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Lean Six Sigma: a clinical treatment for national healthcare system

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Abstract: Lean Six Sigma is a business-driven, multi-faceted approach to process improvement, reduce costs, and increase profit. It helps to improve quality of product and cost saving. Lean Six Sigma is considered to be one of the best quality improvement methodology applied successfully to organisational areas like manufacturing, production, accounting and finance, sales and marketing, information systems, human resource management, etc. Lean Six Sigma is a project driven approach that concentrates on reducing variations, defects and improving the quality of products, processes as well as services. Basically Lean Six Sigma measures 3.4 defects per million of opportunities (DPMO) and it operate on the concept of DMAIC. In the proposed work, guides how DMAIC can be successfully implemented in medical transcription to identify different Lean Six Sigma projects by identifying critical to quality (CTQ).

Keywords: Lean Six Sigma; medical transcription; DMAIC; critical to quality; CTQ; Lean Six Sigma projects.

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1 Introduction

In 1987, Motorola developed and organised the Lean Six Sigma process improvement Methodology to achieve 'world-class' performance, quality, and total customer satisfaction. Since that time, at least 25% of the Fortune 200, including Motorola, General Electric, Ford, Boeing, Allied Signal, Toyota, Honeywell, Kodak, Raytheon and

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Bank of America, to name a few, have implemented a Lean Six Sigma program (Antony, 2018; Hammer, 2002). These companies claim that Lean Six Sigma has significantly improved their profitability (Hammer, 2002). For example in 1998, GE claimed benefits of $1.2 billion and costs of $450 million, for a net benefit of $750 million. The company's 1999 annual report further claimed a net benefit of more than $2 billion through the elimination of all non-value added activities in all business processes within the company (Lucas, 2002). Similarly, Allied Signal reported that Lean Six Sigma was a major factor in the company's $1.5 billion in estimated savings (Lucas, 2002). Lean Six Sigma has also enabled Honeywell to reduce the development time required to redesign Web sites by 84% for its specialty materials.

Lean Six Sigma is a process-focused data driven methodology aimed at near elimination of defects in all processes which are critical to customers (Antony et al., 2017). Lean Six Sigma as a powerful business strategy has been around for almost twenty years and has grown exponentially in healthcare industry during the past five years mainly in the USA (Sodhi et al., 2012). Initially applied in manufacturing industry, it has now dispersed into service industries, most importantly to the healthcare sector. Sigma is a Greek letter used to describe process variability or in mathematical terms, standard deviation of a random variable (Sodhi and Singh, 2013). A number of times sigma indicates the amount of defects that are likely to occur in a given process (manufacturing, service or transactional). For example, a 3 sigma process has a defect rate of approximately 67,000 (6.7%) whereas a Lean Six Sigma process has less than 4 defects per million opportunities. Defects in processes cause increase in costs due to scrap, rework, repair, re-test and so on (Sodhi et al., 2014). For instance, the cycle time for reporting radiology results in a hospital as defined by physicians is 18 hours. This implies that if the turnaround time for any report produced by a physician is over 18 hours, then it may be viewed as a defect. We can calculate the defect per million opportunities (DPMO) and the corresponding sigma quality level (SQL) once we know the number of patient visits per year to the radiology department.

Lean Six Sigma is more than numbers. That is a method and practice that provides tools for businesses necessary for accomplishing results from their processes and products. The main concept of Lean Six Sigma is define-measure-analyse-improve-control (DMAIC), method for analyses and improvement of business processes or operational process (Stoiljkovic et al., 2019). DMAIC itself has five stages: to define opportunities, to measure performances, to analyse opportunity, to improve performances and to control performances. DMAIC is based on original plan-do-check-act cycle (PDCA) (Stoiljkovic et al., 2019).

Lean Six Sigma has been defined as a management strategy for improving product and process quality (Hahn et al., 2018; Harry and Schroeder, 2000; Sanders and Hild, 2000). It is also a statistical term used to measure process variations, i.e., how far a given process deviates from perfection, which causes defects. Lean Six Sigma works to systematically manage variation and eliminate defects or to get them as close to zero as possible (Harrison, 2006). Lean Six Sigma initiatives have typically been implemented on shop floors of manufacturing firms to manage 'process variations' (defects or errors), to improve quality and productivity (Revere and Black, 2003), and as a result, to increase the profitability of a company (Anand et al., 2007; Lucas, 2002). It has evolved into an

efficient business process optimisation. It has become one of the most important strategies for those companies who are pursuing the excellence of management. Thus, more and more projects have become pure Lean Six Sigma projects since they were integrated with the methods, techniques, and personnel of Lean Six Sigma management.

2 Literature review

Fornari and Maszle (2004) suggest that the Lean Six Sigma concepts is adopted for those projects which are addressed quickly based on the priority. Firstly, projects are identified based on customer issues, business strategy, goals and objectives and priorities and then the projects are prioritised and selected according to business impacts and effort. Once project selected, the second stage is to manage them. Resources are assigned and the DMAIC methodology is used to find the best solution for the problem. Progress in each phase is viewed to ensure sustainable results before a new project is created. Projects must be prioritised according to value and must be scoped and broken into manageable sizes. If a project has too broad scope, it can be divided into parallel projects and if it has too aggressive scope, it can be divided into sequential projects. The results of these projects must be carefully tracked.

2.1 About medical transcription

The medical transcription (MT) is one of the service sectors, and is one of many growing professions in the healthcare industry. It offers challenge and interest as well as flexible carrier paths (Sodhi et al., 2019a). The specialty of MT is particular suited to individuals who like to work independently, learn continuously, pay close attention to detail, and produce a perfect product (Ettinger and Ettinger, 2014). An individual who perform medical transcription is known as a medical transcriptionist (MT). A MT is the person responsible for concerting the patient's medical records into the text form recorded dictation. The term transcriber describes the electronic the electronic equipment used in performing medical transcription (Sodhi et al., 2020a).

The MTs are a skilled typist, excellent at interpreting what they read or hear, and a good grammarian. They also have to have strong familiarity with medical language and terms. Further, MTs must be able to take what they hear and edit it, transform it, or make it logical without changing relevant details or medical information (Sodhi et al., 2019b).

In MT there are three types of MTs, junior level (L_1), proof reader level (L_2) and quality check (L_3). The L_1, is lowest level having one to two years of experiences, the L_2 is the middle employee having 3 to 5 years of experience and the L_3 is the top employee having more than 5 years of experience, who does quality check of the files. The converted file can be uploaded to customer if the MTs guarantee that there is no error in that file or it can be uploaded to the next level of MTs. The Association for Healthcare Documentation Integrity (AHDI) has three classifications for medical transcription errors as: minor error, major error and critical error. Hence, in medical transcription process transcribing quality files is more important (Sodhi et al., 2020b).

A minor error is an error that does not affect patient safety or document integrity and may be due to propositions or punctuations. For instance, a misplaced comma would not affect patient care nor would it render a medical transcription document or dictation report unsatisfactory. Sure, you want your medical documents pure and error free as

possible, but some things just are not worth getting worked up over. A major error, by contrast, is errors that do affect the integrity of medical document but have an adverse impact upon patient care or the safety of a patient. If you misspell a medical term, for example, you may not endanger the health of a patient but you could make a medical document difficult to understand and meaningless to the professional who are required to interpret it. It's forgivable to a degree, but it is not life threatening. Critical errors are critical in the stricter sense of the term, hence the name. These could have serious life threatening consequences for the patient or affect the quality of care for the patient. Any files having 98% points and above is called a quality file. Some of the errors which likely to affect the MT process are: grammar, inappropriate editing, inappropriate blank, creative transcription, pertinent omission, wrong medical word, typographical, capitalisation and other type of errors. In medical transcription, the service quality must reach the customer expectation or it should delight the customer. Unless the customer expectation quality meets, no customers willing buy or use it. When it comes to total quality management (TQM) in the service industry, the most fundamental component is service quality (SQ), since the basis of service lies in physical equipment or service equipment and personnel interaction. Thus, to upgrade SQ, the services industries have adopt total quality management techniques: lean production, total quality control, ISO, total productive maintenance and Lean Six Sigma (Dahlgaard and Dahlgaard-Park, 2018). Among these methodologies, Lean Six Sigma attracts more and more attention because it has evolved from a focus on achieving the quality level and process improvement using statistical tool to a comprehensive management framework for managing a business (Snee, 2017). Lean Six Sigma has become the synonym for improving quality, reducing cost and increasing customer loyalty. Lean Six Sigma can be applied for sustainable competitive advantage, operational efficiency and effectiveness (OEE), knowledge making (KM) and to estimate cost of poor quality (COPQ).

2.2 National healthcare service sector challenges

Whilst improvements have been made within the NHS, services are still not good enough. Moreover the NHS is entering a very uncertain period through using market forces and promoting patient choice. The transformation of the whole system by making 'big changes, very quickly' is now required as the NHS enters the latter part of the ten-year implementation plan. Many healthcare systems are now deeply dysfunctional and all require redesign with many indicating that this should be radical redesign. The challenges that face the NHS in order to respond to and meet the ever changing needs services need to be:

- well defined
- coordinated
- efficient
- cost effective
- supported by core processes and systems and require multiple improvement strategies.

To achieve this, Lean Six Sigma as a framework offers the NHS a realistic structured methodology for process improvements (Natarajan, 2006).

2.3 Overview of Lean Six Sigma

Lean Six Sigma allows for more careful analysis and more effective decision making aiming for the optimal solution rather than what is simply 'good enough'. It really takes TQM efforts to the next level and has a great future in healthcare (Lazarus and Butler, 2001). As a methodology for process and quality improvement, Lean Six Sigma has demonstrated its ability to adapt to virtually any process – including healthcare. When appropriately implemented with uncompromising leadership support and the utilisation of change management tools to address cultural barriers and build acceptance, Lean Six Sigma has achieved measurable success (Stahl et al., 2017). Lean thinking is a philosophy which requires the continuous elimination of waste and non-value-added elements from processes and is identified as being closely linked to Lean Six Sigma.

Lean Six Sigma made a beachhead in healthcare around 2000, although its growth was slow and steady. Two years after this, a number of hospitals in the USA have adopted Lean Six Sigma as their core business process improvement strategy (Black and Revere, 2006). Throughout the last five years, many leading healthcare institutions in the USA have implemented Lean Six Sigma with remarkable results in terms of reducing ER cycle time, increasing timely completion of medical records, increasing bed availability, reducing medication errors, etc. (Lazarus and Stamps, 2002). The Red Cross Hospital in Netherlands (Europe) has successfully initiated Lean Six Sigma programme with savings generated from a total of 44 Lean Six Sigma projects amount to over *e*1.2 million (Heuvel et al., 2005). The fact that Lean Six Sigma successfully combines quality improvement and cost reduction substantiates that it could be a solution to current financial problems in healthcare. An important motivation luring different healthcare organisations towards Lean Six Sigma is its effectiveness in increasing customer satisfaction (i.e., patients, physicians and employees), provision of excellent service levels at minimal cost, effectively utilising existing resources and driving out non-value-added activities. In service industries Lean Six Sigma is proving its worth by improving transactional process performance with customer satisfaction in a wide range of sectors (Steele, 2004). Results from the UK service industry indicate that the majority of service organisations have been engaged in a Lean Six Sigma initiative throughout the past three years with the average sigma quality level reached was around 2.8 (approximately 98,000 DPMO). The benefits from the adoption of Lean Six Sigma in service industries is in the form of considerable improvement in the bottom line result but it also increases customer satisfaction and employee morale, improves cross functional teams, increased awareness of problem solving tools and techniques leading to an improved consistent level of service. In the manufacturing sector, it is quite possible to reduce or even eliminate (in some cases) most of human variability through automation. In the healthcare industry, the delivery of patient care is largely a human process, and hence the causes of variability are often difficult to identify and quantify. The challenge for the healthcare sector and staff is to find a way to leverage the data to drive human behaviour. Financial results and their validation continue to be a challenge in the healthcare industry. It is often a difficult task to place a dollar value on a faster test result that may yield a shorter length of stay or the value of a more satisfied patient.

3 Developing DMAIC conceptual framework

The study was conducted in one of the leading medical transcriptions company in Bangalore. The company was not able to meet process quality in the medical transcription. The four months' data is observed to assess causes for the quality. This was the definition of the problem. This problem was measured quantitatively and set different types Lean Six Sigma projects. The Lean Six Sigma projects and projector charter is prepared by observing lean six month previous data, the business case is developed to increase in the MT business in the coming months and requires a proportionate increase in production and quality performance. Opportunity here would be to increase process performance in terms of quality.

The different types of projects were identified by observing past data are: *quality improvement projects* (to minimise the errors), *productivity* (to increase lines per hour), *employee recruitment projects* (to recruit new MTs and to identify the reasons short-listed MTs does not reported) and *account or client specific project* (to address specific reasons). The causes for the above mentioned projects are identified based on the minor, major and critical errors and frequency of the errors by considering the different levels of MTs. A project aimed at incorporating the voice of the customer (i.e., customer's needs) and Lean Six Sigma level targets into the design of products, services or processes and improving quality. Lean Six Sigma improvement models mainly have five phases: define measure, analyse, improve and control.

3.1 Define opportunities

Define phase is to make clear understanding of scope and objective to publish project charter and problems; all relevance stakeholders have been understood. Also, the project purpose and scope will be defined during the phase. One of the key major success factors of Lean Six Sigma project is that, starts with an understanding of what service processes are critical to MT in achieving these objectives. These are also called the critical to quality (CTQ). The cost of service delivery process is an important index and tool that makes to evaluate the process based on and scoring the mentioned process. Also, identifying the problems and defining the measurable objectives and results are the most important objectives of this phase. The most desired result is to set a definitive vision, scope, and strategic approach for quality improvement operations.

Lean Six deliverables has been produced in the define phase:

1 project charter and planning

2 data collection

3 stakeholder analysis, auditing and evaluation

4 critical to quality (CTQ) outline in MT

5 overall overview of the process to be improved.

3.2 Measure performance

Measure performance phase focused on the distribution, collection, and refinement of MT. Planning for collection of the different measurements has been done in the measure phase. It defines the imperfections of quality measurements, evaluate the 'as is' process, and create a current-state assessment of the current service delivery. This phase will help the organisation rank the potential causes of quality improvement, process improvement and productivity improvement, which would be useful in investigation through benchmarking the current process performance. This phase creates four deliverables as follows:

1 process capability and performance

2 critical input and proves variables that can affect output quality

3 service delivery defects

4 critical success factors (CSFs) summary chart.

3.3 Analyse factors impacting performance

The measure phase produces the baseline performance of the service delivery processes. Indeed, in this phase the collected data in the measure phase have been examined to generate a high ranking list of the sources of variation in MT and identify the root cause of problems by using matrix diagram. The following deliverables has been formed in the analyse phase:

1 fishbone diagram of problems

2 frequency plots and graphs from different levels of MTs

3 frequency of types of errors form different levels of MTs

4 data and information flow diagram

5 affinity diagram for brainstorming

6 tree diagram for affinity diagram

7 prioritisation metrics

8 attribute agreement analysis (AAA)

9 critical success factors benchmarked to identify opportunities for improvement

10 regression analysis of data

11 scatter plots and diagrams

12 threats and opportunities.

3.4 Improve performance

The aim of improve performance phase is to identify some options for solutions which can be useful for the identified problems during analysis phase. So, the alternative policies could be identified and select for future improvement. Recommendation and implementation of the solutions are the most important objectives of this phase. In this phase mainly following deliverables has been produced:

1 data and information flow diagram

2 risk assessment

3 design of different experiments

4 ranking different solutions

5 improvement planning for quality improvements.

3.5 Control performance

The problem has been assessed and an improvement process put in place, putting a solution in place can fix problems for the moment, but the work in this phase is designed to ensure the problem stays fixed and secure. Also, the obtained knowledge in the improvement project can be consulted in other areas to help accelerate improvements of service delivery. The following deliverables would be obtained in this phase:

1 control charts for quality improvement

2 quality control process charts

3 standardisation charts for quality

4 process metrics defined and implemented in MT

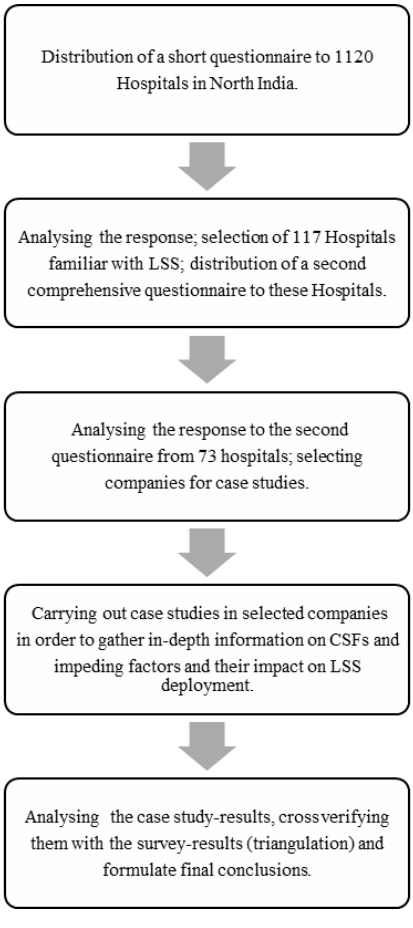
5 control plan implemented

6 risk mitigation actions complete and implemented.

4 Research methodology

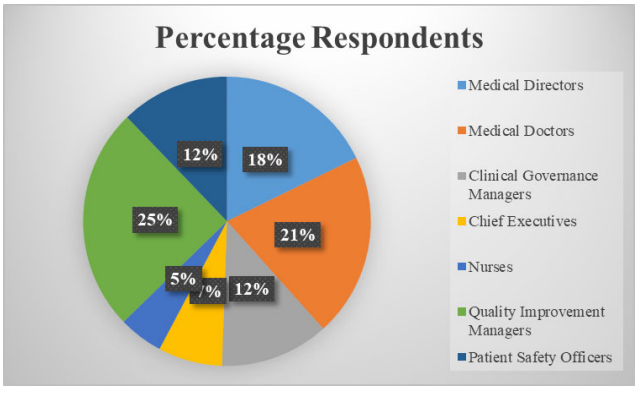
Stepwise research methodology followed is shown in Figure 1 initially a generalised questionnaire is floated in 1,120 hospitals across north India. Out of this 324 responded. One hundred and seventeen hospitals found to be familiar with LSS approach. Therefore; distribution of a second comprehensive questionnaire is done to these hospitals. Analysing the response to the second questionnaire from 73 hospitals; selecting companies for case studies.

Figure 1 Research methodology



Responses were collected from the staff deputed at the various positions various positions in the hospitals. Figure 2 represents the percentage respondents.

Figure 2 Percentage respondents (see online version for colours)



5 Tools and techniques of LSS

Lean manufacturing continuously identifies and removes all kinds of scraps. There are various approaches/techniques which aim at identifying various types of scraps and their sources and then drive methodologies to remove them from the systems on rapid basis. For highlighting the major causes of waste reduction and method to eliminate these, various tools and techniques used are mentioned in Table 1.

Table 1 Tools and techniques for scrap reduction

S. no.	*Tool/technique*	*Brief*
1	TOTAL QUALITY MANAGEMENT	TQM is a technique in which an organisation continuously increases its ability to provide quality products to its customers.
2	QUALITY CONTROL	Quality of product is improved by using seven major tools of quality, i.e., cause and effect diagram (fishbone diagram), control chart, scatter diagram, (alternately, flow chart or run chart), check sheet, Pareto chart, histogram, stratification
3	JUST IN TIME	It focuses on reduction of flow times within production along with response times from is suppliers and customers.
4	POKA YOKE	It is a technique in a lean manufacturing system which aims to avoid mistake made by operator.
5	KAIZEN	KAIZEN stands for continuous improvement. Involving all employees from the CEO to the assembly line workers.
6	LEAN MANUFACTURING	It is a technique for waste elimination in a manufacturing process. Lean is aiming on making systematic processes which can add the value of the product.
7	SIX SIGMA	It is a set of tools and techniques for the improvement of process. There are 99.99966% statistical chances in Six Sigma technique to produce a defect free product.

6 Results and analysis of tools of LSS for NHS

There are a total number of 12 tools and techniques have been identified from the literature which can be implemented in the national healthcare services. Further usage mean ratings, most frequent rings during the survey and the unfamiliar percentage of staff with these tools ad techniques has been calculate in Table 2.

Table 2 Mean rating of LSS tools used for NHS

S. no.	*Tools and techniques*	*Usage mean rating*	*Most frequent ratings*	*Unfamiliar %ge*
1	5s methods	3.25	3	0
2	VSM	3.68	3	5
3	Pareto charts	3.02	3	6
4	Cause and effect analysis	2.51	2	10
5	Kaizen events	3.33	3	9
6	Project charter	3.67	3	12
7	Benchmarking	4.51	5	6
8	Quality initiatives/trainings	4.2	4	5
9	Poka Yoke	3.95	4	2
10	Kanban	2.96	3	39
11	Linking lean/Six Sigma to business strategy, government targets financial indicators.	3.11	3	46
12	Training in lean/Six Sigma	3.62	3	52

7 Critical success factors of Lean Six Sigma deployment in healthcare sector

The idea of identifying the CSFs as a basis for determining the information needs of managers was popularised by Rockart (1979). In the context of Lean Six Sigma, CSFs represent the essential ingredients without which the initiative stands little chance of success. Each one must receive constant and careful attention from management as these are the areas that must 'go right' for the organisation to flourish. If results in these areas are not adequate then the efforts of the organisation will be less than desired. The leaders of healthcare industry should consider the application of Lean Six Sigma from the perspective of improving the quality and capability of current processes as well as the ability of processes to deliver patient care and safety. The following CSFs are essential for the successful development and deployment of Lean Six Sigma in a hospital environment: uncompromising top management support and commitment, applying Lean Six Sigma in a healthcare sector is not easy, and if the senior management team is not on board, it is almost certainly a formula for failure. The deployment of Lean Six Sigma should begin with a two day broad overview of Lean Six Sigma business strategy for the senior management team, ensuring buy-in and commitment for the implementation. Lean Six Sigma project champions responsible for identifying and overseeing projects must be carefully chosen before the training program. In order to buy-in senior management support and commitment, it is also essential to select projects which are tied to strategic business focus. Mean ratings and Cronbach's alpha value of various CSFs is calculated in Table 3.

Table 3 Mean ratings and Cronbach's alpha value of various critical success factors

S. no.	*Critical success factors*	*Mean Rating*	*Cronbach's alpha*
1	Focusing on the needs of patients	4.1	0.97
2	Senior management commitment and involvement	3.9	0.96
3	Strong leadership to continuous improvement processes demonstrated by managers al all levels	3.8	0.92
4	Establishing measurement and feedback systems	3.8	0.91
5	Appointing a project champion/facilitator	3.7	0.89
6	Establishing a culture for continuous improvement	3.7	0.87
7	Focusing on critical processes	3.5	0.87
8	Learning from continuous improvement results automatic capturing and sharing of learning	3.3	0.85
9	Organisation infrastructure	3.3	0.84
10	Understanding methods, tools and techniques, etc.	3.2	0.81
11	Linking Lean/Six Sigma to business strategy, government targets financial indicators.	3.1	7.9
12	Training in Lean/Six Sigma	3	7.6

7.1 Formation of Lean Six Sigma infrastructure and the appropriate training

The selection of right people is crucial for the execution of Lean Six Sigma projects. Once the Lean Six Sigma infrastructure i defined with the assistance of person with adequate experience of Lean Six Sigma in the service industry, training may begin. Project champions known as 'black belts' should receive a good overview of Lean Six Sigma fundamentals and the skills required for project selection, project prioritisation, project scoping and project execution. The 'black belts' must receive four weeks of intensive training, one week each month for four months. The focus of the training must be on the execution of Lean Six Sigma projects and the required tools and techniques for statistical analysis, problem solving and project management. The black belts should work on two Lean Six Sigma projects as part of their certification process with each black belt expected to spend at least 80% of their time on Lean Six Sigma projects.

Green belts are the next level within the organisation and must receive two weeks of training on Lean Six Sigma quality management and have the ability to execute and complete Lean Six Sigma projects. Green belts may work part-time and are expected to select a project from their own processes at the work place. They may also get involved with those projects which are executed by black belts but are also expected to complete at least 2–3 projects annually.

Project selection and the associated financial returns to the bottom-line potential Lean Six Sigma projects within a healthcare setting may relate to operational processes such as billing, registration or work flow or they may involve clinical procedures such as medication administration. When identifying and prioritising projects in a healthcare industry, the first consideration should be the customer and knowing the CTQs characteristics that drives the project. The customer in this context may be the patient, physician, nursing staff, department manager or other stakeholder, depending on the

process being reviewed. The following tips may be useful while selecting potential Lean Six Sigma projects in healthcare industry:

- projects must be aligned with critical hospital issues, patient care issues and strategic objectives of the business
- projects must be feasible to execute from a resource and data standpoint
- project objectives must be clear to everyone involved in the project
- ensure that projects can be completed on time
- ensure that a tollgate review must be performed at every stage of the Lean Six Sigma methodology
- select those projects which have the ability to show measurable improvements in quality, cost and timeliness parameters.

8 Barriers of LSS implementation in national healthcare services

There are several barriers and challenges lurking below the surface that healthcare organisations need to consider prior to the implementation and deployment of Lean Six Sigma business strategy. The first and foremost challenge is the initial investment in Lean Six Sigma belt system training. Secondly the absence or difficulty of obtaining baseline data on process performance is another major challenge. There will be lots of data available in the healthcare sector, however, most of the time these data are not readily available for its analysis. For the healthcare industry, it is often a struggle to understand identify processes which can be measured in terms of defects or errors per million opportunities which can lead to poor analysis of problem situations. Another barrier to Lean Six Sigma deployment in healthcare industry is the psychology of the workforce. Compared to manufacturing processes, healthcare service processes are subject to more noise or uncontrollable factors such as sociological factors, personal factors, etc. The measurement of patient satisfaction in a hospital environment is more difficult due to the human behavioural interaction associated with the delivery of service. Changing the machine parameter settings on a machine is quite a different matter than training staff or adjusting work procedures or tasks. Last but not the least, it is important to present recommendations and improvement report using the business language rather than the statistical language.

9 Results and discussion

Lean Six Sigma has been a significant and most effective tool in manufacturing industries to rejection rates and to enhance productivity, process and quality. The MT is divergent from manufacturing industries and features are different. Thus, the use of Lean Six Sigma in MT and its benefits are vast to identify the Lean Six Sigma projects. From the analyses of the service models, MT processes and also by comparing between the features of other service sectors, the main challenges in application of Lean Six Sigma in MT can be identified. Further analyses of these challenges showed that the proper implementation of Lean Six Sigma in MT requires not only the effective operational strategies, but also

customers needs and satisfaction and internal customer satisfaction must be considered and designed into the implementation phase. The formation of Lean Six Sigma team of different role and responsibilities will be challenging. The green belt (MTs) or subject matter experts will play vital role in the Lean Six Sigma projects MT.

10 Conclusions

The global market is becoming more and more quality conscious. To compete in such an environment, companies need to adopt an efficient technique that can assess and take a diagnostic approach to meet customer needs and expectations. Nowadays, the industrial world has realised that the Lean Six Sigma philosophy is certainly a viable solution to their foundry problems. Lean Six Sigma with DMAIC as a problem solving method, DMAIC is applicable to empirical problems ranging from well-structured to semi-structured, but not to ill-structured problems. By adaptation of DMAIC methodology in the processes can help to identify Lean Six Sigma projects. The DMAIC procedure helps a user to find a strategy for analysing and solving a problem, and thus structure the problem at hand. The organisation implements Lean Six Sigma methodology and the DMAIC problem solving approach should be aware of their characteristics and potential limitations. The future study can be carried how DMAIC methodology can be adopted in above identified Lean Six Sigma projects.

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