

# **The Extent of Six Sigma Methodologies Usage in Services**

Ayon Chakrabarty and Tan Kay Chuan\*

National University of Singapore

## **ABSTRACT**

The last two decades have seen the application of six sigma methodologies in many manufacturing and also some service industries. Six sigma's success in manufacturing is well published. But the same cannot be said about its implementation in services. Applying six sigma to services is still limited to only a small number of services. This paper reviews the application of six sigma in service industries. Emphasis is given to application issues such as what are necessary critical success factors and key performance indicators in order for a project to be successful. A pilot study was carried out in order to highlight the issues discussed. Regardless of the service that is provided, a number of guidelines can be commonly applied to varying types of services. The aim of this paper is to help widen the scope of six sigma application in services.

## **INTRODUCTION**

Since the introduction of six sigma in the 1980s, there have been many success stories from companies like Motorola, General Electric, and Allied Signal. The majority of these stories are from the manufacturing sector. The service sector, barring the health care and banking industries, are lagging behind in applying and reaping the benefits of six sigma.

While quality management tools have existed for a long time, their use is still not widely implemented in services. The emergence of six sigma has renewed interest in the scientific management of service industries. The basic elements of six sigma are really not new. Statistical process control, failure mode and effect analysis, cause and effect diagram, and other tools have been in use for some time. Six sigma offers a framework that unites these basic quality tools with high level management support.

## **SERVICES**

Like six sigma, services in the last two decades have become an important part of the economies of developed countries. The service sector is now a major employment provider in countries like USA, UK, Germany, Japan, and France (Ghobadian et al, 1994; Oakland and Dotchin, 1994; Mersha and Adlakha, 1992; Haynes, 1990). This increased importance has led to much research in service management and innovation.

The bulk of the research that have been done in services can be divided into the following stages: i) an initial realization of the differences between goods and services, ii) the development of conceptual frameworks, iii) the empirical testing of these frameworks, and iv) the application of tools and frameworks to improve service management (Johnston, 1999). The next section reviews the research on service definition, classification, and models.

### *Service definition*

Even though the concept of service goes back to the 1950s, there is currently still no unified definition for a service. The earliest approach to defining services is by Shostack (1977) who labeled services as being rendered and experienced. A service cannot be stored on a shelf, touched, tasted, or tried on for size. There are other approaches to defining services such as “it is an interactive process with a provider” (Harvey, 1998), or “it can be an application of specialized competencies” (Vargo and Lusch, 2004). The most widely used definition is the one based on the characteristics of intangibility, heterogeneity, inseparability, and perishability, as given by Parasuraman et al (1985).

### *Service classification*

“Table 1” summarizes various schemes used by researchers to classify services. Some are outcome based, whereas others are process based.

**Table 1: Summary of selected schemes for classifying services (Oakland et al, 1994)**

Judd	1964	Rented, owned, non-goods
Shostack	1977	Tangible/intangible service element domination
Sasser et al	1978	Service/facilitating goods emphasis
Thomas	1978	Equipment/people-based delivery
Chase	1978	High/low customer contact
Kotler	1980	People/equipment, customer presence, personal/business, public/private/profit/non-profit
Lovelock	1983	Nature of service, relationships, judgment, demand pattern, delivery method
Johnston and Morris	1985	Product/process basis
Schmenner	1986	Degree of interaction/customization, labor intensity
Haywood–Farmer	1988	Labor intensity, contact with customer, customization
Johnston et al	1989	Frequency of transaction
Voss et al	1992	Professional services, service shop, mass services

### *Service models*

A literature review identified over 25 models of service, starting from 1984. A major aim of these models is to enable management to enhance the quality of one’s organization and offer its services in a systematic manner (Ghobadian, 1994). In a comprehensive review of service quality models done by Deshmukh et al (2005), the authors concluded that “there does not seem to be a well-accepted conceptual definition and model of service quality nor there is any generally accepted definition of how to measure service quality.” The authors were able to map out the relationships among the 25 models of services that were reviewed.

## **SIX-SIGMA**

Six sigma is a philosophy, a measure, and a methodology that provides businesses with the perspective and the tools needed to achieve high levels of performance for both product and service offerings (Basek and Roy, 2005). The philosophy of six sigma involves two aspects. One is statistical; the other is business strategy. From the statistical point of view, the focus is on defects per million opportunities (DPMO), and the performance standard is 3.4 DPMO. From the business strategy point of view, six sigma is “a disciplined method of using extremely rigorous data gathering and statistical analysis to pinpoint sources of errors and ways of eliminating them” (Harry and Schroeder, 2000).

The success of six sigma since its introduction can be attributed to its unified framework, which involves tools and methodologies. The tools of six sigma are not new, but their application within a methodology provides a framework for organizations to achieve success. There are approximately 66 statistical tools used in two methodologies. The methodologies are: i) DMAIC (define, measure, analyze, improve, and control); and ii) DFSS (design for six sigma).

The DMAIC methodology is excellent for dealing with existing processes where reaching a pre-defined level of performance will provide the benefits expected. When a new process is required, DFSS would be used instead. DFSS provides a disciplined and rigorous approach to service, process, and product design in order to meet customer requirements.

## **APPLICATION OF SIX-SIGMA IN SERVICES**

Just as for manufacturing, defects found in a service process incur a cost to either scrap or to rework. Such service examples include the need to re-contact a customer in order to verify an order, providing an incorrect service, providing a substandard service, or even over-servicing or providing more than what is required.

Service organizations such as health care and finance have been implementing six sigma and are registering benefits. The breadth of applications is now expanding to other services including call centers (Hallowell and Gack), human resource (Bott, Keim, Kim, and Palser, 2000) and product support services (Schmidt and Aschkenase, 2004).

Our literature review shows that most applications are limited to service industries in North America and the European Countries. It is the financial benefits that have been publicized, as opposed to discussing gain in terms of process improvement. Also important to note is that the applications emphasized the proper identification of critical success factors (CSFs), critical to quality (CTQ) characteristics, and key performance indicators (KPIs). These factors are now discussed (for a fuller discussion, see Ayon and Tan, 2006).

### *Critical success factors*

Critical success factors are necessary in order that any six sigma effort may be successful. The literature review shows that top management commitment; education and training; culture change; and financial benefits are the most important CSFs for the successful application of six sigma in services. Other CSFs mentioned in a few of the literature include customer focus; clear performance metrics; and organizational understanding of work processes.

### *Critical to quality characteristics*

Critical to quality characteristics are the key measurable indicators of a product or process whose performance standards or specification limits must be met in order to satisfy the customer. In simple term, CTQs are what customers expect of a product or service. Irrespective of differences among services, there exist some common CTQs like, time (service time, waiting time, and cycle time), cost, employee behavior, and information (accurate and timely information).

### *Key performance indicators*

KPIs show the success or failure outcome of a process. The outcomes of six sigma projects are usually expressed in financial terms. This leads to a direct measure of achievement which is easy to understand (Goh, 2002). Various KPIs mentioned in the literatures include financial benefit, efficiency, cost reduction, time to deliver, the quality of the service, customer satisfaction, and reduced variation.

In order for six sigma projects to be successful, there needs to be the proper identification of CTQs and KPIs. A pilot study discussed in next section identified the CTQs and KPIs specific to library services. Some of the CTQs and KPIs are similar to those from other services. This suggests and is intuitively so, that different services have similarities in the process characteristics.

## **PILOT STUDY**

A library is a place where knowledge is discovered. Driven by this philosophy, the present study focused on using the DMAIC methodology to improve the efficiency of the processes at a local library. The following process improvement steps were taken for this pilot study:

- a. *Define*. The objective here is to improve library service processes in order to make them more efficient. This includes a review of the CTQs and KPIs such as process costs, staffing level, and outcome measures. The scope of this project covers the technical service processes, library automation, and digital services. The tool used here includes writing up the project charter.
- b. *Measure*. In order to become familiar with the different library processes, an audit was carried out. The audit process include:
  - Selection of the processes to be audited.
  - A critical examination of selected processes.
  - Developing the improved processes.

A critical examination of the library processes during the audit helped to identify the important CTQ and KPIs. These became the basis to develop improved processes. The CTQs and KPIs identified are shown in “Table 2”.

**Table 2: Important library CTQs and KPIs determined from the pilot study**

<b>CTQs</b>	<ul style="list-style-type: none"> <li>• Time</li> <li>• Staffing level</li> <li>• Cost of processes</li> <li>• Volume of output</li> </ul>
<b>KPIs</b>	<ul style="list-style-type: none"> <li>• Staff development</li> <li>• Timely and quality service</li> <li>• Accessibility</li> <li>• Image and reputation</li> <li>• Positive customer experience</li> </ul>

A brief explanation of the CTQs considered for this study is provided below:

- i. *Time*: This involves the time to process user requests through the telephone, e-mail or in person. Time is also spent checking, updating, and shelving the library resources such as books, journals, micro films, etc.
- ii. *Staffing level*: This refers to the library staff involved in various processes of the technical services, loans and user services, and library automation and digital services.
- iii. *Cost of processes*: This refers to the current cost of the various processes in technical services, loans and user services, and library automation and digital services.
- iv. *Volume of output*: This includes the over-the-counter transactions and also transactions using the self-service machines.

The KPIs of this study are discussed below:

- i. *Staff development*: This involves developing the skills of the staff through education and training.
- ii. *Timely and quality service*: This is to be proactive and to have value added services.
- iii. *Accessibility*: This is to make the books and digital library services available as quickly and as efficiently as possible.
- iv. *Image and reputation*: This is the status of the library as seen from a customer's point of view.
- v. *Positive customer experience*: This is to improve the physical ambience of the library premises and to add features such as laptop charging areas, etc, in order to make the library users feel comfortable.

The tools used for this phase include interviewing the library staff in charge of the various processes.

- c. *Analyze*. Using process mapping and cause and effect diagramming, the present status of the library processes was identified. The following shortcomings were revealed:
  - There was a short time frame for processing requests sent to technical services.
  - There was a lack of verification of the claims submitted by vendors.
  - The task of manually inputting and processing claims by vendors was laborious.

- While physically processing the items, there was some degree of work duplication in the receiving and cataloguing sections.
- d. *Improve.* A complete analysis of the library processes provided answers on how the above shortcomings could be eliminated. The suggested solutions to overcome the deficiencies are discussed below:
- i. The time frame required to process requests should be changed from a daily basis to a monthly basis. This would help in reducing the time required to process user requests.
  - ii. To reduce the cost incurred due to claims, an evaluation system to check for vendors on the claims can be set up.
  - iii. Another suggestion is to initiate a process of automated inputs as well as designing the workflow based on the total process (i.e., receiving and cataloguing are considered as steps in the process).

The above improvements may also help in enhancing the accessibility of library resources, which would in turn improve the image and reputation of the library.

- e. *Control.* Any improvement to be gained from the study needs to be established. After which they need to be maintained. This would involve training the library staff on the improved processes and also through monitoring the system such as by data collection.

## CONCLUSION

This paper provides a review and a pilot study on a six sigma application for library services. Considered separately, there is much literature that talks about six sigma or about services. But very little work has been done in applying six sigma in services. Through a six sigma investigation, the pilot study identified a number of important CTQs and KPIs that are unique to libraries. This shows that it is entirely possible to tailor a range of six sigma tools to various services.

The planned framework and a focus on process improvement are the major strengths of six sigma. Service industries can utilize this framework, and can benefit by identifying important parameters like CTQs and KPIs. The similarities among these parameters across different services provide an initial basis for service organizations to apply six sigma.

## REFERENCES

1. "Learning about quality: quality tools", [www.asq.org/learn-about-quality/quality-tools.html](http://www.asq.org/learn-about-quality/quality-tools.html) (last accessed on 23 January 2006).
2. Antony, J. (2004). "Six sigma in the UK service organizations: results from a pilot survey", *Managerial Auditing Journal*, Vol.19 No.8, pp 1006 – 1013.
3. Antony, J. and Banuelas, R. (2002). "Key ingredients for the effective implementation of six sigma program", *Measuring Business Excellence*, Vol. 6 No. 4, pp 20 – 27.
4. Basu, R. (2004). *Implementing quality: a practical guide to tools and techniques: enabling the power of operational excellence*, London: Thomson Learning, 1<sup>st</sup> Ed.
5. Benedetto, A.R. (2003). "Adapting manufacturing-based six sigma methodology to the service environment of a radiology film library", *Journal of Healthcare Management*, Vol. 48 No.4, pp 263 – 280.

6. Bott, C., Keim, E., Kim, S. and Palser, L. (2000). "Service quality six sigma case studies", *ASQ's 54<sup>th</sup> Annual Quality Congress Proceedings*, pp 225 – 231.
7. Chakrabarty, A. and Tan, K.C. (2006) "The current state of six sigma application in services" (Submitted for publication).
8. Coronado, R.B. and Antony, J. (2002). "Critical success factors for the successful implementation of six sigma projects in organizations", *The TQM Magazine*, Vol. 14 No.2, pp 92 – 99.
9. Does, R., Heuvel, E., Mast, J. and Bisgaard, S. (2002). "Comparing non manufacturing with traditional applications of six sigma", *Quality Engineering*, Vol. 15 No. 1, pp 177 – 182.
10. Deshmukh, S.G., Seth, N. and Vrat, P. (2005). "Service quality models: a review", *International Journal of Quality and Reliability Management*, Vol.22 No.9, pp 913 – 949.
11. El-Haik, B. and Roy, D.M. (2005). Service design for six sigma: a roadmap for excellence, *John Wiley and Sons, Inc., Hoboken: New Jersey*.
12. Ghobadian, A., Speller, S. and Jones, M. (1994). "Service quality: concepts and models". *International Journal of Quality and Reliability Management*, Vol. 11 No. 9, pp 43 – 66.
13. Goh, T.N. (2002). "A strategic assessment of six sigma", *Quality Reliability Engineering International*, Vol. 18, pp 403 – 410.
14. Hallowell, D.L. and Gack, G.A. "A six sigma case study – tutorial for IT call center" <http://www.isixsigma.com/library/content/c040414b.asp> (last accessed on 12 February 2006)
15. Hargrove, S.K. and Burge, L. (2002). "Developing a six sigma methodology for improving retention in engineering education", *32<sup>nd</sup> ASEE/IEEE Frontiers in Education Conference*, S3C20 – S3C24.
16. Harry, M. and Schroeder, R. (2000). Six sigma: the breakthrough management strategy revolutionizing the world's top corporations, *1<sup>st</sup> ed., Random House Inc., New York*.
17. Harvey, J. (1998). "Service quality: a tutorial", *Journal of Operations Management*, Vol. 16, pp 583 – 597.
18. Haynes, R.M. (1990). "Service typologies: a transaction modeling approach", *International Journal of Service Industry Management*, Vol.1 No.1, pp 15 – 26.
19. Henderson, K.H. and Evans, J.R. (2000). "Successful implementation of six sigma: benchmarking General Electric company", *Benchmarking: An International Journal*, Vol. 7 No. 4, pp 260 – 281.
20. Hensley, R.L. and Dobie, K. (2005). "Assessing readiness for six sigma in a service setting", *Managing Service Quality*, Vol. 15 No. 1, pp 82 – 101.
21. Heuvel, J., Does, R. and Bisgaard, S. (2005) "Dutch hospital implements six sigma", *ASQ Six Sigma Forum Magazine*, Feb, pp 11 – 14.
22. Johnstone, P.A.S., Hendrickson, J.A.W., Dernbach, A.J., Secord, A.R., Parker, J.C., Favata, M.A. and Puckett, M.L. (2003) "Ancillary services in the health care industry: is six sigma reasonable?", *Quality management in Health Care*, Vol. 12 No. 1, pp 53 – 63.
23. Johnston, R. (1999). "Service operations management: return to roots", *International Journal of Operations and Productions Management*, Vol. 19 No. 2, pp 104 – 124.
24. Jones Jr, M.H. (2004). "Six sigma: at a bank?", *ASQ Six Sigma Forum Magazine*, Vol. 3 No. 2, pp 13 – 17.
25. Kwak, Y.H. and Anbari, F.T. (2006). "Benefits, obstacles, and future of six sigma approach", *Technovation*, Vol. 26, pp 708 – 715.
26. Lovelock, C.H. (1983). "Classifying services to gain strategic marketing insights", *Journal of Marketing*, Vol.47 No.3, pp 9 – 20.

27. Mersha, T. and Adlakha, V. (1992). "Attributes of service quality: the consumer's perspective", *International Journal of Service Industry Management*, Vol. 3 No. 3, pp 34 – 45.
  28. Nonthaleerak, P. and Hendry, L. (2005). "Six sigma: literature review and key future research areas", *LUMS Working Paper Series*, June, pp 1 – 66.
  29. Oakland, J.S. and Dotchin, J.A. (1994). "Total quality management in services Part 1: understanding and classifying services", *International Journal of Quality and Reliability Management*, Vol. 11 No. 3, pp 9 – 26.
  30. Oakland, J.S. and Dotchin, J.A. (1994). "Total quality management in services Part 2: service quality", *International Journal of Quality and Reliability Management*, Vol. 11 No. 3, pp 27 – 42.
  31. Parasuraman, A., Zeithaml V.A., and Berry, L.L. (1985). "A conceptual model of service quality and its implication for future research", *Journal of Marketing*, Vol. 49 No. 4, pp 41 – 50.
  32. Raisinghani, M.S. (2005). "Six sigma: concepts, tools and applications", *Industrial Management and Data Systems*, Vol. 105 No. 4, pp 491 – 505.
  33. Rucker, R. (2000). "Citibank increases customer loyalty with defect-free processes", *Association for Quality and Participation*, pp 32 – 36.
  34. Schimdt, M. and Aschkenase, S. (2004). "The building blocks of service", *Supply Chain Management Review*, July – Aug, pp 34 – 40.
  35. Sehwall, L. and DeYong, C. (2003). "Six sigma in health care", *International Journal of Health Care Quality Assurance*, Vol. 16 No. 6, pp 1 – 5.
  36. Vargo, S.L. and Lusch, R.F. (2004). "The four service marketing myths", *Journal of Service Research*, Vol. 6 No. 4, pp 324 – 335.
  37. Voss, C., Silvestro, R., Fitzgerald, L. and Johnston, R. (1992) "Towards a classification of service processes," *International Journal of Service Industry Management*, Vol.3 No.3, pp. 62–75.
  38. Woodall, T. (2001). "Six sigma and service quality: Christian Grönroos revisited", *Journal of Marketing Management*, Vol. 17, pp 595 – 607.
  39. Wyper, B. and Harrison, A. (2000). "Deployment of six sigma methodology in human resource function: a case study", *Total Quality Management*, Vol. 11 Nos. 4 & 5, pp S720 – S727.
  40. Young, T., Brailsford, S., Connell, C., Davies, R., Harper, P., and Klein, J.H. (2004) "Using industrial processes to improve patient care", *British Medical Journal*, Vol. 328, pp 162 – 164.
-