10.5005/jp-journals-10035-1083

ORIGINAL ARTICLE

# Improving Scan Reporting Time using Lean and Six Sigma

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## ABSTRACT

Hospitals are always looking for ways to improve their processes and systems to provide benefits for all the stakeholders. Radiology department is one of the revenue-generating areas in the hospital where short waiting times and positive experience represent important drivers of patient satisfaction. Quality of care has been given a major focus by hospital and health care organizations across the country. Computed tomography (CT) and magnetic resonance imaging (MRI) are the two important modalities contributing to the revenues through radiology. Since the scan time being low, the significance for more revenue by increasing the patient load will add more value to the services. Certain non-value activities may lead to improper functioning of the department. Lean and Six Sigma tools have been used in this study to identify such activities. This led to reversal of negative performance indicators, streamlining the processes, and regaining the patient satisfaction in this hospital.

**Objectives:** Streamline mapping of workflow to implement Lean and Six Sigma and to improvise the present performance of Radiology Department.

**Materials and methods:** Prospective study with direct observation of workflow. A total of 120 patients were observed for a period of 1 month, to identify the time taken. Failure mode effect analysis (FMEA) was used to identify potential steps for failure, and their effects.

**Results:** Number 490 is the maximum risk priority number (RPN) for report approval and preparation; 920 minutes was the average time taken for CT scan approval and 834 minutes was the time for MRI scan approval.

**Conclusion:** The radiologists were pointing that lesser number of monitors were available for report preparation.


**Keywords:** Customers process mapping, Inputs, Lean and Six Sigma in healthcare, Outputs, Process, Radiology services, Supplier, Total quality management.

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**How to cite this article:** Sweety J, Kantipudi S, Kumar PN. Improving Scan Reporting Time using Lean and Six Sigma. Int J Res Foundation Hosp Healthc Adm 2018;6(1):1-5.

**Source of support:** Nil

**Conflict of interest:** None

## INTRODUCTION

Radiology services is one of the major sources of revenue generation in a tertiary care level. In the Indian scenario, as many outpatient diagnostic centers, stand-alone radiology scan centers are being built, with a huge competition in domestic market.

This leads to patients getting attracted to any center for reasons like quick processing time of scans, turnaround times, accurate reporting, better customer care services in the lounges, and competitive pricing. Hence, radiology department in tertiary care hospitals faces stiff competition and administrators face stiff challenges with workflow and patient flow, if the department does not operate smoothly. Delays can be common and there is rarely a single common cause delaying the system or adversely impacting the patient throughput.

Diminished capacity and diminished productivity will lead to a variety of problems for diagnostic modalities like delay in diagnosis and treatment, increased length of stays, patient dissatisfaction, and referring physician dissatisfaction. Lean and Six Sigma are two approaches that are in use for systematically analyzing and improving process flow and efficiency within industries.

Other approaches are Business Process Modeling, Business Process Reengineering, Workflow Mapping, as well as total quality management (TQM) and continuous quality improvement (CQI)-oriented techniques, such as management accounting systems, Kaizen, and Shewhart cycles. Health care organizations started adopting industrial quality management methods in the late 1980s, including TQM and CQI approaches.[1] The selection of any one process of approach depends upon the specific circumstances and needs, existing in working environment, including the type of processes, the improvement objectives and the skills, knowledge, and resources available in that setting. Where there is optimizing changes among process steps (Lean) or if there are many steps where statistical analysis of defects can be done (Six Sigma), these approaches can be used.

Radiology services in a hospital will aptly suit with both the above situations; hence, we used Lean and Six Sigma tools to reduce the reporting time. Early applications primarily focused on setting up of programs and infrastructure to measure quality and enhancing organizational culture around quality-related problems.[2] Few hospitals used TQM methods toward implementing process improvements and redesigning both supportive and clinical workflows.[3] The phrase "lean transformation" is used by many businesses to characterize a company moving from an old way of thinking to lean thinking. It requires a complete transformation on how a company conducts business. This requires long-term perspective and perseverance. The term was first used by Jim Womack and his team at Toyota and coined by John Krafcik[4] in a 1988 article, "Triumph of the Lean Production System." Six Sigma's core philosophy focuses mainly on reducing variability.

Output variability is reduced by implementing tightly controlled processes. This is done through a methodology that uses five basic processes: Defining, Measuring, Analyzing, Improving, and Controlling (DMAIC). Problem which is identified, data collected, and statistical methods are used to determine sources of variation and opportunities to improve.

Processes are then adjusted to remedy the problem, data collected, and analyzed several times to check for improvement in error rates.[5] Lean philosophy encourages an accentuated continuous improvement strategy supporting creating a simple and direct pathway and eliminating loops in a system. Being of a similar process to Six Sigma, Lean quality improvement methodology identifies an inefficient process, establishes waste within the process by distinguishing value-added and nonvalue-added activities, improves the process by creating standardized work, and uses standardized metrics to guide the work. Like Six Sigma, Lean requires cultural change to result in performance improvement.[6] The purpose of our study was to utilize these methods in understanding the characteristics of the current radiology processes that are limiting the ability of the department to ensure the referral base for the CT and MRI services. Untimely reporting of results is impacting negatively the referrals to hospital, resulting in reduced customer satisfaction, limiting the revenue opportunities.

## MATERIALS AND METHODS

An exploratory research was conducted at a 2000-bed tertiary care hospital's radiology department.

### Primary Data

During the Measure phase, overall performance of business process is calculated. A plan for data collection is prepared to collect the required data, and what type of data, sources of data, and the specific reason to collect data are identified and measured. A sample of 60 cases undergoing CT scan and 60 cases undergoing MRI scan were observed during a 30-day duration.

## RESULTS

The goal of the project is to improve the workflow of department, improve timely reporting process to physicians, and improve patient and physician satisfaction.

Under the Define phase, the Project Charter was prepared and a Supplier, Inputs, Process, Outputs, Customers (SIPOC) process mapping was done. These processes were modified and improved through the remaining phases of DMAIC (Table 1). The department works on all days from 8 am till 5 pm.

It is well equipped and staffed with organization hierarchy showing all cadres of consultants available. There are 12 radiologists, 20 nurses, 34 radiographers, 6 MRI technicians, and 8 CT technicians. During the Measure phase, the researcher observed the time taken for each patient to get serviced in CT scan area and MRI area as identified by the Time study. The findings are as below.

The two factors that became prominent as performance indicators having a direct relationship with patient and physician satisfaction were identified after noting the time taken as in Table 2. These two factors were: (1) Patient waiting time in the lounge is high (>30 minutes) and (2) reporting of results after approval of senior consultant (around 24 hours).

The nonvalue-added activities that lead to dissatisfaction among patients were identified, where the Lean philosophy can be applied. These activities were: (1) Patients waiting at the lounge, (2) time taken to review the film by junior doctor, and (3) time taken to approve the report. In the CT scan area, a staff nurse was deployed to take consent, whereas in the MRI scan area, it was the MRI technician work, so this has been identified as nonvalue-added activity to staff nurses in the CT scan area.

Value-added activities are the steps where customers are willing to pay, as they perceive a better service or better product due to that step. During the Analyze phase, FMEA was used. This process includes rating possible defects, or failures in three ways: The likelihood that something will go wrong, the ability to detect a defect, and the level of severity of the defect. This is done to identify and understand potential failure modes and their causes, the effect of failures on the systems or end users, to assess the risks associated with identified failure modes, effects and causes, and to prioritize issues for corrective actions. It includes analysis of the following: (1) Steps in the process,

**Table 1:** Project charter for radiology: Lean and Six Sigma project

| *Project title* | *Improving the workflow of radiology department using Lean and Six Sigma principles* | | |
|---|---|---|---|
| Problem statement | To improve the workflow of the department, thereby increasing patient satisfaction | | |
| Business case | Describe how the problem for the project affects | Kano status: Wow/expected/ must have/unspoken | Attribute type: Lesser the better/ nominal/greater the better |
| Customers | Customer is affected by prolonged waiting time | Expected | Lesser the better |
| Staff | Staff will be keen to adhere to the set timelines for each step | Expected | Nominal |
| Business | Reduce the average length of stay and the current waiting list will come down | Expected | Lesser the better |
| *Stakeholders affected* | | | |
| Department 1 | Doctors | Increase in number of patients will increase the revenue | |
| Department 2 | Staff nurses | | Resistance due to increased workload |
| Department 3 | Housekeeping staff | | Resistance due to increased workload |
| Department 4 | Billing personnel | | Resistance due to increased workload |
| Department 5 | Management | Increase in patient satisfaction and revenue of the hospital | |

**Table 2:** Time taken by patients in CT scan and MRI areas

| | *Average* | *Minimum time (in minutes)* | *Maximum time (in minutes)* |
|---|---|---|---|
| *Name of the step in CT scan procedures* | | | |
| Patient reaching reception with request and appointment is allotted and entered in HIS | 2.01 | 1.19 | 2.36 |
| Receptionist explains the cost, bill preparation, and bill payment | 2.71 | 1.88 | 3.54 |
| Radiology nurse takes the consent from patient | 0.14 | 0.06 | 0.21 |
| Time taken for patient to change into gown/remove ornaments | 3.28 | 1.81 | 4.76 |
| Patient waits at the lounge for his turn | 93.87 | 67.47 | 120.26 |
| Time taken to review the film by junior resident | 13.09 | 11.69 | 14.49 |
| Time taken to verify and approve the report | 920 | 701 | 1138 |
| Reports dispatched to radiology reception/PACS | 0.05 | 0.05 | 0.05 |
| Total time taken | 1041.39 | 788.11 | 1294.66 |
| *Name of the step in MRI procedures* | | | |
| Patient reaching the MRI room with request and MRI technician giving an appointment and entered in HIS | 2.1 | 1.98 | 2.23 |
| Receptionist registers with bill preparation and bill payment | 2.21 | 1.86 | 2.56 |
| Radiology nurse takes the consent from patient | 0.56 | 0.41 | 1.52 |
| Time taken for patient to change into gown/remove ornaments | 3.18 | 2.81 | 5.01 |
| Patient waits at the lounge for his turn | 23.82 | 11.9 | 35.7 |
| Time taken to perform an MRI procedure | 25.55 | 21.99 | 29.1 |
| Time taken by a patient to leave the MRI room | 2.28 | 1.92 | 2.64 |
| Time taken to review the film by junior resident | 19.49 | 9.84 | 29.14 |
| Time taken to verify and approve the report | 834.55 | 690 | 978.17 |
| Total time taken | 913.74 | 742.71 | 1086.07 |

(2) failure modes (what can go wrong?), (3) failure causes (why can the failure happen?), and (4) failure effects (what could be the consequences of the failure?).

For each failure mode, a numeric value is assigned as RPN for the likelihood of occurrence of detection and severity. Failure modes with high RPNs are the most important parts of the process on which to focus improvement efforts. Modes with low RPNs are not likely to affect the overall process. The findings for the Radiology Department are shown in Table 3.

From the calculation of RPN, it can be seen that following potential failure modes lead to potential failure effects from highest to lowest:

- Report turnover time.
- Machine breakdown leading to cancelation of appointments.

**Table 3:** Failure mode effect analysis of workflow of radiology

| *Process step* | *Potential failure mode* | *Potential failure effects* | *Severity* | *Potential causes* | *Occurrence* | *Current process controls* | *Detection* | *RPN* | *Actions recommended* |
|---|---|---|---|---|---|---|---|---|---|
| What is the step? | In what ways can the step go wrong? | What is the impact on the customer if the failure mode is not prevented or corrected? | 10 | What causes the step to go wrong? (i.e., How could the failure mode occur?) | 10 | What are the existing controls that either prevent the failure mode from occurring or detect it before it should occur? | 10 | 1,000 | What are the actions for reducing the occurrences? |
| Appointment is allotted and entered in HIS | Inaccurate patient information | Billing denials, increased waiting time | 5 | Increased workload on reception staff | 8 | Cross-checking the patient details once entry is made | 3 | 120 | Training clerical staff on data entry |
| Bill preparation by receptionist | Wrong billing using wrong codes | Inaccurate bill payment by the patient | 4 | Increased patient number and negligence by receptionist | 3 | Entering procedure code generating bill slip | 1 | 12 | Performing chart audit |
| Technician performs the procedure | Performing incorrect procedure and low-quality images | Patient dissatisfaction and loss of time | 6 | Handling incorrect case sheets of patients | 6 | Staff nurse cross-checking the patient case sheet and transferring to technician | 6 | 216 | Confirming the patient name and procedure |
| | Machine breakdown | Cancelations of appointments, delayed procedure time, increased ALOS | 7, 5, 4 | Inappropriate maintenance of equipment | 6, 8, 8 | immediate repair of the machine by engineers | 7, 7, 7 | 294, 280, 224 | 1) Daily maintenance of the equipment, 2) Provide idle time between procedures |
| | Reviewing and approving of report by senior radiologists | Report turnover rate is high | Patient dissatisfaction and increased ALOS | 7 | 1) Computer monitors less in number, 2) doctors saying busy, 3) procedures more in number | 10 | Simultaneous viewing and reporting to happen immediately | 490 | 1) Increasing the number of monitors, 2) report must be viewed immediately after procedure |

HIS: Hospital Information System; ALOS: Average length of stay

- Machine breakdown leading to delayed procedure time.
- Machine breakdown leading to increased average length of stay.
- Incorrect procedure performed and low-quality images.
- Inaccurate patient information being captured.
- Wrong billing using wrong billing codes, leading to inaccurate bill payment.

During the Improve phase, the potential failure modes thus identified have got reduced or eliminated due to the actions recommended. This resulted in the reduction of scan reporting time by 42%.

## DISCUSSION

Each section of the department developed interventions to improve its report turnaround time, as per one study by Seltzer et al.[7] In this study, they determined whether TQM techniques were successful in expediting the report turnaround time in Radiology of a teaching hospital. Cancelation of appointment due to machine breakdown and air-conditioning problem has been rectified by daily checking working status of machines by in-house team and periodic maintenance by the outsourced company specialists. And scheduled idle time for machines between the procedures was advised. High turnaround time for the report being approved and signed has been rectified by rearranging the shifts for senior radiologists. At present, the reports were viewed only till 5 pm in the evening, which got extended till 7 pm, so that each day, procedures are reported on the same day. More number of computer monitors were recommended to this department with bigger size and better resolutions. To optimize the process of reporting and uploading radiological examinations, Six Sigma was adopted as a methodical approach, and rigorous statistical analysis to analyze and improve processes was done by Cavagna et al.[8] They succeeded in bringing the turnaround times 62% lesser in a 6-month duration.

## CONCLUSION

As executing Six Sigma programs involve changing human behavior, it is critical to include a carefully built communication plan that identifies and takes care of human issues. Any transformation of any magnitude across health care organization requires discussions with physicians, nurses, managers, and other key stakeholders. Having the right people in the right roles is critical to the success of a Six Sigma initiative. Radiology services along with operation theater services is one of the major areas where Six Sigma projects can bring in maximum benefits to the management of hospitals.

## REFERENCES

1. McLaughlin CP, Kaluzny AD. Total quality management in health: making it work. Health Care Manage Rev 1990 Summer;15(3):7-14.
2. Powell A, Rushmer R, Davies H. Effective quality improvement: TQM and CQI approaches. Brit J Healthcare Manage 2009 Sep;15(3):114-120.
3. Young GY, Charns MP, Shortell SM. Top manager and network effects on the adoption of innovative management practices: a study of TQM in a public hospital system. Strat Manage J 2001 Oct;22(10):935-951.
4. Krafcik JF. Triumph of the lean production system. Sloan Manag Rev 1988;30(1):41-52.
5. DelliFraine JL, Langabeer JR 2nd, Nembhard IM., Assessing the evidence of Six sigma and Lead in healthcare industry. Qual Manage Health Care 2010 Jul-Sep;19(3):211-225.
6. Kwak YH, Anbari FT. Benefits, obstacles and future of Six Sigma approach. Technovation 2006 May-Jun;26(5-6): 708-715.
7. Seltzer SE, Kelly P, Adams DF, Chiango BF, Viera MA, Fener E, Hooton S, Bannon-Rohrbach S, Healy CD, Doubilet PM, et al. Expediting the turnaround time of radiology reports in a teaching hospital setting. Am J Roentgenol 1997 Apr;16(8): 889-893.
8. Cavagna E, Berletti R, Schiavon F, Scarsi B, Barbato G. Optimized delivery radiological reports: applying Six Sigma methodology to a radiology department. Radiol Med 2003 Mar;105(3):205-214.