

# Six Sigma Implementation in Healthcare Industry: Past, Present and Future

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**Abstract**— The need to implement Six Sigma in healthcare care department is felt, as the critical factors such as people becoming more aware of quality, increase in people's expectations from the service provider at real time with efficiency, less medical errors and competition within the organizations is becoming more prevalent with the advancement in technologies and development. Improving quality of health care services in government hospitals in a developing country is a necessary act to improve the efficiency and optimization of services in the population. This paper reviews the implementation of Six Sigma technique in various departments of healthcare organizations to enhance the process. DMAIC approach has its wider application in various areas in hospitals. This paper also present common obstacle in implementing Six Sigma.

**Keywords**— Six Sigma, DMAIC (Define, Measure, Analysis, Improve and Control) methodology, healthcare industry and India

## I. INTRODUCTION

Improving and sustaining patient's satisfaction in Hospitals are the most significant challenges facing healthcare industries today. In India, with recent advancement in technologies, increase in people's expectations and people becoming more aware of quality needs placed more emphasis on increasing the quality of care and increasing patient satisfaction. In this scenario of healthcare reform, it is even more important for providers to have a systematic approach to enhance the way care is delivered. So, there is a growing interest in implementing Six Sigma not only in manufacturing but also in service industries like healthcare, education, banks etc. Many hospitals outside India are on their way or have been implemented Six sigma. But in India, it is still following its own traditional economic domain ignoring the current emerging factors like patient safety, intensive competition within healthcare industries, malpractice, rising healthcare costs. The optimization of processes with zero error strategy is achieved best by applying six sigma ideas to hospitals. Six sigma is a technique that has been around for almost twenty years but has grown exponentially in healthcare industry during past few years. Six Sigma is a disciplined, planned, measurement-based and data-motivated approach to reduce process variation aiming to improve quality by finding the root cause solutions that increases yield which normally is  $3\sigma$  to perfection  $6\sigma$ . This paper presents the review of projects which have implemented Six sigma and their research gaps.

The paper is categorized into sections to tackle these objectives. In section 2, a literature review of Six sigma in

healthcare industry is presented. In section 3, a well description of methodology is mentioned. Section 4 draws conclusion of this study.

## II. LITERATURE REVIEW

The literature review on the application of Six sigma in healthcare industry is focuses on papers published in journals, magazines, and websites of the six sigma community such as [www.isixsigma.com](http://www.isixsigma.com).

Six Sigma was implemented by Motorola in 1980's. It is denoted by a Greek letter " $\sigma$ " which is known as sigma and used to measure the standard deviation which shows the amount of variation among the individuals in the population [4]. Variation is calculated by finding out the DPMO (Defects per million opportunities) of the data collected. Various DPMO and their percentage are shown in table I

TABLE I  
SIGMA LEVELS FOR VARIOUS DPMO

S.no	DPMO	% defective	% yield
1.	691.462	69	31
2.	308.538	31	69
3.	66.807	6.7	93.3
4.	6.210	0.62	99.38
5.	233	0.023	99.977
6.	3.4	0.00034	99.99966

Afsheen Mozammel, Lash B. Mapa, Susan Scachitti [1] explains the Six sigma along with lean methodology implication in health industry. They analyze the workload of Nursing Shift Directors (NSD) who is responsible for management directions of healthcare facility and the result was that they automate some of the tasks performed by NSD and lot of time was saved which then was used to do some value added work.

The implication of Six sigma in improving the quality of operation theatre (OT) which is one of the critical department in hospital was presented by Rohini. R and Dr. Mallikarjin [2]. DMAIC Six sigma approaches was designed to enhance the process in the operation theatre of a corporate multi-specialty hospital in Bangalore, India [2]. DMAIC framework revealed an immense application and how the healthcare organization can be the best in providing services to many people with same facilities available and in addition will be good at management level too. This study helped the hospital to increase the OT utilization and also gave an annual financial savings of amount 6, 45, 30,000 Rs. [2].

Jiju Antony and Maneesh Kumar [3], have done an empirical study on Lean and Six sigma methodologies in NHS Scotland carried out by other authors. They found that Kaizen related processes are being used as a part of process improvement most of the hospitals. Factors such as top management responsibility, education and training of the staff, financial returns on bottom-line are the common obstacles [3]. For Six Sigma initiative, culture and resistance to change was considered as the most important obstacles and also reveals the lack of management commitment towards achieving Six Sigma level of quality care. The difficulty to get the baseline performance data is another major challenge while applying Six Sigma in health care sector. The data in hospitals are sometimes not readily available for its interpretation and analysis [3].

Nur Afni Khaidir, Nurul Fadly Habidin, Naimah Ali, Nurul Aifaa Shazali, Noor Hidayah Jamaludin [4] have proposed a conceptual model using Structural Equation Modeling (SEM) which will be used to study the correlation between Six sigma practices and Organizational Performance (OP) in Malaysian Healthcare organization. They have found that there is a direct relation between Six sigma practices such as customer concerned, administrative focus and Organizational Performances such as financial performance [4].

Thomas Jefferson university hospitals utilized the Value stream mapping approach to identify and execute seven lean projects over four years to systematically improve the Operating Room Patient Flow[13]. Voice of Customers interviews reveals that constant changes to the OR schedule the day before surgery, poor communication among perioperative units, excessive processes and patient travel due to poor layout, inadequate technology for decision making and monitoring flow and workflow variation across all disciplines [13].

A study on determination & implementation of Operation Theatre Management System in a Private Hospital, Trichy by applying six sigma approaches by Vishu V. Raja & Bhooma Devi [5]. The purpose of this project was to increase the number of operations which will in turn optimize the Operation Theatre utilization. Industrial sector efficiency rate calculation formula was used to calculate the efficiency rate of Operation Theatre[5]. They found out that prior admission procedures, delay of patients, drugs delay, large gaps between consecutive surgeries etc. are found to be critical factors which requires attention.

Six Sigma projects which can be applied in Operation Theatre areas are:

- Improving start times of first operation case
- Development of technologies
- Work on room turnover times
- Making sure of exact scheduling
- Improving admission and registration process
- Assessing OR charging mechanism

For many healthcare organizations, there is a domino like effect on the rest of the schedule if there is a delay in first case. The average operating room turnover time (from the time one patient leaves the room until the next patient enters) is affected by many critical factors such as work load confusion among staff, patient absent on the scheduled time, inaccurate length of surgery, inadequate manpower etc. that can influence OR utilization and throughput (isixsigma.com)

Patients or their representative's participation in quality management programs in European's hospitals and their effect on patient-centered care strategies research was carried out by Groene and shows that current levels of involving patients and their representatives in QM functions in European Hospitals are low at hospital level (mean score 1.6 on a scale of 0 to 5, SD 0.7), but even lower at departmental level (mean 0.6,SD 0.7) . Smallest hospitals were more likely to have implemented patient-centered care strategies.

The Six Sigma reduces the variance of a desired process and optimizes the averages[6].The outcome which is desired can be a reduction of the patient registration time in emergency dept., lost charges for billing in Patient Financial Service, overdue medical records, lab results turnaround time, patient's length of stay and medical defects. To illustrate 200,000 wrong prescriptions per year account to 3.8 sigma and 68 accounts for 6 sigma by Andy Ganti, GE medical system and Dr. Anita G. Ganti

Shei-Ling Ku, Ching-Shui Huang, Pa-Chun Wang, Ya-Hui Chen [8], have explore the impact of Six sigma initiatives on the service efficiency of a surgery process in the operating room Cathay General Hospital, Taipei, Taiwan. Statistical analysis of the data was calculated by means of t-test, Chi-Square test and descriptive analysis [8]. Patient's total holding time were bettered from 37.9 minutes before implementation to 34.3 minutes after implementation[8] . Patient's turnover time was reduced from 10.51 minutes to 7.42 after implementation within three months.

Zied Ben Atallah and Amar Ramudhin [6] suggested that the combination of business process modeling with six-sigma helps to achieve a highly reliable, process-based and customer focused healthcare system. The process of Business process grants a deep understanding of complex care dimensions and helps in identifying those dimensions which are critical to the patient [6].

Reducing waiting time in OPD (Outpatient department) is also important as it is the initial floor where service starts. Dinesh T., Dr. Sanjeev Singh, Prem Nair and Remya T R conducted two sample t-test to analyze the voice of customers at OPD and reduction in waiting time at the cardiology Department was achieved [11].

DFSS approach is not widely used in healthcare industries as this process is to design new processes which meet the customer's voice.[12] Because of the nature of hospital's potential of zero error DFSS can be applied. [12]

### III. RESEARCH METHODOLOGY

The use of quality improvement and performance measurement in the healthcare sector is very important as the input variables determining the output, which is desired by customers are intangible and difficult to measure in numbers. In this paper, Six Sigma DMAIC (Define, Measure, Analysis, Improve and Control) and DFSS (Design for Six Sigma) methodology in various healthcare departments are studied to know the concept and weaknesses of these methods and among them which one will be used in future to achieve the Six Sigma level of patient satisfaction.

DMAIC methodology is used for existing processes and DFSS methodology is used for designing of new processes based on customer needs. This approach not only makes use of Six Sigma tools and increases patient satisfaction but also reduces the unrealistic cost of defects. How DMAIC methodology can be applied in hospitals are discussed in details as follows:

#### A. Define phase

The primary objectives of this phase are:

- 1) Identify the customers and their voices or needs like in case of hospitals it can be doctors, patients, staff etc.
- 2) Identifies the area where six sigma can be applied and key performance measures such waiting time in the lobby.
- 3) Find out the important characteristics to quality factors which influences the patient satisfaction level
- 4) Identify the process performance gaps and opportunities

#### B. Measure phase

The steps to achieve this phase are:

- 1) Planning data collection method and to collect data
- 2) Defining the relationship between the process variation and process specification
- 3) To find out of control quality characteristics such operation case delay, waiting time etc.
- 4) To identify the trend of process performed during the period of study

The data collection plan consists of two steps:

Measurement method-the patient satisfaction regarding the facility, service provided by the doctors, nurses, staff, lab technicians, actual and desirable waiting time of the patient in the lobby of the hospital before treatment can be recorded by observation, conducting questionnaire surveys and interviews.

Sample size –the patients who came for being treated during a period of study has been taken into account.

#### C. Analyze phase

The primary objectives of this phase are:

- 1) Identify the most significant dimensions or variables which affect the overall satisfaction level
- 2) Validate the root cause by analyzing the data collected in the previous step using analytical tools
- 3) Find out the major causes which held back the process from being six sigma levels.
- 4) To find the failure modes

There are two types of analysis that can be formulated in this step i.e.

- a. Process analysis: A depth study of the processes in order to identify non-value added activities which not only is a time waste but also wastage of resources and money.
- b. Data analysis: using the data collected in the measure step one can find the differences and variation that can suggest, support, or rejects the factors about the causes of defects at service or production level.

#### D. Improve Phase

Improve phase consist of sustaining the improvements made in improve phase. Various steps involved are:

1. To identify and formulate the best possible improvement actions
2. Application of advanced technological systems to keep the data intact and easily assessable whenever required without having to delay the case
3. Optimization of the flow work

#### E. Control phase

It is the most important step among all. It needs wide attention from top management team. The phase activities consist of

1. To standardize improvement plan to sustain the gains of the improvement
2. To maintain the system which sustain the continuous improvement of the patient satisfaction level.
3. Implementation of control plans

Different tools for each phase of DMAIC approach are listed in table II.

TABLE II  
TOOLS AND TECHNIQUES USED IN DMAIC  
METHODOLOGY

S.NO.	PHASE	TOOLS USED
1.	D-Define	Project Charter, Benchmarking, Process flow mapping SIPOC table (Supplier, inputs, process, outputs and customer)
2.	M-Measure	Value stream mapping, Surveys, Control charts, Process capability, Time study analysis, DPMO (defects per million opportunities)
3.	A-Analysis	Fish bone diagram, FMEA (Failure Mode Effect and Analysis), Pareto charts, Statistical process control charts
4.	I-Improve	DOE (Design of experiments), Final value stream map, Brainstorming, Training, Automation, Ergonomics
5.	C-Control	Pareto charts, Statistical Process control charts

DFSS consists of several steps which are as follows:

#### A. Define phase

This stage is similar to define phase of DMAIC approach. Goals are designed regarding to customers' expectations.

#### B. Measure phase

This stage consists of measuring critical to quality characteristics and to see which affects the most in achieving the goal.

#### C. Analyze phase

This phase consists of following steps:

- 1) To develop the design which is modeled on the basis of customer's demand
- 2) To search for the design alternative

#### D. Design phase

This phase consists of:

- 1) Process parameters which are critical and needs attention are identified
- 2) An improved alternative based on analysis on previous step is designed.

#### E. Verify phase

Product testing through the pilot testing is being conducted among the customer to find the readiness and marketability of the product.

### IV. CONCLUSION

Although Six sigma technique has been used in many high level manufacturing industries like General Electrical, Motorola, Texas Instruments, IBM etc. and its implementation in healthcare industry is still in its beginning stage. Many healthcare organizations in US and European countries are making Six sigma their way of quality improvement. From the literature reviews, it is clearly seen that most of the healthcare industries have implemented Six Sigma DMAIC approach in the past and also in the present

context. But soon the DFSS approach will be used widely to improve the quality of service in healthcare industry. The study validated the application of Six Sigma DMAIC methodology to reduce the patient dissatisfaction regarding healthcare facility, service providers etc. along with optimization of healthcare cost.

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