

# A SIX SIGMA APPROACH TO BILLING IN HOSPITALS

<sup>1</sup>M.KrishnaKarthek

<sup>1</sup>Assistant Professor

<sup>1</sup> Apollo Institute of Hospital Administration, Apollo Health City, Hyderabad, India

## ABSTRACT

Medical billing in hospitals can be done for Inpatient, Day Care and Outpatient. A lengthy and inefficient patient billing process from hospital is an essential component that needs to be addressed in order to improve the quality of healthcare facility. In a healthcare facility, one of the biggest challenges apart from patient's care is mostly about medical billing and patient checkout process. The total quality of the service is being determined by this major factor. To minimize the financial losses caused by the billing errors and to minimize variability in the work process and to improve patients' satisfaction, the DMAIC strategy is being used as a fundamental tool for quality/ process improvement in Six sigma approach for this study. The main objectives of the study are to observe the current Billing processes and to improve and redesign the Billing process using Six-Sigma approach.

### DMAIC – Strategy used for improvement of process quality:

**Define:** Identification of stages and process of IP and OP billing

**Measure:** Measuring each step in process.

**Analysis:** Identify potential causes for the problems

**Improve:** Reducing cycle time, Developing standards

**Control:** Monitoring the improved process, Documentation

The Data collection is done mostly by primary sources through observation method.(i.e., from cash billing, Billing Records), questionnaire and also by Secondary sources through hospital records. Different statistical tools are used for calculating variance, standard deviation and mean time. This study suggests various improvement strategies to reduce the billing process time of the patients. Also, a control plan check sheet has been developed to sustain the Improvements obtained. This Study would facilitate the Health Care Managers to reduce and optimize the cycle time of Patients billing process in Hospitals using Six Sigma DMAIC Model.

**Keywords:** Billing, Process Improvement, Quality, Six-Sigma

## 1.INTRODUCTION

In today's competitive world, almost every hospital is concerned about the Quality of Health Care facilities and the term "Quality" becomes an essential element to combat competition in the Health care Environment. In the process of attaining Quality, each and every process in the Hospital needs to be improved by redesigning to the fullest satisfaction of the patients. One such process that drives direct attention from the patients is billing process. Billing process in hospitals, also known as Medical Billing is a crucial component for hospital management. Although it is the final step in hospital, but is directly proportional to patient satisfaction. A lengthy, inefficient process for billing in-patients is one of the problematic area for the hospitals in India. It not only causes frustration to the patients but also results in financial loss to the organization. The aim of this study is to evaluate the functioning of billing department in a tertiary care hospital as it plays an important link role between the management and the patients. When patients visit a hospital, the facility's business staff works together with the clinical staff of physicians and nurses and with the support staff, such as pharmacy, housekeeping and food service, to make the interactions as satisfactory as possible. Clinicians plan and perform medical treatments and procedures while the business staff ensures that all services are documented and reimbursed. After patients are registered, the medical care provided to them is documented in their medical records. Also recorded is the cost of each service or supply that is billable to a patient's account. At the end of the inpatient hospitalization or outpatient visit, the charges are collected and entered in the patient accounting system which prepares the final patients' bills. This work is done carefully to avoid billing errors that might lead to incorrect charges, unpaid bills, or late payments. When the discharge instruction is given to the patient by physician all the information from patients' account is extracted for generation of final bill. Billing process comprise all the activities essential for preparing bill to submit for patients and private providers to obtain reimbursement for the hospital. This process constitutes patients' account, bill chart, claims preparing and generating invoice of patients for submission, controlling and monitoring of patients' account.

### About Six-Sigma

Privatizations of health care has changed the functioning and demand of health care system. As today's competitive environment leaves no scope for error, we need to delight our patients, look for new ways to exceed their expectations on continuous basis, with a focus on improvement in technical skills, human skills and to develop cost effective methodologies. To meet such challenges, implementation of Six-sigma is the utmost solution. Six-sigma is a business improvement strategy used to improve business profitability to drive out waste, to reduce costs of poor quality and to improve the effectiveness and efficiency of all operations so as to meet or even exceed customer's needs and expectations. The name Six-sigma comes from the fact that it is managerial approach designed to create processes that results in no more than 3.4 defects per million opportunities. Six-sigma is a scientific concept that provides measurement of every activity in the hospital by using various statistical tools. Delay in billing of patients was a chronic problem among many of the Indian Hospitals. Good discharge and faster billing management are vital to ensure patient satisfaction; bed availability for emergency and elective admissions; and hence quality of patient care remains high.

Pioneered at Motorola in the mid-1980s, Six-sigma was initially targeted to quantify the defects occurred during manufacturing processes, and to reduce those defects to a very small level. Motorola claimed to have saved several million dollars by following this approach. Another popular success was at GE where the concept contributed over US \$ 300 million to GE's 1997 operating income. 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. While the particulars of the methodology were originally formulated by Bill Smith at Motorola in 1986, Six-sigma was heavily inspired by six preceding decades of quality improvement methodologies such as quality control, Total Quality Management and Zero Defects. Six-sigma stands for six standard deviations from mean. The Six-sigma methodology provides the techniques and tools to improve the capability and reduce defects in any process. Six-sigma is a systematic process of “quality improvement through the disciplined data-analyzing approach and by improving the organizational process by eliminating the defects or the obstacles which prevents the organizations to reach the perfection.” Improved Customer Satisfaction is the prime goal of Six-sigma. Its implementation program covers a variety of processes related to manufacturing and services including distribution, operations, warehousing and inventory management, hospitality, health care, electronics equipment manufacturing, electronics component manufacturing, boiler industry to printed circuit board industry, banking to insurance business, etc. The fundamental objective of the Six-sigma methodology is the implementation of a measurement-based strategy that focuses on process improvement and variation reduction through the application of Six-sigma improvement projects. This is accomplished through the use of two Six-sigma sub-methodologies: DMAIC and DMADV.

The Six-sigma DMAIC methodology (Define, Measure, Analyze, Improve, Control) is an improvement system for existing processes falling below specification and looking for incremental improvement. The Six-sigma DMADV methodology (Define, Measure, Analyze, Design, Verify) is an improvement system used to develop new processes or products at Six-sigma quality levels.

### Steps in Six-sigma methodology (DMAIC):

**Define:** Define the project goals and deliverables for both internal and external customers

**Measure:** Measure the process to determine current performance. Establish valid and reliable metrics to help monitor progress towards the goals defined at the previous step. Begin by determining the current base line.

**Analyze:** Analyze the system to identify ways to eliminate the gaps between the current performance of the system or process and desired goal. Use statistics to find the root cause of the problem and generate a prioritized listing of them.

**Improve:** Improve the process by eliminating defects. Be creative in finding new ways to do things, better, cheaper, or faster.

**Control:** Control future process performance by monitoring the new system.

The Six-sigma DMAIC (Define, Measure, Analyze, Improve, Control) methodology can be thought of as a roadmap for problem solving and product/process improvement. The DMAIC methodology should be used when a product or a process is in existence but is not meeting customer expectations or is not performing adequately. Once successfully implemented it can result in increased customer/patient satisfaction and care, increased Physician satisfaction and Reduced Cost & improved quality.

For the two decades, many manufacturing companies have implemented Six-sigma to improve their processes. But its implementation in service industries like health care is much limited since Six-sigma is a journey to reach the target by changing culture of the organization which is a long term process. On reviewing the literature, few studies demonstrated the utility of Six-sigma Models in Health care Industries with specific focus on surgery turnaround time (Adams *et al.*, 2004), clinic appointment access (Bush *et al.*, 2007), scheduling radiology procedures (Volland, 2005), catheter-related bloodstream infections (Frankel *et al.*, 2005), meeting standards for cardiac medication administration (Elberfeld *et al.*, 2004), and operating room (OR) throughput (Fairbanks, 2007). More recently, Rosalie Sager and Eric Ling (2007) conducted a study by implementing the Six-sigma methodology to improve the Hospital bed availability and emphasized that the Leadership support and active participation from employees were key factors in successful implementation of Six Sigma Methodology in Hospitals. Similarly, Heath Rushing and Carolyn Pexton (2006) conducted a study using Six Sigma Model and reduced the admitting delays by improving Bed Management.

## 2. METHODOLOGY

### 2.1 Study Settings

This study was conducted at a private hospital in Hyderabad during the the year 2018-2019 for a period of 3 to 4 weeks. As a measure to improve the Quality of Services, one critical issue consisting of delay in billing of outpatient and inpatient services to the Patients was identified and necessary action was taken to address the underlying issues that might be causing the delays in the billing process of the patients. Accordingly, various Quality approaches were identified and finally it was decided to use DMAIC Model with an objective to optimize the cycle time of Patients billing process. Finally, necessary process redesign was carried for obtaining optimal results.

### 2.2 Scope & Methodology

The study in this review is able to shed a degree of light on Billing Process in Hospital. Six-sigma methodology can be effective change tool to improve Billing Process time. This is increasing concern to improve the quality of administration in the hospitals to meet the rising expectations of people by applying Six Sigma tools. Study focus only on DMAIC methodology. The study is mainly observational and descriptive in nature as it is detailed study of the existing system of billing process in the hospital. The information is clearly defined as to what is the expected outcome. It is mainly based on studying the representative sample. Inpatient billing process for cash, credit & concession patients and also outpatient billing process are explained by using flow chart as an analysis tool. The factors influencing delay in billing process are analyzed by using root-cause analysis as a tool. The data is mainly primary data and also secondary, which was collected by shadowing and interacting with the patients and employees and also form the records of the hospital. Convenience random sampling technique is used and 100 patients were taken as the representative sample in the pre-operative phase and another 100 samples were considered in the post-operative phase. Suggestions are framed as research report for optimizing the billing process in hospital.

### 2.3 OBJECTIVES

The brief objectives of this study are as follows:

1. To study the existing work flow of inpatient and outpatient billing process in the hospital.
2. To determine the overall defects in the billing process of the hospital
3. To track the voice of internal and external customers and identify the causes for the defects in the billing process.

4. To measure the gap and enhance the performance of the organization through Six-Sigma approach.
5. To determine the performance of the organization after the quality improvements.

## 2.4 DMAIC – STRATEGY USED FOR IMPROVEMENT OF BILLING PROCESS QUALITY:

The DMAIC strategy is being used as a fundamental tool for quality/ process improvement in Six sigma approach for this project. The following are the steps,

### 2.4.1 Step 1 – Define: identification of stages and process of IP and OP billing, Timings, Peak times, Patient flow

There are five high-level steps in the application of Six Sigma to improve the quality of output. The first step is **Define**. During the Define phase, few major tasks are undertaken. They are project team formation and roles determination and documentation of the selected business process.

Below are the processes of all the types of billing.

The peak times for billing and patient flow is 9:00 AM -12:00 PM

#### For Arogyasree Billing

Client comes in → Goes to Arogyasree Counter → ArogyaMithra checks and verifies their Arogyasree Card → ArogyaMithra enters Patient's credentials into Arogyasree website "arogyasree.telangana.gov.in" → If the credentials were matching, Mithra gives a prescription with printed details of patient on the backside with a signature of RMO is given and if inpatient a casesheet is also provided → investigations/ surgery is done for patient → At the time of Discharge, For an inpatient, The patients are supposed to get photographed for further process as an evidence with Mithra and RMO of hospital.

The procedure is same for EHS- Employees Health Scheme for State Government employees of Telangana.

#### Pharmacy Billing:

The Pharmacy building is separate and is situated near entrance. There are different types of Pharmacy Billing – Inpatient Pharmacy Billing, Out Patient Pharmacy Billing, Company Pharmacy Billing.

Patient/Attendant comes and hands the prescription to Counter → the bill is generated and medicines are dispatched

For a Company Bill, the bill is cashless. i.e., the bill is generated but patient will not pay. It is then attached to patient's company form and is then reimbursed.

If any medicines are not available, the patients are asked for wait and collect the next day or other. They store and pack the required medicines for Company patients with a separate bill.

The medicines for ArogyaSree is also provided by the hospital Pharmacy. There is separate billing in pharmacy for this purpose.

#### OP Billing:

OP billing counter is located at the main entrance and hence they are very easily accessible and easy to locate. There is a different counter for Investigations (X-RAY, CBP, HIV SPOT etc.,) for OP. The whole process is based on Cash. Debit and credit cards are accepted. They are open 24x7.

Patient comes → waits in queue → Staff fills in details of patients → registration of patient is done for respective doctor → cash is paid by patient/attendant → a bill is generated → an OP number is generated and an OP book for a patient is issued → Patient goes to respective Doctor.

Prescribed investigations are shown in counter by patient/attendant → Staff then enters the patient's OP number and record the investigations → a bill is generated → bill attached in OP book → patient can proceed to get respective investigations.

They offer no referrals or referral services. Once a patient is registered, the consultation is valid for 15 days.

#### IP Billing:

IP billing counter is located opposite to OP billing counter. It is solely based on cash. Credit and debit cards are accepted. There are department wise case sheets for IP where as there is only one type of case sheet for OP. IP counter is also open for 24x7.

#### At the time of admission

Patient Registration → consultation of respective doctor → Cashier IP- Advance payment → Issue of Gate pass (Pink slip), issue of respective case sheet → Analysis of patient condition → investigations → problem identification and consultation of required doctors → Admission → Treatment → Discharge → Final bill.

#### At the time of discharge

A case sheet is bought for discharge to IP bill counter → First a manual bill is calculated in case sheet (by calculating all charges including bed charges, investigations, consumables, Doctor consultations, etc → prepare a computerized bill → Check the manual bill with computerized Bill → If matched, print the final bill → Explain the final bill to patient → Issue final bill → Discharge Summary is given by nurses if final bill is shown → Patient is discharged.

### 2.4.2 Step 2 – Measure: Measuring each step in process in terms of time taken for each step, frequency of -patients, errors, delay time cases, improper documentation cases.

During the Measure Phase, the overall performance of the selected Business Process is measured. The important parts of Measure Phase are data collection and data evaluation.

Voice of customers: Listening to customers. In a hospital there are two kinds of customers.

1. **Internal customers** include include Physicians, PRE's, Secretaries, technicians, etc., and they play an important role in Process flow. Interaction with all them was done to know the reasons for delay.
2. **External customers** will be the patients. For External customers, i.e., customers to know the reasons a patient satisfaction survey is done on random sample in hospital regarding Billing in various departments.

The questionnaire was administered to 100 patients/attendants. The results of the survey are depicted as follows:

**1. The accessibility of the Office.**

In 80% of the cases the patients/attendants, it is good and readily available

**2. Waiting Time in Counters.**

69% of them didn't face any problem while 31% have waited in long queues.

**3. The courtesy of Staff**

Overall 70% of patients/attendants are satisfied with Staff

**4. Queries addressed by Staff, Response of Staff**

Overall 70% of Patients/attendants were satisfied regarding response of staff and queries

**5. Do they make it easy for patients to pay their bills (use of credit cards, notification of co-pay amount, given before visit)**

74% were satisfied with the process and were happy with it.

**6. Do you have any complaints about billing errors or problems**

70% of them did not have any problems with bills while 30% of them disagree.

**7. Overall how do you rate your experience**

Overall 75 % of the people were satisfied with current process and rated as Good.

At this stage, the collected data is evaluated and sigma is calculated. It gives an approximate number of defects. A Six Sigma defect is defined as anything outside of customer specifications. A Six Sigma opportunity is the total quantity of chances for a defect. First we calculate Defects Per Million Opportunities (DPMO), and based on that a Sigma is decided from a predefined table.

$$\text{Defects Per Million Opportunities, DPMO} = \frac{\text{Number of defects}}{\text{Number of Units} \times \text{Number of opportunities}} \times 1000000$$

As stated above, Number of defects is the total number of defects found, Number of Units is the number of units produced, and number of opportunities means the number of ways to generate defects.

In the present study, the number of opportunities to generate defects are 4 viz,

- a) billing not on time
- b) errors in billing
- c) billing process not convenient
- d) no courtesy from staff

Based on the primary data from 100 patients, the following responses are recorded

- a) billing not on time = 16
- b) errors in billing = 10
- c) billing process not convenient = 5
- d) no courtesy from staff = 2

Therefore, Total Number of defects = 16 + 10 + 5 + 2 = 33

$$\text{Defects Per Million Opportunities, DPMO} = \frac{\text{Number of defects}}{\text{Number of Units} \times \text{Number of opportunities}} \times 1000000$$

$$\text{DPMO} = \frac{33}{100 \times 4} * 1000000$$

$$\text{DPMO} = 82500$$

According to the Yield to Sigma Conversion Table, 82500 defects per million opportunities is equivalent to a sigma performance of between 2.9 and 3.0. The value of sigma denotes that there is greater scope for improvement in the billing process of the hospital.

**2.4.3 Step 3 – Analysis: Identify potential causes for errors, delay times, congestion.**

Six-sigma aims to define the causes of defects, measure those defects, and analyze them so that they can be reduced. We consider five specific types of analyses that help to promote the goals of the project.

**Source Analysis**

This is also called root cause analysis. It attempts to find defects that are derived from the sources of information or work generation. After finding the root cause of the problem, attempts are made to resolve the problem before we expect to eliminate defects from the product.

**Process Analysis**

Process analysis includes creating a more detailed process map, and analyzing the more detailed map, where the greatest inefficiencies exist. The source analysis is often difficult to distinguish from process analysis. The process refers to the precise movement of materials, information, or requests from one place to another.

**Data Analysis**

The data itself may have defect. There may be a case when products or deliverables do not provide all the needed information. Hence data is analyzed to find out defects and attempts are made to resolve the problem before we expect to eliminate defects from the product.

**Resource analysis**

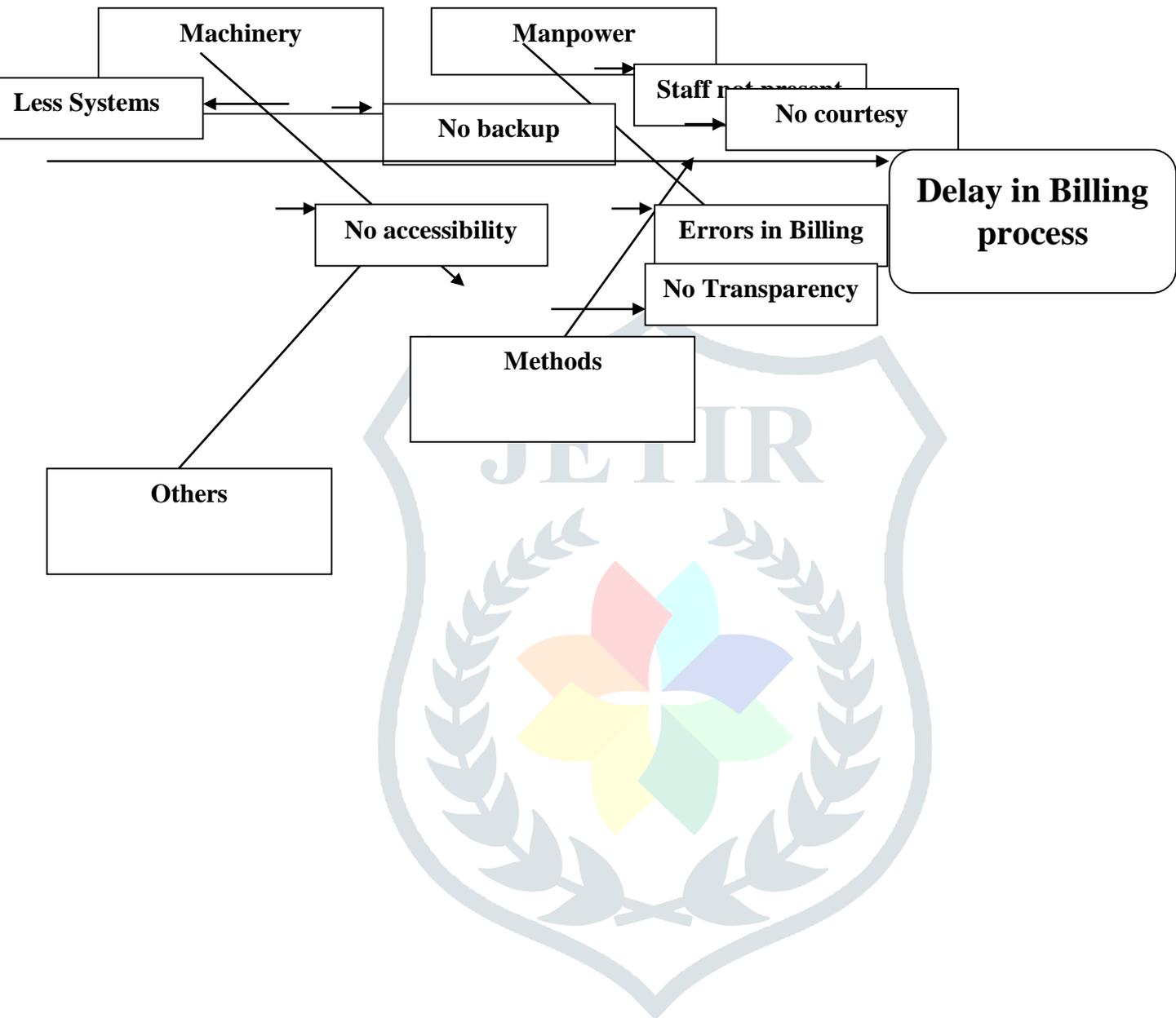
We also need to ensure that employees are properly trained in all departments that affect the process. If training is inadequate, you want to identify that as a cause of defects. Other resources include stationary materials, etc.

**Communication analysis**

One problem common to most process high in defects is poor communication. The classic interaction between a customer and a retail store is worth studying because many of the common communication problems are apparent in this case.

**Fishbone diagram:**

Subsequently, based on the above data a relevant fish bone diagram is used to depict the root causes and the effect in the billing process.



#### 2.4.4 Step 4 – Improve: Reducing cycle time, Developing standards, feedbacks, Reviews, Documentation

In this Phase, the results of the analyze phase were carefully implemented to make appropriate change in the design of Patients billing process by removing the non-value added activities and adding value added activities contributing to the delay in billing process of the patients and following recommendations were implemented viz:

a) The process improvement team was sent to the billing area for direct line of sight observation as to how a number of tasks were carried out and to identify the scope for improving the delays and disturbances in the department. It became immediately apparent that the documentation process, integration with other departments and congested space were slightly inefficient. In order to overcome those mentioned inefficiencies and improve the billing process, the following quick actions were suggested, considering the time and availability of resources for the organization.

1. Personal self-assessment and self-monitoring by each staff of capacity to meet the standard
2. Review by either a peer or supervisor
3. Independent audit by the quality department
4. Audit independent of the facility, i.e., by corporate

b) Up-to-date information is generated about the bills of the patients before the billing process in the hospital using Information technology system. Also it's ensured that all the information about the patient is available in a computer generated printed form prior to arrival of the patient in order to decrease the delay.

c) Efforts have been taken to train and utilize the technical staff at the billing department so that the delay in processing of the patients' bill could be reduced. The task of carrying out the preparation of patients' bill is assigned to specific staff so that the task would be completed at appropriate time.

d) Purchase and install suitable ERP software in all the Computers through the Electronic Data Processing (EDP) Department and electronically link all the specialty departments so that the delay in getting the clearance from the Billing department would be reduced. Responsibility was assigned to the billing personnel to update all the inpatient bills clearance to till time, every day and upload the information in the Computer.

In the present study, after improvising the billing process, the number of opportunities to generate defects are reduced to 3 viz,

- a) billing not on time = 4
- b) errors in billing = 1
- c) billing process not convenient = 1

Therefore, Total Number of defects = 4 + 1 + 1 = 6

$$\text{Defects Per Million Opportunities, DPMO} = \frac{\text{Number of defects}}{\text{Number of Units} \times \text{Number of opportunities}} \times 1000000$$

$$\text{DPMO} = \frac{6}{100 \times 3} * 1000000$$

$$\text{DPMO} = 20000$$

According to the Yield to Sigma Conversion Table, 20000 defects per million opportunities is equivalent to a sigma performance of between 3.5 and 3.6.

Therefore, after implementation of few of the above suggestions for the period of 10 days, the data was collected to study the total defects for billing another 100 Patients. Overall, the total defects in the billing process of the Patients was reduced from 82500 to 20000, demonstrating a subsequent increase in sigma value.

#### 2.4.5 Step 5 - Control: Monitoring the improved process, Scope for future aspects

The recommendations which are piloted, and implemented during the improve phase were standardized, confirmed and institutionalized in the Control Phase. The Process improvements obtained during the improve phase will only work if it leads to long term changes in Performance. The control phase was very important, because it many times draws attention to the shortcomings that in the implementation of the changes may occur in spite of the fact that in the measurement and analysis phase have not been identified. The control phase was carried out using the following steps:

- Process monitoring,
- Making the Plan of reaction,
- Process documentation,

Few management principles to ensure smooth process and quality in the service,

1. Customer Focus companies must focus their resources on customer satisfaction.
2. Leadership - Good leadership increase a company's effectiveness
3. Involvement of People People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organizations benefit.
4. Process Approach A desired result is achieved more efficiently when activities and related resources are managed as a process.
5. System Approach to Management Identifying, understanding and managing interrelated processes as a system contributes to the organizations effectiveness and efficiency in achieving its objectives.
6. Continual Improvement Continual improvement of the organizations overall performance should be a permanent objective of the organization.

The goal is to develop a quality management system to assure the organization is customer driven, process focused and continually improves, uses a systematic approach by management and leadership which is mutually beneficial to suppliers as well as customers.

### 3. DISCUSSION OF FINDINGS

The use of Six Sigma concept is focused on saving company costs, improving the quality of business processes and effectiveness of the overall work. This study is the documentation of the effectiveness of implementing Six Sigma DMAIC methods to reduce and optimize the Patients billing process at a private hospital in Hyderabad. In order to execute this study, the billing department was selected based on the homogeneity of services offered and the complexity of the patients handled in the department. There are some of the ways by implementing the same one can optimize the overall billing process in the organization. They are as follows by increasing the manpower in the department, by implementing responsibility and authority matrix for all kinds of IP patients,

control chart or standard operating procedures to optimize the process, training and education of the staff and key performance indicators for analyzing the overall department performance. By implementing the above said suggestions one can optimize the billing process of overall department billing. From the study, it is clear that through the Six-sigma approach, the number of defects have been reduced from 82500 to 20000 and there is a subsequent sigma improvement from 3.0 to 3.6. It even helps in decreasing the direct loss to hospital by means of deduction.

#### 4. SUGGESTIONS

1. Increase the manpower in the department for smooth functioning.
2. Implementation of a standard Billing module or a comprehensive HIS in the hospital.
3. Control Chart/Standard Operating Procedures for Optimizing the Billing Process.
4. Training and education to the staffs.
5. Set department goals and streamline individual goals with department goals. Include objective measures related to key functions of each job role, track their performance and reward the high/good performers.
6. Wait time for the customers can be reduced, even the emergency services could be categorized with different verticals and specialist duty doctors if present at that time.
7. Speed of Billing Counters- increasing the billing counters VERTICAL wise (patients getting treated with respect to their problem)
8. Most of queries are left unanswered in the bills provided by the hospital. A Draft bill should be issued and there must be a service desk to clarify all the doubts before the final bill is release. Utilization of manpower can be segregated with respect to the workload of the staff in the billing section.

#### 5. CONCLUSION

Billing process is a part of discharge process but still it is one of the vital functions for maintaining the financial essence of organization. If the billing process system is poorly understood it leads to incorrect documentation, which can result in claim rejection. The project was carried out using the DMAIC methodology and the progress of all its phases was described in detail. Hence it is important for billing personnel's to understand the billing process and to have good communication skills in order to have an effective billing process in healthcare organization.

#### REFERENCES

- Adams, R., Warner, P., Hubbard, B., & Goulding, T. (2004). "Decreasing turnaround time between General Surgery Cases: a six sigma Initiative. *Journal of Nursing Administration*, 34, 140-148.
- Basu, R. (2009). *Implementing Six Sigma and Lean. A Practical Guide to Tools and Technique*. Butterworth-Heinemann: Oxford, United Kingdom.
- Bush, S.H., Lao, M.R., Simmons, K.L., Goode, J.H., Cunningham, S.A., & Calhoun, B.C. (2007). Patient access and clinical efficiency improvement in a resident hospital-based women's medicine center clinic. *American Journal of Managed care*, 13, 686-690.
- Elberfeld, A., Goodman, K., & Van Kooy, M. (2004). Using the Six Sigma approach to meet quality standards for cardiac medication administration. *Journal of Clinical Outcomes Management*, 11, 510-516.
- Fairbanks, C.B. (2007). Using six sigma and lean methodologies to improve or throughput *AORN Journal*, 86, 73-82.
- Frankel, H.L., Crede, W.B., Topal, J.E., Roumanis, S.A., Devlin, M.W., Foley, A.B. (2005). Use of corporate Six Sigma performance-improvement strategies to reduce incidence of catheter-related bloodstream infections in a surgical ICU. *Journal of American College of Surgeons*, 201, 349-358.
- Kumar, R.K., Kumar, T.B., Ahmed, I. (2013). Reducing Process variability by using DMAIC model: a case study in Bangladesh. *International Journal for Quality Research*, 7(1), 127-140.
- Sager, R., & Ling, E. (2007). Leveraging Six Sigma to Improve Hospital Bed Availability. Retrieved from: <http://www.isixsigma.com/new-to-six-sigma/dmaic/leveraging-six-sigma-improve-hospital-bed-availability>. Accessed February 25, 2014.
- Rushing, H., & Paxton, C. (2006). Reducing admitting delays by improving bed management using six-sigma methodology. Retrieved from: <http://www.isixsigma.com/new-to-six-sigma/dmaic/reducing-admitting-delays-improving-bed-management>. Accessed February 25, 2014.

Reducing Laboratory Billing Defects Using Six Sigma Principles - <https://academic.oup.com/labmed/article/44/4/358/2505052>

Case Study: Improving Medical Bill Review Cycle Time - [https://www.isixsigma.com/industries/healthcare/case-study-improving-medical-bill-review-cycle-time/Volland, J. \(2005\). Quality Intervenes At a Hospital. Quality Progress, 38, 57.](https://www.isixsigma.com/industries/healthcare/case-study-improving-medical-bill-review-cycle-time/Volland, J. (2005). Quality Intervenes At a Hospital. Quality Progress, 38, 57.)