Research Article

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A Study to reduce TAT (Turnaround time) in Dental Care using Six sigma Methodology

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ABSTRACT

Aim: The purpose is to study, analyze and improve various healthcare parameters like TAT (turnaround time), chair side time, waiting time etc with reference to dental care at a select hospital in Hyderabad city.

Materials and Method: Before the start of the actual study a pilot study has been done taking 20 outpatients coming to hospital in month of May 2015. Later actual study was done for one month from 6th June 2015 to 6th July 2015. Data collection sheet has been circulated among 30 patients for 6 days with a total sample size of 180 patients. DMAIC process of Six Sigma is taken into consideration to reduce turnaround time which includes the tools like SIPOC (Supplier, Input, Process, Output and Customer), Process analysis flow diagram, fishbone diagram, benchmarking, value Stream Mapping (VSM), box plot and Pareto analysis. Capability rates (Cp, Cpk) as performance measures between baseline and improved data. P value <0.05 is considered as significant value. After implementation of suggestions, again same sample of 180 respondents were analyzed by application of tools in improve phase which shows that there is an improvement in TAT.

Results: The average turnaround time in the present study by application of six sigma methodology, per patient decreased from 3.11±1.06hours (186.6±63.6 minutes) to 1.989± 0.116 hours (119.34±6.96minutes) after implementation of six sigma process with its tools. Estimate for difference is 1.1224. P-Value is found to be highly significant with p= 0.000.

Conclusion: Six sigma is a scientific approach to excel business. Six sigma strategies can be successfully utilized in almost all organizations to remove the obstructions in the success of the organizations as well as to improve customer satisfaction. In present study there is an increase in outpatients which lead to customer satisfaction and increase in profit of organization.

Keywords: TAT, SIPOC, DMAIC process, VSM, Capability rates (Cp, Cpk), Six sigma.

INTRODUCTION

In the present era, the most important asset of any organization is customers. These customers are educated, aware of market prices and look for values even in small amount of money they spend, thus customer service is one of the areas where they demand value. Customer satisfaction became a measure of quality. The health care industry is no different; poor patient satisfaction will damage an institution`s brand equity.[1] Long waiting times from registration to treatment, chair side operational time and patient treatment satisfaction level are the critical aspects that need the attention of managing authorities to boost the OPD(outpatient department) of hospitals.

Quality: Quality in healthcare can be defined as the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.[3]

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Problems affecting quality: Lack of sufficient involvement of management both clinical and administrative, inadequate staff supply, inadequate training and weak performance monitoring systems are the Major Factors that Cause Quality Problems.

Six Sigma : Sigma is a universal scale. It is a scale like a yardstick measuring inches or like a balance measuring ounces or a thermometer measuring temperature. The sigma scale allows us to compare very different business processes in terms of the deviation or variation of the process to stay within the quality limits established for that process. In health care, six sigma methodologies seek to provide near-perfect services and to reduce costs incurred by organizations.[8]

Six Sigma approach was pioneered at Motorola Corporation in the 1980s and after the Corporation won the Malcolm Baldrige National Quality Award in 1988 the secret of their success became public knowledge and the Six Sigma revolution was on.[15] A comprehensive definition of Six Sigma is that it is an improvement approach or an improvement program whereas a complete definition of Six Sigma states that it is an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives. It is a management strategy to embed awareness of quality in all organizational processes.[3]

DMAIC: Six Sigma projects focus on improving/solving existing quality problems follow the roadmap of Define, Measure, Analyze, Improve,

Control (D M A I C)[6]. DMAIC is a structured improvement and problem solving method guided by using tools and techniques. This methodology constitutes five steps which stand for defining a problem, measure, analyze, improve and control.

TAT (Turnaround time): Turnaround time is a crucial aspect that strongly affects patient's satisfaction and success of the hospital. It is defined as the time from patient arrival to time patient leaves hospital after completion of treatment.

The reasonable Turnaround Time for a patient on appointment should be about one and half hours to two hours, however in the present dental hospital it was not met. In other words, the hospital is facing a challenge of addressing the long turnaround Time (TAT). It was observed that there was a decline in number of out patients in the last 1 months and the average OP services TAT for the past one month was 3.11 hours(187 minutes) against a target of 1.5 hours(90minutes) leading to patient's dissatisfaction . Hence the present study was undertaken to address this issue by applying DMAIC strategy of six sigma methodology at Sowjanya Dental Hospital in Hyderabad city. The importance or rationale of proposed investigation was to improve health service delivery and increase patient satisfaction.

Objectives of the proposed study:

Primary Objective:

To reduce the TAT(turnaround time) in Sowjanya Dental Hospital by application of six sigma methodology.

Secondary Objectives:

i. To study patients Turn Around Times in a dental hospital for specialty care in departments like Oral surgery, Endodontics, Prosthodontics, Orthodontics, Pedodontics, Periodontics.

ii. To investigate the waiting time issues at the various stages of dental hospital.

iii. To analyse the existing system and to identify the "bottlenecks" and give suggestion for the area of improvement.

iv. To study the management system by application of six sigma.

v. To analyze and compare turnaround times between select hospitals.

vi. To develop a model to optimize utilization time.

vii. To study the patient satisfaction with reference to turnaround time, and quality of service.

viii. To segregate quality of service parameters through "DMAIC"

MATERIALS AND METHOD

The study is planned and conducted with the participation and cooperation of six sigma team including Champion, Black belt and three team members in order to systematically improve turnaround time in a dental hospital in Hyderabad city. Ethical clearance has been taken for the commencement of the study from the ethical committee of the institute.

The study was carried out from 6th June to 6th July 2015 in a corporate dental hospital namely Sowjanya Dental Hospital.

Hypotheses tested are:

Null Hypothesis: There is no significant change in Turnaround time before and after application of six sigma methodology in the dental hospital.

Alternate Hypothesis: There is a significant change in Turnaround time before and after application of six sigma methodology in the dental hospital.

Information is collected from primary and secondary quantitative data by direct observation, interviews and check sheets. The pilot study was carried out on 20 subjects reporting to SOWJANYA DENTAL HOSPITAL seeking treatment in the month of May 2015.From this information we came to know that there was a decline total outpatients from past one month due to decreased patient satisfaction which affected hospital finances and fame of the hospital. To overcome this lacunae actual study has been done from 6th June to 6th July 2015 with a sample size of 30 patients taken for 6 days making a total of 180 patients. Check sheets are given to the hospital assistants to record exact time using digital clocks. Later on Patients are also interviewed directly.

The **DMIAC** process is employed beginning with the identification of CTQ (Critical to Quality) by trying to capture the cause through the customer voice. The primary focus for the project i.e., CTQ(critical to quality) is TAT of patients with dental related problems. The methods used to understand customer requirements are feedback forms and patient escalation to grievance cell. Before commencing the improvement activities, the team created a structured team charter (table 1) to allow the team to clarify its goals and objectives for the improvement project. The team generated a SIPOC (Supplier, Input, Process, Output and Customer) table (table 2) to understand process boundaries, scope and constraints. Data collection template is designed to calculate the turnaround time from patient entering the hospital till the completion of treatment process by general dentist or specialist

In the measure phase the team determined the data collection plan and metrics to measure the existing process. Detailed process flow diagram (Figure1) is framed for easy understanding of different stages of hospital and CTQ characteristics i.e. TAT (turn around time).TAT for outpatient services is established with target time of 1.5 hours(90minutes) and upper specification limit (USL) of 2 hours(120)minutes. Performance standards are established, appropriate training is given to staff to collect data and all the clocks are calibrated to same time and performance evaluation (stability analysis) is carried out in which normality test is used to check the weather our data is following normal distribution curve. Probability plot is used to check the P value.

In the third phase i.e; analyze phase benchmarking is done with the neighboring hospitals to establish performance gap, fishbone diagram (Figure 2) is used to study the causes and effects for turnaround time, current Value Stream Mapping (VSM) is done to find out underutilized, over utilized process steps and non-value added waiting time. Box plot and Pareto analysis are used as tools to analyze variation sources so that improvement suggestions are made accordingly.

In the fourth phase i.e; improvement phase, again same sample of 180 respondents has been taken and future Value Stream Mapping (VSM) is prepared according to the suggestions in analyze phase and the new plan is implemented which shows that our TAT decreased from 3.11 hrs(186minutes) to 1.99hrs(119minutes) by application of all the above mentioned tools.

In the fifth phase control phase, the improved process is put under control and comparison is done between baseline and improved data. Capability analysis (Cp: potential capability, Cpk: achieved capability) is done for a stable process and is done to know the extent of natural variability and is calculated as

The C_p rate of capability is calculated from the formula:

$$C_p = \frac{USL - LSL}{6 \times \hat{\sigma}}$$

Where *s* represents the standard deviation for a population taken from $\hat{\sigma} = \frac{\bar{s}}{c_4}$, with *s-bar* representing the mean of deviation for each rational subgroup and c_4 representing a statistical coefficient of correction.

The C_{pk} capability rate is calculated by the formula:

$$c_{pk} = min\left(\frac{USL - \mu}{3 \times \hat{\sigma}}, \frac{\mu - LSL}{3 \times \hat{\sigma}}\right)$$

considering the same criteria of standard deviation. USL & LSL are upper and lower specification limits.

P value <0.05 is considered as significant value and at this situation null hypothesis has been rejected. Normal Probability power plots or Anderson-Darling test (AD) is used to test the hypothesis. Graphical summary charts are used to determine waiting time and cycle times in a dental hospital for specialty care in departments like Oral surgery, periodontics, endodontics, prosthodontics, orthodontics and pedodontics.

RESULT

Quality is degree of excellence of a product or service provides. In simple terms we can put quality as Consistent delivery of a product or service according to expected standards. Health care involves three main groups of people , customers (patients), employees (service providers) and the managers interacting with one another in the provision of healthcare. Quality can be achieved by a methodology or a benchmark based system called as six sigma. Six sigma is a set of tools for reducing the variations and improving the performance by following DMAIC road map. DMAIC is a five phase methodology.

In the first phase i.e**, Define phase** of our study, top level view of project has been done to identify the problem and a project charter has been developed which stated that the average OP services TAT for the past 1 month was 3.11 hours(187minutes) against a target of 1.5 hours(90minutes) leading to patients dissatisfaction.

The second phase is **measure phase** which identifies performance variables on which data need to be collected (data collection sheets).In our study performance variable is patient TAT . Data in our study is measurable or variable or continuous that follow normal distribution, so I-MR control chart is used which shows Xbar(individual value) value of 3.11 which is turnaround time and MRbar(moving range) which gives inherent variability value as 1.243.(graph 1)

Probability plot of TAT (graph 2), one of the stability diagnostic tool which is used to test hypothesis with sample size of 180 showed mean value of 3.11, standard deviation value1.06, AD value = 0.289 and p-value =0.612(graph 2) As the p-value is greater than 0.05, null hypothesis is rejected and alternative hypothesis is accepted which means turnaround time before improvement is greater than turnaround time after improvement.

Then Process capability or inherent capability which tells us natural variability of a process reveals that Cp(potential capability) is 0.30 which is greater than 1 so statistically not good and Cpk (achieved capability) is -0.34 (graph 3) mean the process is outside specification limits. Thus the pre-improvement data obtained showed that TAT is 3.11± 1.06 hours(187±64 minutes),Cp is 0.30 and Cpk is -0.34.

In the **analyze phase**, current value stream mapping (VSM) showed underutilized process steps are U1 at Registration, U2 at Assistant recording info, U3 at general dentist diagnosis, U4 at specialist diagnosis, $U3^I$ at General dentist treatment; over utilized process steps are fee payment utilization and $U4^I$ at specialist treatment and non-value added services i.e. waiting time WT1 at registration, WT5 at specialist diagnosis and WT6 at specialist& general dentist treatment.

WT is waiting time at different stages of process. Numbers below are all waiting times(0.5,0.16,0.16,0.15,0.18,0.35). U denotes utilization. FTE is full time employees. Numbers below represent cycle times(CT) (0.08, 0.11, 0.08, 0.07, 0.14, 0.11, 0.98).When we add all WTs and CTs

Table 1: Project Charter.

Business Case: It is observed that there is a decline in number of out patients in the last 3 months by 35% leading to revenue loss and reputation loss. As per the data collected from patients feedback it is observed that longer service times are leading to dissatisfaction and reduction in OP numbers. Hence there is an urgent need to address this issue	In Scope: Out patients Out Scope: In patients and time spent at pharmacy
Goals & Objectives: To reduce OP services TAT from 3.11 Hours(187 minutes) to less than 2.9 Hours(174minutes) by 6-July-2015	Constraints: Non availability of Doctors, hygienist Non availability of admin staff Non availability of dental stock
Problem Statement: The average OP services TAT for the past one month is 3.11 Hours(187minutes)against a target of 1.5 Hours(90minutes) leading to patients dissatisfaction and revenue loss	Milestones: Define:6th June to 10th June 2015 Measure:11th June to 15th June 2015 Analyze:16th June to 25 June 2015 Improve:26th June to 30th June 2015 Control: 1st July 2015 to 6th July 2015

Table 2: High level process map: SIPOC (Supplier, Input, Process, Output and Customer).

S	I	P	O	C
Supplier	Input	Process	Output	Customer
Doctors	Primary service	1.OP registration	OP treated	OP (Out-Patient)
Staff	Support services	2.Fee payment 3.Assistant recording general information 4.Diagnosis 5.Treatment	OP hospital records updated	Hospital Management
Patient	Provides need for the service			

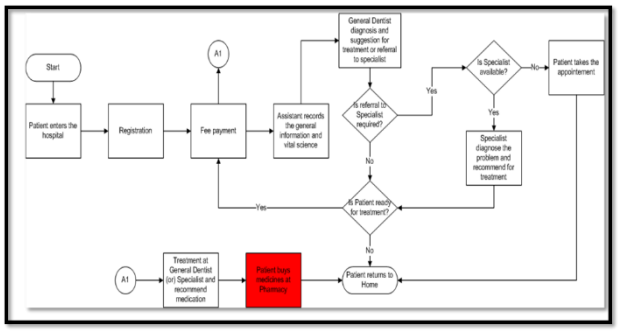


Fig 1: Detailed Process Analysis (Process Flow Diagram).

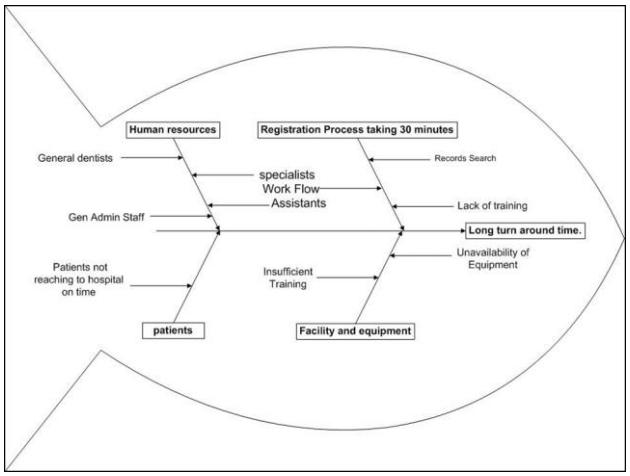


Fig 2: Fishbone (Ishikawa) diagram.

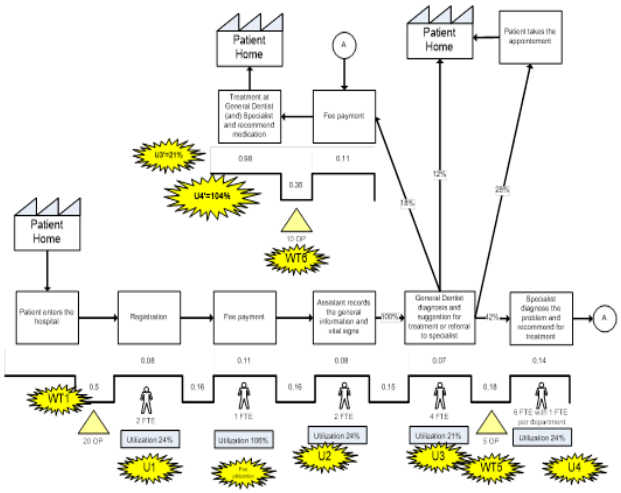


Fig 3: Value stream map obtained during analyze phase.

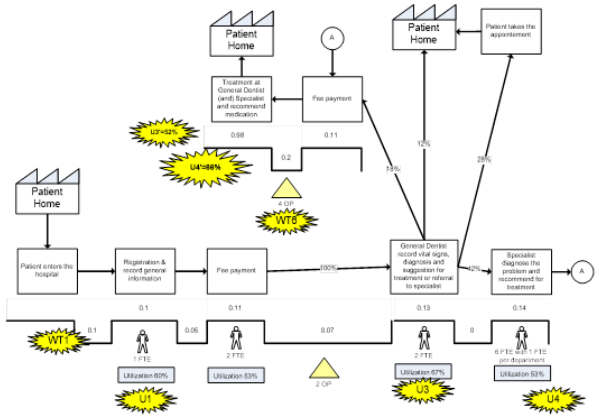
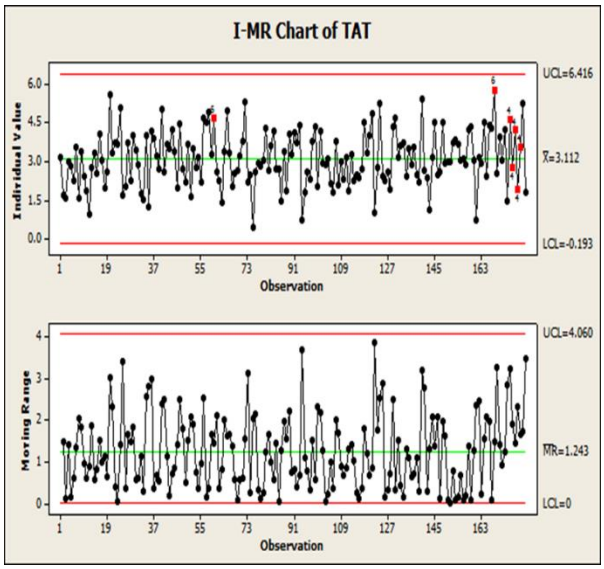
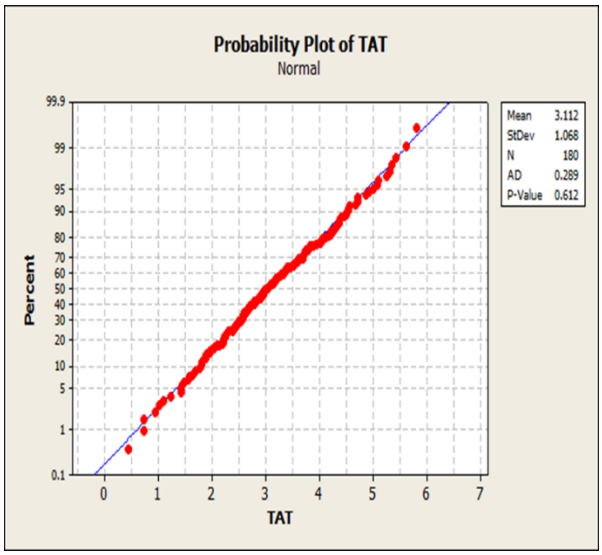


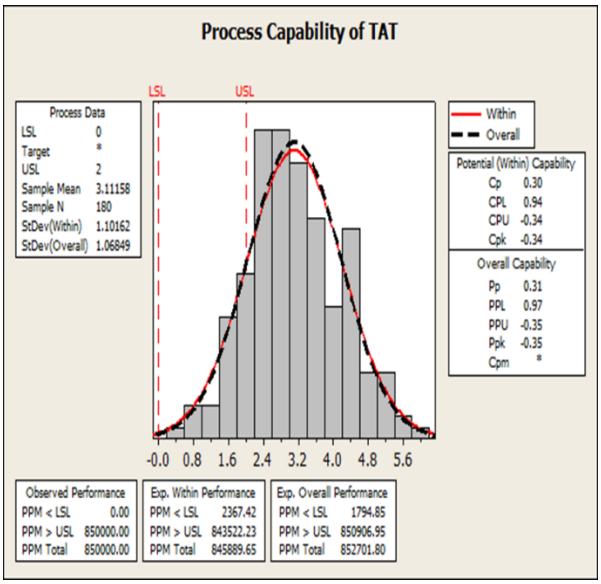
Fig 4: Future state Value stream Mapping (VSM) (Improve phase).



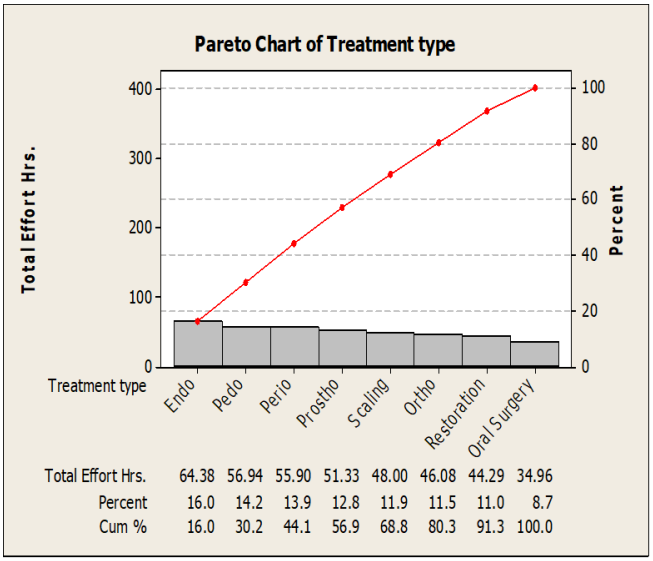
Graph 1: I – MR chart of TAT.



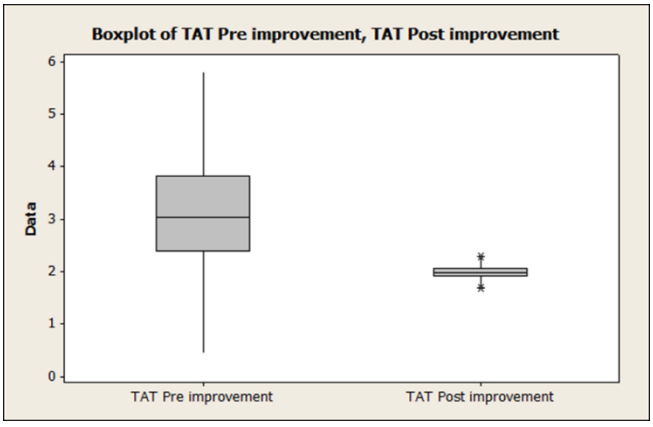
Graph 2: Probability plot of TAT,



Graph 3: Process Capability chart of TAT.



Graph 4: Pareto chart of treatment type.



Graph 5: Box plot of TAT pre and post improvement phase

then we get turnaround time(TAT). Utilization% is calculated as U%= number of OP per day * cycle time of that stage / number of working hours per day * number of FTEs

Pareto analysis(graph 4) which is a simple problem solving tool, used to isolate important factors leading to increased turnaround time and prioritize actions. It talks about the vital few and trivial many. Here pareto analysis is done according to treatment type. Department of endodontics, pedodontics, periodontics are the main departments where the turnaround time increases.

Improvement suggestions after analysis of underutilized staff (U1) and longer waiting times (WT1) at registration area are to provide appropriate training and monitoring the performance to prevent delay due to untrained employees, removal of 1 FTE (Full-time equivalent) at registration area to improve utilization and add this resource removed from registration stage to fee counter; suggestion for underutilized resources (U2) at the level of assistant recording general information and vital signs are to eliminate the current allocated FTE and to assign the task of general information collection at registration and recording of vital signs at general dentist diagnosis; suggestion for underutilized resources (U4) and longer waiting time (WT5) at the level of specialist diagnosis were to reduce available hours from 1.65 to 0.75 hours(99 to45 minutes) of specialist dentist to improve utilization and to allocate define time slot of 0.75 hours(45minutes) for diagnosis only to make sure availability of the specialist; suggestions for underutilized general dentist ($U3^{I}$), over utilized specialist ($U4^{I}$) and longer waiting time at treatment level was to reduce available hours of general dentist, to increase available hours of specialist and WT^{1} will reduces as $U4^{I}$.

In the **improve phase** suggested plans are implemented and 10 days training program from 26-June to 6-July was carried out. Future value stream mapping is framed which showed the improved Utilizations (figure 4) with reduction in waiting times subsequently leading to reduction in TAT from 3.11hrs to 1.99hrs.

Box plot or positional plot depicts data vertically which identifies outliers. In our research box plot is done to compare pre and post improvement of turnaround time(graph 5) In **control phase** Control plan is framed to maintain the improved process in controlled state.

DISCUSSION

Long waiting times from registration to treatment, chair side operational time and patient treatment satisfaction level are the critical aspects that need the attention of managing authorities to boost the OPD of hospitals. Six sigma is a set of tools and techniques have that can be employed to improve the processes to achieve zero defects. The use of these tools and techniques is guided by an overarching structured improvement method known as DMAIC.[5] DMAIC stands for (D) define the goals of the improvement project, (M) measure the present working system, (A) analyze the system to identify ways to eradicate the gap between the current functioning of the system or process and the desired goal, (I) improve the system and (C) control the new improved system.[2] In the define phase, the team needs to frame a project charter or a business charter that documents the business case, goal statement, project scope, projects team and timeline associated with the project. This phase is usually about creating the charter, communication plans, roles and responsibilities and process maps.[6]

It is crucial to understand and identify the CTQs for the success of any project. Critical To Quality (CTQs) are the internal critical quality parameters that relate to the wants and needs of the customer.[7] CTQs aims at capturing the voice of customer to identify the cause of dissatisfaction among the customers. In the present study turnaround time and wait time was found to be CTQs and turnaround time was found to be the CTQ that was primary focus. As per the data collected from patients feedback it is observed that longer service times were leading to dissatisfaction and reduction in outpatient numbers. Hence there is an urgent need to address this issue. Identified CTQ was aligned with strategic business driver (SBOs). SBOs specific to the project revealed TAT for services, from the patient entering the premises but the average OP services TAT for the past one month in the present dental hospital was 3.11 hours(187 minutes).

The Six Sigma process is a data driven methodology. Decisions are made on statistics and facts, rather than instinct or past history. Data has to be

gathered to determine the baseline performance of a process in order to validate that an improvement has been made.[8]

Six sigma tools utilized to measure and analyze the process defects were detailed process analysis flow diagram, fishbone diagram, benchmarking, value Stream Mapping (VSM), box plot and Pareto analysis. The present turnaround time was measured, analyzed and improvements were suggested and implemented accordingly. 10 days training program was scheduled from 26th June to 6th July 2015. General dentist were given schedule about diagnosis and treatment training and were advised to strictly adhere to it. General dentists were trained about the proper utilization of working hours to avoid long waiting times and their under utilization. Timing schedules were given to specialists and were instructed to strictly follow it to avoid long waiting times. The present study showed difference between pre and post average turnaround time per patient from 3.11±1.06 hours (187±63.6minutes) to 1.989±0.116 hours(119±6.6minutes). Karen R et al[9] carried out a similar study to improve patient flow and reduce delays in the initiation of treatment and found that 29% of the treatments started within 22 minutes before implementing the project but after implementation it increased to 78%. Similarly Brown EC et al[4] carried out a study to reduce the room turnaround time by using process-mapping techniques along with heuristic approaches and analyzed reduction in post study room turnaround time. Cuevas E et al[10] also carried out a improving process turnaround time in an outpatient clinic using DMAIC strategy. Similarly, Khan V[11] analysed outpatient waiting time and recommended towards minimizing long wait time using this six sigma methodology. A DMAIC process was undertaken at North Shore University Hospital to reduce delays assignment to the patients and on analysis it was found that staff was incorrectly using electronic bed tracking system. The improvement system resulted in improve in waiting time from 226 minutes to 69 minutes.[12] Bucci RV et al[13] carried out a similar study utilizing six sigma methodology and found that the project resulted in decrease in complaints from patients and physicians, reduction in patient wait time in commencement of procedures from a five day to almost zero.

Six sigma is a novel prologue in the healthcare to bring under control the challenges encountered by the profession.[14] Six sigma strategies can be successfully utilized in all organizations whether it is healthcare, software development, manufacturing sector, etc to remove the obstructions in the success of the organizations as well as to improve customer satisfaction.

CONCLUSION

Six Sigma methodology aims at all-round quality improvement decrease in cost of production, increase in productivity and customer satisfaction. The application of this process in healthcare organizations tend to deliver constantly better services to the patients and is essential to increase revenues and patient satisfaction.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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