Deploying Lean Six Sigma framework in a healthcare organisation: a case experience

Vikas Swarnakar*, A.R. Singh and Anil Kr Tiwari

Department of Mechanical Engineering,
National Institute of Technology,
Raipur, GE Road, Raipur-492010, Chhattisgarh, India
Email: vikkiswarnakar@gmail.com
Email: arsingh.mech@nitrr.ac.in
Email: anil.kr.tiwari@gmail.com
*Corresponding author

Abstract: Healthcare organisations have struggled with service quality problems to achieve operational excellence. Redundant waiting of patients is scathing to throughput and sustain organisations in a competitive environment. This study utilised a structured Lean Six Sigma DMAIC approach to reduce patient waiting time and improve service quality through systematic analysis of the problem of gynecology and obstetrics department of a multinational hospital. The structured implementation of the LSS framework was observed with significant improvement in different aspects. The outcomes of the study revealed that 117% improvement in patient waiting time was observed for already appointed patients on weekdays whereas 68% in the case of arrived patients on Saturdays only. Further, 90% improvement was observed for walk-in patients who arrived on weekdays whereas 65% in the case of patients arrived on Saturdays only. The improvements were also calculated in terms of benefits, the average profit per year calculated as INR 36,939,600 that leading to an anticipated INR 292,981,025 by 2028. The findings of this study encourage researchers, practitioners, and decision-makers to employ the same method in other healthcare organisations to achieve the benefits.

Keywords: Lean Six Sigma; LSS; service quality; healthcare organisation; patient waiting time; bottom-line results.

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Biographical notes: Vikas Swarnakar is currently working as a RESEARCH scholar in the Department of Mechanical Engineering, National Institute of Technology, Raipur, India. He earned his MTech in Industrial Engineering and Management from National Institute of Technology, Tiruchirappalli, Tamilnadu, India. He earned his BTech in Industrial and Production Engineering from GGU (Central University), Bilaspur, India. He has published more than 20 journals and conference papers in reputed journals. He has published papers in 'A' grade journals such as *Computers and Industrial Engineering* (Elsevier). He is in the article review committee of many journals. He served as an Assistant Professor in JK Engineering College, Bilaspur and Shankaracharya College Bhilai. His research interest includes lean

manufacturing, Six Sigma, sustainability, agile manufacturing, supply chain management, optimisation, etc. He is a member of IEI, IIE, ORSI, and IAENG. He is a Certified Lean Six Sigma Black Belt.

A.R. Singh is an Assistant Professor in the Mechanical Engineering Department at National Institute of Technology, Raipur, India. He holds a PhD in Mechanical Engineering from Motilal Nehru National Institute of Technology, Allahabad, India. He has a Master of Technology degree in CAD-CAM from Motilal Nehru National Institute of Technology, Allahabad, India. His areas of specialisation are operation research, supply chain management, lean manufacturing, Six Sigma, optimisation techniques, Omni channel, block chain, education policy, and multi-criteria decision making. He has published more than 40 papers in international journals and international/national conferences.

Anil Kr Tiwari is a Professor in the Mechanical Engineering Department at NIT, Raipur, India. He received his BE degree in Mechanical Engineering from GEC Raipur in 1986. He did his MTech in Thermal Engineering, in 1997 from the Department of Mechanical Engineering, IIT Delhi. He has obtained his PhD degree from the Centre for Energy Studies, IIT, Delhi, India. His areas of interest are thermal engineering, solar thermal application, passive heating and cooling, refrigeration, and air conditioning, alternate fuels of IC engine. He has published more than 80 papers in international journals and international/national conferences.

1 Introduction

The Healthcare sector is one of the backbones of the planet as it cares about living things life. It also has a tremendous impact on the economy. According to IBEF healthcare data, healthcare has become one of the leading largest sectors, in the view of both revenue generation and employment (IBEF Report, 2020). The primary objective of any healthcare organisation is to provide the best care to their customers. Unfortunately, the fulfilment of this objective can be challenging when the process/system is poorly designed (Kannampallil et al., 2011). The poor process tends to increase the unnecessary patient waiting time resulted in dissatisfied patients, loss in business, and damage to the reputation of the organisation (Chasm, 2001). The waiting time of the patient to meet the doctor is directly correlated with satisfaction (Anderson et al., 2007). Therefore, the patients waiting time to meet physicians should be minimum (Kovach and Ingle, 2019).

The patient waiting time can be described by the total time taken for check-in to check-out and it typically measured by the cycle time (Time, 1993). However, the waiting time of the patient can be minimised by the redesigning of the service process. It can also be reduced by eliminating the non-value-added activities from the process (Bhat and Jnanesh, 2014; Fischman, 2010; Naidoo and Mahomed, 2016; Delisle et al., 2015; Singh and Rathi, 2020). Therefore, healthcare organisation should adopt some approaches which successfully eliminate the non-value added activities from the service process and concentrate on the reduction of patients waiting time. Many approaches such as total quality management (TQM), Lean Management (LM), Six Sigma (SS) have been approached by the authors which can eliminate non-value added activities from the process and improve the service quality of the organisation (Hackman and Wageman,

1995; Weisman et al., 2001; Wiegel and Brouwer-Hadzialic, 2015; Al-Zain et al., 2019). LM strategy can eliminate the wastes and SS can rectify the variation presented in the current process (DelliFraine et al., 2010; Sodhi et al., 2020). While the merger of these two approaches [i.e. Lean Six Sigma (LSS)] brings drastic improvements such as minimise the patients waiting time, operational cost, improve efficiency, timeliness of care, quality of care, patient flow, and discharge process to increase customer satisfaction (Allen et al., 2009; Glasgow et al., 2010; Trzeciak et al., 2018; Trehan et al., 2019; Henrique and Filho, 2020). Further, the successful implementation of the LSS strategy in healthcare organisation improves the bottom-line results. Also, the successful adaptation of LSS in the organisation helps to sustain in the present competitive market. To explore the further LSS adaptation process, the following research objectives (RO) addressed in the present study are:

RO1 Develop a structured LSS framework that facilitates to reduce waiting time and improve the service quality of healthcare organisation.

RO2 Implement the developed framework in the concerned organisation.

RO3 Assess the improvement opportunities.

To address these RO, the present study demonstrates a case example of a structured LSS framework implementation in the gynecology and obstetrics department of one healthcare organisation towards improving the service quality by reducing patient waiting time. The structured framework included various LSS tools and techniques within the SS DMAIC methodology. This framework implementation involves problem identification part, mapping the service process, collection of related data, check reliability of data, analyse the process, identification and prioritisation of causes, suggested solutions, and calculate the benefits in terms of profit. The finding of the present study helps researchers, practitioners, and decision-makers to perform the same study in other organisations to improve service quality. The rest of the study is put forth in the following way. Section 2 discussed the literature review, research methodology has been presented in Section 3. Section 4 described the detailed case study. Further, Section 5 covers the result and discussion followed by managerial implications, and Section 6 presented a conclusion with limitations and future work.

2 Literature review

The literature has been reviewed from the perspective of LSS studies in the healthcare environment.

Many studies introduced several quality improvement methods such as TQM, LM, SS, deming cycle plan-do-check-act (PDCA) approach, business process reengineering (BPR) have been widely applied in the healthcare sector to enhance the service process. Carboneau et al. (2010) implemented the LSS approach to improve the rate of hand hygiene of health workers. The case study was conducted in one healthcare unit in Albuquerque, New Mexico. The findings of the study observed a 51% reduction in patient infection due to hand hygiene of health workers that resulted in the hospital saved US$ 276,500 every year. Mandahawi et al. (2011) presented a process improvement case study performed at a hospital-based on a customised LSS approach. The study incorporated a SS DMAIC approach with including various LM tools to reduce the

patient's length in the ophthalmology department. The outcomes assured a 48% reduction in actual patients' length of stay at the hospital. Gijo et al. (2013) applied the LSS methodology to reduce the patients waiting time in the pathology department of a hospital attached to a manufacturing company. The study utilised SS DMAIC methodology integrated with several lean tools to improve the patients served. The outcome of the study observed a 50% reduction (24 min to 11 min) in the average waiting time of patients. Gijo and Antony (2014) addressed the issue related to longer patients waiting times in the out-patents department of hospitals attached to one manufacturing industry situated in India. The LSS methodology was utilised as a solution methodology to solve the problem. The successful implementation of the LSS framework provided a significant reduction (57 min to 24.5 min) in patients' waiting time. Bhat and Jnanesh (2014) implemented the LSS approach in one rural hospital for decreasing the cycle time of out-patients. The study utilised a SS DMAIC approach to reduce the cycle time for quality improvement and timely service to the community. The findings of the study observed that a 97% reduction in average waiting time in the system and a 91% waiting time in queue length. Kubilius et al. (2015) presented how the LSS approach and change management tools were used to reduce the various problems such as slips, trips, and falls in joint commission field staff. The study utilised a survey approach to collect the related data and multiple risk factors also associated with solving the above-mentioned problems. Almorsy and Khalifa (2016) implemented the LSS approach to reduce the unnecessary quality control runs in one healthcare unit. The study utilised the SS DMAIC methodology to systematically update the policies, procedure to reduce the NVA. The findings of the study observed a significant reduction in non-value added activities related to quality control runs. Furterer (2018) applied the LSS DMAIC methodology to improve the patient's length stay of in a hospital. The successful implementation of the LSS approach resulted in a reduced length of stay by 30% within three months and reduced the patients leaving rate without treatment from 6.5 to 3%. Davies et al. (2019) applied LSS to improve the efficiency of the daycare unit towards generating a positive impact on nursing time optimisation and improving patients care. The study was conducted in one private hospital. The study utilised a SS DMAIC approach to overreach problem solutions. The findings of the study were observed a significant improvement in the optimisation of nursing time. Godley and Jenkins (2019) utilised LSS DMAIC methodology to minimise the waiting time of patients thereby increase the satisfaction rate. The study was performed in a radiology department of a healthcare organisation. The outcomes of the study observed a significant reduction of patients waiting time in three areas; registration, test, and likelihood to recommend time. Brown et al. (2019) used the LSS approach to improve the rate of surgery admission patients in the surgery department of a national level hospital. The study employed the LSS methodology to identify and remove the NVA in patients' journeys to improve the day surgery rate. The result of the study observed a 75% improvement in day surgery. Nabiyouni and Franchetti (2019) applied the LSS approach to improving the management of infectious wastes in a healthcare organisation. The study optimised the red bag waste management program through the adoption of the LSS method in case hospital. The findings of the study reveal that a 55% reduction was observed in total waste which leads to minimising environmental and economic impact. Bhat et al. (2019) explored the voice of customers, critical to quality characteristics, key performance indicators, critical success factors, and common tools required to implement LSS in hospitals. The study was performed in five different Indian hospitals to improve the process of keeping a medical record. The

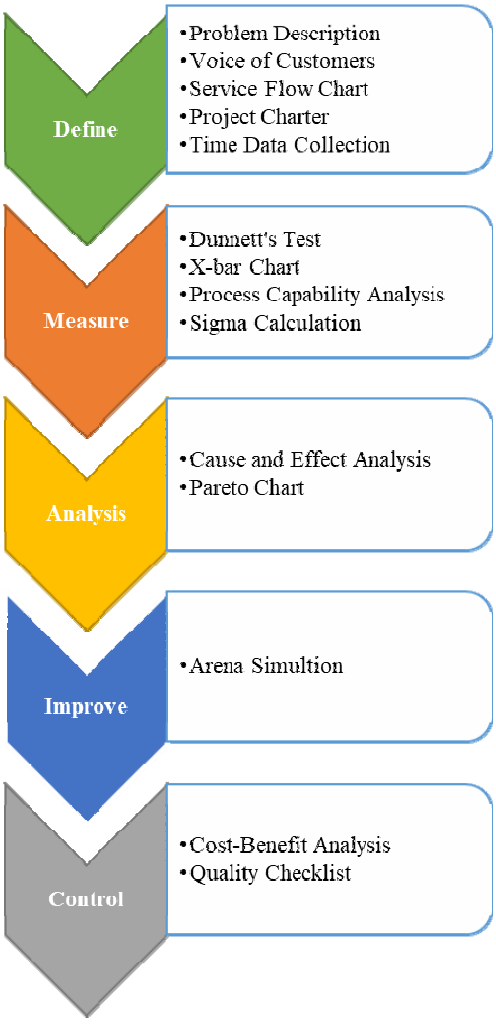
findings of the study reveal that the excess patient waiting time hams their health and increases the service cycle time. The research also observed effective leadership, proper availability of data, effective communication, and multi-skilled team are key factors of LSS implementation success. Henrique and Filho (2020) reviewed the existed 118 kinds of literature related to empirical studies of LSS performed in the healthcare environment. The study explored the guidelines to create continuous improvement culture practice and sustain the improvement opportunities. The study also explored the specific barriers which affect the LSS implementation process in hospitals. Trakulsunti et al. (2020) reviewed the existed literature on LSS intervention and tools to reduce medication errors in healthcare organisations. A pool of 24 pieces of literature was reviewed by the authors in different perspectives such as LSS tools and techniques used in the context of medication errors, LSS project selection in a hospital environment, its benefits, challenges, and success factors. Ricciardi et al. (2020) deployed LSS to reduce the patient length of hospital stay. The study implemented the LSS approach in fast track knee replacement surgery unit of the hospital for reducing the patient length stay time. The outcomes of the study observed that 19.9% reduction in patient's length stays. Sunder et al. (2020) applied the application of LSS in the mobile hospital. The study presented a case application of improving the patient's satisfaction by reducing the turnaround time. The study used the define-measure-design-analyse-verify roadmap to design the intervention to solve the real-time problem.

There are various studies presented in the literature that implemented the LSS framework in their organisation to minimise the waiting time and improve the service quality of the process. These literature have agreed that successful adaptation of the LSS framework in healthcare organisation brings important benefits in terms of quality, efficiency, speed, cost, customer satisfaction (Laureani et al., 2013; Costa and Filho, 2016; Peimbert-Garcia, 2019). However, these studies performed in very particular units, for example, emergency department, surgery, intensive care unit, laboratory, pharmacy, operating room, radiology, nursing, oncology, gynecology, pathology, cardiology, telemetry unit, fast track unit, medication centres, waste management (Peimbert-Garcia, 2019; Nabiyouni and Franchetti, 2019; Henrique and Filho, 2020; Trakulsunti et al., 2020; Ricciardi et al., 2020), and observed the benefits such as reduce the initiating time delay in the operating room (Does et al., 2009), patient length stay (Basta et al., 2016; Trzeciak et al., 2018; Ricciardi et al., 2020), patients discharge time (Allen et al., 2009), improvement in measurement system (Kovach and Lima, 2018), operating room efficiency (Cima et al., 2011), service process improvement (De Koning et al., 2006), error-proofing process (Kovach et al., 2013; Trakulsunti et al., 2020). The previous studies do not demonstrate the structured implementation of the LSS framework with consideration of a proper set of tools and techniques. These studies also do not analyse the benefits in terms of cost-benefits. Further, no studies provided a comprehensive solution approach to control the problem and thus sustain the organisation in the long run. The purpose of the present study is to reduce the patient waiting time and improve service quality through developing and implementing the LSS framework in the gynecology and obstetrics department of one healthcare organisation.

3 Methodology

The LSS-DMAIC framework has been proposed to solve the patient waiting time problem in this study. The proposed framework consisted of five stages and each stage includes some tools that help to clearly describe the solution process. The tool used in each stage is represented in Figure 1, the systematic use of those tools helps to reduce all kinds of waste presented in the process. The framework has included detailed procedures to implement LSS and calculate the implementation benefits. The detailed evaluation process is described in detail in the next section.

Figure 1 LSS framework (see online version for colours)



4 Case explanation

The present study was conducted in the gynecology and obstetrics department of one multinational hospital. The organisation was continually receiving complaints from its customers related to excess waiting time than expected, resulted in a decreasing rate of new customers in the hospital. The regular decrease in trend had become a matter of concern for hospital management. The management was looking to reduce the excess waiting time of patients and wanted to implement any continuous improvement approach which brings out current problems and attracts more customers. The management discussed with us, we proposed them to implement the LSS framework and discussed the detailed adaptation process. As they were very keen to resolve problems, they permitted us to carry out the present study in their hospital. The management also supported and helped to carry out the comprehensive steps discussed in the framework (Figure 1). The next section discussed the detailed framework implementation process.

4.1 Proposed LSS framework

The subsection clearly describes the steps performed for LSS framework implementation in the case hospital.

4.1.1 LSS define phase

This stage includes various tools that help to define the actual problem of the organisation. The tools included in this stage are discussed in detail below.

- *Problem description.* A meeting was held with top management to discuss the excess patient waiting time and their impact on hospital income. In the meeting, the discussion had on several perspectives such as expenditure, implementation process, required resources, etc. The main objective of this stage was to identify the current problem.
- *Voice of customers.* The actual need for customers was collected through a questionnaire survey. For this, a structured questionnaire was prepared and distributed among patients and their caretakers in the hospital. A total of 490 questionnaires was distributed to customers and collected their response by spent 15 regular days. The survey result showed that more than 75% of patients were not satisfied with the present service provided by the hospital.
- *Service flowchart.* The patient flow data was collected to identify the various process involved in the hospital to meet the physician. The detailed steps of the service process that patients needed to follow to meet the doctors are presented in the form of a flow chart which is shown in Figure 2.
- *Project charter.* A project charter was prepared to clearly define the complete project plan from start to end. It includes detailed objectives, aims, problems, team members, benefits, and expected schedules. The project charter can be used as a reference for describing the future status of the project. The project charter is developed based on the detailed study of case problems and discussion with LSS experts which is presented in Table 1.

- *Time data collection.* Time data were collected to recognise the cycle time of each process and thereby calculated the total lead time. To do so, LSS experts visited the hospital and systematically studied the layout, and observed the present ongoing system. Team members collected all the time-related data, it starts from patients enters into the hospital followed by patient entry to the service, physician checkup, and till the end of the process. The time data were collected using a stopwatch and by the use of the pen. The hospital uses two methods (i.e. direct walk-in and telephonic call) to provide appointments to its customers. Based on hospital guidelines, the standard waiting time was 10 minutes for already appointed patients and 30 minutes for direct arriving (walk-in patients). The systematic analysis of time data of 30 regular working days with 470 patients, the data revealed that the average waiting time calculated was 56.8 minutes for appointed patients whereas 86.3 minutes for walk-in patients. The collected data were systematically measured in the measure phase, the details are discussed in the next section.

Figure 2 Service flowchart (see online version for colours)

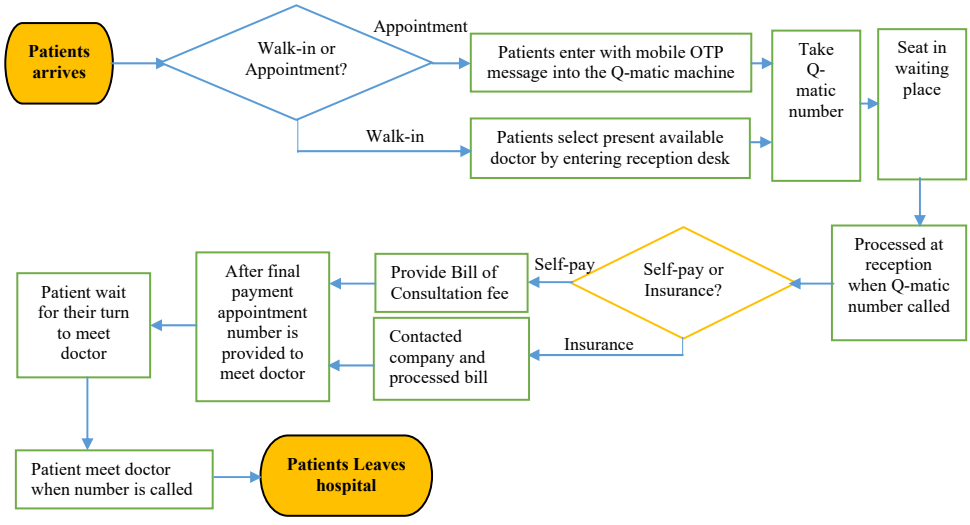


Table 1 Project charter

Business problem	*Excess patient waiting time*	*Name of organisation*	*XYZ hospital*
Expert	Dr. A	Lean Six Sigma Master Black Belt Certified Experts	PhD with more than 12 Years' experience to implement LSS in manufacturing and service organisations
Coordinator	Mr. B, and Mr. C (LSS Black Belt Certified with more than 10-year experience in the concerned field)	Team members	LSS Green Belt certified persons and Some of the staffs of XYZ hospital

Table 1 Project charter (continued)

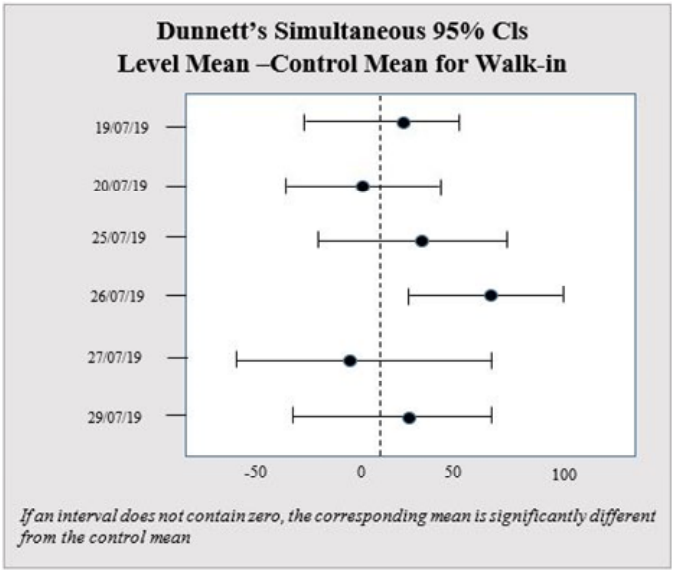
Business problem	*Excess patient waiting time*	*Name of organisation*	*XYZ hospital*
Champion	Dr. D (Dean of XYZ hospital)		
Project start date	01/06/2019	Project completion date	10/12/2019
Problem	LSS framework implementation to reduce patient waiting time		
Objective	Improve the service quality of the organisation and increase the benefits		
Deficiency	Factors prevention during LSS framework implementation		
LSS anchorage	Waste elimination, minimise the lead time of service		
Project scope	Development of LSS framework reduce the patient waiting time and provide quality service within expected time and schedule		
Benefits	Decrease waiting time will improve the service quality that satisfies the customers		
Tools and techniques	Voice of customers, Flow chart, Project charter, Dunnett test, X bar chart, Process capability analysis, Sigma calculation, Cause, and effect analysis, Pareto chart, etc.		
Schedule	*Activity name*	*Start date*	*Completion date*
	Problem identification	01/06/2019	15/06/2019
	Define phase	16/06/2019	15/07/2019
	Measure phase	16/07/2019	15/08/2019
	Analysis phase	16/08/2019	25/09/2019
	Improve phase	26/09/2019	15/11/2019
	Control phase	16/11/2019	10/12/2019

4.1.2 LSS measure phase

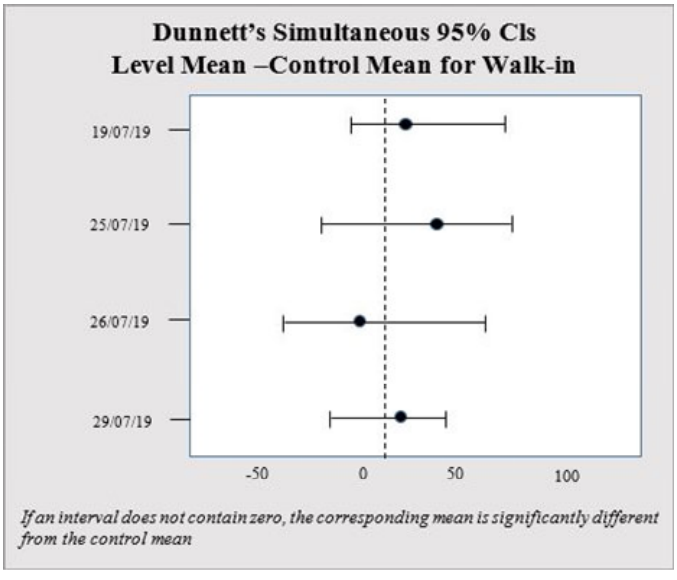
This stage includes various tools that help to measure the collected data from the case organisation. The tools included in this stage are discussed in detail below.

- *Dunnett's Test.* This test is used to identify the pairs with significant differences. This test compares the mean from several experiment groups against a control group mean to observe the main differences. Here one fixed control group is required to compare all other samples. The data were separately analysed for both types of patients (e.g. appointed patients and walk-in patients). The analysis revealed that the average waiting time for walk-in patients was longer on Saturday in comparison to other weekdays which is shown in Figure 3(a). The test was performed after excluding Saturday data to make sure other days had no longer effect on patient waiting time, the result is shown in Figure 3(b). A further test was also performed for appointed patients and observed comparable results.

Figure 3 (a) Dunnett's test results for walk-in patients (weekdays) (b) Dunnett's test results for walk-in patients (weekdays except for Saturdays)



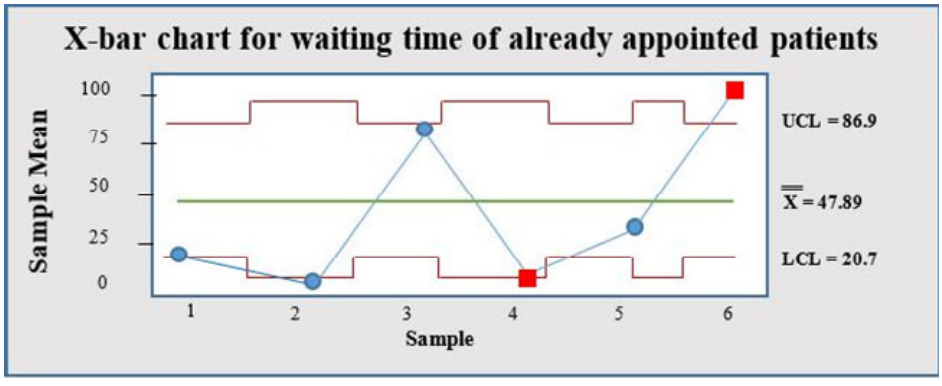
(a)



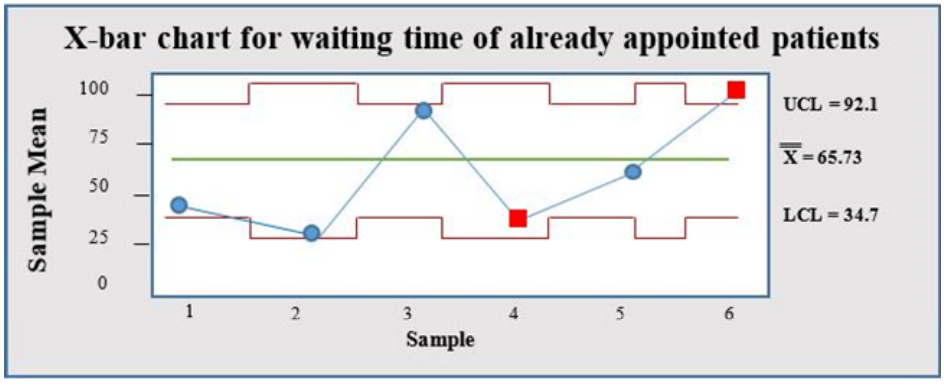
(b)

- *X-bar chart.* The X-bar chart was used to monitor the arithmetic means of successive patients waiting for the time sample for already appointed patients. The chart shown in Figure 4(a), represents the sample average of patients waiting time on weekdays whereas Figure 4(b) represents on Saturdays only. The average waiting time for appointed patients was calculated as 47.89 minutes on weekdays whereas 65.73 minutes on Saturdays only.

Figure 4 (a) Average sample of already appointed patients waiting time on weekdays (b) Average sample of already appointed patients waiting time on Saturdays only (see online version for colours)



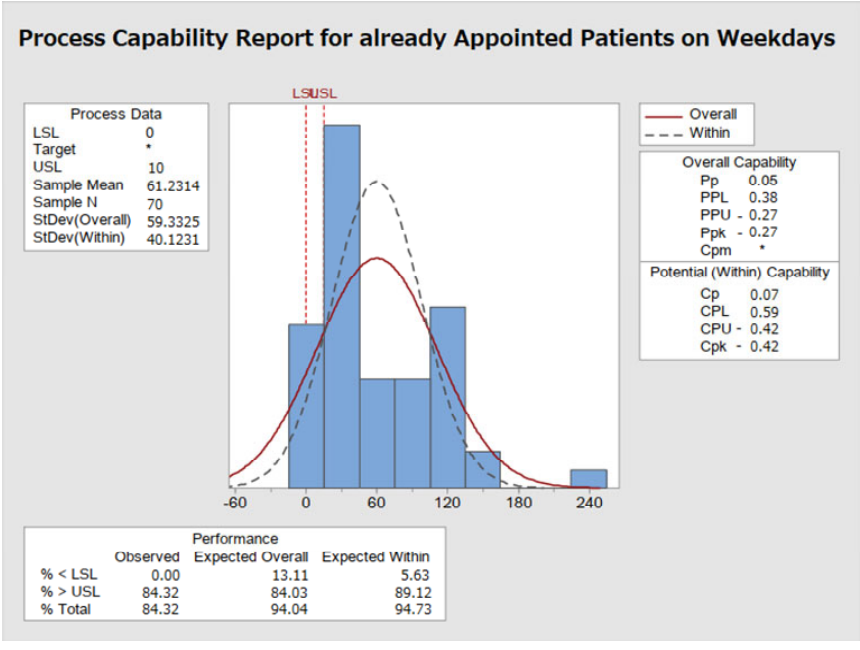
(a)



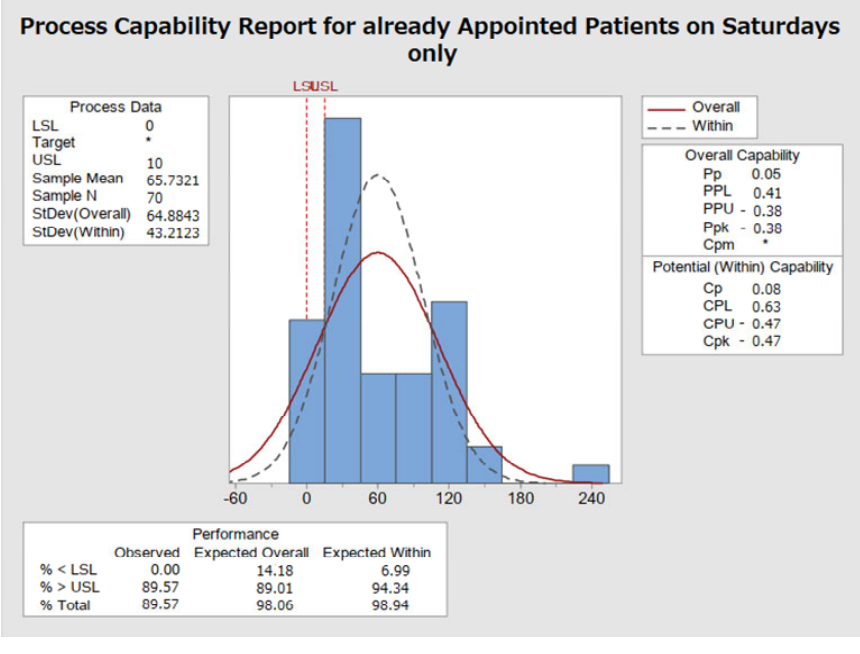
(b)

- *Process capability analysis.* Process capability is used to determine how well the process meets a set of specified limits. The study analysed the process capability for already appointed patients on weekdays and Saturdays only. The lower (0 minutes) and upper (10 minutes) specification limits were decided by the top management. Based on the survey data, 84.32% of patients were waiting for more than the specified time on weekdays whereas 89.57% of patients were waiting on Saturdays only. The excess patients waiting time was the major issue in the hospital, there was an urgent need to reduce waiting time and bring it within a specified control limit. The result of process capability analysis for already appointed patients on weekdays and Saturday only is shown in Figures 5(a) and 5(b).

Figure 5 (a) Process capability report for already appointed patients on weekdays (b) Process capability report for already appointed patients on Saturdays only (see online version for colours)



(a)



(b)

- *Sigma calculation.* The various parameters were defined to calculate the patient waiting for time sigma level such as
  1 the patient's counts on weekdays and Saturdays only
  2 patients waiting time more than the specified time of the hospital was considered as a defect.

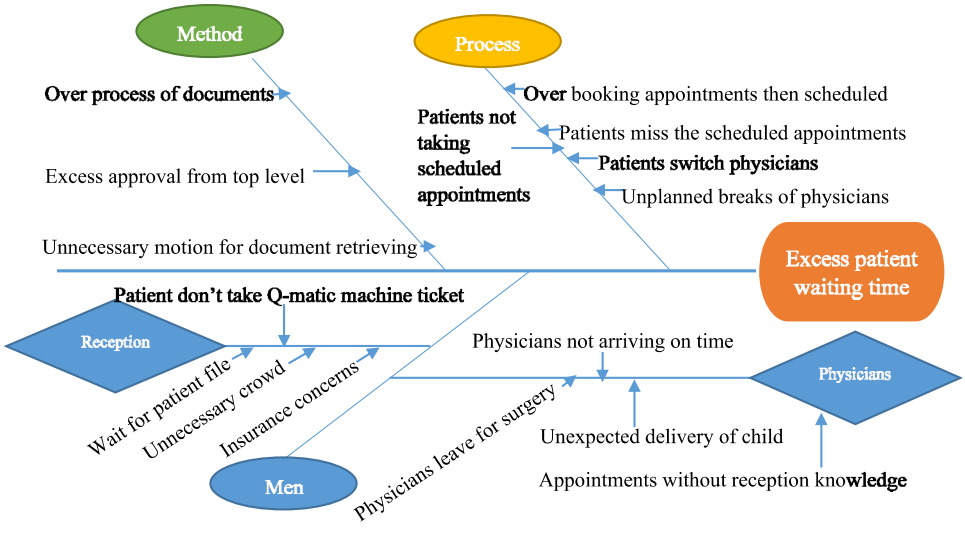
  Equation (1) was used to calculate the defect per million opportunities (DPMO). The calculated DPMO percentage systematically converted into sigma level to recognise the process tends to shift for the long term. As per Motorola standard, the sigma level adjusted to 1.5 Sigma's to recognise the process tends to shift in the long run. The DPMO calculation analysis result is presented in Table 2.

$$DPMO = \frac{Total\ defects * 1,000,000}{Total\ defect\ opportunities\ per\ unit * Number\ of\ units} \quad (1)$$

Table 2 DPMO results

Days	*Patients type*	*DPMO*	*DPMO %*	*Sigma level*
Weekdays	Walk-in	892,189	89	0.5
	Already appointed	796,351	80	0.8
Saturdays only	Walk-in	743,589	74	0.9
	Already appointed	491,298	49	1.4

Figure 6 Cause and effect diagram (see online version for colours)

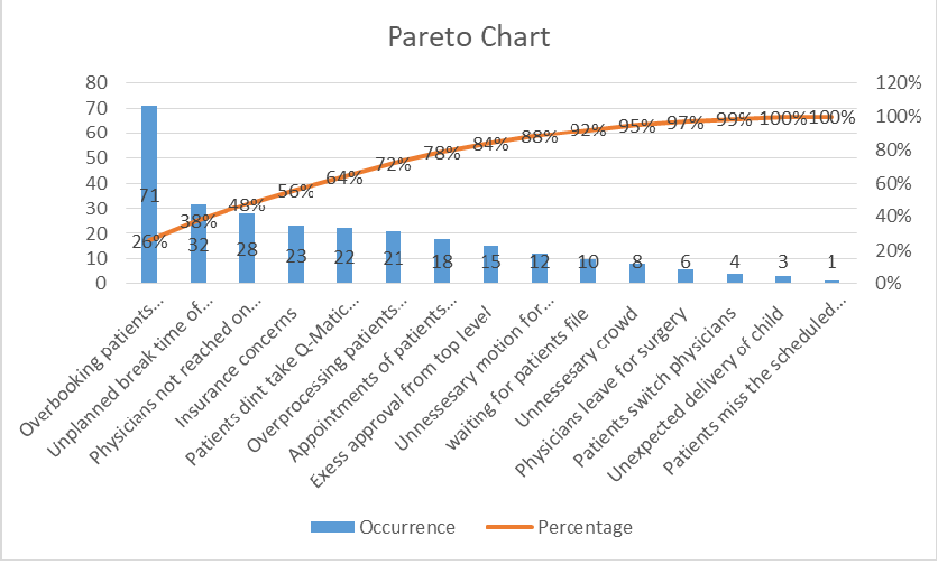


4.1.3 LSS analysis phase

This stage includes various tools that help to analyse the actual data gathered from the case organisation. The tools included in this stage are discussed in detail below.

- *Cause and effect analysis.* The analysis is used to investigate the source causes of the present occurring problem in the case organisation. The systematic study was performed in a case hospital and drawn the cause and effect diagram for long patient waiting times. The LSS experts investigated and determined that the excess patients waiting time were occurred due to the three primary causes (i.e. men, method, and process). Under these primary causes, there had several secondary and territory causes which were also defined by the experts based on the detailed observation of the case organisation, the identified secondary causes are shown in Figure 6.
- *Pareto chart. A* Pareto chart was drawn to identify the root cause for excess patient waiting time. The chart was drawn based on the data gathered from the cause and effect analysis result which is shown in Figure 7.

Figure 7 Pareto chart (see online version for colours)



Based on the observation of Figure 7, five major causes were observed that were increasing the patient waiting time. These causes are overbooking appointments of patients then scheduled, unplanned break time of physicians, physicians are not arriving on their scheduled duty time, issues with an insurance processing time of patients who have taken insurance from various companies, and patients dint take Q-magic number. These causes were produced from the various roots, e.g. the overbooking appointments of patients then scheduled was occurred due to patients take appointments from the various sources (i.e. receptionist person, doctor itself, and call centre representatives). The unplanned break taken by physicians was occurring due to no specified time rule follow by the case organisation. Further, physicians were not arriving on their scheduled duty time, the investigation results cleared that no strict rule had been made by the case organisation in related concerns. The issues occurred with the insurance processing time of patients because the receptionist took a long time to get approval from the insurance company. Moreover, patients were not taking Q-Matic number, such a problem was occurred due to the unavailability of clear information.

4.1.4 LSS improve phase

This stage includes various tools that help to determine the problem solution of the case organisation. The tools included in this stage are discussed in detail below.

- *Arena simulation.* This simulation was used to test the possible improvements in the form of a prototype test. Several possible changes were performed as input to minimise the current patient waiting time. A primary simulation test was performed for the present data to verify the outcomes, afterward, several changes had been made based on expert suggestions (e.g. for input/independent parameter we considered as doctor count, service time, patient equally distribution, etc. and output/dependent parameter as waiting time and patients count). After a lot of changes in input data, the simulation test provided results with a reduced waiting time. The simulation model has been validated based on the study performed by (Najmuddin et al., 2010; Jamjoom et al., 2014). The test results were compared with actual data and observed that the significant improvement in waiting time, the result is represented in Table 3. Several solutions have been provided to healthcare organisations that were tested during a simulation test to eliminate those waiting time-related problems which are presented in Table 4.

Table 3 The comparison result of current data with a simulation study

		Weekdays	*Saturdays only*	*Improvement % (weekdays)*	*Improvement % (Saturdays only)*
Average waiting time	Already appointed the previous situation	47.89 minutes	65.73 minutes	117%	68%
	After simulation	22.12 minutes	39.03 minutes		
	Walk-in previous situation	56.31 minutes	74.86 minutes	90%	65%
	After simulation	29.59 minutes	45.31 minutes		
Served patients count	Average patients count previously per day	73	81	33%	26%
	Average simulated patients count per day	97	102		

Table 4 Suggested solutions

Root	*Cause*	*Suggested solutions*
Overbooking appointments of patients	1 Appointments scheduled in surgery timing	Appointments should not provide during surgery time
	2 Appointments provided by doctors without reception knowledge	Appointments should be provided by reception only
	3 More appointments are provided than the scheduled average	The average number of patient's appointments count per day fixed by LSS experts

Table 4 Suggested solutions (continued)

Root		*Cause*	*Suggested solutions*
Insurance-related concerns	1	Maximum time is taken for approval from the organisation	Skip approval from the organisation
	2	Time is taken for contact and get approval from insurance companies	Collaboration has been made with representatives of leading insurance companies
Reception	1	All (walk-in and already appointed) patients serve reception	The appointment schedule taken patients can visit the direct payment section for payment and further process
	2	The patients without insurance affected by insurance patients	A separate window is suggested for insurance and without insurance patients
Queue system	1	Patients don't take Q-magic numbers after entry	Clear instruction has been provided with the help of the poster
	2	Maximum patients enter directly for a checkup without their turn	A strict rule has been made which does not allow patients without their turn
Due to the physician's delay	1	Physicians were not arriving at the right time	A penalty rule has been made for latecomers in the organisation
	2	Unplanned break by physicians	The proper schedule has been provided for several breaks
No priority	1	No priority was provided to already appointed patients	The rule has been revised where already appointed patients can get the exact time to meet a physician

4.1.5 LSS control phase

This stage includes various tools that help to continuously monitor the results obtained from the analysis. In this section, comparisons have been made with the previous results with the present improvement. The tools used in this stage are discussed in detail below.

- *Cost-benefit analysis.* The analysis is used to summarise the results obtained by this project. The results obtained from this study were encouraging the top management to implement such recommendations. The analysis included all required expenditures needed for project success and the benefits which can get from the success of the project. The calculated cost-benefit analysis results for the improved system are shown in Table 5.

  Based on the result of the cost-benefit analysis the improvement was observed in terms of money. The total incurred cost was calculated by expenditure in several instruments such as flip board, LED display, surveillance cameras for monitoring purpose, sigh boards, etc., that could enhance the current system. The benefits were calculated based on the improvements observed in Table 3. The calculated benefits show that the average 24 patients increased per day that resulted in average benefits Rs. 4965. The yearly benefits of the hospital were calculated using equation 2. The total average working days of the hospital were 310 days excluding Sundays and unplanned holidays.

Table 5 Result of a cost-benefits analysis

Year	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*2025*	*2026*	*2027*	*2028*
Undiscounted flows										
Incurred cost	Rs. 1,30,680	Rs. 0	Rs. 0	Rs. 0	Rs. 0	Rs. 0	Rs. 0	Rs. 0	Rs. 0	Rs. 0
Observed benefits	Rs. 0	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600
Net cash flow	– Rs. 1,30,680	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600	Rs. 36,939,600
Discount factors										
Discount rate	2.5%									
Start year	2019									
Year index	0	1	2	3	4	5	6	7	8	9
Discount factor	1.000	0.975	0.950	0.926	0.902	0.879	0.857	0.835	0.814	0.793
Discounted flows										
Costs	Rs. 1,30,680	Rs. 0	Rs. 0	Rs. 0	Rs. 0	Rs. 0	Rs. 0	Rs. 0	Rs. 0	Rs. 0
Benefits	Rs. 0	Rs. 36,016,110	Rs. 35,092,620	Rs. 34,206,069	Rs. 33,319,519	Rs. 32,469,908	Rs. 31,657,237	Rs. 30,844,566	Rs. 30,068,834	Rs. 29,293,102
Net	Rs. 1,30,680	Rs. 36,016,110	Rs. 35,092,620	Rs. 34,206,069	Rs. 33,319,519	Rs. 32,469,908	Rs. 31,657,237	Rs. 30,844,566	Rs. 30,068,834	Rs. 29,293,102
Cumulative	Rs. 1,30,680	Rs. 36,029,170	Rs. 71,121,790	Rs. 105,327,859	Rs. 138,647,378	Rs. 171,117,286	Rs. 202,774,523	Rs. 233,619,089	Rs. 263,687,923	Rs. 292,981,025

$$Total\ yearly\ benefits = increase\ patient\ per\ day * total\ working\ days * average\ benefits\ per\ patients \quad (2)$$

A total nine-year forecast was calculated with a 2.5% discount rate per year as the provision of reserve banks of India in calculating the project value. The total cost incurred in expenditure was calculated as Rs. 1,30,680 was needed for the improvement of the system. The net value for the year 2028 is calculated as Rs. 29,293,102, and the annual project income calculated in Rs. 292,981,025 on 2028.

- *Quality checklist.* A checklist was prepared by the LSS experts and provided to top management to regularly assess the improvements and sustain the projects in the long run. It is the responsibility of qualified staff to periodically assess the improvements with the help of the checklist shown in Table 6.

Table 6 Quality improvement checklist

Key	*Quality improvement checklist*				
Project name	Lean Six Sigma framework implementation to reduce the patient waiting time				
Completed by		Y	N	Y/N %	Action/comment
Item	Description				
1	All staffs actively involved				
2	All doctors working as scheduled				
3	A separate window is open for insurance and without insurance patients				
4	All appointed patients are given priority				
5	LCD screen always shows the patients information with the schedule				
6	All patients are organised in a manner				
7	All walk-in patients take a Q-Matic number after entry				
8	All instructions are posted properly				
9	All appointments are given by the receptionist				
10	Any additional solution implemented for further improvements				

5 Results and discussion

LSS framework facilities effective problem explanation and higher authority commitment for bringing effective improvement in the service process. It develops a good relationship between top management, staff, and customers for maintaining improvements in service organisations. The same explanation has been provided by the various studies (Bhat et al., 2019; Narottam et al., 2020; Swarnakar et al. 2020a, 2020b). The present study developed an LSS framework to reduce the patient waiting time and improve the service quality of the gynecology and obstetrics department of one healthcare organisation located in India. The case hospital is in the initial stage of deploying the LSS framework

and planning for big savings. The implementation of the LSS framework enabled the improvement in terms of various key metrics such as waiting time, patients count, and cost. The adoption of a standard housekeeping program also helps to rectify customer complaints, identify customer demands, and bring cultural changes in organisations. Researchers also entail the standard housekeeping program helps to implement LSS in the organisation successfully (Improta et al., 2019; Swarnakar and Vinodh, 2016; Henrique and Filho, 2020). The present study observed a huge amount of non-value added activities in the service process, which increases the patient waiting time and leads to excess crowed in the hospital. After a successful deployment of the LSS framework, certain improvement in key metrics has been observed as shown in Table 3. The improvements are calculated in terms of patient count and savings from the perspective of money and time. The findings of the present study encourage researchers, practitioners, healthcare planners, and decision-makers to perform a similar study in other organisations to reduce the waiting time and improve the service quality of the organisation.

5.1 Managerial/practical implications

The present study focuses on deploying the LSS framework in the gynecology and obstetrics department of a multinational hospital for reducing patient waiting time and improving the service quality of the organisation. For initiating the deployment process, management, or higher authority approval is needed to initiate the implementation process of the LSS framework. After approval, the development of LSS framework starts with the systematic analysis of the problem and a detailed investigation of the process. The structured training is required to understand the knowledge of LSS tools and techniques for model development and a detailed implementation process. The practitioners are being trained with appropriate tools required for framework development. The team members are also needed to provide structured training by LSS experts, this may help in the effective participation of staff towards LSS implementation. Once the model has to be framed with a structured SS Define-Measure-Analysis-Improve-Control phase, the framework has to be presented with management. Further, the framework has to be executed in the organisation and improvement needs to be observed in terms of various key metrics. The structured procedure has to be provided for timely control of the process that helps to sustain the process in long run.

6 Conclusions

The purpose of the present study is to implement LSS for reducing the patients waiting time in the gynecology and obstetrics department. The study was conducted in one multinational hospital situated in India. The systematic study was performed on case organisation by the LSS experts to analyse the root causes of current patients waiting time problems. Several LSS tools and techniques were applied during the analysis such as project charter, Pareto chart, cause and effect diagram, X-bar chart, Dunnett's test, process capability analysis, cost-benefit analysis, etc. The system was analysed with the help of Arena simulation software, a further comparison was presented in the form of final improvement results. The possible improvement has been observed and suggested to top-level management. A systematic solution has also been provided to top-level

management to improve the current system. Based on the improvement cost-benefit analysis was performed for this study and improvement has been observed in the form of net benefits of the organisation. The net benefits for 9 years were calculated as Rs. 292,981,025. The study also provided a checklist to check and control the system to achieve net benefits. The organisation successfully implemented the LSS framework in its organisation and initially calculating the benefits. The present study guides practitioners, researchers, decision-makers, healthcare managers to systematically develop and implement the LSS framework in a healthcare organisation and thereby resolve the related problems. This study also encourages researchers to perform the same study in other healthcare organisations to reduce the waiting time and improve the service quality of healthcare organisations.

6.1 Limitations and future work

The present study successfully developed the LSS framework and implemented it in a gynecology and obstetrics department of a case organisation. The developed framework was integrated with different tools and techniques based on LSS-DMAIC methodology. The model was developed based on the problem of the case hospital and the tools were selected based on current requirements. Therefore, the model may observe different outcomes for different organisations. The tools and techniques used in this model were based on the experience of LSS experts; hence the developed model can be fitted in any other healthcare organisation by adding new LSS tools based on the applicability of problems. The present study developed an LSS framework for a single unit of organisation, near future framework will be developed for the whole hospital. The new and advanced tools could be included for increasing effectiveness. Further, this study does not evaluate success and failure factors, in the future, it can be included. Besides this, the sustainability assessment could be also considered. The authors trust that the present study provided a foundation for practitioners, researchers to further extend the research in the area of LSS deployment in the healthcare environment.

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