

Application of 'Six Sigma' Quality Improvement Tool in Libraries for the Enhancement of Library Services - An Overview

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Abstract

Six sigma is a quality improvement tool used to measure the process output for error reducing in a system. It aims to maximize user/customer satisfaction and minimize defects in products and services being offered by an organization. This tool is intended to evaluate user satisfaction and assess the quality of the products or services, which are modified or newly introduced. In this paper, *Six sigma* quality improvement tool has been described in detail, along with its applications. Besides, case studies are also reported to demonstrate the efficiency of the tool in the library system. This present review anticipated that implementation of *Six sigma* in the academic and public libraries of Sri Lanka, would improve the quality of library services and have an impact on the user satisfaction.

Keywords: Service quality, *Six Sigma*, Library service, Quality improvement.

Introduction

For the enhancement of quality management in an organization, purposeful quality arrangement is imperative. Since ancient times, traditional quality management theories and concepts such as statistical quality control, statistical process control, zero defect and total quality measurement were used for this purpose. However, *Six sigma* was developed as a mathematical concept and introduced by Motorola. Later, it was used as a tool in overcoming the difficulties which occur during the assessment of day-to-day operations, by the SPC (Statistical Process Control), FMEA (Failure Mode Effect Analysis), and TQM (Total Quality Management) methods, while seeking for the quality improvement (Ulhe and Patil, 2011). In this regard, support of the respective organization is vital.

The *Six sigma* is being the tool for assessing the quality of the services, in addition function as a problem solving tool for corporate sectors. It is applicable in the library system too (Dutt, 2013). User satisfaction with regard to the services offered is the ultimate goal of a library system (Zubi and Basha, 2010). This goal can be achieved with the help of the *Six sigma* tool. It uses a set of quality management and statistical methods to obtain the maximum user satisfaction. This tool supports in library management, and improve the quality of the services offered by the library system. Further, *Six sigma* helps in continuous appraisal and delivery of quality services by the library system, in order to satisfy the needs of the library users (Agrawal, 2011).

This paper emphasizes that implementing *Six sigma* in the evaluation of library management activities (e.g. acquisition, cataloguing & classification, stock maintenance), and assessment of services offered (e.g. Inter library loan, CAS, SDI, etc.) would have an impact on user satisfaction. Moreover, application of *Six sigma* helps to provide quality library services in the present competitive world to accomplish the needs of the users.

Description of *Six sigma* tool

Six sigma is a Greek word and it implies 'standard deviation' in English. It is known by the symbol ' σ '. *Six sigma* means 'the system for removal of defects in the present processes and provides specialized products and services to the customer with high quality' (Coronado and Antony, 2002). In simple sense, *Six sigma* means a standard for measurement of six deviations from the mean. It is a standard to completely remove the defects in any constituent, in relation to quality. This is one of the well-known and reputed quality improvement tools, in the world (Kaushik, 2007).

Six sigma in Motorola is considered at three different levels, known as metric, methodology, and management system. Essentially, *Six sigma* function at all three levels at the same time. Furthermore, key factors to be examined using *Six sigma* tool are:

- User satisfaction
- Figure of defects
- Processing time

***Six sigma* process methodologies**

There are two types of *Six sigma* process methods, namely *Six Sigma* DMAIC and *Six Sigma* DMADV. Each term of these process methods derived from the major steps involved in the process.

1. *Six sigma* DMAIC is a process that Defines, Measures, Analyzes, Improves, and Controls existing processes that fall below the *Six sigma* specification. Hence, it is used to improve an existing business process.
2. *Six sigma* DMADV Defines, Measures, Analyzes, Designs, and Verifies new processes or products that are trying to achieve *Six sigma* quality. Therefore, it is employed to design a new process.

Both *Six sigma* processes are executed by *Six sigma* Green belts or *Six sigma* Black belts, white belts which are then overseen by a *Six sigma* Master Black belts, terms created by Motorola.

Measuring sigma level of a process

Six sigma calculation for a library process is described below:

Circulation of library materials is considered as a process in a library system. In general, circulation process depends on six factors, namely valid membership, technical processing (cataloguing & classification), physical processing, power supply (in an automated library), condition of barcode, and system error. By considering these six factors *Six sigma* levels for circulation process of a library can be calculated.

As per the above description circulation of books in a library depends on six factors. Suppose each factor influencing this process has two chances to have defects (e.g., power failure may be due to short circuit or interruption, system error may be due to hardware or software, and so on), then,

Total defect opportunity is $\longrightarrow 6 \times 2 = 12$

If 20 circulations out of 100 circulations taking more time than expected or defective, then,

Defects per issue $\longrightarrow 20/100 = 0.2$

Defects Per Opportunity (DPO) $\longrightarrow 20 / (12 \times 100) = 0.01666$

Defects per Million Opportunities (DPMO) $\longrightarrow 0.01666 \times 1000000 = 16660$

For DPMO 16660, the Sigma level is calculated by using the conversion table given below (Table 1).

Table 1: Six sigma conversion table

Sigma level	Quality (%)	Defects Per Million Opportunities (DPMO)
6 Sigma	99.999998	3.4
5 Sigma	99.999943	233
4 Sigma	99.9937	6210
3 Sigma	99.73	66807
2 Sigma	69.1	308537
1 Sigma	30.1	691462

According to the above conversion table, sigma level for DPMO 16660 falls within 3-4, and quality falls between 99.73% - 99.9937%. Subsequently, the actual sigma value of this book circulation process would be obtained from Z-table.

In order to improve the sigma value, the root cause for low quality need to be identified, and factors which are more influencing the circulation process (among the six factors mentioned earlier) have to be further examined. Thus, the implementation of *Six sigma* would help to identify the gaps and enable to take appropriate action for improvement, in relation to circulation process.

Case studies: Application of *Six sigma* tool in libraries

Jayakar Library, University of Pune, India: The study on *Six sigma* implementation in Jayakar library of Pune University was done by Ulhe and Patil (2011). *Six sigma* tool was implemented at Pune University in 2007 and was applied to all sections of the

library. In defect determination phase, they grouped the defects in three categories i.e., in context of quality, in context of management, and in context of other departments. After identification of defects or errors, they decided to go for phase wise improvement and rectified more than 25 defects out of 86 defects identified. Though they could not achieved the level of 3.4 DPM, lot of improvement has been observed. The library is still working on it and expected to achieve 3.4 DPM level of *Six sigma* in the near future.

Sungkyunkwan University, Seoul, South Korea: A detailed case study on the advantages and disadvantages of *Six sigma* implementation in Sungkyunkwan University was carried out (Kim, 2010). Sungkyunkwan University applied *Six sigma* tool in all the departments of the university, including library. Data collected through interview and questionnaire was analyzed using qualitative as well as quantitative techniques. Researcher observed certain positive effects due to *Six sigma* implementation, such as scientific way of working, increased process capacity, and turning subjective knowledge into a formal format. Besides, the negative effects include lack of time management, lack of interest among employees, poor standardization procedures, and difficulty in defining work process. The researcher finally concluded that there are many advantages of implementing *Six sigma* tool in a library. However, he pointed out that at present it is too early to expect great results from the implementation. Furthermore, implementation of *Six sigma* tool requires organizational support to change the mindset of the participants. Moreover, a high level of transparency is required for the successful implementation of *Six sigma* tool.

University of Arizona Library, Arizona, United States: In University of Arizona Library, *Six sigma* was implemented as a seven month project with the purpose of improving the Document Delivery Services (DDS), which includes ILL (Interlibrary loan), scanning, printing, and photocopying services. Later in 2009, a study was carried out by Voyles *et al.* in relation to this project. Initially, to execute the plan, library consulted the *Six sigma* specialists from Raytheon Missile Systems (manufacturing company). During the application of *Six sigma* tool, they identified the problems in the process of DDS. Implementation of *Six sigma* resulted in reduction of turnaround time for requested articles to 70%, increased output via appropriate staffing, etc. Researchers observed that application of *Six Sigma* DMAIC and similar process improvement approaches in libraries would be beneficial to current and future customers only. On the basis of their findings, they concluded '*Six sigma as a data-based analysis of current processes, tool for identifying gaps between service expectation and delivery of service, and a team approach to discover and design process improvements*'.

Newcastle University Library, Newcastle, United Kingdom: This is another *Six sigma* application at the Newcastle University Library (UK) with the purpose of improving

self-services facility in the library. Pre-implementation statistics had shown high level of satisfaction among readers with regard to self-services. Students and staff rated 89.6% and 72% respectively. However, the total rate of self-issue was quite lower, i.e. 35% of total circulation. Since, library had made quite a large investment on self-circulation system, there was a need to justify this expenditure. Kumi and Morrow (2006) did a study based on *Six sigma* and identified the defects in the self-circulation system at Newcastle University Library. This plan was implemented for a period of six months and certain recommendations were made. Those are:

- Reduce the staff strength at the circulation desk
- Move the self-issue units to more appropriate locations
- Encourage self-issue among readers by increasing the loan period for self-issued materials, conducting user awareness programs on self-issue system, and increase the number of self-issuable resources available in the library.

The library benefited from *Six sigma* tool not only in the aspect of increasing self-service percentage, but it also provided a powerful method of addressing a problem effectively and efficiently in a systematic way.

Application of *Six sigma* tool in a library system

In a library system, Chief Librarian is the master black belt, Assistant Librarians are black belt, Library Assistants are green belt, and Library Attendants are white Belt. In most occasions, their roles and duties are assigned according to the hierarchy. The potential areas of a library system, where the *Six sigma* tool could be applied are as follows:

- Acquisition of materials for the library
- Technical (Classification & Cataloguing) and physical processing of acquired materials
- Circulation of library materials
- Maintenance of library collection
- Library services

Among the two process methods mentioned above, *Six sigma* DMAIC method is generally applied to improve the existing library system and discussed below, in detail.

According to Figure 1, initial step of the *Six sigma* DMAIC process emphasizes on *defining* the problems, opportunities, processes, projects, goals and customers. The second step is named as *Measure*, which helps to study the current status, existing

processes, customer needs and requirements. The next step of the process is known as *Analyze*, which guides to identify the origin and source of defects. Eventually, the fourth step helps to *improve* the existing system by eliminating defects in the performance / current procedure / standard of work. Finally, the step termed as *Control*, takes overall control of all the steps mentioned above. In order to attain the proposed goal, DMAIC cycle method should be repeated several times (Sharma, 2004).

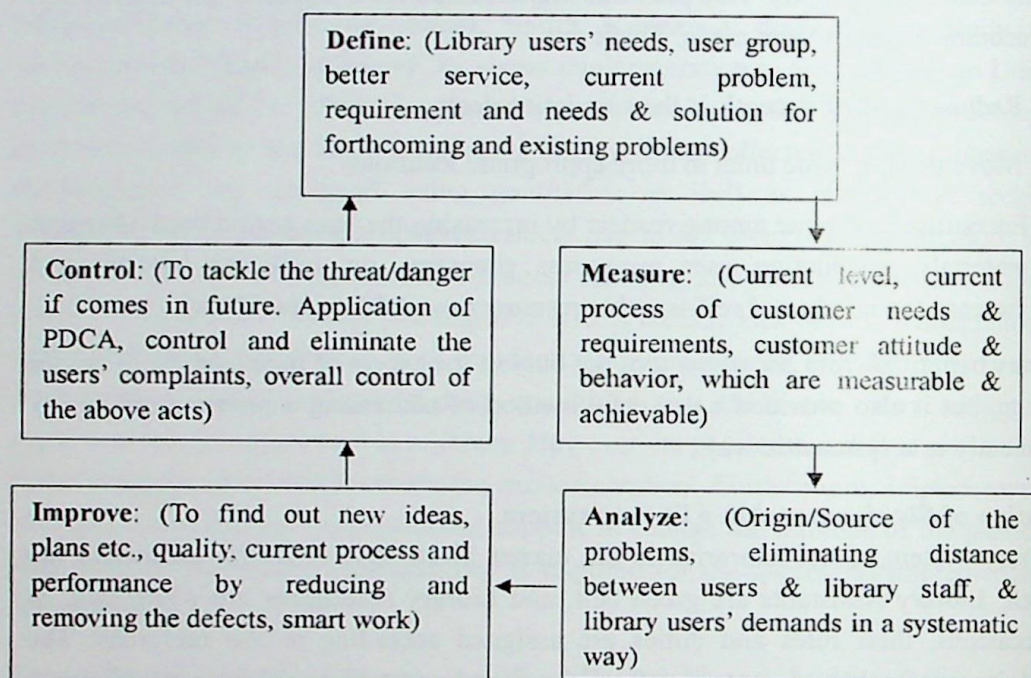


Figure 1: Six sigma DMAIC cycle method (Sharma, 2004)

Detail description of the steps involved in the *Six sigma* DMAIC cycle is given in the following section, with special reference to acquisition of materials for libraries.

➤ *Define:*

This is the first and foremost stage of the *Six sigma* DMAIC process. In this step, the problem is identified, clearly defined and analyzed from its inception. Hence, helps to construct the *problem statement*. This problem statement will provide a clear description of the problem and its significance. Moreover, this phase will help to understand the existing problem, and assist in developing suitable objectives and goals to meet the requirements. For example, if we consider acquisition of materials for libraries, major problem may be time delay during the purchase of materials. Some sample questions are given below, which would be helpful in formulating the problem statement.

- Define the existing problems and necessary requirements of the library?

- Define the solutions for existing and forthcoming problems in the library?
- Define the user groups of the library?
- Define the needs of the different library users groups?
- Define how library services could be improved to satisfy the needs of different user groups?

➤ *Measure:*

The second stage of the *Six sigma* DMAIC process is *measure*. The purpose of this stage is to collect data and facts related to problems. Data collection is one of the important processes before analyzing the situation. Measurement will be done based on the data collected. This will lead to analysis of data, mapping the process with analyzed data, and description of the process. In relation to acquisition of materials, measuring the time taken between different steps in the procurement procedure of books and periodicals would be helpful in analyzing the situation. Further, libraries should always set up measurable and achievable targets or goals, and follow appropriate strategies to improve library services.

➤ *Analyze:*

In this stage, the origin of the problem is analyzed, in order to find ways to eradicate the problem/ reduce its impact. Better solution could be attained by analyzing the root cause of the problem. In general, this is the most difficult task of the process. If the root cause has been identified, then it can be analyzed in a systematic way. In acquisition of materials for libraries, it was observed that delay in purchasing is due to procurement procedure. Therefore, time duration between different stages of the procurement procedure (book selection, call for quotation, quotation opening, technical evaluation, obtain approval, placing order and delivery of books) need to be measured and analyzed to find out the root cause.

➤ *Improve:*

This stage helps to enhance the existing library condition and improve the library services provided. In this phase, the library procedures need to be modified to incorporate new ideas, plans, thoughts, and ways to attract users to the library. Further, library functions to be performed effectively to meet the needs of the library users. This will result in saving the money, labor, and time of the library, and promote easy and quick access to resources required by the users. Hence, efficient and systematic approach is indispensable to improve the quality of the library services. In the above example, if the root cause is identified as delay in book selection, then action to be taken to improve

it (e.g., perform the book selection throughout the year, ask the readers to select books from the trade catalogues available at library, etc.), in order to enhance the efficiency of acquisition process.

In addition, this phase would guide the library employees to work smart rather than work hard. Thereby, helps to minimize the workload and maximize the delivery of services to the library users.

➤ *Control:*

This is the final stage of the *Six sigma* DMAIC process. This stage helps to review and update the process. It takes control over, all stages or phases mentioned above. At this stage, it is mandatory to determine the effectiveness of the processes implemented. Hence, there should be a feedback mechanism for validation. Moreover, controlling the existing system and policies to prevent the repetition of the problems is also essential.

The *Six sigma* DMAIC process which has been applied for libraries in the past, is presented in this article. This method supports in controlling or removing the grievances of the library users, enhance the competence of library employees, improve the quality of library services, etc.

Some of the major advantages of *Six sigma* tool for a library system are listed below:

- It helps to improve the service level of the library
- It increases the patron satisfaction with regard to quality of library services
- It improves the efficiency of library staff
- It reduces the waste and streamline the library functions
- It makes awareness of the customer requirements
- It helps to prioritize the work or process
- It detects the defects of the process
- It verifies the reason for failure of the current process
- It provides continuous support for the improvement of the existing process

Conclusion

Six sigma is a philosophy for quality improvement. By applying the strategic principles of this philosophy in libraries, quality of services could be improved to the level of readers' satisfaction. It would also help to enhance the efficiency of the routine process, and improve the capabilities of the staff. Usually, libraries have issues related to over dues, number of users, missing books, stock verification process, library automation, etc.

These issues could be addressed by the *Six sigma* tool, and appropriate solution for each problem could be identified.

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