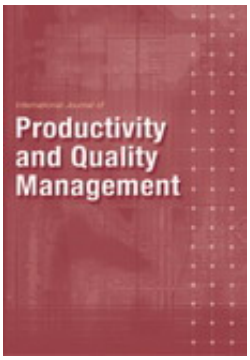

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Comprehending the deployment intention of Lean Six Sigma in healthcare: the moderating role of change management

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Comprehending the deployment intention of Lean Six Sigma in healthcare: the moderating role of change management

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Abstract: In the healthcare sector, high-quality and quicker patient services are paramount. Due to these operations priorities, Lean Six Sigma practices have received considerable attention as a viable option for process improvement. However, the intention among healthcare managers to deploy this proven methodology is relatively low, considering varying difficulties in the adoption process. This study aims to understand the direct effects of these difficulties on the deployment intention of healthcare leaders in India. Furthermore, the central focus of this study is to examine the role of change management in moderating the relationships between these challenges and the intention to deploy LSS. The data for this study is collected from 160 doctors in India who are in managerial/leadership positions in different private hospitals. Partial least square-based structural equation modelling is used to estimate various relationships. The findings offer crucial insights for academicians and practitioners in the field of LSS and healthcare.

Keywords: Lean Six Sigma; LSS; change management; healthcare; deployment intention; India.

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1 Introduction

Healthcare businesses are constantly seeking continuous quality improvement (QI) methodologies such as total quality management (TQM), Lean, Six Sigma, and Lean Six Sigma (LSS) to fulfil the increasing demand for high-quality services (Vaishnavi and Suresh, 2021). LSS, with its hybrid nature, addresses the shortcomings of stand-alone Lean or Six Sigma methods by reducing process variances and wastes, which results in increased customer satisfaction and bottom-line benefits for businesses (Sunder et al., 2018). Unlike manufacturing organisations, the quantum of variation in the healthcare sector is very high. It is because the principal customer in healthcare is the patient, and each patient is different from others. Again the impact of non-material wastes related to time, motion and employee morale, etc. in a healthcare process is highly sensitive as it deals with the life of human beings. Hence, implementing a QI methodology such as LSS is paramount in this sector.

The level of ease or difficulty in deploying a new methodology in any organisation influences the perception of its adoption. Also, the various challenges in deploying LSS in healthcare are the deciding factor for its adoption. Assessing these challenges beforehand helps uncover the gap between the current and target states. The risk associated with attempting the change can be reduced as the gap is more clearly defined and minimised. The role of change management (CM) in closing this gap is the main focus of this study. Effective implementation of LSS requires not only project management but also CM. The focus of project management is on the activities that need to be completed to meet project requirements, whereas the direction of CM is on the human aspects of participation. There is a pressing need to investigate the aspects of communication and culture change regarding LSS implementation (Gupta et al., 2020).

1.1 Motivation for the study

Most healthcare industries rely on efficiency and effectiveness to remain competitive in the healthcare market. LSS helps healthcare organisations deliver superior service and improve processes while reducing waste to meet the current needs of their customers to stay competitive (Sunder et al., 2020). Well-designed reforms can enhance organisational effectiveness and efficiency, but management must focus on employee resistance, which can pose a long-term threat (Kumar et al., 2011). A recent review of quality management practices in the 21st century reveals the lack of employee involvement in enterprises concerning business model development and tactics (Gunasekaran et al., 2019). Also, for the implemented change through quality management practice to be successful and sustainable, the approaches carried out by the management to harness human values are predominant (Khan and Smuts, 2019). So far, no studies have explored the interaction effects of CM aspects in moderating the relationship between the LSS challenges and the deployment intention. Therefore, this study attempts to understand the notion of healthcare managers on the direct relationship between various challenges and the deployment intention of LSS in the healthcare environment. The impact of CM in moderating this direct relationship is also explored. Therefore, the objectives of the study are:

- To examine and understand the challenges at various levels of healthcare organisations in deploying LSS.
- To evaluate the role of CM in moderating the interaction between the various challenges and deployment intention.

2 Review of literature

The review comprises a detailed summary of existing literature on the following three perspectives.

2.1 LSS application in healthcare

LSS methodology is a hybrid approach that synergises the Lean and Six Sigma methods (Sunder et al., 2018) by utilising tools from both Lean and Six Sigma (Trakulsunti et al., 2020). Six sigma was first developed and implemented in Motorola to reduce variation in the process (Teller et al., 2020), while Lean was developed by Toyota motor corporation to eliminate waste and add value (Wilson et al., 2020). The healthcare industry has identified and tested several QI methods to improve quality and reduce costs (D'Andreamatteo et al., 2015). LSS is one of the QI methods that helps to enhance performance by process improvisation (Peimbert-García, 2019).

In most developing countries, the healthcare sector is one of the fastest-growing parts of the economy. The healthcare industry has significantly impacted economic growth and social welfare in modern economies. In reality, this sector's performance is quite unsatisfactory. Long wait times, inefficiency, low productivity, stressed medical staff, and unhappy patients are all signs of how this sector is doing. Continuous improvement methods like LSS give hospital administrations hard evidence about current practices,

values, beliefs, and assumptions. It also helps the administration develop a systematic way to find problems and improve its future performance. The comprehensive review of 154 case studies by Samanta et al. (2023) documented the process improvements by LSS in terms of quality, cost, delivery, growth, and productivity in various healthcare settings worldwide. LSS intervention resulted in the following benefits: reduced overcrowding (Didden et al., 2019), maximising equipment efficiency (Tekes et al., 2016), decreased turnaround time (Bhat and Jnanesh, 2013), a higher number of patients undergoing surgery in 48 hours (Murphy et al., 2019), CT dose optimisation (Greenwood et al., 2015), and reduced hemolysis by 91% in emergency care centre (Damato and Rickard, 2015), etc. to mention a few. The rise in popularity of LSS in the healthcare industry can be attributed to its growing interest to improve the quality. However, initiating the process of LSS implementation in healthcare organisations is arduous due to certain crucial factors.

2.2 Challenges in deploying LSS in healthcare

A comprehensive examination of the literature provides the essential foundational process necessary for the effective application of LSS in healthcare firms. It was found that leadership, organisational culture, communication, training, measurement and reward systems, a decentralised management style, and an end-to-end process view were all essential in the field of healthcare (Bakar et al., 2015). It was underlined as a crucial requirement for the project's success to have top-level management support and continuous interaction with the stakeholders. The dedication of a team to the transition and the availability of data was also cited as critical success factors, in addition to employee participation in the project, clear communication of project goals, and the availability of data (Raval et al., 2018).

LSS is more challenging to execute in service sectors since many relevant indicators (e.g., procedures, customer expectations, demand, and strategy) are hard to assess because they are subjective and perceptual (Radnor et al., 2012). Over the previous decade, several different studies (Antony, 2014; Bakar et al., 2015; Swarnakar et al., 2020; Vaishnavi and Suresh, 2021) assessed the barriers/challenges of LSS in healthcare. Determining the degree of challenge in the healthcare organisations to deploy LSS would help know the potential of an organisation to make the change process effective. The organisation would be able to measure the ability within the organisation, improve the organisational capabilities, and enrich the organisation if they can assess LSS implementation challenges. They would also be able to determine the level of motivation among employees for delivering and implementing change. Before the organisational change is implemented, it is anticipated that the assessment will govern how prepared employees are for the change. It is in this context the role of CM is considered.

2.3 Role of CM in adopting a new methodology

CM has been defined as the process of renewing the organisation concerning physical, social, technological, political, and other external environments to meet the market's ever-changing needs (Gilani et al., 2018). CM methods are highly valued because they enable the application of new approaches in complex and unique health situations and provide change-guiding principles suitable for use in synergy with implementation and improvement methods (Harrison et al., 2021). Although the initiative to deploy an

improvement method like LSS is essential in healthcare, even it is more important to integrate this LSS into the organisation's culture and CM (Neufeld et al., 2013). Therefore, when the tools of CM are appropriately utilised in adopting LSS, the acceptance of change by the workforce will be smooth (Antony et al., 2007). Because whenever an improvement initiative is deployed, the employee will resist as people, by nature, resist change (Jacobsen, 2008). Integrating CM within the LSS deployment process will help bring the communication, motivation and required training to mitigate the resistance to change (Lertwattanapongchai and Swierczek, 2014).

Many CM models are available in the literature. However, specific models such as General Electric's change acceleration process (CAP), The McKinsey 7-S model, Kurt Lewin's CM model, Kotter's 8-step change model, and awareness, desire, knowledge, ability, and reinforcement (ADKAR) are considered the most favoured and tested models (Galli, 2018). The general process of CM constitutes evolving from the current state to the desired state by applying a set of tools in a structured manner for leading the people side of change to achieve the desired outcome (Rosenbaum et al., 2018). Whenever any improvement initiative is deployed, most employees resist the change if they do not understand the process, tools, terminologies, etc. Discarding this human side of the problem and devoting time and resources to the technical side will limit the people's engagement in the deployment process (Ray et al., 2013). Educating the workforce will develop the analytical and reasoning capabilities to perform effectively (O'Reilly et al., 2019). Appropriate training is highly pertinent when an organisation wants to execute the LSS approach (Shokri et al., 2016; Antony et al., 2018).

Previous literature has documented the improvements in the operational efficiency of the implementation of LSS in healthcare (Sanders and Karr, 2015; Molla et al., 2018; Ortiz-Barrios and Alfaro-Saiz, 2020; Baker et al., 2020). But, none of these studies discussed cultural change; instead, these studies focus on process changes during and after LSS implementation. Considering these aspects, this study will investigate the role of the CM approach in moderating the direct relation of various challenges with the deployment intention of LSS.

3 Methodology

A three-step procedure starts with

a identification of constructs

b questionnaire development

c data collection and hypotheses formulation.

A conceptual model is developed with six constructs and 31 indicators. Further hypotheses were formulated and tested for their acceptance using partial least square-based structural equation modelling (PLS-SEM) through Smart PLS software which is highly recognised by researchers and practitioners (Hair et al., 2019). The following sections explain the step-by-step approach to analysing the relationship between the chosen constructs and how they will impact the implementation process.

Table 1 Developed constructs for LSS challenges and their indicators

Constructs	*Definition*	*Indicators*
Organisational challenge (OC)	The present research defines OC as the difficulty of operating and managing organisational barriers concerning LSS.	Leadership support (OC1)
		Supportive organisational culture (OC2)
		Deployment infrastructure (OC3)
		Consistent and accurate data collection (OC4)
		Recognition and reward system (OC5)
Inherent LSS challenge (ILC)	The extent to which specialised LSS knowledge is imparted and the performance measured as LSS involve significant statistical concepts and tools that are difficult to understand and emulate.	Training and workshops (ILC1)
		Uncertain implementation cost (ILC2)
		Wrong selection of LSS tools (ILC3)
		Time required to implement and reap benefits (ILC4)
		Lack of awareness of the need for LSS (ILC5)
		Lack of a performance measurement system (ILC6)
Human resource challenge (HRC)	The current research extends this definition to incorporate the people side of change while adopting the LSS methodology.	Lack of technical expertise (HRC1)
		Resistance to culture change (HRC2)
		Employee trust (HRC3)
		Employee empowerment (HRC4)
		Teamwork (HRC5)
		Stakeholders' commitment (HRC6)
External challenge (EC)	The perceived degree of difficulty in managing external factors for LSS deployment.	Lack of customer involvement (EC1)
		Uncertainty and competition (EC2)
		Effective use of technology (EC3)
		Lack of supplier and other stakeholders involvement (EC4)

Source: Taken from Yadav and Desai (2017) and Yadav et al. (2018)

3.1 Identification of indicators and constructs

A comprehensive literature review has been consolidated by the authors with respect to challenges/barriers to LSS deployment in healthcare organisations all the factors/ indicators that were considered barriers/challenges for the LSS deployment were filtered out. Various researchers previously used these selected indicators and validated them at their point of application. After careful evaluation, it is found that the indicators used by the researchers that represent challenges/barriers to LSS deployment are mostly repetitive. Two studies (Yadav et al., 2018; Yadav and Desai, 2017) summarised all of these LSS deployment challenges from previous literature and classified these challenges under different levels.

From these two studies, 21 indicators were chosen which are directly related and can explicitly describe the challenge they impose at various levels while implementing LSS in healthcare organisations. Some of the indicators such as: leadership support, deployment infrastructure, stakeholders' commitment, etc. are presented in neutral sense however, these should be considered in negative sense while representing the respective constructs as challenges. For example, the indicator 'recognition and reward system' should be considered as 'lack of recognition and reward system' with respect to the

construct 'organisational challenge'. These selected indicators are then classified under four specific constructs, as shown in Table 1. The other constructs used in the model development are LSS deployment intention (LDI) and CM. The five indicators to measure the construct LDI specifically in the healthcare context are:

1 need to improve overall hospital performance

2 employee self-esteem

3 future challenges

4 rapid success

5 competition (Dellifraine et al., 2010; Stanton et al., 2014).

Five indicators characterise the construct CM:

1 individual development

2 communication

3 coaching

4 stakeholder resistance

5 monitoring and controlling (Lertwattanapongchai and Swierczek, 2014; Galli, 2018).

3.2 Instrument development and data collection

As the first step in this process, all the indicators were converted into a meaningful question format. A preliminary questionnaire review was done with the help of experts from academia and healthcare institutions. The necessary modification was done as per the advice of review members to improve clarity and internal consistency. The measurement scale for the indicators of the first four constructs (OC, ILC, HRC, and EC) is 1 to 5, with 1 being the least challenging and 5 being the most challenging indicator. For quantifying the indicators of the constructs LDI and CM, the Likert scale of 1 to 5 is used, with one (1) being very low and five (5) being very high.

Healthcare professionals in India are approached by personal visits to them for this survey. These respondents include a combination of experienced doctors and hospital administrative staff in managerial positions. The selection of managers as the respondent for the study is prompted by the fact that either they are aware of the improvement methods like LSS and CM or they can understand easily after a short explanation. Another reason for this selection is that managers have a significant decision-making role in the organisational change process. The data was collected from a total of 160 respondents. The above number is sufficient to match the minimum sample size based on inverse square method criteria for result analysis in Smart PLS software (Kock and Hadaya, 2018). But before this, the hypotheses are stated, and the conceptual model for the research is also prepared.

3.3 Hypothesis formulation

The following section explains the theoretical rationale and the associated hypotheses that imply the relationship among the six constructs considered in this study.

3.3.1 The direct impact of various LSS challenges on the deployment intention

Managers adopt new methods when they believe the new approach is effortless and easy to understand and follow (Rejikumar et al., 2020). The employees' perception of a new method's compatibility, complexity, trainability and observability influence the deployment intention (Wang and Chen, 2010). Hence, it is anticipated that the "lesser the effort required to adopt a new approach, the higher will be the intention to deploy." On the contrary, when the adoption process is challenging, the intention will be low. Therefore, it is hypothesised that all the LSS challenges are negatively related to the deployment intention.

H1 The effect of OC on LDI is significant and negative.

H2 The effect of ILC on LDI is significant and negative.

H3 The effect of HRC on LDI is significant and negative.

H4 The effect of EC on LDI is significant and negative.

3.3.2 Moderating the direct relationship between LSS challenges and deployment intention: the role of CM

A moderator or moderating variable is any variable that affects the association between two or more other variables (Dawson, 2014). According to previous literature in the domain of CM it is evident that CM models can mitigate the various human barriers (McKenney et al., 2015) and organisational barriers (Niaei et al., 2014) for new technology or methodology adoptions. So it is proposed that CM, as a moderator, could impact the association of various challenges and deployment intention in a positive manner. Harrison et al. (2021) proposed the possibility of CM models to complement and support improvement and implementation methods. Hence, it is likely presumed that CM could help mitigate all the selected challenges. Thus it is hypothesised that:

H5 CM positively moderates the relationship between OC and LDI.

H6 CM positively moderates the relationship between ILC and LDI.

H7 CM positively moderates the relationship between HRC and LDI.

H8 CM positively moderates the relationship between EC and LDI.

3.4 Research model

The stated hypotheses are formulated under the impact of the four selected constructs referred to as challenges (OC, ILC, HRC, and EC) on the two constructs, LDI and CM, considering insights from previous literature. A research model is developed considering the assumptions made by the above-stated hypotheses. The proposed research model and the stated hypotheses are presented in Figures 1 and 2, respectively.

Figure 1 Conceptual research model

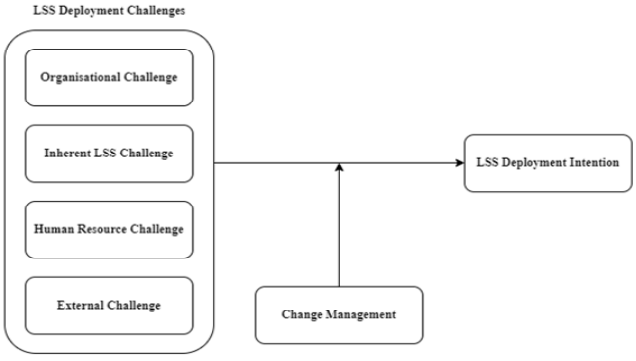
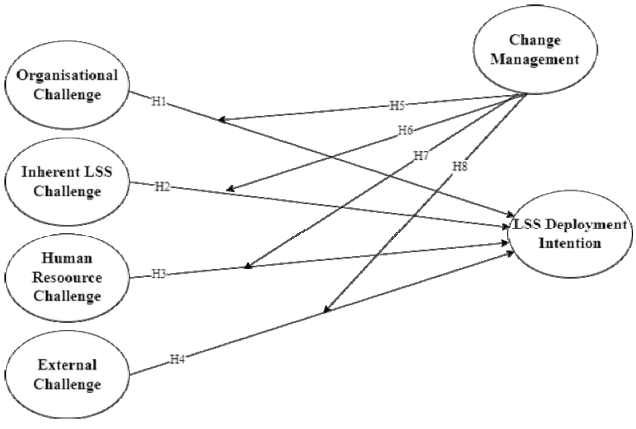


Figure 2 Hypothesis formulation



4 Results of analysis

Smart-PLS 3.3.3, a partial least square-based structural equation modelling tool capable of dealing with multivariate data with normality deviations, is used to estimate the significance level to understand the linkage among different constructs (Hair et al., 2017).

4.1 Reliability and validity measures

The measures of the factor loading assess the reliability of the indicators. A threshold of 0.5 and above is considered as the criteria for acceptability (Chin et al., 2003; Han and Li, 2015). The absolute standardised outer loadings in the model are well within this acceptable limit and range from 0.502 to 0.983. The reliability of the scales was assessed through Cronbach's alpha (CA) test. All latent variables have a CA value of more than 0.7. Hence, the validity of the measurement scales was found to be significant (Bagozzi and Yi, 1988) with values of 0.808 for OC, 0.863 for ILC, 0.917 for HRC, 0.772 for EC, 0.853 for LDI, and 0.886 for CM. The adequate composite reliability (CR) or internal

consistency reliability measured in this study ranged from 0.718 to 0.939 suggesting high level of internal consistency reliability (Hair et al., 2011). Moreover, the present study also met the convergent validity (AVE) threshold of at least 0.5 (Fornell and Larcker, 1981). The above results justify using reliable measures in this study (Table 2).

Table 2 Validity and reliability

Variables	*Indicators*	*Factor loadings*	*Cronbach's alpha (CA)*	*Composite reliability*	*Average variance extracted (AVE)*
Organisational challenge	OC1	0.734	0.808	0.828	0.783
	OC2	0.536			
	OC3	0.701			
	OC4	0.816			
	OC5	0.710			
Inherent LSS challenge	ILC1	0.871	0.863	0.855	0.615
	ILC2	0.577			
	ILC3	0.502			
	ILC4	0.872			
	ILC5	0.784			
	ILC6	0.817			
Human resource challenge	HRC1	0.646	0.917	0.870	0.605
	HRC2	0.511			
	HRC3	0.518			
	HRC4	0.881			
	HRC5	0.854			
	HRC6	0.603			
External challenge	EC1	0.800	0.772	0.794	0.795
	EC2	0.688			
	EC3	0.553			
	EC4	0.749			
LSS deployment intention	LDI1	0.921	0.853	0.718	0.677
	LDI2	0.565			
	LDI3	0.563			
	LDI4	0.838			
	LDI5	0.730			
Change management	CM1	0.959	0.886	0.939	0.807
	CM2	0.779			
	CM3	0.972			
	CM4	0.767			
	CM5	0.983			

Henseler et al. (2015) challenged the capability of Fornell and Larcker's (1981) criterion as the trustworthy measure of discriminant validity in every research area. Hence, this study employed the heterotrait-monotrait (HTMT) ratio to assess discriminant validity,

which should be less than 0.9 as the threshold value (Gold et al., 2001). Prevalent with the criteria, the HTMT ratio is less than 0.9 for each measured variable, as shown in Table 3. The R^2 value for the endogenous variable is found to be 0.614. This value indicates that 61.4% of variations in LDI occurred because of independent variables. As a guideline, the R^2 value of 0.75, 0.5, and 0.25 can be considered robust, moderate, and weak, respectively (Hair et al., 2019).

Table 3 Discriminant validity (HTMT ratio)

Constructs	*Organisational challenge*	*Inherent LSS challenge*	*Human resource challenge*	*External challenge*	*LSS deployment intention*	*Change management*
Organisational challenge						
Inherent LSS challenge	0.708					
Human resource challenge	0.613	0.697				
External challenge	0.598	0.657	0.758			
LSS deployment intention	0.311	0.751	0.584	0.633		
Change management	0.530	0.566	0.736	0.418	0.706	

4.2 Hypothesis testing

The Smart PLS software enables the re-sampling of collected data through bootstrapping to determine the significance of path coefficients. The results are presented in Figure 3 and Table 4.

The findings show that the direct effect of organisational challenge (OC) ($\beta = –0.094$, $t = 2.351$ and $p = 0.018$), inherent LSS challenge (ILC) ($\beta = –0.163$, $t = 3.156$ and $p = 0.001$), and human resource challenge (HRC) ($\beta = –0.350$, $t = 4.927$ and $p = 0.000$) on the LDI is negative and significant. Thus, hypotheses H1, H2, and H3 are supported, while H4 [direct effect of external challenges (EC) on LDI] is not supported ($\beta = –0.035$, $t = 1.139$ and $p = 0.142$). The moderating effect of CM is found to be positive and significant on OC ($\beta = 0.095$, $t = 1.987$ and $p = 0.046$), ILC ($\beta = 0.140$, $t = 2.762$ and $p = 0.031$), and HRC ($\beta = 0.300$, $t = 3.058$ and $p = 0.001$). Hence hypotheses H5, H6, and H7 are supported. In contrast, the moderating effect of CM on EC is positive but insignificant ($\beta = 0.016$, $t = 1.367$ and $p = 0.172$).

For interpreting the moderating effects of CM on various LSS challenges, the interaction plots were drawn (Dawson, 2014), as shown in Figures 4, 5, 6, and 7. Figure 4 outlines that with high CM, there is minimal improvement in the negative relationship between OC and LDI. Figure 5 illustrates that the principles of CM can turn the negative ILC-LDI relation into a neutral one. In the case of the HRC-LDI relationship, the moderating impact of CM is very high. The visible change in the low CM and high CM line slopes in Figure 6 imply that CM contributes to turning the strong negative relationship between HRC and LDI towards a positive relationship. The almost parallel

lines of low CM and high CM in Figure 7 demonstrate very small effect of CM on the EC-LDI relationship.

Figure 3 Path coefficients and outer loading (see online version for colours)

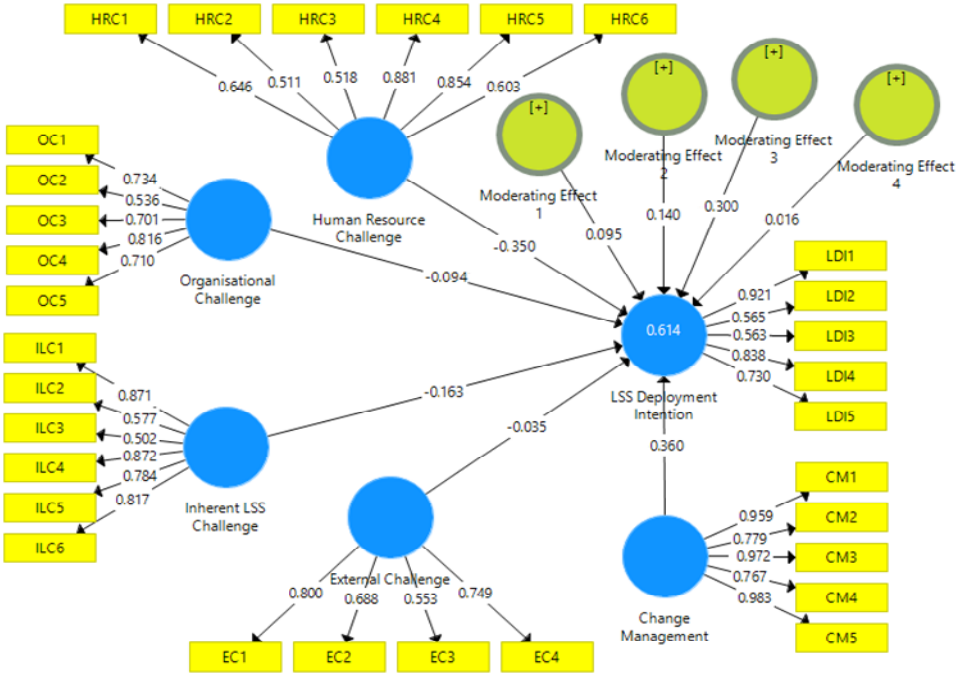


Figure 4 The moderating role of CM on the OC-LDI relationship

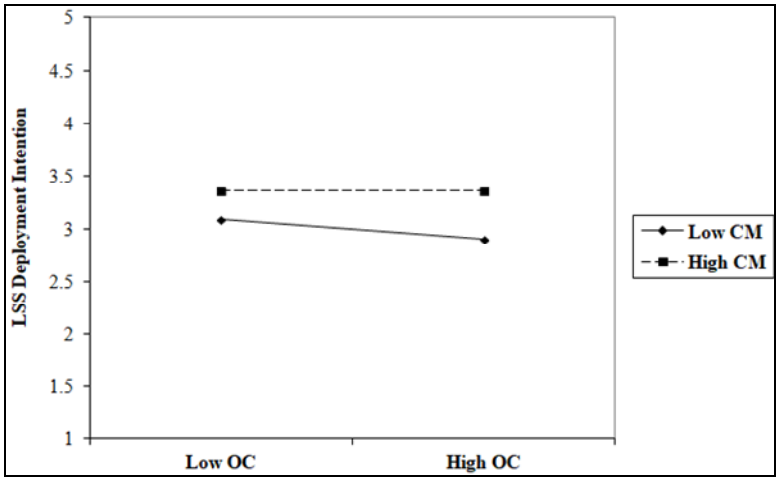


Figure 5 The moderating role of CM on the ILC-LDI relationship

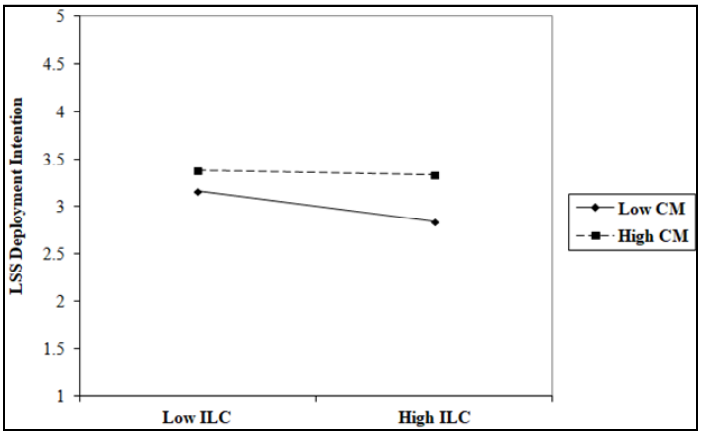


Figure 6 The moderating role of CM on the HRC-LDI relationship

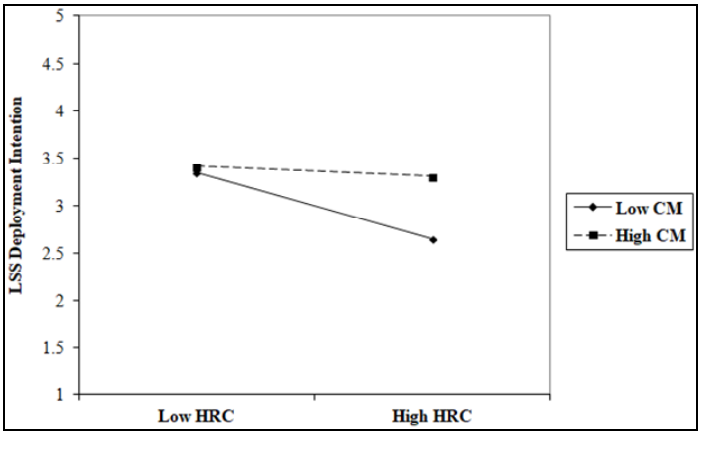


Figure 7 The moderating role of CM on the EC-LDI relationship

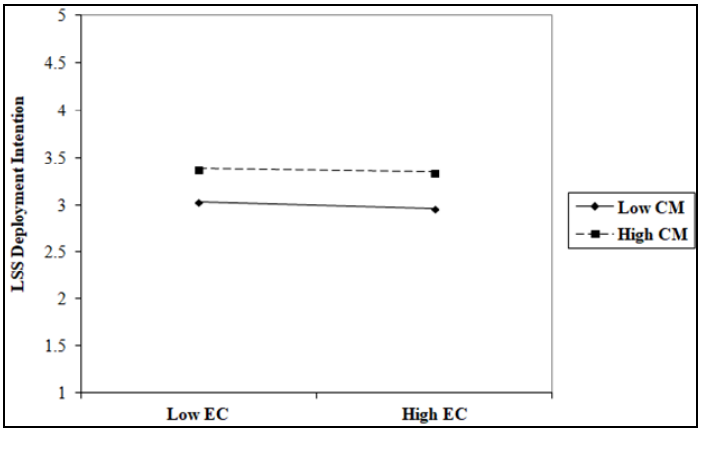


Table 4 Structural model

Hypothesis	*Relationship*	*Path coefficient (β)*	*t statistics*	*p values*	*Decision*
H1	Organisational challenge → LSS deployment intention	–0.094	2.351	0.018	Supported
H2	Inherent LSS challenge → LSS deployment intention	–0.163	3.156	0.001	Supported
H3	Human resource challenge → LSS deployment intention	–0.350	4.927	0.000	Supported
H4	External challenge → LSS deployment intention	–0.035	1.139	0.142	Not supported
H5	Moderating effect 1(OC * CM) → LSS deployment intention	0.095	1.987	0.046	Supported
H6	Moderating effect 2(ILC * CM) → LSS deployment intention	0.140	2.762	0.031	Supported
H7	Moderating effect 3(HRC * CM) → LSS deployment intention	0.300	3.058	0.001	Supported
H8	Moderating effect 4(EC * CM) → LSS deployment intention	0.016	1.367	0.172	Not supported

5 Discussion

The results from the study indicate that healthcare organisations have to overcome all those internal challenges associated with infrastructure, leadership, employees, etc. during the initial phases of LSS adoption. These internal factors, initially considered as barriers, can become LSS facilitators if mitigated properly (Shokri et al., 2016). In turn, these facilitators surmount the distinct barriers specific to LSS, such as the need for expertise, implementation cost, training, and awareness. In addition, ECs, such as competition, lack of supplier coordination, delayed technology upgradation, customer support, etc. might be responsible for insignificant EC-LDI relationships. One possible reason we did not find support for this relationship may be due to the personalised nature of healthcare, which involves high variability between patients and providers. Product or service characteristics are usually unique for a particular setup in manufacturing and other service sectors. In contrast, each customer in the healthcare service is uniquely different from others because of differences in age, sex, disease, and genetic makeup of patients. Hence, at the conjecture, it can be inferred that diminishing the internal impediments to LSS, such as employee resistance, top management attitude, weak infrastructure, poor communications, etc. could defend the external and inherent LSS-specific challenges.

This study's findings align with the previous study by Galli (2018) that the priority for successful and sustainable improvement in any organisation is people rather than any other resource. The finding seemingly affirmed that bringing cultural change through awareness, education, and training is likely to exhibit a higher commitment toward adopting new methods like LSS in healthcare settings. Hence, organisational leadership must support employee empowerment by facilitating deployment infrastructure, recognition and reward system, financial resources, and team autonomy. The external

determinants like supplier and customer involvements, competitive market and advanced technology, etc. are less likely to be addressed by CM methods, as witnessed from the results.

5.1 Theoretical implications

The present study enhances the scope of LSS literature by augmenting the CM practice into it. The model developed in this study contributes the CM literature in the perspectives of the applicability of CM models in supporting and facilitating the acceptance of QI methods. Previous studies tried to understand the various LSS challenges through interpretive structural modelling. However this study attempted to use SEM to understand the various LSS challenges as well as CM aspects through opinions of healthcare experts. This is the first comprehensive empirical study to understand such a phenomenon.

5.2 Managerial implications

Our findings demonstrated that CM is crucial in easing all the challenges considered in this study. However, it imparts more influence on human resource-related challenges. Whenever any improvement initiative is deployed, most employees will resist the change if they do not understand the process, tools, terminologies, etc. Discarding this human side of the problem and devoting time and resources to the technical side will limit the people's engagement in the deployment process (Ray et al., 2013). CM approaches can mitigate such issues by bringing in proper training, motivation, and communication and reducing resistance (Lertwattanapongchai and Swierczek, 2014). These findings can be implied in healthcare organisations in several ways. Leaders and human resource professionals ensure adequate measures in conducting awareness programs to create a desire in the workforce to accept such improvement methodologies. Leaders and other employees may be trained in various training programs of LSS such as green belt, black belt and champion. Top management must provide ample scope to those trained professionals to engage in various improvement projects by utilising their learned skills. These findings will provide solid foundation to support and strengthen the adoption of process improvement methodologies like LSS in healthcare context.

5.3 Limitations and future scope

The data collected in this study is from a single state in south India, where the healthcare sector is booming as compared to other states in the same country. This may limit the study's findings to being generalised in other states or countries. The sample size can further be enhanced to better the scope of this study. Also, the public sector hospitals are not considered in this study, hence providing scopes for future research. This study found no significant direct or moderating effect on the relationship between ECs and the LDI. Future research can verify the mediation effect of CM between EC and LDI relationship to accentuate the strength of other intervening relationships.

6 Conclusions

This research is based on LSS and CM theory and examines the role of different LSS challenges in influencing LDI, with CM moderating the existing relationship. The findings supported the direct hypothesised relationship of organisational, inherent, and HRCs with LDI, with CM acting as a moderator between these relationships. However, no direct and moderating effect exists on the relationship between ECs and LDI. Furthermore, the moderating effect on human-related challenges is relatively high compared to organisational and LSS-specific challenges.

This study's empirical results have established healthcare leaders' perception of accepting LSS by fostering CM as a guiding theory to counter challenges. In light of this, establishing cultural acceptance prior to process changes is vital for the smooth and sustainable transformation of healthcare service. The study highlighted the vital role of human-related obstacles to be mitigated in implementing LSS in healthcare organisations. The findings also revealed how CM could make a big difference in solving challenges concerning human resources. Findings also downplayed the impact of CM in lessening the extrinsic challenges. This may suggest that the top management of such private sector hospitals should avoid looking at external factors but improve the process and people within the organisation to ensure better adoption of LSS. Successful change occurs when both the process change and people change synchronise.

References

Antony, J. (2014) 'Readiness factors for the Lean Six Sigma journey in the higher education sector', *International Journal of Productivity and Performance Management*, Vol. 63, No. 2, pp.257–264.

Antony, J., Downey-Ennis, K., Antony, F. and Seow, C. (2007) 'Can Six Sigma be the 'cure' for our 'ailing' NHS?', in Bowerman, J. (Ed.): *Leadership in Health Services*, Vol. 20, No. 4, pp.242–253.

Antony, J., Gupta, S., Sunder, M.V. and Gijo, E.V. (2018) 'Ten commandments of Lean Six Sigma: a practitioners' perspective', *International Journal of Productivity and Performance Management*, Vol. 67, No. 6, pp.1033–1044.

Bagozzi, R.P. and Yi, Y. (1988) 'On the evaluation of structural equation models', *Journal of the Academy of Marketing Science*, Vol. 16, No. 1, pp.74–94.

Bakar, A.F.A., Subari, K. and Mohd Daril, M.A. (2015) 'Critical success factors of Lean Six Sigma deployment: a current review', *International Journal of Lean Six Sigma*, Vol. 6, No. 4, pp.339–348.

Baker, M., Jaeger, C., Hafley, C. and Waymack, J. (2020) 'Appropriate CT cervical spine utilisation in the emergency department', *BMJ Open Quality*, Vol. 9, No. 4, p.e000844.

Bhat, S. and Jnanesh, N.A. (2013) 'Enhancing performance of the health information department of a hospital using Lean Six Sigma methodology', *International Journal of Six Sigma and Competitive Advantage*, Vol. 8, No. 1, pp.34–50.

Chin, W.W., Marcolin, B.L. and Newsted, P.R. (2003) 'A partial least squares latent variable modeling approach for measuring interaction effects: results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study', *Information Systems Research*, Vol. 14, No. 2, pp.189–217.

D'Andreamatteo, A., Ianni, L., Lega, F. and Sargiacomo, M. (2015) 'Lean in healthcare: a comprehensive review', *Health Policy*, Vol. 119, No. 9, pp.1197–1209, Elsevier Ireland Ltd.

Damato, C. and Rickard, D. (2015) 'Using Lean-Six Sigma to reduce hemolysis in the emergency care center in a collaborative quality improvement project with the hospital laboratory', *The Joint Commission Journal on Quality and Patient Safety*, Vol. 41, No. 3, pp.99–107, The Joint Commission.

Dawson, J.F. (2014) 'Moderation in management research: what, why, when, and how', *Journal of Business and Psychology*, Vol. 29, No. 1, pp.1–19.

Dellifraine, J.L., Langabeer, J.R. and Nembhard, I.M. (2010) 'Assessing the evidence of Six Sigma and Lean in the health care industry', *Quality Management in Health Care*, Vol. 19, No. 3, pp.211–225.

Didden, A.G.M., Punt, I.M., Feczko, P.Z. and Lenssen, A.F. (2019) 'Enhanced recovery in usual health care improves functional recovery after total knee arthroplasty', *International Journal of Orthopaedic and Trauma Nursing*, March, Vol. 34, pp.9–15, Elsevier.

Fornell, C. and Larcker, D.F. (1981) 'Evaluating structural equation models with unobservable variables and measurement error', *Journal of Marketing Research*, Vol. 18, No. 1, pp.39–50.

Galli, B.J. (2018) 'Change management models: a comparative analysis and concerns', *IEEE Engineering Management Review*, Vol. 46, No. 3, pp.124–132.

Gilani, H.R., Kozak, R.A. and Innes, J.L. (2018) 'A change management model for the adoption of chain of custody certification in the British Columbia value-added wood products sector', *Journal of Change Management*, Vol. 18, No. 3, pp.240–256, Taylor & Francis.

Gold, A.H., Malhotra, A. and Segars, A.H. (2001) 'Knowledge management: an organizational capabilities perspective', *Journal of Management Information Systems*, Vol. 18, No. 1, pp.185–214.

Greenwood, T.J., Lopez-Costa, R.I., Rhoades, P.D., Ramírez-Giraldo, J.C., Starr, M., Street, M., Duncan, J. et al. (2015) 'CT dose optimization in pediatric radiology: a multiyear effort to preserve the benefits of imaging while reducing the risks', *Radio Graphics*, Vol. 35, No. 5, pp.1539–1554.

Gunasekaran, A., Subramanian, N. and Ngai, W.T.E. (2019) 'Quality management in the 21st century enterprises: research pathway towards Industry 4.0', *International Journal of Production Economics*, September, Vol. 207, pp.125–129.

Gupta, S., Modgil, S. and Gunasekaran, A. (2020) 'Big data in Lean Six Sigma: a review and further research directions', *International Journal of Production Research*, Vol. 58, No. 3, pp.947–969, Taylor & Francis.

Hair, J., Hollingsworth, C.L., Randolph, A.B. and Chong, A.Y.L. (2017) 'An updated and expanded assessment of PLS-SEM in information systems research', *Industrial Management & Data Systems*, Vol. 117, No. 3, pp.442–458.

Hair, J.F., Ringle, C.M. and Sarstedt, M. (2011) 'PLS-SEM: indeed a silver bullet', *Journal of Marketing Theory and Practice*, Vol. 19, No. 2, pp.139–152.

Hair, J.F., Risher, J.J., Sarstedt, M. and Ringle, C.M. (2019) 'When to use and how to report the results of PLS-SEM', *European Business Review*, Vol. 31, No. 1, pp.2–24.

Han, Y. and Li, D. (2015) 'Effects of intellectual capital on innovative performance: the role of knowledge-based dynamic capability management decision', *Management Decision*, Vol. 53, No. 1, pp.40–56 [online] https://doi.org/10.1108/MD-08-2013-0411.

Harrison, R., Fischer, S., Walpola, R.L., Chauhan, A., Babalola, T., Mears, S. and Le-Dao, H. (2021) 'Where do models for change management, improvement and implementation meet? A systematic review of the applications of change management models in healthcare', *Journal of Healthcare Leadership*, Vol. 13, pp.85–108.

Henseler, J., Ringle, C.M. and Sarstedt, M. (2015) 'A new criterion for assessing discriminant validity in variance-based structural equation modeling', *Journal of the Academy of Marketing Science*, Vol. 43, No. 1, pp.115–135.

Jacobsen, J. (2008) 'Avoiding the mistakes of the past: lessons learned on what makes or breaks quality initiatives', *The Journal for Quality and Participation*, Vol. 31, No. 2, pp.4–8.

Khan, H.U. and Smuts, R.G. (2019) 'A comparison of change management guidelines to address technology adoption barriers: a case study of higher educational institutions', *Journal of Theoretical and Applied Information Technology*, Vol. 97, No. 7, pp.1999–2020.

Kock, N. and Hadaya, P. (2018) 'Minimum sample size estimation in PLS-SEM: the inverse square root and gamma-exponential methods', *Information Systems Journal*, Vol. 28, No. 1, pp.227–261.

Kumar, M., Antony, J. and Tiwari, M.K. (2011) 'Six Sigma implementation framework for SMEs – a roadmap to manage and sustain the change', *International Journal of Production Research*, Vol. 49, No. 18, pp.5449–5467.

Lertwattanapongchai, S. and Swierczek, F.W. (2014) 'Assessing the change process of Lean Six Sigma: a case analysis', *International Journal of Lean Six Sigma*, Vol. 5, No. 4, pp.423–443.

McKenney, S., Kali, Y., Markauskaite, L. and Voogt, J. (2015) 'Teacher design knowledge for technology enhanced learning: an ecological framework for investigating assets and needs', *Instructional Science*, Vol. 43, No. 2, pp.181–202.

Molla, M., Warren, D.S., Stewart, S.L., Stocking, J., Johl, H. and Sinigayan, V. (2018) 'A Lean Six Sigma quality improvement project improves timeliness of discharge from the hospital', *The Joint Commission Journal on Quality and Patient Safety*, Vol. 44, No. 7, pp.401–412, Elsevier Inc.

Murphy, C., Mullen, E., Hogan, K., O'Toole, R. and Teeling, S.P. (2019) 'Streamlining an existing hip fracture patient pathway in an acute tertiary adult Irish hospital to improve patient experience and outcomes', *International Journal for Quality in Health Care*, Vol. 31, No. Supplement_1, pp.45–51.

Neufeld, N.J., Hoyer, E.H., Cabahug, P., González-Fernández, M., Mehta, M., Walker, N.C., Powers, R.L. et al. (2013) 'A Lean Six Sigma quality improvement project to increase discharge paperwork completeness for admission to a comprehensive integrated inpatient rehabilitation program', *American Journal of Medical Quality*, Vol. 28, No. 4, pp.301–307.

Niaei, M., Peidaei, M.M. and Nasiripour, A.A. (2014) 'The relation between staff cyberloafing and organizational commitment in organization of environmental protection', *Kuwait Chapter of Arabian Journal of Business and Management Review*, Vol. 3, No. 7, pp.59–71.

O'Reilly, S.J., Healy, J., Murphy, T. and Ó'Dubhghaill, R. (2019) 'Lean Six Sigma in higher education institutes: an Irish case study', *International Journal of Lean Six Sigma*, Vol. 10, No. 4, pp.948–974.

Ortiz-Barrios, M. and Alfaro-Saiz, J-J. (2020) 'An integrated approach for designing in-time and economically sustainable emergency care networks: a case study in the public sector', Memari, A. (Ed.): *Plos One*, Vol. 15, No. 6, p.e0234984.

Peimbert-García, R.E. (2019) 'Analysis and evaluation of reviews on Lean and Six Sigma in health care', *Quality Management in Health Care*, Vol. 28, No. 4, pp.229–236.

Radnor, Z.J., Holweg, M. and Waring, J. (2012) 'Lean in healthcare: the unfilled promise?', *Social Science & Medicine*, Vol. 74, No. 3, pp.364–371.

Raval, S.J., Kant, R. and Shankar, R. (2018) 'Lean Six Sigma implementation: modelling the interaction among the enablers', *Production Planning & Control*, Vol. 29, No. 12, pp.1010–1029, Taylor & Francis.

Ray, S., Das, P., Bhattacharyay, B.K. and Antony, J. (2013) 'Measuring Six Sigma project effectiveness using fuzzy approach', *Quality and Reliability Engineering International*, Vol. 29, No. 3, pp.417–430.

Rejikumar, G., Aswathy Asokan, A. and Sreedharan, V.R. (2020) 'Impact of data-driven decision-making in Lean Six Sigma: an empirical analysis', *Total Quality Management & Business Excellence*, Vol. 31, Nos. 3–4, pp.279–296, Taylor & Francis.

Rosenbaum, D., More, E. and Steane, P. (2018) 'Planned organisational change management', *Journal of Organizational Change Management*, Vol. 31, No. 2, pp.286–303.

Samanta, A.K., Varaprasad. G. and Gurumurthy, A. (2023) 'Implementing Lean Six Sigma in health care: a review of case studies', *International Journal of Lean Six Sigma*, Vol. 14, No. 1, pp.158–189, https://doi.org/10.1108/IJLSS-08-2021-0133.

Sanders, J.H. and Karr, T. (2015) 'Improving ED specimen TAT using Lean Six Sigma', *International Journal of Health Care Quality Assurance*, Vol. 28, No. 5, pp.428–440.

Shokri, A., Waring, T.S. and Nabhani, F. (2016) 'Investigating the readiness of people in manufacturing SMEs to embark on Lean Six Sigma projects', *International Journal of Operations & Production Management*, Vol. 36, No. 8, pp.850–878.

Stanton, P., Gough, R., Ballardie, R., Bartram, T., Bamber, G.J. and Sohal, A. (2014) 'Implementing Lean management/Six Sigma in hospitals: beyond empowerment or work intensification?', *The International Journal of Human Resource Management*, Vol. 25, No. 21, pp.2926–2940.

Sunder, M.V., Ganesh, L.S. and Marathe, R.R. (2018) 'A morphological analysis of research literature on Lean Six Sigma for services', *International Journal of Operations & Production Management*, Vol. 38, No. 1, pp.149–182.

Sunder, M.V., Mahalingam, S. and Krishna, M.S.N. (2020) 'Improving patients' satisfaction in a mobile hospital using Lean Six Sigma – a design-thinking intervention', *Production Planning & Control*, Vol. 31, No. 6, pp.512–526, Taylor & Francis.

Swarnakar, V., Tiwari, A.K. and Singh, A.R. (2020) 'Evaluating critical failure factors for implementing sustainable Lean Six Sigma framework in manufacturing organization', *International Journal of Lean Six Sigma*, Vol. 11, No. 6, pp.1069–1104.

Tekes, A., Jackson, E.M., Ogborn, J., Liang, S., Bledsoe, M., Durand, D.J., Jallo, G. et al. (2016) 'How to reduce head CT orders in children with hydrocephalus using the Lean Six Sigma methodology: experience at a major quaternary care academic children's center', *American Journal of Neuroradiology*, Vol. 37, No. 6, pp.990–996.

Teller, C., Author, E., Bravo, P., Garrote, S., Ruiz, C., Piquero, F. and De Farmacia, S. (2020) 'Implementation of the Lean Six Sigma in the improvement of the medication dispensing circuit', *Journal of Healthcare Quality Research*, Vol. 35, No. 6, pp.364–371.

Trakulsunti, Y., Antony, J., Dempsey, M. and Brennan, A. (2020) 'Reducing medication errors using Lean Six Sigma methodology in a Thai hospital: an action research study', *International Journal of Quality & Reliability Management*, Vol. 38, No. 1, pp.339–362.

Vaishnavi, V. and Suresh, M. (2021) 'Assessment of readiness level for implementing Lean Six Sigma in healthcare organization using fuzzy logic approach', *International Journal of Lean Six Sigma*, Vol. 12, No. 2, pp.175–209.

Wang, F-K. and Chen, K-S. (2010) 'Applying Lean Six Sigma and TRIZ methodology in banking services', *Total Quality Management & Business Excellence*, Vol. 21, No. 3, pp.301–315.

Wilson, J., Swee, M., Mosher, H., Scott-Cawiezell, J., Levins, L., Fort, K. and Kumar, B. (2020) 'Using Lean Six Sigma to improve pneumococcal vaccination rates in a veterans affairs rheumatology clinic', *Journal for Healthcare Quality*, Vol. 42, No. 3, pp.166–174.

Yadav, G. and Desai, T.N. (2017) 'A fuzzy AHP approach to prioritize the barriers of integrated Lean Six Sigma', *International Journal of Quality & Reliability Management*, Vol. 34, No. 8, pp.1167–1185.

Yadav, G., Seth, D. and Desai, T.N. (2018) 'Prioritising solutions for Lean Six Sigma adoption barriers through fuzzy AHP-modified TOPSIS framework', *International Journal of Lean Six Sigma*, Vol. 9, No. 3, pp.270–300.