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A Review of Lean Six Sigma in the Healthcare Sector among Asian Countries

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ABSTRACT

Purpose: This review article aims to provide information on using Lean Six Sigma (LSS) methodologies in improving quality healthcare processes and services based on various research and studies conducted in Asia.

Method: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was used in this review article, with the main topic of LSS used in the health sector in Asian countries.

Results: Most of the research was empirical, generally conducted from 2016 to 2021. The research articles deal mainly with the management process (4), followed by the medical process (3) and general process (2).

Conclusion: With an emphasis on Asian countries, crucial challenges faced by their health sectors were encountered despite the painstaking effort to improve healthcare services using the LSS. It was sought that LSS be applied more to medical processes rather than focusing on the whole organization. The collaborative effort for quality improvement will be more practical if it is addressed initially by each department or section. Empirical research conducted in developing countries sought critical factors that may affect the full implementation of LSS, such as commitment and leadership of the management, financial capabilities, employee training, and availability of experts. Moreover, continuous monitoring and evaluation for improvement after LSS implementation was strongly suggested to achieve sustainability.

Keywords: *Lean Six Sigma, healthcare sector, Asian countries*

Introduction

Healthcare institutions deal with endless demands to provide the needs and requirements of their patients, employees, and even the organization, necessitating state-of-the-art strategies and approaches. Hospitals have a business orientation and need to maintain an urgent provision of service to attract clients. Several methodologies would be applicable to improve hospitals' business processes and operations.

In the world of business, Six Sigma is a set of methodologies and tools utilized to improve business processes by reducing defects and errors, minimizing variation, and increasing quality and efficiency so that a nearly perfect level of quality with only 3.4 defects per million opportunities is achieved [1] or to reach 99.9997% accuracy [2]. This has been widely used in the health field for process or quality improvement, constituting a profusely investigated topic [2]. The Six Sigma system, defined, measured, analyzed, improved, and controlled (DMAIC), identifies and solves problems [3]. Lean management is a management method that supports the concept of continuous improvement. These sustainable approach processes systematically seek to achieve gradual changes in the processes to improve efficiency and quality [7].

Commonly in developing Asian countries, increasing the efficiency of the healthcare system may address the financial issues of healthcare institutions to maintain or improve outcomes [4]. For instance, in India, it was observed that LSS implementations have transformed both clinical and non-clinical processes among the hospitals such that it cut costs by 20 percent by embarking on Lean deployment [18]. Because of this perspective, research done by scholars and professionals among medical organizations using Six Sigma to improve healthcare processes is gaining more attention in the world of the healthcare system [5,6]. This review article provides information on using Lean Six Sigma methodologies to improve quality healthcare processes and services based on various research and studies.

Method

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was used in this review article, which follows (3) significant phases as shown in Figure 1. Identifying topics on Lean Six Sigma Methodologies and the healthcare Sector from databases is the first phase, followed by the

screening phase, which eliminates all articles published for more than ten years, are limited to English, and are exclusive only to Asian Countries. Further screening, filtered studies that cannot access the full-text version, and excluding articles with combined other methodologies with LSS. Out of 80 articles, nine were included, which satisfied all the inclusion criteria. The review used journal databases such as ResearchGate, PubMed Central, Emerald Insight, and Google Scholar. The search strategy was established for the articles which determine the inclusive/ exclusive criteria as follows: (1) focused on the topic related to Lean Six Sigma methodology; (2) topics related to the healthcare sector; (3) limited to the English language; (4) recent articles from 2014 until present; and (4) confined in Asian countries only.

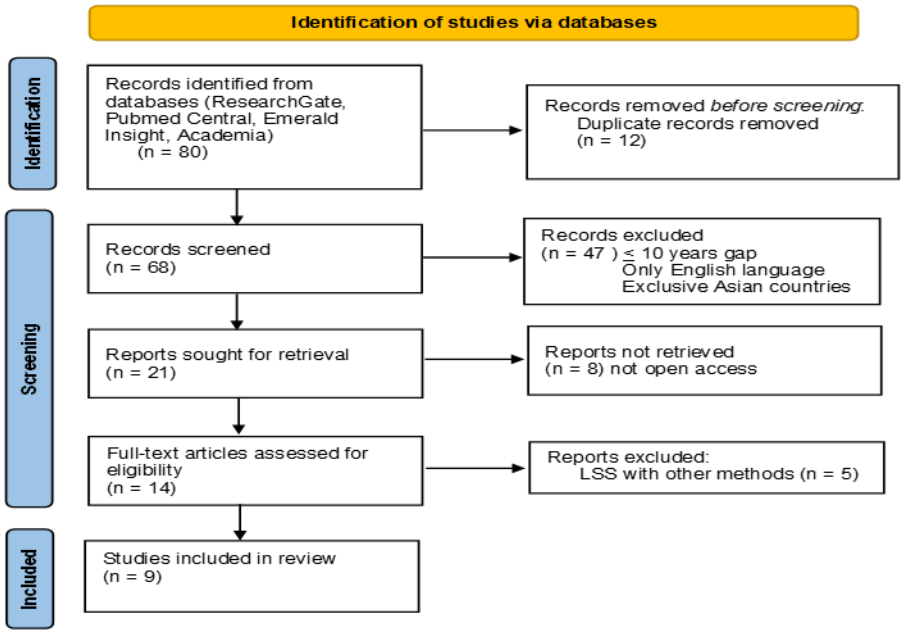

Figure 1. Systematic Literature Review Flow Process

Figure 2 shows how the articles were characterized based on research category and time of conduct. The research category is categorized into four types: conceptual, descriptive, empirical, and exploratory. Conceptual research represents theories and ideas developed using observations but without experimentation [8]. A descriptive research study represents all the significant contributions, changes, or things happening concerning the field under the project scope [9]. An empirical research study is an experimental study that uses observational methods to collect data, then experimentation is done to verify those observations [10]. The time indicates the year in which the study was conducted or published. The search started on May 19, 2024.

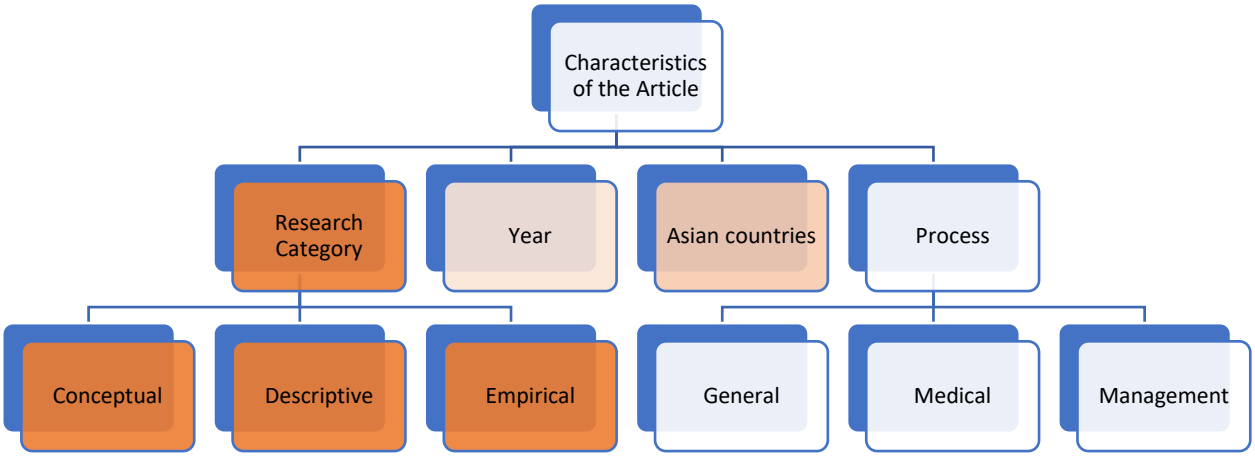

Figure 2. Characterization of the Articles

Results and Discussion

Most of the research articles were conducted in India (2) and Saudi Arabia (2), where most were empirical types that were mostly recently performed in 2014 and 2019. The research articles deal mainly with the management process (4), followed by the medical process (3) and general process (2).

Based on this review, starting in 2016, Asian nations showed breakthrough interest in using Lean Six Sigma to address issues or problems in their healthcare sector. This dramatic increase in research studies in Asian countries is because each place demonstrates varied, unique issues and problems in the health sector [13] and thus requires unique solutions.

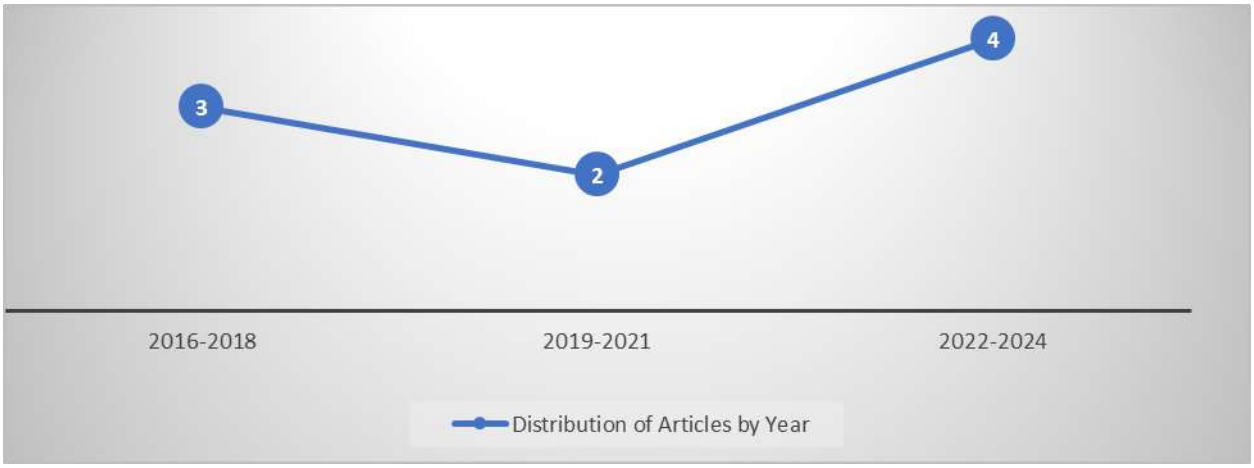

Figure 3. Distribution of Articles based on the year of publication (n = 9).

Among the Asian countries, India and Saudi Arabia were observed to have prevalent research about Lean Six Sigma in the healthcare sector, considering its rapid expansion in revenue and employment in this sector [14]. Other Asian countries find this matter a hassle as it entails financial challenges and legislation. Legal mandates, accreditation, and administrative regulations are seen as factors that affect quality in the healthcare sector by controlling entry into the practice of healthcare [15].

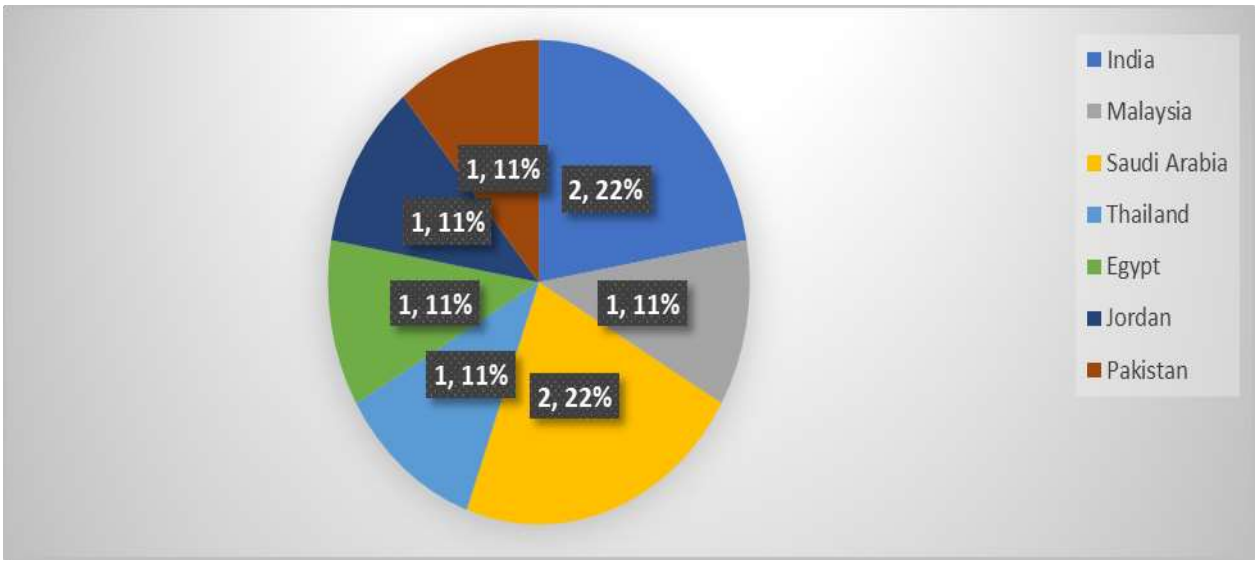

Figure 4. Distribution of Articles according to region of conduct of LSS implementation (n = 9).

According to the results from the empirical research, multiple processes and services have used this tool, mainly management processes. This may be attributed to using quality management systems as crucial in ensuring efficiency because committing errors may seriously harm patients [11]. Moreover, the objectives of these empirical researches are to improve the quality of service and increase or maintain the satisfaction of patients by reducing time, cost-cutting, and minimizing committing errors using Lean Six Sigma methodologies [12]. Empirical research in developing countries sought critical factors that may affect the full implementation of LSS, such as management willingness and effective leadership, resource and financial capabilities, employee training and trust, and availability of expertise and knowledge.

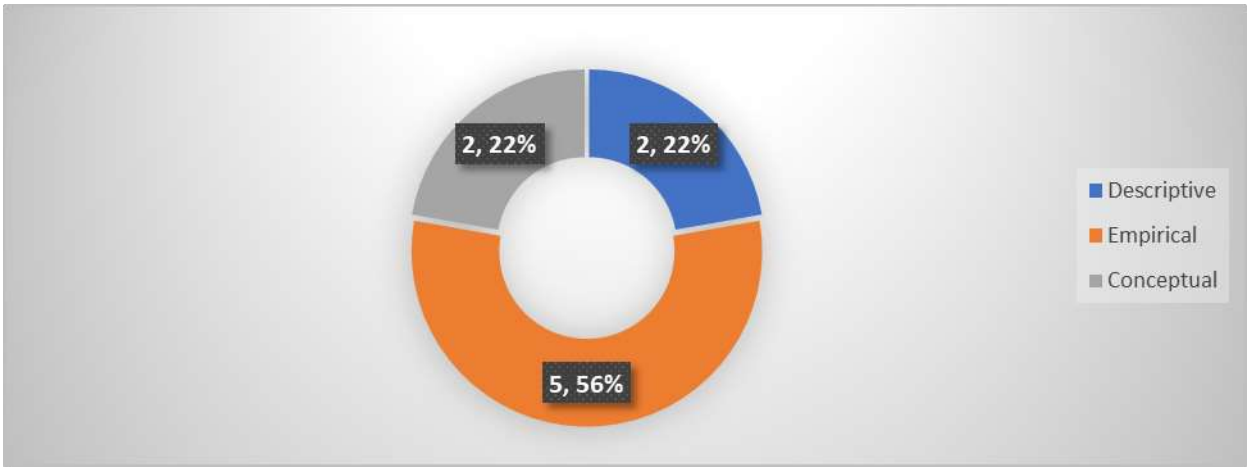

Figure 5. Distribution of Articles according to research category (n =9) of LSS implementation

Distribution of the articles according to process mainly focuses on the managerial process in the health sector, as strategic management is becoming increasingly important for sustainable management in healthcare [16]. Regarding the medical process sought from the articles, the LSS was used in emergency departments, nursing services, and laboratories. The general process includes all the aspects of the health sector, not only in hospitals but also primary health facilities.

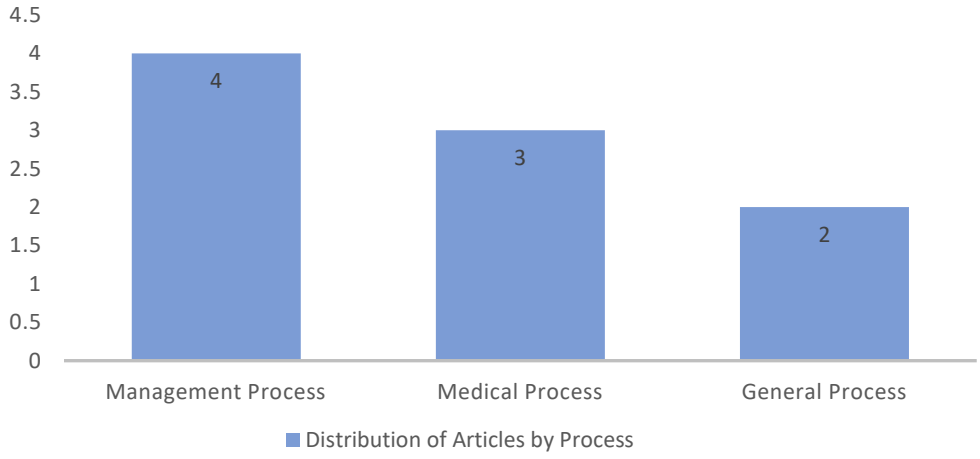

Figure 6. Distribution of Articles according to the Process the LSS was implemented (n = 9)

The following are the Lean Six Sigma implementation benefits:

A. Medical process:

1. Improve the timeliness of routine CBC results in the hematology laboratory. The Sigma level improved from 2.4 to 3.7.
2. Turnaround time (TAT) of the medical records preparation process was reduced from an average of 19 minutes to 8 minutes, and the standard deviation was reduced by one-tenth.
3. The inventory of medical records was reduced from 40 units to 0.
4. The project reduced the staffing level from the earlier level of six to the current level of four.
5. Decreased dispensing errors from 6 to 2 incidents, representing a 66.66% reduction.
6. Improvement of communication channels between the hospital pharmacy and the pharmacy technicians.
7. Provide significant improvements by doing simple and minor modifications within the system specific to the person, process, and place; the cumulative effect of the steps outlined will support more significant changes in how the system runs and the quality of service given.
8. It will improve staff efficiency and stakeholders' satisfaction and reduce waste and service costs.
9. It will enhance the value of the care delivered to patients.

B. General process:

1. Reduced delayed physician response by 2% for urgent cases and a 5% reduction for typical or non-urgent cases in the referral system.
2. Private hospital staff perceive Lean management initiatives, Six Sigma initiatives, patient safety, and teamwork more favorably than public hospital staff.
3. Senior hospital staff (more than ten years of working experience) perceive patient safety and teamwork more favorably than other working experience groups.

C. Management process:

1. Revealed a new practical method to select projects based on criticality.
2. It showed how we can include competing performance measures in one calculated measure we call the importance index.
3. Revealed a framework that aligns with Six Sigma teachings and the decision maker's priorities.
4. Provides direction for the formulation of long-term policies.

The following are the implications and future opportunities provided by the implementation of LSS in the healthcare sector:

1. This well-structured methodology adapts to different settings, resources, and personnel, including public healthcare facilities in low- and middle-income countries.
2. Although generalizing the specific results of the study is limited, the approach adopted, and the lessons learned from this study can be generalized.
3. PDCA (Plan, do, check, and act), DMADV (design, measure, analyze and improve), JIT (just in time), QFD (quality Function Development), FMEA (Failure mode and effect analysis), and many other quality improvement methodologies can be adopted for enhancing the hospital quality management system.
4. Recommendations to achieve sustainability:

a) adequate and ongoing awareness and training facilities be provided to the related staff b) a reward system or some other such system be implemented to increase motivation, which is crucial for continuous improvement

c) Create a dashboard for monitoring the agreed KPIs and taking proper action on the spot to overcome any difficulties.

Based on the reviewed articles, several factors affect the implementation of LSS, including management commitment and leadership, financial capabilities, employee training, and the availability of experts.

Conclusion

Lean Six Sigma is widely known and utilized in manufacturing alone [17]. With the advancement in technology and increasing interest among scholars in the health sector, this method can also be used to improve the quality of service [13]. The collaborative nature of work in the health sector best suits the implementation of LSS in improving aspects that are deemed necessary.

The prevalence of research in Asian countries may vary according to their specific health needs and demands. However, research about LSS in the health sector in the Philippines is nil in publications except in the engineering sector [18].

The researcher finds the gap in the few articles sought for developing countries because most are not related to the healthcare sector, and others may be related but need to use the English language.

Table 1. Summary of the final screened articles about Lean Six Sigma Methodologies in the Healthcare Sector from Asian countries.

Search	**Reference**	**Title of the Study**	**Lean Six Sigma implementation focus areas**	**Lean Six Sigma methodology implemented**	**Lean Six Sigma tools and techniques used**	**Lean Six Sigma Implementation benefits**	**Implication**
1.	Bhat, S., Gijo, E.V. and Jnanesh, N.A. (2016)	Productivity and performance improvement in the medical records department of a hospital: An application of Lean Six Sigma	Medical Records Department (MRD)	LSS Approach	Problem Definition, Literature Review, Project Design, and Data Analysis (Bryman and Bell, 2006)	Turn-Around-Time (TAT) of medical records preparation process was reduced from an average of 19 to 8 minutes, the standard deviation was reduced by one-tenth. Reduced in the work-in-process inventory of medical records from 40 units to 0 at the end of the day. Project in-turn reduced the staffing level from the earlier level of six to the current level of four.	Generalization of the results is limited to the study, but it can be adopted and learned.
2.	Alkinaidri A., Alsulami H. (2018)	The Lean Six Sigma approach has improved the hospital referral system.	Referral process	DMAIC methodology		Improvement in compliance with physician response to the urgency and non-urgency of the cases in the referral system.	It promotes sustainability by providing staff with awareness and training, implementing systems to increase motivation,

							and creating constant monitoring, such as dashboard monitoring for KPIs , to adequately address difficulties.
3.	Ahmed, S., Abd Manaf, N.H. and Islam, R. (2018)	Measuring Lean Six Sigma and quality performance for healthcare organizations	Quality performance in Malaysian hospitals using LSS methodologies	Self-administered survey questionnaire	Data analysis based on reliability analysis, exploratory factor analysis (EFA), independent samples t-tests, and one-way ANOVA	* Lean management initiatives and Six Sigma initiatives, patient safety, and teamwork have significant differences between public and private hospital staff. *Six Sigma initiatives, Lean management initiatives, teamwork, and patient safety are perceived by private hospital staff favorably compared to public hospital staff. *Senior hospital staff (more than ten years of working experience) perceive patient safety and teamwork more favorably compared to other working experience groups.	Results are exclusively limited to the Malaysian health sector and do not apply to other countries.
4 4.	Gutierrez-Villalpando, T., Cárdenas-Cuevas, M., Pérez, L.,	Lean Tools implementation for scrap reduction in a production line - A Case	Registration process in the Health Information Department (HID)	LSS DMAIC methodology	*formulating the research problem *literature survey	Improvements in the HID through the power of LSS.	The result is limited to this study but can be adopted and learned.

	Gutierrez, E., & Zavala, A. (2022)	study. IIE Annual Conference. Proceedings			*preparing the research Design *collecting the data *analysis of data *hypothesis testing *interpretation and implementation of results	Reduction in patients' average waiting time. Reduction in queue length. Reduction in the percentage of scheduled utilization of staff for the process.	
5.	Buestan, M., & Perez, C. (2022).	Identification of Predictive Nursing Workload Factors: A Six Sigma Approach. Sustainability, 14(20), 13169	Healthcare logistics	DMAIC methodology	Six Sigma in healthcare logistics. Case study implementing the proposed the framework at Jordanian hospitals.	*Revealed a new practical method to select projects based on criticality. *Showed how we can include competing performance measures in one calculated measure we called importance index. *Revealed a framework that is in line with Six Sigma teachings and with the decision maker's priorities.	Six Sigma is a management tool. Hospital management may differ from that of a typical company; thus, future research may also reveal obstacles and opportunities when dealing with hospital management while implementing a Six Sigma project in healthcare logistics.
6.	Trakulsunti, Y., Antony, J., Dempsey, M. and Brennan, A. (2021)	Reducing medication errors using Lean Six Sigma methodology in a Thai hospital: an action research study	Pharmacy	Used the Lean Six Sigma Define, Measure, Analyze, Improve, Control (DMAIC) methodology	Define, Measure, Analyze, Improve, Control (DMAIC) methodology	Dispensing errors decreased from 6 to 2 incidents, representing a 66.66% reduction. Improvement in the communication channels between the hospital	The result is limited to this study but can be adopted and learned.

						pharmacy and the pharmacy technicians .	
7.	Tufail, M. M. B., Shakeel, M., Sheikh, F., & Anjum, N. (2021).	Implementation of lean Six-Sigma project in enhancing health care service quality during COVID-19 pandemic	Hospital system	DMAIC lean six-sigma problem-solving methodology	* Voice of Customer (VOC) and Supplier, Inputs, Process, Outputs, Customers (SIPOC) processes, *fishbone diagram *Kano model *proposed process improvement by incorporating Kaizen process improvement methodology	It integrates different LSS tools aligned with the DMAIC process to solve the hospital's operational complications. Provides direction for the formulation of long-term policies.	PDCA (Plan, do, check, and act), DMADV (design, measure, analyze and improve), JIT (just in time), QFD (quality Function Development), FMEA (Failure mode and effect analysis), and many other quality improvement methodologies can be adopted for enhancing the hospital quality management system.
8.	Ibrahim, I., et.al. (2022)	Using Lean Six Sigma to improve timeliness of clinical laboratory test results in a university hospital in Egypt	Hematology Laboratory	LSS DMAIC methodology	Pareto charts, flowcharts, Spaghetti diagrams,	The use of LSS successfully improves the timeliness of inpatient routine CBC tests. only 1% of inpatient routine CBCs were verified later than the desired target compared to 19% in the measure phase. The Sigma level improved from 2.4 to 3.7.	The principles and tools used are universal, customizable, and can hence be used in any other set of processes, people and place
9.	Al Owad, A., Yadav, N., Kumar, V., Swarnakar, V., Jayakrishna, K., Haridy, S. and Yadav, V. (2023)	Integrated Lean Six Sigma and Kotter change management framework for emergency healthcare services in Saudi Arabia	Emergency care unit (ECU)	Literature review structure	Proposed integrated LSS Kotter Framework	*Provide significant improvements by doing simple and minor modifications within the system specific to the person, process, and	Healthcare managers or planners can use the same methodological steps followed in the present study and develop a new framework for other regions.

						place; the cumulative effect of the steps outlined will support more significant changes in the way the The system runs, and the quality of service is given. *Will improve staff efficiency and stakeholders' satisfaction and reduce waste and service costs. * Will improve the value of the care delivered to patients	It has yet to be tested in a real-life setting.

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CONFLICT OF INTEREST

The author has no conflict of interest to declare.

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ETHICAL APPROVAL

This article does not involve any utilization of test animals or human subjects.

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