Reducing and Optimizing the Hospital Discharge Process using Six Sigma Approach

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Abstract *– In today's world, the competitive environment in the healthcare industries leaves no margin for error. As such, new ways to improve the patient's expectations on a continuous basis by focusing on technical and human skills; and developing cost effective methodologies are imperative. In order to improve the quality of healthcare system and because patient comfort and satisfaction are vital, the processes of discharging patients from medical facilities must be addressed accordingly. Some of the benefits of having an efficient discharge protocol are, but not limited to, bed availability for emergency scenarios, selective admissions (arrange in advance), an increase in customer satisfaction and hospital profitability. Therefore, this study aimed to minimize the patient's discharge time by 20% using the Six Sigma DMAIC Model approach in a multidisciplinary hospital setting in Puerto Rico's West area. Major findings in this study indicated that using a Six Sigma approach could improve patient flow by decreasing length of stay and wait time. Moreover, this method can improve patient volume in hospitals resulting in higher profitability. This study can serve as an example for healthcare managers to reduce and optimize the hospital discharge processes; allowing for a greater influx of patients, increased profit and yet maintaining high customer satisfaction.*

Key Terms – *Discharge Process, DMAIC Model, Hospital, Six Sigma.*

INTRODUCTION

Six Sigma is a business improvement strategy used to improve business profitability to drive out waste, reduce costs of poor quality and to improve the effectiveness and efficiency of all operations in order to meet or even exceed the customer's needs and expectations [1]. In other words, Six Sigma is an organized and systematic method used for strategic process improvements and new product and service development that rely on both statistical and scientific methodology in order to make dramatic reductions in customer-defined defect rates [2]. The name Six Sigma comes from the fact that it is a managerial approach designed to create processes that results in no more than 3.4 per million defects [3]. DMAIC (Define, Measure, Analyze, Improve and Control) in Six Sigma is described as an approach for problem solving. DMAIC is applicable to empirical studies ranging from well-structured to semi structured, but not to ill-structured problems or pluralistic messes of subjective problems [4]. One of the advantages of this method is that it has a high-degree of versatility. Today, Six Sigma is delivering business excellence, higher customer satisfaction, and superior profits by dramatically improving every process in an enterprise; whether financial, operational or production based [5].

Key Elements of Six Sigma According to a Study [5]

- It is based on voice of customer (Vic) in order to meet their requirements and achieve maximum satisfaction levels in a minimum period of time.
- The quantification of both defects and opportunities as to measure their causes and identify any possible pathway for improvement.
- Defining processes and metrics.
- Team-based cooperation and a higher employee integration.

Today, everybody is concerned about the quality of healthcare facilities, and hospitals are

becoming the most important service industry. Statistical data from the Organization for Economic Cooperation and Development (OECD), in relation to expenditure on healthcare, shows that all developed countries had increased its expenditure year after year [6]. In the process of attaining quality, every protocol involved in the healthcare facility was optimized in order to comply with patient needs. Therefore, hospital managers should strive to the utmost level of customer satisfaction and focus on reducing waste while properly addressing the unnecessary activities that result in an increase of the discharge process, which, naturally, ends up affecting the patient.

One key protocol that attracts a patient's attention is the preparation and the timely availability of discharge summary at the moment in which they are leaving the hospital [7]. By ensuring the proper discharge process, we can guarantee patient satisfaction and optimize the resources for more inpatient care. An inefficient patient discharge protocols not only cause frustration to the patients and, consequentially, their family members, but also has a negative impact on the incoming patient influx and the organization's revenues. For a successful implementation of Six Sigma, leadership support and active participation from employees are key factors.

PROBLEM STATEMENT

Today, public hospitals are facing enormous challenges due to a high volume of patients and a shortage of available beds. In a study conducted by Jones in 2011, it stated that most English hospitals operate a daily average occupancy rate close to 100% for more than a six-month period, which can lead to a 30% increase in the chance of in-hospital death.

RESEARCH DESCRIPTION

This project is about decreasing the time of a patient discharge process from a medical facility. The efficacy of the Six Sigma tool and how it can increase the profit margin by reducing costs and the possible barriers will be analyzed, as well as the limitations of this methodology. More importantly, it will be evaluated how Six Sigma can reduce the discharge time process resulting in an improved flow of patients and a better-quality service.

RESEARCH OBJECTIVES

The aim of this project is to examine the effectiveness of Six Sigma DMAIC Methodology tool in the hospital discharge management process to increase operational excellence, customer satisfaction and finally cost reduction. The main objective is to reduce the patient's discharge time by 20%.

RESEARCH CONTRIBUTIONS

As result of this study, by reducing and optimizing the discharge time process, more patients will be managed. In turn, this will have a positive effect by increasing the number of admissions, enhancing customer satisfaction and boost hospital profitability. This study also demonstrated the contribution of the team members of the hospital in reducing the discharge time of the patients.

LITERATURE REVIEW

Constant technological advances, globalization, and other competitive pressures have forced different organizations around the world to incorporate new changes to keep themselves competitive, innovate and strive for operational excellence by reducing waste and optimizing process to be more effective and reduce costs.

The most popular process improvement methodology is called Six Sigma which fundamentally focuses on process improvement and variation reduction. Six Sigma was pioneered at Motorola in the mid-1980s. Another very popular success of the implementation of Six Sigma was at GE, which this methodology had delivered $300 million to its bottom line in 1997, $750 million in 1998, and $2 billion in 1999 [8]. Other companies

like Ford, General Motors, and Xerox had adopted this innovative methodology. Six Sigma aim is to reduce variations in products and process, to finally achieve quality levels of less than 3.4 defects per million opportunities (DPMO). Sigma Quality Level is a measure used to indicate how often defects are likely to occur. Table 1 shows different sigma levels and their respective defects per million opportunities.

Table 1

Sigma Performance Levels [8]

Sigma Performance Levels – One to Six Sigma		
Sigma Level	**Defects Per Million Opportunities**	**Percentage Yield**
1	690,000	31
2	308,537	69
3	66,807	93.3
4	6,210	99.38
5	233	99.977
6	3.4	99.99966

As shown above, by moving to Six Sigma Level 6 (99.997%), significant improvement has taken place resulting in good customer satisfaction and high quality. Table 2 shows differences from sigma level 4-5 to sigma level 6. It should be noted that sigma levels from 4-5 show varying scenarios that may be unacceptable to a customer's point of view. For example, with a 99.9% acceptance (Sigma Level 4-5) it shows around 5,400 arterial bypass failures in a year. The same case with a Sigma Level of 6 it shows only 18 cases a year.

Table 2

Sigma Levels Comparison Performance [8]

Comparison of performance improvement with 99.9% and 99.9997 acceptance		
Scenarios	**99.9% acceptance (Sigma Level: 4 to 5 Sigma)**	**99.997% acceptance (Sigma Level: 6 Sigma)**
Arterial bypass failures in a year	5400	18
Commercial aircraft take off aborted each year	31,536	107
Train wrecks a year	180	<1
Visa issued to dangerous persons	50	none

Six Sigma when coupled with 'Lean Principles' is called 'Lean Six Sigma' which professes eliminating waste in process steps by using 'Lean Tools', based on Toyota's Production System (TPS), that enhances value in Six Sigma implementation one-step further by increasing speed by identifying and removing non-value adding steps in a process [8].

General Concepts of DMAIC Methodology

The DMAIC model, developed by Motorola, has a five-phase approach with the objective to achieve the highest level within Six Sigma. DMAIC refers to a data-driven improvement cycle used for improving, optimizing and stabilizing business processes and designs. DMAIC methodology is very versatile and can be used in any improvement project or application generating outstanding results. In a 2011 research study the authors Vivekananthamoorthy and Sankar describe the 5 phases as:

- **Define:** The focus is to define the current state by making the problem statement, which specifies what the team wants to improve upon which illustrates the need for the project and potential benefit.
- **Measure:** The goal of this phase is to establish a clear understanding of the process you desire to improve. Using accurate data, a base line measure is taken and this becomes the origin from which the team can undertake improvement.
- **Analyze:** The data is collected to be analyzed and determine root causes of defects and opportunities for improvement. One of the most frequently used tools in the analyze phase is the "Cause and Effect Diagram". Root cause is the main priority coming out of the analysis step.
- **Improve:** The objective of this phase is to design creative solutions in order to fix the problem and prevent future occurrences. The team should come up with lasting process improvements that address the root causes. The

most preferred tool used in this phase is the affinity diagram.

- **Control:** The control phase helps to maintain and improve the newly implemented process. This phase requires the development, documentation and implementation of an ongoing monitoring plan. One of the important tools that can be used to achieve this objective is Statistical Process Control (SPC).

On the other hand, Table 3 shows a summary of the DMAIC Methodology and tools used.

Table 3
DMAIC Methodology [8]

Strategic Steps	Deliverables	Tools used
Define	Project Charter or Statement of Work (SoW)	Gantt Chart/Time Line Flow Chart/Process Map Quality Function Deployment (QFD)
Measure	Base Line figures	SIPOC or IPO diagram
Analyze	Identified Root Causes	Cause-and-Effect Diagram 5-Why Scatter Diagram Regression ANOVA
Improve	Selected root causes and counter measures Improvement Implementation Plan	Affinity Diagram Hypothesis Testing DoE FMEA
Control	Control Plan Charts & Monitor SOP Corrective Actions	Control Charts Poka-Yokes Standardization Documentation Final Report Presentation

Figure 1
Six Sigma DMAIC Methodology

METHODOLOGY

One of the organization's top concerns is the delay in the discharge of patients. This leads to patient frustration and discomfort. In turn this impacts availability of bed, which ultimately affects revenues. Following a process of selection and scoping, a Six Sigma project was assigned to a hospital located in the West area of Puerto Rico. The main objective of this research study is to decrease the discharge time of the patients while maintaining great customer satisfactions and quality of the procedures. Safety of the patients will be ensured at all times. Actually, the hospitals protocols suggest a discharge time no more than 120 minutes (2 hours).

Defining the Problem – In this first phase, a Voice of the Customer (VoC) or patient feedback will be used and consequently analyzed. In this research study 250 people were interviewed to find out the critical issues that the hospital is going through. According to patients, the hospital managers need to address 6 important issues: (1) reduce discharge time (32%), (2) facilities needs better equipment (20%), (3) hospital need more trained personnel (16%), (4) increase number of medical procedures performed (14%), (5) better hygiene/cleanliness (10%) and (6) superior customer service and better management of complaints (8%). Figure 2 shows these critical issues and their respective percentage.

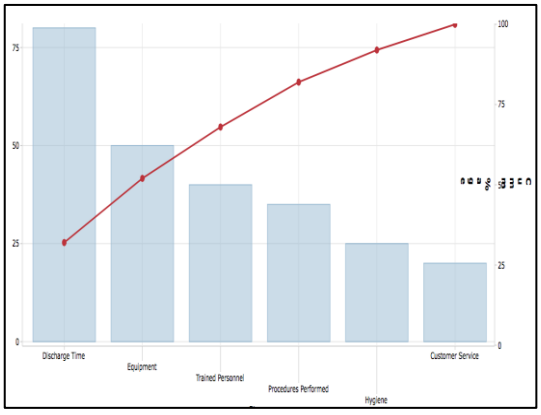

Figure 2
Patients Main Complaints

By analyzing the Voice of the Customer, it was inferred that there is a need to reduce patient discharge time, which had been identified as one of the critical factors contributing to dissatisfaction among 32% of the patients interviewed. In our

study, customer service had the lowest impact on patients with only 8%.

Next, a project charter is made to have a clear vision of the project goal, problem and timeline.

Table 4
Project Charter

Project Charter
Problem Statement: The patient's discharge time from a hospital is taking more than 2 hours.
Goal Statement: Decrease the patient's discharge time by 20%.
Project Timeline: 3-4 weeks

Measure the Current Process – In this second phase, the existing discharge process will be evaluated to find root causes of the delay that is resulting in patient discomfort. For better understanding, a flow diagram will be developed to map a visual representation of all the major steps in the discharge process. The mapping of the discharge process started from the decision of the physician to discharge a patient and continued until it was finally handed to the patient. A time study was used to measure each step in the process to determine the time consumed by each activity. It should be noted that the Upper Specification Limit (USL) is 120 minutes. The USL is decided by the hospital's general regulations and parameters. In other words, the hospital has a general rule of 120 minutes (2 hours) for the discharge process. The discharge process was broken down into 7 steps as seen in Figure 3.

Table 5 shows the discharge process with the observed mean time (in minutes) and the USL also in minutes. As mentioned before, the USL is 120 minutes (goal set by the hospital) and the observed mean time was 250 minutes. It can be inferred that the hospital is taking double the time to discharge a patient, consuming approximately 4 hours instead of the ideal of 2 hours. It should be noted that this study observed 50 discharge patients.

Analysis of the Data – Table 5 represents the observed mean time versus the USL's, which is 120 minutes. This is set by hospital regulations and customer's expectation. The observed mean time for a discharge process was 250 minutes, which doubles the hospital goals. A normal discharge time should occur in 2 hours and this study showed that it was taking more than 4 hours. The activity that took most of the time was #3 or when the discharge summary was sent to the multi task desk (MTD) for final billing. This process took 70 minutes instead of the 10 minutes goal set by the organization. It should be noted that none of the processes comply with the USL. In order to find the reasons for the delay in the discharge process, a root cause analysis was carried out. This analysis was done by fishbone diagram to visually identify variability in the process.

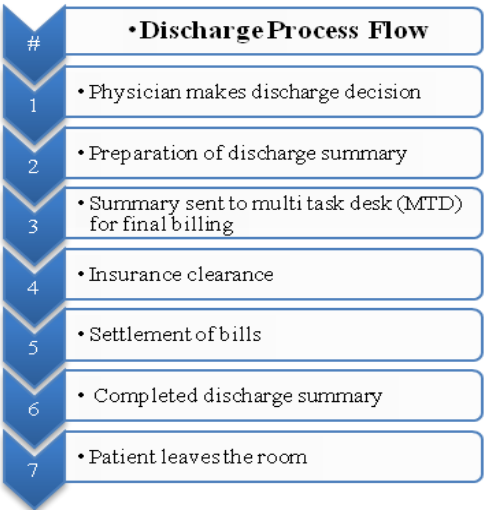

Figure 3
Patient's Discharge Process Flow

Table 5
Observed Mean Time Versus USL

Process	**Observed mean time (min)**	**USL (min)**
1. Physician makes discharge decision	30	20
2. Discharge summary preparation	40	25
3. Summary sent to MTD	70	10
4. Insurance clearance	30	25
5. Settlement of bills	25	10
6. Completed discharge summary	30	20
7. Patient leaves the room	25	10
Total	**250**	**120**

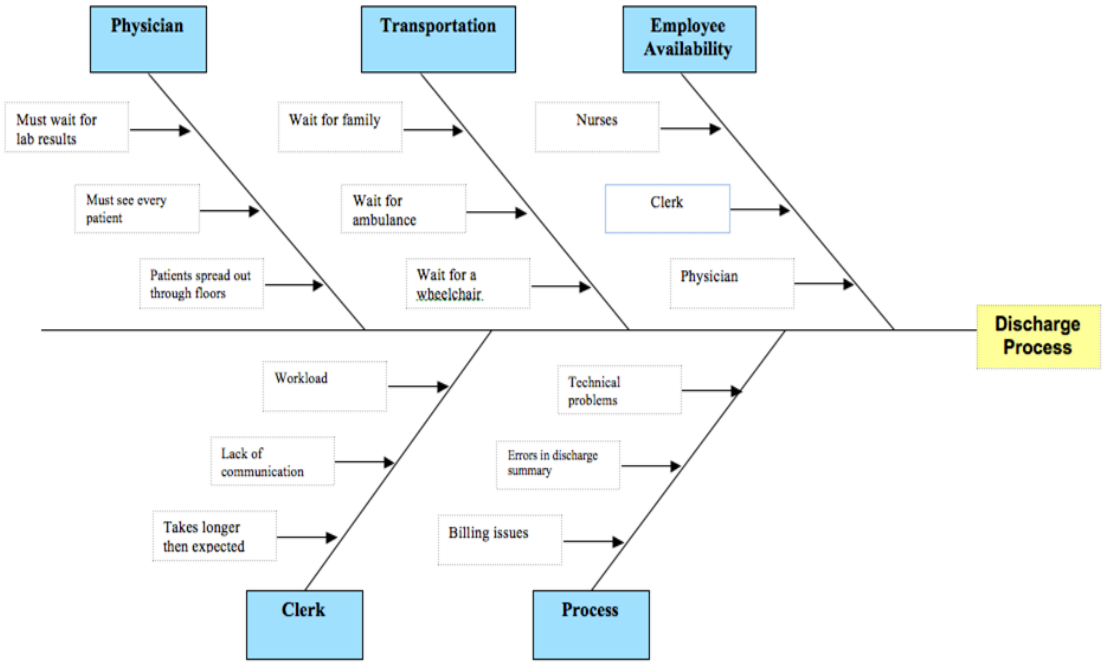

Figure 4
Fishbone Diagram for Discharge Process

Improve Phase – In this phase, with root causes uncovered and prioritized, actions were taken to improve the discharge time. It is very important to remove the non-value added activities that are contributing to the delay in discharging patients. The following recommendations were suggested:

- Billing hour start from 8:00 am instead of 9:00 am.
- Up to date computers and technology.
- Discharge process flow placed in the patient's room for better communication and understanding.
- During peak hours, additional trained employee from another department.
- Patient education must occur throughout the hospitalization, not during the time only of the discharge.
- Improved communication between nurses, physicians, and case managers. Preparation of discharge summary at least 24 hours in advance.
- Early identification of patient for possible discharge; preferably 24 hours in advance.
- Make sure lab test are on time at least 24 hours in advance.

After the implementation of the above suggestions, data was collected to study the discharge time of the patients. Overall, time required for patient discharge was reduced from 250 to 190 minutes, a 24% decrease. The goal of this investigation was to reduce the discharge time by 20%. Table 6 shows the improvement results.

Table 6
Improvement Discharge Time Results

Process	Observed mean time (min)	USL (min)
1. Physician makes discharge decision	30	20
2. Discharge summary preparation	30	25
3. Summary sent to MTD	30	10
4. Insurance clearance	30	25
5. Settlement of bills	25	10
6. Completed discharge summary	30	20
7. Patient leaves the room	15	10
Total	**190**	**120**

Control Phase – The improvements obtained during the improve phase will only work if it leads

to long-term changes in performance (Arum, 2014). To track results and to ensure the improved process remains as such over time, a checklist was created. Table 7 shows an example of the process checklist to sustain and control improvement. Table 8 shows an example of the sustain improvement month by month. In this table can be monitored the percentage of which months comply with the goal of 120 minutes or which months had the greatest time in late discharge process.

Table 7
Checklist to Sustain Improvement

Name of the Patient	Start Time	End Time	Total Time	Goal
Patient #1	1:00 pm	4:00 pm	180 minutes	120 minutes
Patient #2				

Table 8
Sustain Improvement by Month

Month	On time Discharge	Late Discharge	Late Discharge %
May 2019	35	20	36%
June 2019			

CONCLUSION

This research study validated the application of the Six Sigma DMAIC methodology to reduce and optimize the discharge time of a hospital in Puerto Rico. The discharge time was reduced from 250 minutes to 190 minutes resulting in a 24% decrease. The goal of the project was a 20% reduction. The organization limit for a discharge process is set to 120 minutes. Practically, the discharge time was reduced from 4 hours to 3 hours. This project resulted in more patients being managed, resulting in a direct impact on the revenues. Also, this affected the satisfaction of the patients positively. Active participation from employees was a key factor in successful implementing this project. Six Sigma is a great solution to address mentioned concerns providing reliable results.

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