

# Enhancing Service Quality of a Healthcare Organization through Lean Six Sigma Methods

Sudipta Saha, A.M.M. Nazmul Ahsan, Md. Imran Mahmud, Prof. Dr. Tarapada Bhowmick, Hemendra Nath Roy

**Abstract**— The issue of customer satisfaction has gained increasing attention from executives across the healthcare industry. One of the primary challenges is sustaining customer satisfaction improvement initiatives in the face of competing priorities and diminishing resources. Lean Six-sigma methodology has been implemented in a public healthcare organization to fulfil the organization's mission of enhancing its customer satisfaction. Thirty key criteria of patient satisfaction have been identified to correlate most highly to a patient's overall satisfaction with the hospital. This paper demonstrates how significant each of those thirty criteria for the overall satisfaction. The coordination of care has been found to have the most powerful effect in terms of patient satisfaction during a hospital stay. Through the implementation of the procedural steps of Lean Six-sigma methodology, it has been possible to enhance the healthcare service quality of the organization.

**Index Terms**— DMAIC; Six Sigma, RPF, performance matrix, Lean, control chart, process capability, cause-effect diagram

## 1 INTRODUCTION

IN Bangladesh, unfortunately, the health care delivery system is overwhelmed with a variety of problems. Even with the increased allocation to health care, access to the system continues to be problematic and is evident from a variety of indicators: Critical staff are absent, essential supplies are generally unavailable, facilities are inadequate, and the quality of staffing is poor. Problems of supervision and accountability exacerbate the problems, while corrupt practices seem to be on the increase as media reports indicate [1].

One of the primary concerns in healthcare sector centres around the issue of patient/customer satisfaction. There have been more and more enterprises implementing six sigma since Motorola practiced 6σ in 1989. And many healthcare organizations are positive about the applicability of Lean and/or Six Sigma within their healthcare industries. Recent activities include minimizing patients' length of stay [2], improving efficiency [3], enhancing patient and staff satisfaction [4], reducing waiting time [5] using Six Sigma philosophy etc. Besides, Heuvel et al. [6-8] presented different cases where Lean and/or Six Sigma are used as tools to undertake present healthcare challenges at a Red Cross hospital through some projects.

In this paper, Lean and Six Sigma tools are integrated to enhance customer satisfaction of Khulna Medical College & Hospital (KMCH). The study focuses on increasing patient satisfaction through lean embedded DMAIC, an effective management of available capacity and information. The paper is organized as follows: Section 2 presents a review of six sigma and lean methodology, Section 3 illustrates the implementation process of lean six sigma methodology, Section 4 presents the findings of the study and Section 5 contains the conclusions.

## 2 SIX SIGMA AND LEAN

Lean focuses on smoothing and accelerating flow by eliminating wastes, Six Sigma focuses on improving quality by reducing variation [9]. Six Sigma eliminates defects but does not address the question of how to optimize the process flow [10]. The procedural steps of six sigma comprise Define, Measure, Analyze, Improve and Control [11]. Six Sigma problem solving methodology is recommended by Snee and Hoerl [12] when the causes of the problems is ambiguous, whereas lean tools are used to identify and eliminate wastes through continuous improvement. Antony et al. [13] showed that the application of the Six Sigma- DMAIC reduced the number of defects in the engine cylinder manufacturing process and hence enhanced the customer satisfaction and profitability of the company. With a view to enhancing customer satisfaction, this paper presents the implementation of Lean Six Sigma in a healthcare organization.

## 3 IMPLEMENTATION

The lean embedded six sigma is implemented in KMCH through its procedural steps: Define, Measure, Analyze, Improve and Control. The implementation phase is conducted as follows:

### 3.1 Define

Mandahawi et al., [14] stated that, "The Define phase concentrates on forming the team, defining the project's goals, mapping the process, identifying customers, and identifying the high impact characteristics or the critical to quality (CTQs)". In this study, Performance Matrix [10] and Risk Priority Factor analysis are utilized to identify potential criteria responsible for customer dissatisfaction.

A survey of questionnaire demonstrated by Parasuraman, Zeithaml, and Berry [15] is conducted on a sample of customers of KMCH based on five dimensions for both customer's importance and satisfaction along 30 service criteria. A 5-point scale is used to measure customer's importance and satisfaction of each service criteria of the hospital. On the 5-point scale

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1, 2, 3, 4, or 5 have been used to score each criterion if it is highly unimportant, unimportant, moderately important, important, or highly important, respectively and the same scores is used if customers are highly dissatisfied, dissatisfied, moderately satisfied, satisfied, or very satisfied, respectively with that criterion. Thus A higher score means greater importance and greater satisfaction. The satisfaction and importance indices of the aforesaid 30 service criteria are defined according to as follows:

$$P_i = (\mu_i - \text{min}) / R \tag{1}$$

$$P_s = (\mu_s - \text{min}) / R \tag{2}$$

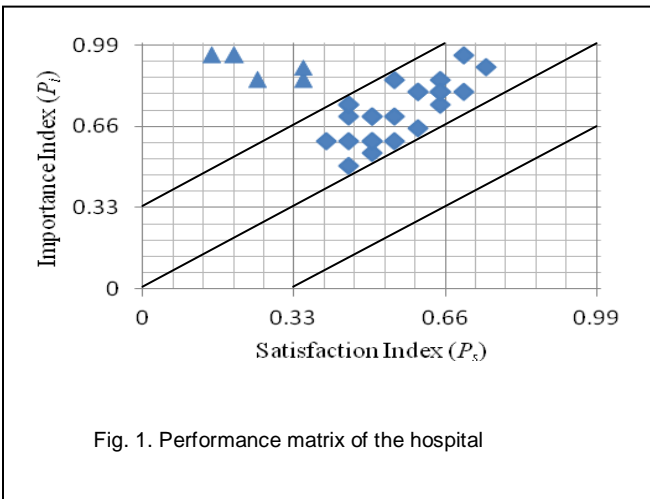
Where,  $P_i$  and  $P_s$  represent the importance index and satisfaction index of the service criteria of the hospital respectively. After getting these indices (Table 1), the performance matrix is constructed as shown in Fig.1.

**TABLE 1**  
 THE PERFORMANCE AND SATISFACTION INDEX VALUES FOR CUSTOMER SATISFACTION CRITERIA

No	Criteria	Importance Value ( $\mu_i$ )	Satisfaction Value ( $\mu_s$ )	Importance Index ( $P_i$ )	Satisfaction Index ( $P_s$ )
1	Clearness of Information Provided by Personnel	3.8	2.8	0.7	0.45
2	Employees' Politeness in Treatment of Customers	4.4	2.4	0.85	0.35
3	Simplicity of Forms and Procedures	3	2.8	0.5	0.45
4	Processing Time of Cases or Applications	3.4	2.6	0.6	0.4
5	Follow up of Employees on Customer Requests	3.4	2.8	0.6	0.45
6	Knowledge of Employees	3.6	3.4	0.65	0.6
7	Problem Solving, (if applicable)	3.4	3.2	0.6	0.55
8	Waiting Time in Reception Offices	3.8	3	0.7	0.5
9	Ease and Clarity of IT Systems (if applicable)	3.4	3	0.6	0.5
10	Reasonableness of Fees Charged	4.4	2	0.85	0.25
11	Skill of Nurses	3.2	3	0.55	0.5

**TABLE 1(CONTINUED)**  
 THE PERFORMANCE AND SATISFACTION INDEX VALUES FOR CUSTOMER SATISFACTION CRITERIA

No	Criteria	Importance Value ( $\mu_i$ )	Satisfaction Value ( $\mu_s$ )	Importance Index ( $P_i$ )	Satisfaction Index ( $P_s$ )
12	Responsiveness to Customers' Complaints (if applicable)	4	3.6	0.75	0.65
13	Availability/Clarity of Laws and Regulations	4.2	3.8	0.8	0.7
14	Cleanliness, Lighting, and Comfort of the Hospital Premises	4.8	1.8	0.95	0.2
15	How Well Staffs Worked together to Care for You	3.8	3	0.7	0.5
16	Communication with Nurses	3.4	3	0.6	0.5
17	Response to Concerns/Complaints Made During Your Stay	4	2.8	0.75	0.45
18	Amount of Attention Paid to Your Personal and Special Needs	4.2	3.6	0.8	0.65
19	Staff Sensitivity to the Inconvenience of Hospitalization	4.2	3.4	0.8	0.6
20	How Well Nurses Kept You Informed	4.4	3.6	0.85	0.65
21	Staffs' Efforts to Include You in Decisions about Your Treatment	4.8	3.8	0.95	0.7
22	Nurses Attitude towards Your Request	4.2	3.6	0.8	0.65
23	Satisfactory Quality of Service Received by KMCH Customers	4.6	4	0.9	0.75
24	Friendliness of Nurses	4.2	3.6	0.8	0.65
25	Pain Management	4	2.8	0.75	0.45
26	Quietness of Hospital Environment	4.8	1.6	0.95	0.15
27	Discharge Information	4.4	3.2	0.85	0.55
28	Overall Cheerfulness of Hospital	3.8	3.2	0.7	0.55
29	Communication with Doctors	4.2	3.4	0.8	0.6
30	Skill of Doctors	4.6	2.4	0.9	0.35



### 3.2 Measure

Measure is the second step of DMAIC model, this step is necessary to measure the existing state of process. In this study Control Chart is used to measure the customer satisfaction state. Another Lean tool 5S scoring is also integrated for measuring the current status of the service level and hospital environment.

#### 3.2.1 $\bar{x}$ Control Chart

A  $\bar{x}$  Control Chart of customer satisfaction values for all the service criteria is constructed as shown in Fig. 2. UCL is 4.46, centre line is 3.04 and the LCL is 1.61. Customer satisfaction criteria 10, 14 and 26 lie beyond the lower 2 $\sigma$  line (2.10). The lower 2 $\sigma$  line is set according to KMCH infrastructure and expected customer satisfaction value. The 2 $\sigma$  line is selected to reduce the deviation of customer satisfaction at the same time.

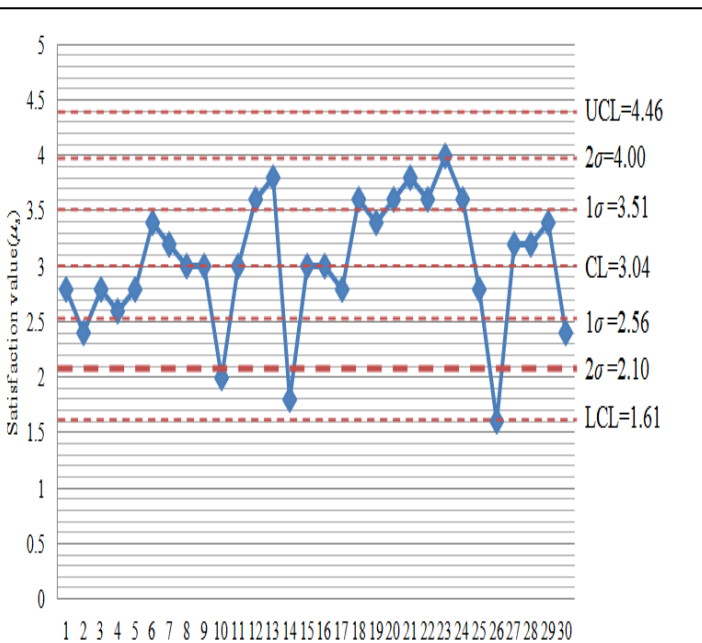


Fig. 2.  $\bar{x}$  chart of customer satisfaction value

#### 3.2.2 5S

In 5S score sheet the name of factors and the description are listed. A criterion having four, three, two, one or zero problems is considered to have one, two, three, four or five scores, respectively. To prepare a 5S score sheet, all thirty criteria are categorized into main seven main categories which are related to customer satisfaction in the hospital and the major problems are also detected associated with those seven categories respectively. The 5S score sheet is shown in Table 2. From the 5S score sheet, the overall 5S score is found as 2.14 which is much less than maximum score 5. So Actions are to be taken to get a safe, organized, clean and high-performance environment that will ensure a high level of customer satisfaction.

TABLE 2  
5S SCORE SHEET

No.	Factor	Description	Scores	Notes for the next level of improvement
1	Skill	All supporting staffs, nurses and doctors must have sufficient skills for proper treatment of patients	1	a) Lack of knowledge of doctors in identifying respective diseases b) Poor skill of surgeons and nurses c) Inadequate training to personnel d) Employees' low knowledge
2	Communication	Adequate communication facilities are essential in a hospital	2	a) Insufficient communication with nurses b) Insufficient communication with doctors c) Irregular update about patients' current condition provided by nurses and staffs
3	Information Availability	Timely and accurate information flow must be assured	3	a) Inaccurate discharge information b) No detailed information on internet
4	Facility	All necessary facilities should be addressed for good customer/ patient satisfaction	1	a) Low number of ventilators b) Scarcity of water c) Dirty sanitation facility d) Low space for lounge

TABLE 2(CONTINUED)  
5S SCORE SHEET

5	Environment	The premises should possess enough lighting, comfort, cleanliness	2	a) low level of cleanliness b) insufficient or excessive lighting c) noisy environment
6	Cooperation	Coordination among all personnel like patients, nurses, staffs, doctors should be maintained	2	a) Nurses are not much friendly b) Insufficient Responsiveness to Customers' Complaints c) Less politeness for caring of patients
7	Procedure	Easy procedures and simplicity of forms and applications should be obtained	4	a) complexity of forms and procedures and therefore long processing time
Total			15	
5S Score			2.14	

### 3.3 Analyze

After measuring, which criteria are responsible for poor customer satisfaction and how much they are responsible are found out and analyses are made on the causes of poor satisfaction. Several techniques and tools are available to analyze a process. Cause-Effect analysis is done in this study. A Cause-Effect diagram shown in Fig. 3 is developed based on the observations on the hospital and discussions with groups of experienced individuals from the hospital. In conducting the analysis, four main categories of causes are created, including Facility, Personnel, System and Environment. Causes under each of the four categories are causes that contributed to the problems.

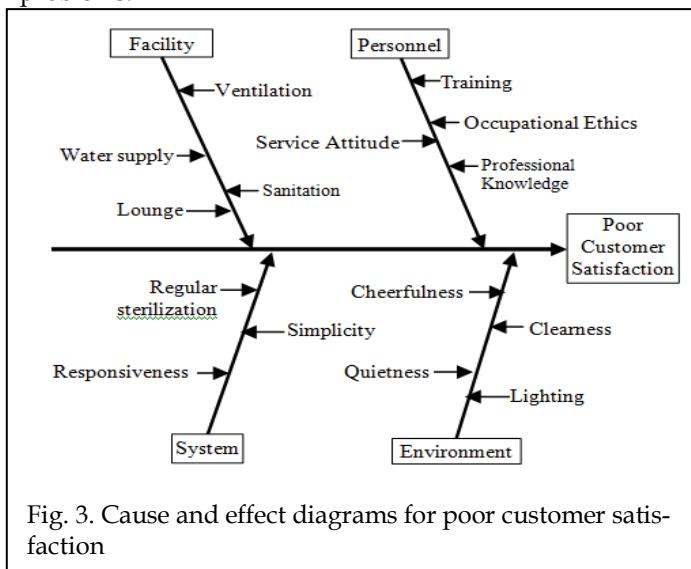


Fig. 3. Cause and effect diagrams for poor customer satisfaction

### 3.4 Improve

Following action plans are taken on several areas -

#### 3.4.1 Person

The hospital staffs must be trained to:

- Know the different "types" of patients and how to satisfy them.
- Communicate clearly and effectively with patients, families and other staff members.
- Work as a team to achieve extraordinary results.
- Improve patient flow and processes between departments.
- Identify and resolve any issues or concerns as they occur.

#### 3.4.2 Facility

'Improved' water supply generally involves better physical access and the protection of water sources, including stand post, borehole, protected spring or well or collected rain water. Improvement does not mean that the water is necessarily safe, but rather that it meets minimum criteria for accessibility and measures are taken to protect the water source from contamination. Lounge, a specific space with a minimum size of 10x10 m, are provided for the significant purpose of providing a social space for patients to meet, relax, play games, socialize, bond, and have activities which will take them away and break from the rigors of their hospital stay.

#### 3.4.3 System

Recently, KMCH has been piloting interventions such as more frequent rounding to ensure that patients' needs are being met. We are seeing improvements in their performance.

#### 3.4.4 Environment

Lighting in healthcare Settings:

- Provide windows for access to natural daylight in patient rooms, along with provisions for controlling glare and temperature.
- Orient patient rooms to maximize early-morning sun exposure.

Recent efforts to increase quietness, not only to enhance patient care experience, but also to improve working conditions for all:

- Allowing a very limited number people to stay with the patients at the wards.
- Providing patients with sleep aids such as ear plugs.

#### 3.4.5 Action plan after 5S scoring

Some action plans have to be taken to reduce the number of problems as much as possible. The action plan for improvement after 5S scoring is shown in table 3 as below.



**TABLE 3**  
 ACTION PLANS TO REDUCE NUMBER OF PROBLEMS

No.	Action Plans	Improved notes
1	Training programs and practices	Poor skill of surgeons and nurses
2	Increasing the number of nurses and regular monitoring nurses' activities and having a reward system for good performance	Insufficient communication with nurses
3	Launch a website with detail information of the hospital.	No detailed information on internet
4	Air control, filtration and ventilation technologies for, Regulated water supply, safer disposal of excreta by septic tank, simple pit latrine and sufficient lounge space for significant purpose.	Low number of ventilators, Scarcity of water, Dirty sanitation facility, Low space for lounge
5	Regular cleaning activities of floor, equipments and providing of windows for access to natural daylight in patient rooms	low level of cleanliness, insufficient or excessive lighting
6	Behavior changing training and training to provide a consistent level of personalized service and politeness	Nurses are not much friendly, less politeness for caring of patients
7	Preparing a simple form and making of easy procedures	Complexity of forms and procedures and therefore long processing time

**3.5 Control**

Once a facility is redesigned and employees are relocated into the new or renovated space, it is usually time to 'put out the next fire'. The DMAIC approach attempts to 'hold the gains' made through the project, using a control phase. The key components are the implementation of a monitoring plan, creation of a response plan, transfer of ownership (project closure) and sharing the 'lessons learned' with the organization. As part of the monitoring plan, the use of the tools application (survey and reports from a database) is implemented as a part of permanent feedback. The information collected is a source of data for the performance matrix. Control chart, which is used for assessing the ongoing quality of the hospital environment. These tools will be being used to collect data to track the variance in performance on each of the KPIs over time. In this case, the response plan is a simple set of steps (the root cause analysis) which allows the team to identify and rank any problems and brainstorm design responses as required. Finally, the data being gathered are shared with the organization through meetings involving leads of the facility management staffs and tools including a PowerPoint presentation and a case study.

**4 RESEARCH FINDINGS**

After proposing the action plans to the KMCH authority another survey is conducted regarding to the customer satisfaction value after six months. The survey is limited only with those five criteria that were found in our top priority after conducting performance matrix and control chart. From the second survey again average customer satisfaction value ( $\mu_s$ ) among five people and satisfaction index from the equation 2 for all those seven criteria is calculated.

In table 4 it is easily seen that the average customer satisfaction value ( $\mu_s$ ) is changed for all those five criteria compared to the previous average customer satisfaction value ( $\mu_i$ ). Consequently the customer satisfaction index ( $P_s$ ) is also changed for those five criteria. Finally using the importance index and customer satisfaction index value, another performance matrix is constructed as shown in fig.4, from which it is easily seen that the ( $P_i - P_s$ ) value for all the thirty criteria is less than 0.33 and as a result all the customer satisfaction criteria lie in block 1. That means customer satisfaction values of all the thirty criteria are in allowable zone of performance matrix.

**TABLE 4**  
 PERFORMANCE INDEX VALUES AFTER IMPROVEMENT

No.	Criteria	$\mu_i$	$\mu_s$	$P_i$	$P_s$
2	Employees' Politeness in Treatment of Customers	4.4	3.2	0.85	0.55
10	Reasonableness of Fees Charged	4.4	3.6	0.85	0.65
14	Cleanliness, Lighting, and Comfort of the Hospital Premises	4.8	4	0.95	0.75
26	quietness of hospital environment	4.8	3.8	0.95	0.7
30	Skill of doctors	4.6	4	0.9	0.75

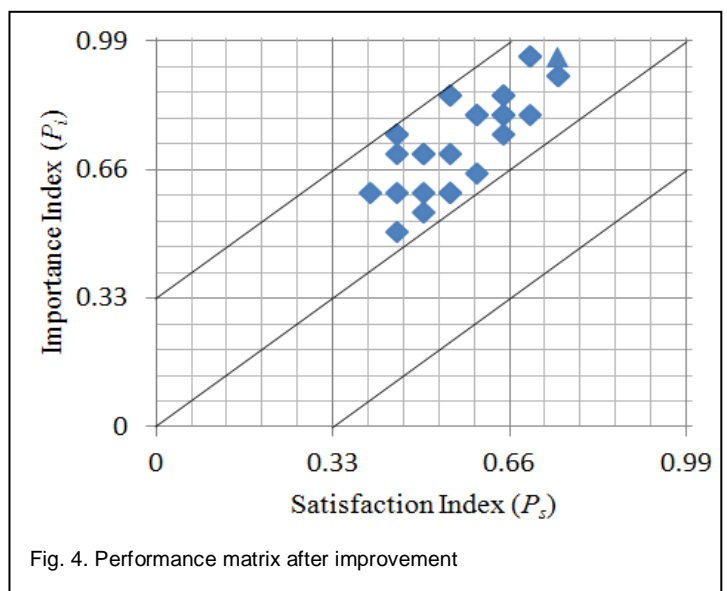


Fig. 4. Performance matrix after improvement

**TABLE 5**  
**5S SCORE SHEET AFTER IMPROVEMENT**

Another  $\bar{X}$  Control Chart of customer satisfaction values for all the service criteria is constructed after implementing Lean Six Sigma as shown in Fig. 5. In this control chart, UCL is 4.72, centre line is 3.32 and the LCL is 1.91. It is found that satisfaction value for all the thirty criteria are within lower  $2\sigma$  line.

After implementing the action plans mentioned earlier, another 5S score sheet is prepared again as shown in table 5, from which it is easily seen that the 5S score is changed to 3.86 from its previous score 2.14, which means 5S score has been increased by 1.72

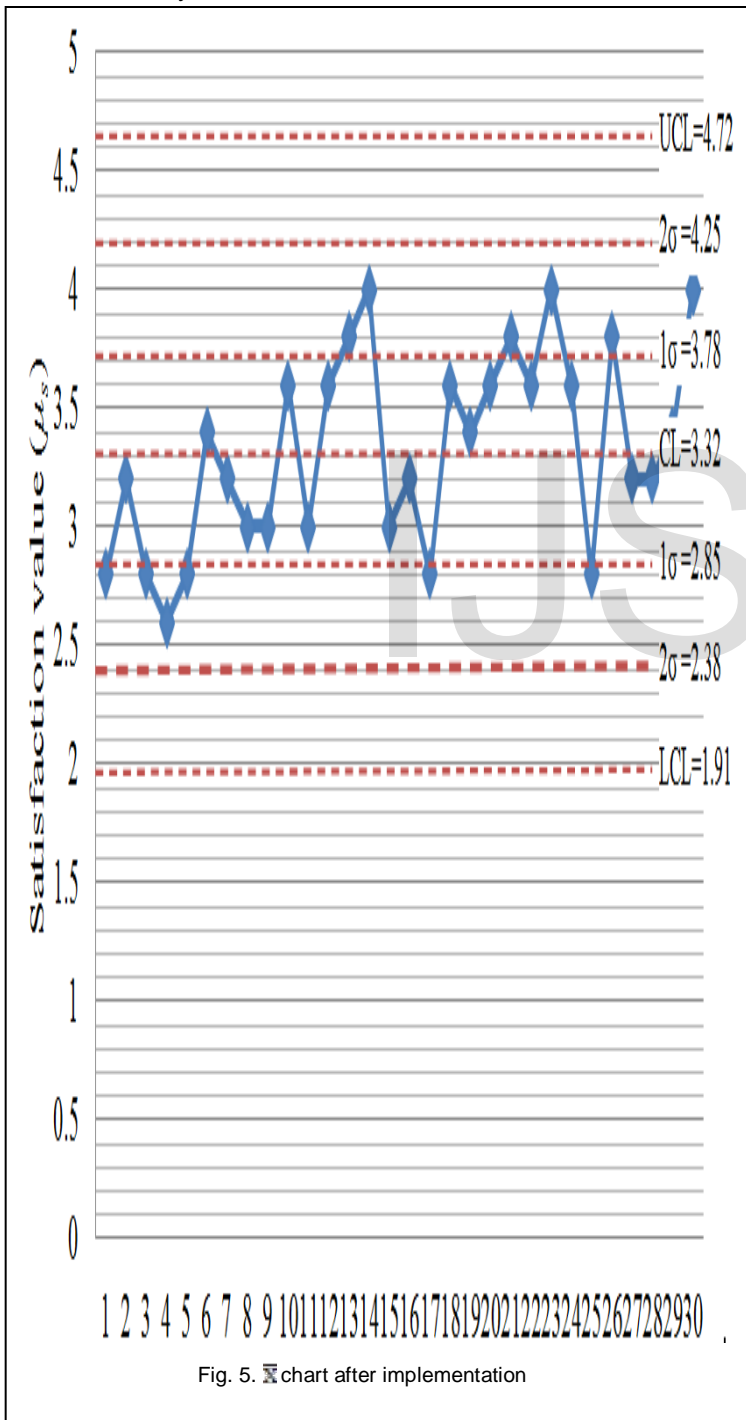


Fig. 5.  $\bar{X}$  chart after implementation

No	Factor	Description	Scores	Notes for the next level of improvement
1	Skill	All supporting staffs, nurses & doctors must have sufficient skills for proper treatment of patients	2	a) Lack of knowledge of doctors in identifying respective diseases b) Inadequate training to personnel c) Employees' low knowledge
2	Communication	Adequate communication facilities are essential in a hospital	3	a) Insufficient communication with doctors b) Irregular update about patients' current condition provided by nurses & staffs
3	Information Availability	Timely & accurate information flow must be assured	4	a) Inaccurate discharge information
4	Facility	All necessary facilities should be addressed for good customer/patient satisfaction	5	
5	Environment	The surroundings & premises should possess enough lighting, comfort & cleanliness	4	a) noisy environment
6	Cooperation	Coordination among all personnel like patients, nurses, staffs, doctors should be maintained	4	Insufficient Responsiveness to Customers' Complaints
7	Procedure	Easy procedures & simplicity of forms & applications should be obtained	5	
<b>Total</b>			<b>27</b>	
<b>5S Score</b>			<b>27/7 = 3.86</b>	

## 5 CONCLUSION

In a situation where customers are expecting as well as demanding higher level of service quality and new competitors are increasing, healthcare organizations are facing a tough challenge of how to boost customer satisfaction. This Research proves to be an extremely rewarding experience. From reviewing extensive literature, a deep understanding of the Lean Six Sigma approach, and the implementation framework of the methodology is attained that is later applied in the case study at the KMCH. A set of statistical tools are used in the case study of the hospital. The objective was to implement the Lean Six Sigma methodology to improve the process capability and reduce customer dissatisfaction. The DMAIC cycle is executed to achieve the objective, going through the Define, Measure, Analyze, Improve, and Control phases. At the completion of the case work, some root causes for the dissatisfaction are defined and analyzed and some actions are implemented as well as some ideas are proposed for improvements and control. A significant improvement in service quality is noticed after post-implementation analysis. The hybrid of Lean and Six Sigma has thus proven to be a powerful and effective approach to attain the organization's goal. by adopting this methodology, the organizations could prompt the service quality to be sustainable enough to achieve customer satisfaction

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