

The Utilization of Lean Six Sigma Methodologies in Enhancing Surgical Pathways and Surgical Rehabilitation

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Abstract: The authors offer their perspective on the application of Lean Six Sigma methodology to surgical pathways, from referral to post-operative rehabilitation, and how it has resulted in sustainable improvements in patient outcomes, and patient and staff satisfaction. The origin of Lean Six Sigma is described before considering its application to improving scheduled surgical care. The concept of ‘flow’, and its relevance to pre-, intra-, and post-operative care, is discussed as well as the role of Lean Six Sigma in supporting innovation and in promoting an organizational culture that promotes openness to new ideas. The elements of the methodology that render it especially suitable for the redesign of surgical pathways include eliciting the customer voice, co-design, enabling system awareness and inculcating a continuous improvement mindset. The necessary conditions for the successful implementation of Lean Six Sigma initiatives include managerial support, high-quality education and training, and alignment with organizational strategy. Future directions for practice and research are discussed before presenting a key finding from the literature and from the authors’ collective experience: Lean Six Sigma initiatives will not lead to sustainable improvements where the key elements of the methodology are not recognized and enacted, and where the necessary conditions are absent.

Keywords: lean; six sigma; surgery; pre-operative; peri-operative; recovery; rehabilitation



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1. Introduction

One of the biggest healthcare challenges globally continues to be equitable and fair access to quality services. Many countries struggle with disparities in access to healthcare based on factors such as income, location, ethnicity, and gender, leading to inequalities in experiences of care and health outcomes [1]. Meanwhile, healthcare costs continue to rise worldwide, making it difficult for some individuals and communities to afford necessary medical care, which can result in delayed or inadequate treatment, leading to poor health outcomes [2]. Globally, countries are experiencing demographic shifts with aging populations posing challenges to health services. An aging population often requires increased healthcare services, including long-term care and management of chronic conditions, which can strain healthcare systems and resources [3]. More recently, the pandemic has underlined how infectious diseases such as COVID-19 and influenza can overwhelm healthcare systems leading to increased demand for care and considerable strain on resources [4]. All of these challenges are compounded by workforce shortages with healthcare services facing challenges in recruiting and retaining enough skilled workers. Shortages of healthcare professionals, including doctors, nurses, and allied health personnel, can limit the capacity of health services to deliver timely and quality care [5]. Technological advances, including precision medicine, telehealth, and artificial intelligence, present both

opportunities and challenges for health services staff [6]. These challenges can vary widely across different countries and regions, and require context-specific solutions and strategies to address them effectively.

One key area of healthcare that presents an enduring challenge is scheduled (or planned) surgery; problems include timely patient access to surgery and the availability of surgery-designated beds [7]. The issue of long waiting times for scheduled surgeries is not a recent phenomenon but it has been exacerbated by the COVID-19 pandemic [8]. A recent study estimated that worldwide, 28.4 million surgeries were either postponed or cancelled during the peak of COVID-19 disruption [9]. Lengthy surgical waiting times have been shown to adversely affect patients, both psychologically, through increased pre-operative anxiety, stress, frustration, and anger [10], and physically, through poorer pre-operative quality of life and reduced physical functioning [11].

Drucker described healthcare organisations as the most complex form of human organisation to manage [12], suggesting that the complexity derives in part from the confluence of clinicians (e.g., doctors, nurses, and other health and social care professionals) and other stakeholders (e.g., patients, relatives, and other health system professions and occupations), often with seemingly incompatible perspectives and competing timelines. A surgical patient's journey from initial consultation and diagnosis to actual surgical intervention and rehabilitation reflects the complexity Drucker highlighted, relying on an intricate interplay of clinical and administrative processes that support the work of surgeons and the wider multidisciplinary team [13]. Deming's seminal work explored conceptual frameworks that can be usefully brought to bear on process improvement [14]. Henrique and Filho, in a review of the empirical literature on Lean Six Sigma, found that it is one of the most frequent continuous improvement methodologies used for process and quality improvement in hospitals today [15].

The authors of this paper include qualified Lean Six Sigma practitioners and healthcare professionals with over 30 years' experience with backgrounds in nursing, physiotherapy, biotechnology, architectural healthcare design, and healthcare research and education. Additionally, authors 1 and 4 have extensive clinical and managerial experience in the areas of peri-operative and post-operative care and rehabilitation. Over the last 10 years the authors have facilitated over 250 process improvement projects within the health system that have resulted in demonstrable improvements in patient and staff experiences of care, and patient outcomes [16]. This paper is a perspectives paper, which draws on current literature in the field, and the experience and personal assessment of the authors. We offer our perspective on the value of Lean Six Sigma in designing and redesigning complex surgical pathways, and on the future direction of improving surgical pathways in the health system.

2. Lean Six Sigma Use in Healthcare

2.1. *Lean*

Lean is a management system, a methodology and a philosophy that can support employees and enable them to deliver better care to their patients [17]. Whilst Lean was developed for car manufacturing and utilised in engineering and production operations, other industries quickly picked up on its inherent benefits and it is now used in pharmaceutical, electronic and healthcare settings with noted improvements in process flow, impacting factors such as patient wait times, releasing clinician time to care, error reduction and improved patient outcomes [18,19]. In effect, the application of Lean in healthcare is about shortening the time between the patient entering and leaving a care facility by eliminating what is termed Non-Value Add (NVA) time and activity for patients and staff [20,21]. Antony and colleagues note that Lean has been widely adopted for healthcare process improvement even in fundamentally different healthcare contexts [22].

2.2. *Six Sigma*

Lean is often used in conjunction with Six Sigma, another widely used improvement methodology developed by Motorola to optimise its manufacturing processes by reducing their

variability through the rigorous collection and statistical analysis of process metrics [13,23]. Six Sigma's data-driven process approach is designed to improve process capability and enhance process throughput [24]. The Lean Six Sigma, Define, Measure, Analyze, Improve, Control (DMAIC) framework provides a model for a structured approach to change [13]. Six Sigma has a strong emphasis on eliciting and acting on the 'Voice of the Customer' and understanding customers' expectations of services [20,25]. This emphasis on customer voice aligns well with the user expectations of healthcare services, where the primary goals are to improve patient safety, quality of care, process efficiency, patient and staff satisfaction, and process performance [26].

2.3. Lean Six Sigma

Lean Six Sigma is a combination of both Lean and Six Sigma that is increasingly and successfully being used in healthcare internationally as a combined improvement methodology [22,25,27,28]. In healthcare, Lean is typically used to release time to care while Six Sigma focuses on reducing unwanted variation in day-to-day work processes [20]. Their combined use has been identified as having an impact on health outcomes, processes and quality of care, finance, and patient and staff satisfaction [29]. For example, Lean Six Sigma has been used to streamline pathways for people following hip fracture [30] and to release time to care for nurses in hospitals, both private [31–33] and public [34–36]. The literature demonstrates improvement at patient, staff, and organisational levels [37]. The widespread adoption of Lean Six Sigma has led to an increase in the number of scholarly studies of its application in healthcare, with a steady annual increase in published papers [22,25] supporting its use in health systems internationally. Based on this publication frequency, Lean, Six Sigma, and Lean Six Sigma are among the most frequently used continuous improvement methodologies used for quality improvement initiatives in hospitals [15,38]. Lean Six Sigma uses a pre-and post-intervention study design that measures the occurrence of outcomes of interest before and after a particular intervention is implemented [4]. Pre-and post-intervention studies involve the measurement of variables of interest before and after the intervention in the same study site, on the assumption that any difference in measurement between 'before' and 'after' is attributable to the intervention. Although this design has the limitation of ascribing outcomes to an intervention with certainty [4], this study design has been widely used to implement and evaluate Lean Six Sigma interventions in healthcare [13,21,23,30,32–35].

3. The Application of Lean Six Sigma to Surgical Pathways

3.1. The Concept of Flow

In healthcare, the term 'flow' refers to the progressive movement of patients through care processes and the overall healthcare system [39,40]. Flow comprises the clinical care, physical resources, and internal systems required to enable patients to progress from their initial engagement with the healthcare system (e.g., General Practitioner [GP] or family physician consultation) to their admission to the system and on to the point of discharge, whilst constantly maintaining quality and realizing patient and staff satisfaction [39]. Management of flow is often challenged by the complexity of the care required and the number of healthcare units or teams involved [39,40]. We now discuss the use of Lean Six Sigma as applied specifically to improving scheduled surgical pathways.

3.2. Preparation for Surgery

Preparation for surgery can be complex [13,41,42] and involves several initial steps, including consultation with a GP or family physician, referral to a surgery centre, and receiving an appointment for an outpatient clinic to see the surgeon. Once this is complete, the patient engages with the surgeon in the outpatient clinic, and undergoes evaluation, pre-operative testing and any required diagnostics, patient education, and preparation for the planned surgery. By applying Lean Six Sigma principles to this process, healthcare providers can identify and eliminate delays and unwanted variation in the pre-operative pathway, improve efficiency, and enhance patient outcomes [20–25].

Targeted areas for the application of Lean Six Sigma in preparing patients for surgery include:

- Reducing the wait time from GP (or family physician, or another healthcare professional) referral to initial surgical consultant engagement [42–45], enabling faster access to expert assessment, diagnostics, and the development of a plan of care.
- Standardizing the pre-operative evaluation process. By establishing a standardized process for evaluating patients prior to surgery, healthcare providers can reduce unwanted variability and ensure that all patients receive the required level of care [34].
- Reducing wait times for required pre-operative testing. By identifying and eliminating bottlenecks in the pre-operative testing process [34], healthcare providers can reduce wait times for patients and improve the overall efficiency of the process [34,45].
- Enhancing patient education. By identifying the most effective methods for educating patients about their surgery and post-operative care, healthcare providers can improve patient outcomes and reduce the likelihood of complications, which include both psychological problems such as stress [46,47] and physical post-operative complications such as infection [48,49].
- Streamlining documentation. By identifying and eliminating unnecessary steps in the documentation process, healthcare providers can eliminate overprocessing, reduce clinical staff time spent on paperwork, and ensure that all necessary patient information is available and communicated clearly [4,13,49].

Overall, the use of Lean Six Sigma in preparing patients for surgery can help healthcare providers to improve efficiency, reduce NVA, and enhance patient outcomes. By applying these principles to the preparation process, healthcare providers can ensure that patients receive the highest quality of preparatory care for their surgery.

3.3. Surgery

Flow, the efficient and smooth coordination of tasks and processes [39,40], is of paramount importance in the operating room (OR). The OR is a complex and high-stakes environment where collaborative teams of surgeons, anaesthetists, and nurses work together with other healthcare professionals and support staff to provide safe and effective patient care [33]. Achieving optimal flow in the OR is critical for patient safety, surgical outcomes, and team efficiency [32,33,50]. Lean Six Sigma has demonstrated its effectiveness as an improvement methodology when applied to the following in the OR:

- Patient Safety. Flow in the OR is essential for ensuring patient safety. An organized and streamlined workflow minimizes the risk of errors, such as wrong-site surgery [51] or medication mistakes [52], which can have serious consequences for patients. The use of Lean Six Sigma in designing patient safety protocols and operating procedures has been shown to improve OR efficiency and quality of care [53] and also helps to prevent delays in surgical start times, which can reduce the risk of peri-operative complications and infections.
- Surgical set-up times. Where Lean Six Sigma has been used to reduce the time required in the preparation of consumables, equipment and instrumentation for surgery, there is a corresponding positive impact on both OR turnaround times and on the time available for nurses to spend on direct patient care [32,33].
- Surgical Outcomes. A well-coordinated OR ensures that surgical teams have the necessary resources, instruments, and equipment readily available, allowing them to perform procedures efficiently and effectively [32,33]. The use of Lean Six Sigma to identify and streamline key steps can lead to significantly improved surgical outcomes for patients, including reduced operative times [33] that ultimately enhance patient safety and the quality of surgical care provided [54].
- Team Efficiency. Teamwork in the OR is an important component of OR efficiency, quality of care, and patient safety [55]. Efficient flow in the OR enhances teamwork and collaboration among surgical team members. It helps to establish clear roles and responsibilities, promotes effective communication, and optimizes the utilization of

resources [53]. Lean Six Sigma facilitates the understanding of roles and responsibilities through its promotion of cross-functional teams of healthcare staff, co-designing to enable sustainable solutions, and focusing on staffs' as well as patients' experiences of care [21,25]. A smoothly running OR that demonstrates 'flow' reduces unnecessary distractions and interruptions, allowing surgical teams to focus on their tasks and work together cohesively. This can enhance team morale, staff satisfaction [55,56], and overall OR performance.

- **Time and Cost Savings.** Flow in the OR can also result in time and cost savings. Efficient workflow reduces both delays to surgery and scheduled surgery cancellations, which can help to optimize OR utilization and increase patient throughput [32,33]. This can result in cost savings by minimizing overtime shifts [32], reducing peri-operative resource wastage [32,33], and maximizing revenue generation from increased surgical volumes [31].
- **Organizational reputation and patient experience.** The flow in the OR also impacts the reputation of the healthcare facility and the overall patient experience. Patients and their families expect timely and well-coordinated care [57], and efficient OR flow contributes to a positive patient experience. A good reputation for efficient and safe surgical care can enhance patient and staff satisfaction, staff retention [58], increase patient referrals, and boost the overall reputation of the healthcare facility.

In summary, the use of Lean Six Sigma enhances OR efficiency, allowing flow that ensures patient safety, optimizes surgical outcomes, improves team efficiency, saves time and costs, and enhances patient and staff experiences of care.

3.4. Rehabilitation

Surgical rehabilitation, also known as post-operative rehabilitation, is a specialized area of healthcare that focuses on the recovery and rehabilitation of patients who have undergone surgery. Rehabilitation is a dynamic and critical component of any modern healthcare system, associated with improved health outcomes, reduced disability, and improved quality of life [59]. Surgery can have both physical and psychological effects which may influence recovery and clinical outcomes; therefore, a thorough assessment and an individualised approach in the pre-operative period [41,42] are key to effective post-operative rehabilitation [60]. Rehabilitation involves a multidisciplinary approach that aims to optimize patient outcomes, improve functional recovery, manage pain, and facilitate a safe return to daily activities following surgery [61], an approach for which Lean Six Sigma has proven highly effective [62]. Surgical rehabilitation typically involves a large team of healthcare professionals, including surgeons, physiotherapists, occupational therapists, nurses, and other specialized healthcare providers, who work together to provide comprehensive care for patients recovering from surgery [63].

Post-operative rehabilitation focuses on restoring physical abilities and relearning skills. It also involves patients learning to cope and adapt to the changes they experience after surgery [64], encouraging them to play an active role in their rehabilitation by involving them, where appropriate, in goal setting to maximise their recovery potential and reduce any secondary problems as a result of the surgery. The goals of surgical rehabilitation will naturally vary depending on the type and complexity of the surgery, the patient's individual needs, and the specific requirements of the surgical procedure.

The application of Lean Six Sigma methodology in post-operative care and rehabilitation can support the recovery process for patients regardless of the specific surgery, when applied at the following common areas for potential improvement:

- **Restoring function.** Surgical rehabilitation aims to help patients regain their pre-surgery level of function or achieve the highest level of functional recovery possible. Lean Six Sigma has proven effective in enhancing processes for therapies including physiotherapy [30,62], occupational therapy [65], and other modalities to improve mobility, strength, flexibility, coordination, and other functional abilities.

- **Pain management.** Pain is a common issue after surgery, and effective pain management is an important aspect of surgical rehabilitation. Lean Six Sigma has been used to reduce nursing delays in administering medication [66] and to maximize the availability of opioid pain management medications [35] to help patients manage pain during their recovery process.
- **Wound care.** Meticulous wound care protocols are essential for preventing infections and promoting healing after surgery [67]. Surgical rehabilitation may involve monitoring and managing surgical wounds, providing education on wound care, and coordinating with the surgical team to ensure optimal wound healing. Lean Six Sigma has proven effective in reducing the number of patients who get hospital-acquired infection (HAI), resulting in a significant reduction in the patient length of stay [68].
- **Patient education.** As with preparation for surgery, education plays a critical role in surgical rehabilitation as patients need to understand their surgical procedure, the recovery process, the need for early mobilisation after surgery [62,69], and how to manage their post-operative care at home. Post-operative patient education is a key component of Lean Six Sigma initiatives that leads to reduced post-operative complications [34,62].
- **Enhanced Recovery Programs.** The Enhanced Recovery After Surgery (ERAS) concept, sometimes referred to as 'fast track', 'accelerated,' or 'rapid recovery' surgery, was first introduced in 1997 [70,71]. It initially concentrated on colorectal surgeries in which patients were treated with a multimodal approach including epidural analgesia, early mobility, and early oral nutrition [70]. ERAS is a multidisciplinary and evidence-based protocol that promotes fast recovery by reducing the patient's surgical stress and organ dysfunction, and optimizing their physiologic function [71]. The ERAS has proven effective in reducing post-operative complications, shortening the length of hospital stay, improving patient satisfaction, and accelerating recovery [70–72]. With increasing interest in ERAS, the literature available on it in orthopaedic surgery is also rapidly accumulating [70]. ERAS enables effective pain relief that facilitates early rehabilitation in the patients involved and reduces the length of patients' hospital stay, with minimal post-operative complications [70–72]. Lean Six Sigma has enabled the redesign of ERAS pathways [34,73], contributing to reduced patient length of stay and enhanced post-operative outcomes.

We have shown how the use of Lean Six Sigma to design or augment post-operative care programs improves patient safety [68], enhances restoration of function [30,62,65], and ensures that patients receive consistent evidence-based care [73], leading to improved patient outcomes and enhanced healthcare delivery [54,62,73].

3.5. Supporting Innovation in Surgical Pathways

The risks and morbidity associated with surgical procedures have been steadily decreasing in recent decades [74], due primarily to improvements and innovations in patient preparation for surgery, anaesthetic, and surgical procedures during surgery. Innovation in surgery has led to new instruments, equipment, and operative procedures, which all contribute to reduced morbidity and mortality [75]. Examples include laparoscopic or robotic procedures, changes in theatre practice, and novel surgical implants. One of the most impressive changes has been the introduction of minimally invasive surgery [76]. These developments have also contributed to the increased use of ambulatory and semi-ambulatory settings for surgical procedures. Innovations in anaesthesia and orthopaedic surgery procedures have enabled advances in post-operative rehabilitation protocols, earlier physiotherapy intervention, and the promotion of ambulation [69]. The introduction of innovative day surgeries and day-of-surgery admissions (DOSAs) has led to the opportunity for day-of-surgery physiotherapy and mobilization [34,62]. Lean Six Sigma promotes an organizational culture that promotes openness to new ideas [25] and helps to realise an innovation strategy that responds to customer demands and requirements, competition, and technological capabilities [77]. An organisational culture that supports Lean Six Sigma

deployment, which includes encouraging and welcoming the articulation of the voices of staff and patients, provides fertile ground for the germination of innovative ideas [20,25,78].

The ways in which Lean Six Sigma methodology has been applied to all stages of the surgical pathway are summarised in Table 1.

Table 1. An overview of the application of Lean Six Sigma to surgical pathways.

Pathway	Results
Preparation for surgery	<ul style="list-style-type: none"> • Reduced wait time from referral to surgical consultation • Reduced wait time for required preoperative testing • Enhanced patient education leading to improved post-operative outcomes • Reduced clinical staff time on administrative function
Surgery	<ul style="list-style-type: none"> • Efficient and smooth task coordination • Reduced clinical risk, e.g., wrong site surgery, medication error • Reduced surgical set up times • Reduced theatre turnaround time (TAT) • Enhanced quality of care in the OR • Increased staff morale and teamwork in the OR • Reduced resource wastage • Minimized overtime and associated cost saving
Rehabilitation	<ul style="list-style-type: none"> • Restored function through enhanced therapy processes • Improved processes for post-operative pain management • Reduced post-operative hospital acquired infection (HAI) rates • Reduced patient length of hospital stay • Consistent, evidence-based care

4. Discussion

We now discuss some of the key elements of Lean Six Sigma methodology that have led to its success in improving surgical pathways and surgical rehabilitation [79,80], as well as the conditions necessary for its successful implementation.

4.1. Key Elements of Lean Six Sigma's Suitability for the Redesign of Surgical Pathways

4.1.1. Customer Voice and Co-Design

The importance of interdisciplinary teamwork and communication in surgical teams is well documented [81,82] with shared goals, knowledge, and respect for persons creating the conditions for timely problem solving [83]. Lean Six Sigma encourages a collaborative and cross-functional approach to problem solving [20,21,25], which, for surgical pathways, engages surgeons, nurses, anaesthetists, administrative, and support staff in identifying and resolving issues related to pathway efficiency. By bringing together diverse perspectives and expertise, Lean Six Sigma can foster a culture of continuous improvement, communication, and engagement among OR staff leading to sustained improvements in efficiency [55,84].

The voice of the customer approach to understanding requirements is synergistic with person-centredness and the principle of respect for person [20,25]. Participants in Lean Six Sigma initiatives have found that the methodology enabled them to better engage with colleagues and patients, actively listen to their voices, and try to meet their expectations [85]. The significance of open and clear communication, at the levels of department, unit, ward, or practice area, was found to be a cornerstone of Lean Six Sigma practice [25] that facilitated process change by engaging staff from all specialities and levels of seniority in co-designing solutions [21].

4.1.2. Enabling System Sight

The focus of Lean Six Sigma initiatives on interdisciplinary, cross-functional teams helps to dismantle barriers between departmental ‘silos’, allowing multiple hospital clinical departments and support services to collaborate for the benefit of patients [17,25]. Rather than pockets of improvement being completed in isolation, Lean Six Sigma initiatives can be linked, and their outcomes used to inform further process improvement [21] and hospital performance [86]. The value created by Lean Six Sigma initiatives in the redesign of particular surgical pathways is enhanced by their role in enabling staff to transcend their traditional departmental silos [25], revealing a system-level view of surgical care as a whole within the context of the wider organization situated in its external environment [21,37]. The system sight afforded by Lean Six Sigma methodology, when it is properly understood and implemented, clearly shows that Lean Six Sigma entails much more than a tick-box exercise or decontextualised toolkit [16,25,37]. Rather, it presents a rigorous scientific improvement methodology underpinned by an appreciation of systems and a clearly articulated set of principles and values that are realised through the judicious selection and application of specific tools.

4.1.3. The Lean Six Sigma Toolkit

The implementation of Lean Six Sigma methodology in surgical care is supported by a robust and versatile set of improvement tools that enable healthcare teams to visualise and understand the multiple, interacting processes that comprise the surgical pathway, from patient scheduling to post-operative care and rehabilitation [34]. These tools help to identify sources of NVA in processes, such as unnecessary waiting time, excessive movement of equipment or personnel, redundant steps, excess inventory, and overproduction of supplies [32,33]. By identifying and eliminating NVA, Lean Six Sigma can streamline the entire surgical pathway, reduce delays, and improve overall efficiency [51,53].

4.1.4. Standardisation of Processes

Lean Six Sigma emphasizes the importance of standardization to reduce process variability and ensure consistent outcomes, and to improve the value of care delivered to patients [87]. In the OR, standardizing processes such as pre-operative assessment, patient preparation, surgical instrument setup [32,33], and post-operative care can minimize errors, reduce variability, and improve overall efficiency [34]. Standardization can also help with the training and induction of new staff, and enable effective performance measurement and monitoring [20].

4.1.5. Data-Driven Decision Making

Six Sigma emphasises the importance of data and statistical analysis to identify the root causes of problems and to drive improvement [88]. By collecting and analysing data on key performance metrics, such as surgical time, patient turnaround time, and equipment utilization, Lean Six Sigma can facilitate a rapid root cause analysis [4], identifying areas for improvement and prioritizing staff’s efforts accordingly [41]. In surgery, standardized pathways provide a framework for data collection and analysis, which facilitates research that can contribute to the advancement of surgical care and inform further service improvements [50]. Data-driven decision making can also help track progress and sustain improvements over time [88].

4.1.6. A Continuous Improvement Mindset

Lean Six Sigma promotes a culture of continuous improvement [20,21,89,90] whereby staff are encouraged to identify and address problems proactively on an ongoing basis. This encouragement supports staff ownership of process improvement. In successful Lean Six Sigma initiatives, staff have been educated, trained, nurtured, and sustained by other internal healthcare staff who are themselves proficient in Lean Six Sigma [19,25]. A continuous improvement culture entails the regular review of performance metrics,

frequent process audits, and continuous small-scale improvement projects. By fostering a continuous improvement mindset, Lean Six Sigma can drive a culture of innovation and efficiency in the OR.

The key elements of Lean Six Sigma that make it suitable for use in surgical pathways are summarised in Figure 1. Having discussed these elements, we now discuss the key conditions for its successful implementation.

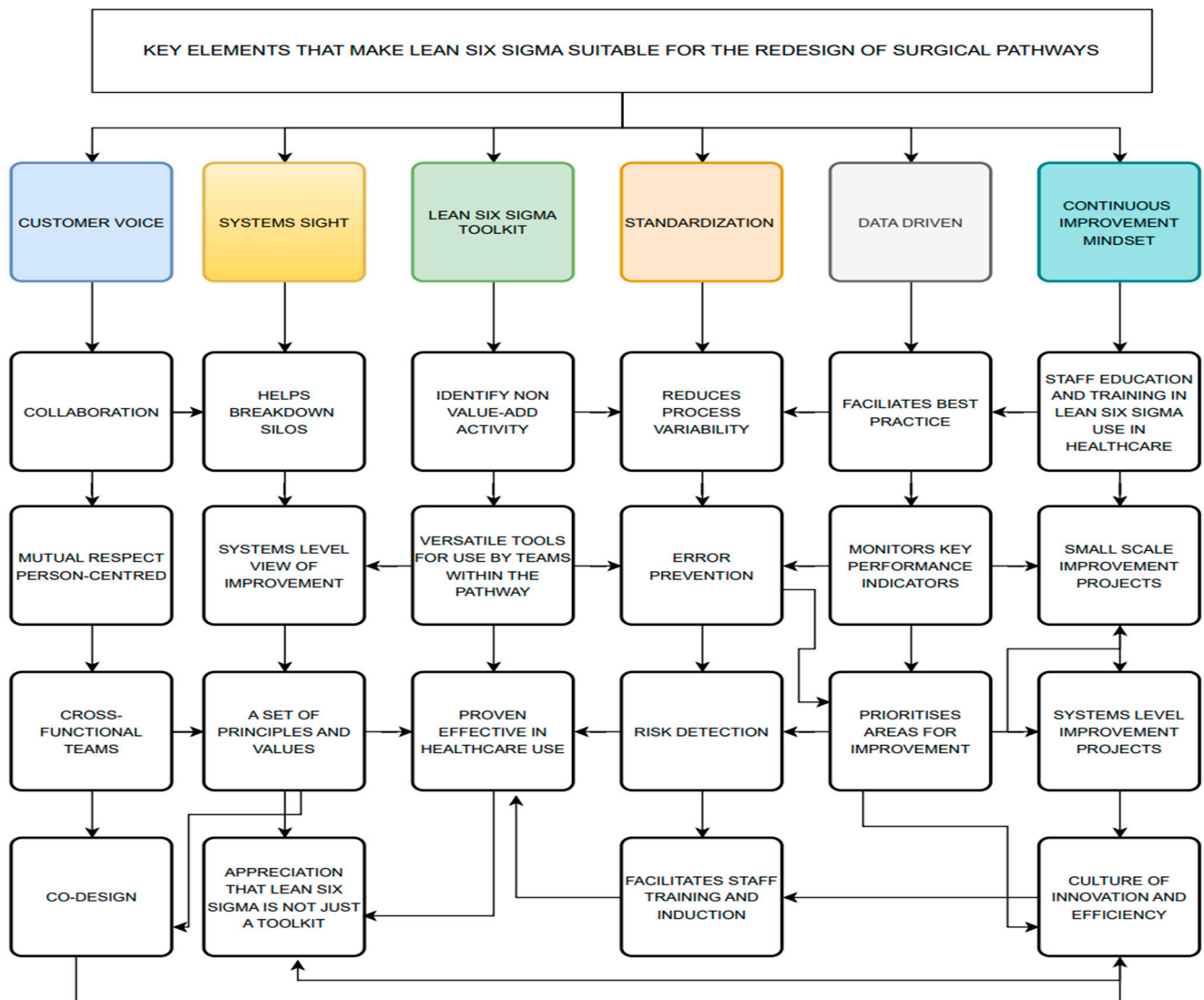


Figure 1. The key elements that make Lean Six Sigma suitable for the redesign of surgical pathways.

4.2. Key Conditions for Lean Six Sigma Implementation

4.2.1. Organisational Support and Staff Engagement

The key driver of any successful Lean Six Sigma implementation is the organisation's staff who must 'buy in' to any intervention. Without their engagement, there can be no successful pathway redesign [25]. When healthcare organisations support their staff, Lean Six Sigma deployment works [25,90–93]. Managers visibly and meaningfully support staff by providing education and training in Lean Six Sigma methodologies, as well as protected time to engage in improvement initiatives and events. Staff who are supported by management in this way are more likely to successfully deploy Lean Six Sigma across the entire process pathway, rather than within the silo of a single service [25]. Lean Six Sigma becomes the way that services operate rather than being seen as 'the latest fad' [19]. The explicit and tangible support of management to create and sustain an

improvement culture [90] has been shown to encourage staff participation and engagement in Lean Six Sigma initiatives [25,94,95], particularly where improvement was focused on the experiences of both patients and staff [25].

4.2.2. The Competency of Lean Six Sigma Improvement Facilitators

Staff are supported and facilitated by Lean Six Sigma facilitators who have completed training and education in the principles and theory of both Lean and Six Sigma methodologies, and who are experienced improvement practitioners [16,91,96]. There is evidence that the competency [94] and interpersonal skills [92] of these facilitators are key determinants of the success of Lean Six Sigma deployment. Any improvement within surgical pathways will be dependent on the facilitators' interpersonal skills and their ability to support staff in implementing improvements.

4.2.3. The Quality of Lean Six Sigma Training and Education

The quality of the training and education provided for staff working on improvement initiatives can greatly influence both patient and staff experiences of care, and patient outcomes [25]. Training that focuses purely on a narrow toolkit approach neglects the values and principles that underpin the methodology, resulting in staff applying Lean Six Sigma in a rote, tool-based manner [16,25,97]. Training wrenched from the essential foundations of the methodology in this way is partial and devoid of intrinsic meaning. It demotivates staff, prevents the acquisition of system sight and decreases the likelihood of sustainable, system-wide improvements. Programs that educate staff in Lean Six Sigma methodology, its underpinning principles and values, as well as its tools or methods, will develop their self and system awareness, enabling them to situate themselves and their improvement work in a proper systemic context [16]. This enables staff to take account of, and address, the power dynamics that can potentially undermine creativity and innovation, sabotage productive team partnerships, and arrest the required improvement [14,98,99].

4.2.4. Linking Improvement to Organisational Strategy

A key goal of Lean Six Sigma in healthcare is to move from the current, suboptimal state to a future, more productive state. In order to achieve this, healthcare organisations' management must focus their quality initiatives in key areas that directly link to organisational goals and identify meaningful performance metrics [100]. This approach to Lean Six Sigma deployment in healthcare organisations enables a focus on quality improvement that is part of an overall organisational strategy that links to institutional culture and focused leadership [101] contributing to a culture of quality [102].

5. Future Directions

Although there is much evidence in the literature on the successful deployment of Lean Six Sigma to redesign surgical pathways [2,21–25,34,45], there is little substantive work into the experiences of staff directly involved in the process (e.g., referring doctors, surgeons, anaesthetists, nurses, diagnostic, and support teams), apart from feedback on the improvement outcomes themselves. An important focus for future study, therefore, is identifying the specific contexts and ways staff are enabled to engage with Lean Six Sigma initiatives that lead to particular outcomes [25] in surgical pathways. This will further inform understanding of the key enablers of organisational support and staff engagement that are crucial to successful Lean Six Sigma initiatives.

The demonstrable value of Lean Six Sigma in enhancing innovative surgical programs, such as ERAS [72], to improve surgical pathway processes should be examined further with a view to discerning what other areas of surgical innovation may benefit from the application of process improvement methodologies. Again, this can be informed by repeated stakeholder engagement with staff working in and on all areas of the surgical pathway, facilitated by intensive and extensive voice of the customer sessions [20,25,26].

Data gained from the analysis of surgical pathways' processes have been used to inform simulation modelling of clinics, to accurately represent patient flow [103]. Lean Six Sigma projects could be designed to identify and map problems related to patient access and utilisation of healthcare services, more generally [104]. Industry 4.0, the fourth industrial revolution, involves the utilisation of a range of modern technologies including but not limited to digitisation, artificial intelligence, and augmented reality [105]. The application and appropriate use of such modern technologies within the Lean Six Sigma DMAIC framework [13] could greatly assist process improvement efforts in achieving sustainable change within the healthcare system [106].

6. Conclusions

Dixon Woods [107], writing in 2019, indicated that the study of quality improvement methodologies in healthcare contributes to developing an empirical and theoretical base to underpin and inform specific improvement interventions. Within our own research and clinical practice, the authors have continued to contribute to this empirical and theoretical base [25,108]. In this paper, we offered our perspectives on the application of Lean Six Sigma methodology to surgical pathways, from referral to post-operative rehabilitation, and how it has elicited sustainable improvements in patient outcomes, and patient and staff satisfaction. We discussed the key elements of the methodology that render it particularly suitable for application to the redesign of surgical pathways and highlighted the necessary conditions for its successful implementation.

In setting out these elements and conditions, we draw attention to a key finding from the literature and from our collective experience: Lean Six Sigma initiatives will not lead to sustainable improvements where the key elements of the methodology are not recognized and enacted, and where the necessary conditions are absent. Without these fundamental requirements, the potential of Lean Six Sigma methodology to drive and sustain improvement will not be realized, nor will the potential of all stakeholders to co-design effective solutions to the enduring challenges in surgical pathways and surgical rehabilitation.

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