivery. Six sigma should put greater emphasis on the training and behaviour of the service providers. This is especially important given that the perception of service quality is consistently associated with the perception of the attributes of the service provider.

- **Does six sigma make significant contributions in terms of the empathy of service delivery (Dimension 4)?** No, at least not yet. No applications of the six sigma methodology have focused on this aspect of the service delivery. This is a critical aspect of service delivery that has a significant impact on the difference between expected and perceived service quality.

- **Does six sigma make significant contributions in terms of the tangibles of service delivery (Dimension 5)?** Yes. This is another strong feature of the six sigma methodology. By ensuring consistency of delivery of the physical aspects of the service, e.g. availability, access, appearance, ease of use of facilities, customer expectations are formed and fulfilled.

Implications and conclusion
In an era characterized by Pine II and Gilmore (1999) as the “experience economy”, the need for a deeper understanding of what constitutes customer expectations and experiences is greater than ever before. The gaps and quality dimensions identified in the service quality framework provide an avenue to address the difficulties that service organizations encounter when using six sigma to improve quality and reduce costs. Many of the methods used in six sigma are applicable to services as well as to manufacturing. In services, the DMAIC method and tools such as VOC (voice of the
customer), QFD, value added flow charts, root cause analysis, and process measurement are valuable, and the number of successful applications reported in the literature attest to the usefulness of six sigma in services. However, the nature of services and the ways customers tend to evaluate service quality pose important challenges for six sigma. As evidence of this, all studies of six sigma applications to services reported in the literature focus on manufacturing-like situations, i.e. highly repetitive processes with no or very low human behavior component. This record indicates that the six sigma methodology has limited application or that six sigma provides insufficient help in improving service quality and meeting customer expectations.

The service quality framework provides an important intellectual contribution with significant practical value to six sigma. When it comes to services, minimizing process variation is not as important as minimizing the variation of the expectation-perception gap. This model also highlights how the perception-expectation gap (Gap 5) can be linked to four other gaps: quality determinants, quality specifications, quality delivery, and quality communication gaps. While six sigma is the preferred approach for the environments with a low behavior content and low variability in customer expectations, its effectiveness is reduced as the behavior content and the role of customer expectation increase. We understand that six sigma was not designed to be the “cure of all ills”. However, as discussed in this paper, six sigma can be extended to many service operations if new concepts and tools are developed and if the training of black belts is modified to address areas that are critical-to-service-quality (CTSQs). Alas, the curricula used in six sigma training focus on manufacturing industries, and all examples and applications that we analyzed pertained to manufacturing or highly repetitive service processes.

Many of the concepts and methodologies critical to understanding and measuring service quality are already available: customer surveys and panels, transaction analysis, perception surveys, mystery shoppers, analysis of complaints, employee research, competitive benchmarking analysis, and intermediary analysis. The full potential of six sigma in services is yet to be realized. This will not happen unless black belts are trained not only in six sigma tools and concepts but also are knowledgeable in service quality ideas and methods. Service quality training is vital for the successful development of six sigma in services.

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