

**Arab American University
Faculty of Graduate Studies
Department of Administrative and
Financial Sciences
Master Program in Quality Management**



**Assessing the Impact of Lean Six Sigma (LSS) Methodology
Implementation on Day Care Surgical Services at Saint
Joseph Hospital in Jerusalem**

Samer Ibrahim Jaber Da'beis

201912764

Supervision Committee:

Dr. Ashraf Abed Al-Wahhab Almimi

Dr. Sami Sameer Sader

Dr. Eba'a Abdulraziq Da'san

**This Thesis Was Submitted in Partial Fulfilment of the
Requirements for the Master Degree in Quality Management**

Palestine, 08/2025

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Faculty of Graduate Studies
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Sciences
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Thesis Approval

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Samer Ibrahim Jaber Da'beis

201912764

This thesis was defended successfully on August 02, 2025 and approved by:

Thesis Committee Members:

Name	Title	Signature
1. Dr. Ashraf Abed Alwahab Almimi	Main Supervisor	
2. Dr. Sami Sameer Sader	Member of Supervision Committee	
3. Dr. Eba'a Abdulraziq Da'san	Member of Supervision Committee	

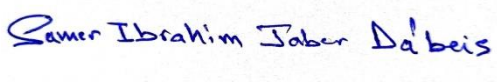
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Declaration

I declare that, except where explicit reference is made to the contribution of others, this thesis is substantially my own work and has not been submitted for any other degree at the Arab American University or any other institution.

Student Name: Samer Ibrahim Jaber Da'beis

Student ID: 201912764

Signature: 

Date of Submitting the Final Version of the Thesis: 25.12.2025

Dedication

This thesis is dedicated to my precious family, my wife Rawan, my daughter Valentina, and my two sons Rafa'el & Gabriel, for their unwavering support, love, and encouragement.

To my dear friends who stood by me, believed in me, and offered me the help whenever it was needed, whom their presence made this journey possible.

& To

My people elsewhere,

Whom nobody cares,

Nor desires to hear,

To whom their things were scattered in air,

Whose beloved not here,

But there,

No safe,

No food,

No water,

Just scare,

To My People in Gaza

Samer Ibrahim Jaber Da'beis

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Samer Ibrahim Jaber Da'beis

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Dr. Ashraf Abed Al-Wahhab Almimi

Dr. Sami Sameer Sader

Dr. Eba'a Abdulraziq Da'san

Abstract

Hospitals increasingly seek methods to enhance quality of care while optimizing its resources. Lean Six Sigma (LSS) has emerged as an effective framework to reduce inefficiencies (waste and variation) and improve patients' outcomes. At Saint Joseph Hospital in Jerusalem, day care surgical services were affected by such inefficiencies like high no-shows and surgery cancellation rates, prolonged waiting times, and patient dissatisfaction. This study aimed to evaluate and improve these key performance indicators (KPIs) through a structured LSS intervention over a 16 months period (January 2024 - April 2025). This includes application of Define, Measure, Analyze, Improve, and Control (DMAIC) phases, Value Stream Mapping, Failure Mode and Effects Analysis (FMEA), Pareto analysis, 5S methodologies and others.

A quasi-experimental nonequivalent-groups mixed-methods pre-post design was used, incorporating both qualitative and quantitative data. All day care surgery patients were included (N = 4,080). Quantitative and qualitative data were collected from hospital information systems, surgery schedules, patient satisfaction surveys, and staff inputs.

Analyses involved descriptive statistics, control charts, and hypothesis testing using Minitab. LSS implementation included digital workflow enhancements and standardized patient-education processes, which led to substantial improvements; No-show rates of patients who were scheduled for day surgery decreased from 21.4% to 16.3% (SD from 0.0398 to 0.0388), surgical cancellation rates declined from 2.5% to 0.7% (SD from 0.0126 to 0.00754), waiting times improved across major service intervals with total admission-to-operating-room time reduced from 183 to 114 minutes (SD from 34.6 to 27.7), and patient satisfaction increased from 91.6% to 94.1% (SD from 0.0141 to 0.0113). However, variability analysis using Levene's and Bonett's tests showed inconsistent reductions in processes variations, indicating opportunities for further standardization.

The study concludes that LSS is an effective methodology for driving operational improvements in day care surgical services in hospitals. Recommendations include continuous monitoring through control charts, LSS staff training, future research incorporating longer timelines, and qualitative staff feedback. These outcomes contribute to improving healthcare quality, and support LSS integration as a sustainable model in hospital settings.

Keywords: Lean, Six Sigma, Lean Six Sigma, Hospital, Day Care Surgery.

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List of Definitions of Abbreviations

Abbreviations	Title
5S	Sort, Set in order, Shine, Standardize, and Sustain
AAUP	Arab American University - Palestine
AD	Anderson-Darling Test
CI	Confidence Interval
CT	Cycle Time
CTQ	Critical-to-Quality
CTS	Critical-to-Satisfaction
DF	Degrees of Freedom
DMAIC	Define, Measure, Analyze, Improve, and Control
DT	Downtime
FMEA	Failure Mode and Effects Analysis
HMIS	Hospital Management Information System
I-MR	Individuals and Moving Range
KPI	Key Performance Indicator
LCL	Lower Control Limit
LSS	Lean Six Sigma
LT	Lead Time
M	Mean
MR	Moving Range
NVA	Non-Value-Added
OR	Operating Room
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SD	Standard Deviation
SIPOC	Supplier-Input-Process-Outcome-Customer
SPO	Structure-Process-Outcome
SQL	Structured Query Language
UCL	Upper Control Limit
VoB	Voice of Business
VoC	Voice of Customer
VoP	Voice of Process
VSM	Value Stream Mapping

Chapter One: Introduction

1.1 Introduction and Background

Worldwide, healthcare institutions face increasing pressure to provide healthcare services with high quality, cost-efficient care, optimal patient satisfaction, and high revenues and performance outcomes (Giese et al., 2024). These needs are also necessary in day care service as well, since organizational and harmonized functioning processes and activities of these services directly influence healthcare outcomes and patient satisfaction (Gilliard et al., 2006). Day care surgeries - also referred to as ambulatory or same-day surgeries - offer notable advantages to both healthcare organizations and patients as well, such as shorter length of stay, lower infection rates, and improved patient outcomes and experiences (Xu, 2025).

However, running day care services may face shortcomings, interruptions, variability in processes, and uncontrolled waste (Dantas et al., 2018), these issues often result from patients arriving to the hospital not well prepared (e.g., missing diagnostic tests, not fasting, or wrong referrals), scheduling and administrative failures, and lack of hospital beds or busy operating theater (Koushan et al., 2021). Such inefficiencies can produce defects such as patient no-shows, same-day surgery cancellations, idle or over-stretched staff and resources, and long waiting times. Collectively, these problems negatively affect patients' experiences, reduce staff satisfaction, prolong hospital stays. Ultimately, they undermine hospital outcomes and revenues (Abate et al., 2020; Cohen-Yatziv et al., 2019; Koh et al., 2021; Schouten et al., 2023; Toker et al., 2024), as Dixon-Woods (2019) argues, quality improvement methodologies in healthcare extend beyond individual interventions, positioning quality improvement efforts as both a challenge and an opportunity for a system-wide change.

In the context of day care services, maintaining an agile, efficient, standardized, and reliable workflow is crucial, especially in day care surgical units, where high patient volumes are handled within a short time period (Dixit & Sun, 2024). Factors such as scheduling inefficiencies, inappropriate or late before surgery preparation, and lack of resource and staff shortages can significantly disrupt the workflow and compromise care quality (Al Amin et al., 2025; Cholewa et al., 2024).

To address these challenges and failures, the application of Lean Six-Sigma (LSS) principles presents a promising pathway for healthcare facilities seeking quality improvement while reducing costs and optimizing the workflow and outcomes (McDermott et al., 2022). LSS combines principles of Lean and Six Sigma; historically, Lean methodology originally started by Toyota and its Production System, which aims to eliminate the non-value-added (NVA) activities and simplify work operations to achieve greater effectiveness and efficiency. Six Sigma, developed by Motorola, focuses on decreasing process variations and improving quality through metrics and statistical methods (Ilin, 2023). As Lean and Six Sigma were integrated, they combined their respective strengths to create a comprehensive process-improvement approach known as “Lean Six Sigma”. LSS has become one of the most widely applied quality improvement methodologies in healthcare. Consequently, it was selected as the methodological foundation of this study

LSS is a data-driven methodology that combines Lean principles which focuses on eliminating waste, with Six Sigma which targets variation reduction, hence improving quality and performance. In healthcare settings, LSS has been increasingly applied to enhance safety, efficiency, and patient satisfaction (Gardim et al., 2024). It gained momentum as a structured strategy to enhance operational performance and patient outcomes (Kam et al., 2021). Studies showed that LSS implementation in healthcare can lead to remarkable improvements in the cycle time, enhance patient satisfaction, and reduce defects and defectives like no-show of patients or day surgery cancellation (Mason et al., 2015; Rathi et al., 2022). However, where healthcare institutions are interested in cost savings and increased growth, the patients are interested in the improved service and treatment quality leading to misalignment in priorities (Wackers et al., 2022).

Lean principles can help identify and eliminate these shortages and defects, while Six Sigma tools offer a framework for controlling and improving the process variability and sustaining the improvements as well. Previous studies suggest that LSS initiatives in day care surgical services settings have led to a reduction in surgical site infection, improved surgery timeframe, and enhanced resources usage and utilization (Costa & Godinho Filho, 2016; McDermott et al., 2022). LSS with the methodology of the DMAIC cycle supports identifying, measuring, analyzing, and sustaining the organizational improvements, DMAIC stands for Define, Measure, Analyze, Improve,

and Control, and it is considered central structure of LSS that guides the systematic process improvement, it has been effectively used in hospital settings to reduce waiting times, reduce surgical cancellations, decline operational costs, and patient satisfaction scores (Rosa et al., 2024). Such key performance indicators are commonly tracked in healthcare to monitor quality improvement efforts (Daniell, 2024).

LSS tools include, but are not limited to, Value Stream Mapping (VSM), which visualizes the patient pathway to detect delays and inefficiencies (Marin-Garcia et al., 2021); Gemba walk, a Lean management practice in which leaders and improvement teams go to the actual workplace and directly observe work processes, engage with frontline employees, and identify inefficiencies, waste, and opportunities for improvement in real time (Micieta et al., 2021); and the 5S, a structured workplace-organization approach consisting of Sort (Seiri), Set in order (Seiton), Shine (Seiso), Standardize (Seiketsu), and Sustain (Shitsuke). The 5S method supports the creation of a clean, orderly, and safe work environment that exposes waste and enables stable, repeatable work processes (Kanabar et al., 2024).

Other LSS tools include Failure Mode and Effects Analysis (FMEA), a systematic and proactive approach used to identify potential process failures, assess their causes and effects, and prioritize corrective actions to reduce risk (Roseen et al., 2024); Pareto analysis, which prioritizes improvement efforts by highlighting the “vital few” causes that account for most problems (Alkiayat, 2021); control charts, which are used to monitor process behavior over time and distinguish common-cause from special-cause variation (Yoon et al., 2025); and fishbone (Ishikawa) diagrams, which provide a structured method for uncovering root causes in healthcare operations (Tagaram & Chen, 2024).

In addition to Lean and Six Sigma improvement tools, in the late 1980s, Parasuraman, Zeithaml, and Berry developed the SERVQUAL model, this model conceptualizes service quality as the gap between customers’ expectations and their perceptions of actual service performance, and it builds a framework for measuring service quality across multiple sectors, including healthcare. The model originally identified five core dimensions: tangibles, reliability, responsiveness, assurance, and empathy, jointly they capture how consumers evaluate service encounters. (Parasuraman et al., 1988). In healthcare settings, SERVQUAL has been frequently

adapted to reflect clinical priorities such as communication, safety, professionalism, access to care, and timeliness, while still maintaining the foundational structure of evaluating expectation-perception gaps. Studies have demonstrated that SERVQUAL provides a systematic and validated approach for assessing patient satisfaction and identifying areas for quality improvement, making it highly relevant in hospital performance evaluation and LSS driven quality initiatives (Rahmatia et al., 2025).

However, implementation of LSS in healthcare settings faces challenges like resistance to change and new methods of work, lack of trained staff, absence of clear procedures and pathways, and lack of administrative support, that often impedes successful implementation of LSS. Fortunately, leadership engagement, staff training and orientation, and absorption of safety continuous improvement culture offer essential enablers for LSS success in healthcare themes (Wang et al., 2025). Moreover, the use of data-driven decision making and adopting the performance metrics style, like key performance indicators (KPIs), is very important for monitoring the progress and achieving improvements and sustainability (Gardim et al., 2024).

This study is guided by Donabedian's Structure-Process-Outcome (SPO) model, which supports the improvement in healthcare settings as a yield of optimizing structural enablers and process workflows (Guzman-Leguel & Rodriguez-Lara, 2025). Surgical patient flow processes efficiency was examined by Knox et al. (2024) through the use of a "surgical enhanced readiness dashboard" that improved first-case on-time surgery start, it was not explicitly grounded in the SPO framework, focusing instead on real-time process monitoring. In contrast, the study implemented the SPO model to day care surgical services scheduling, findings showed that ensuring structural supports (e.g., leadership, management information system, staff training) and process improvements (e.g., standardized workflows, waste elimination, reduced variability) are systematically linked to the outcomes such as: no-show and cancellation rates, waiting times, and patient satisfaction. By adopting this theoretical framework, this study will find out how to develop sustainable improvements that align with the operational efficiency of day care services and patient-centered outcomes at Saint Joseph Hospital in Jerusalem.

However, with the advancement of technology and treatments, healthcare institutions continued to struggle with challenges of increased demand for health

services, their speciality, diversity and complexity (Spanos et al., 2024), In response, methodologies such as LSS offers a structured and practical approach to streamline operations, reduce variability, and enhance overall care quality and patient outcomes (McDermott et al., 2022). To date, no published research has evaluated the systematic application of LSS in day care surgical services within Palestinian hospitals' context, highlighting the feasibility and necessity of this study. Saint Joseph Hospital, as a general hospital, with a high day care surgical volume and documented inefficiencies, provides a particularly suitable and feasible setting for conducting this study. This study adopts the DMAIC methodology as the core framework of LSS and utilizes several LSS tools, including VSM, FMEA, Pareto analysis, 5S, and control charts, to identify root causes and prioritize improvement actions. This structured approach provides actionable insights for Saint Joseph Hospital in Jerusalem by identifying performance gaps and guiding targeted improvement interventions. Furthermore, the study contributes to the broader discourse on quality management and performance excellence in day care surgical services and enriches the existing academic literature in this field.

1.2 Problem Statement

Healthcare systems worldwide expose patients to avoidable harm and unwarranted variations in quality, As Dixon-Woods (2019) emphasizes, the study of quality improvement methodologies in healthcare contributes to and is important in developing an evidence-based that looks at more than improvement interventions alone, rather it can be weighted as both a challenge and an opportunity for success.

Day care surgical services are one of the health care services. They are defined as services that include procedures in which patients undergo elective surgery on the day of their admission and they are discharged within 24 hours after surgery (Xu, 2025). For that, these services are considered as high-speed services, that require high quality levels of administrative, operational, and clinical activities (Glowka et al., 2023). Waste and variability in practice lead to defects and operational failures that negatively affect patients' experiences, staff satisfaction, and hospital outcomes. Such wastes and variability can be a result of inappropriate referrals, unready patients for surgery (like lack of diagnostic tests or poor preparations), increased hospital stay, non-utilized staff, non-utilized operating room (OR), long waiting times, unnecessary admission, canceled admissions, canceled surgeries, delayed surgeries, unsatisfied patients, wrong diagnosis,

bed crises, increased infection risk, poor care to other patients, and staffing shortages (McDermott et al., 2022).

Despite the growing global adoption of LSS in healthcare, its application in Palestinian hospital settings -particularly in day care surgical services- remains underexplored. At Saint Joseph Hospital in Jerusalem, process inefficiencies such as high patients' no-show rates, high surgery cancellation rates, increased waiting times, and patients' dissatisfaction have been observed in day care surgery. Therefore, this study seeks to evaluate and improve these process challenges by implementing LSS methodology, with the aim of optimizing hospital's operational performance and patient experiences.

1.3 Research Objectives

The purpose of this study is to improve day care surgical services efficiency at Saint Joseph Hospital while maintaining safe and quality patient care. This includes:

1. Evaluate the effect of LSS methodology implementation on hospital outcomes and patient experiences in day care surgical services.
2. Optimize patient surgical outcomes in day care department, through standardization, waste reduction, and variability reduction.
3. Identify the performance metrics' changes in day care services; both before and after applying the LSS methodology.

1.4 Research Questions

1. Does the Implementation of LSS methodology on day care surgical services affect hospital outcomes and patient experiences?
2. How do LSS practices affect day care surgical services outcomes?
3. To what extent can the application of LSS methodology affect performance metrics of day care surgical services?

1.5 Research Hypotheses

H1: Implementation of LSS Methodology on day care surgical services have a positive effect on hospital outcomes and patient experiences.

H2: Implementation of LSS Methodology on day care surgical services have positive outcomes including standardization, waste reduction, and variability reduction.

H3: Performance metrics before LSS implementation differ from those after LSS implementation in day care services.

1.6 Research Variables

The independent variable is the implementation of the LSS methodology at Saint Joseph Hospital. It is operationalized as a binary variable: before implementation (January - August 2024) and after implementation (September 2024 till April 2025). The dependent variables are the measurable outcomes used to assess process performance and patient experiences, this includes the no-show rate (%), surgery cancellation rate (%), patient waiting times (minutes), and patient satisfaction rate (%). These variables are used to assess the impact of LSS methodology application (Independent variables) on the hospital performance and its impact on patients' outcomes and experiences (Dependent variables).

1.7 Conceptual Framework

This study adopts Donabedian's SPO model as its theoretical foundation. The model enables the improvements in healthcare outcomes by optimizing the structure/inputs (resources and systems) and processes (clinical and administrative workflows) of care delivery (Guzman-Leguel & Rodriguez-Lara, 2025).

In this study, the independent variable is the implementation of LSS methodology, specifically, the DMAIC methodology, and other tools of quality improvement such as VSM, FMEA, Pareto chart, 5S, control charts, and fishbone diagrams. These interventions target process variables, including workflow standardization, waste elimination, and variation reduction across peri-operative care.

The dependent variables are the KPIs of day care surgical services, which includes:

1. No-show rate.
2. Same-day surgery cancellation rate.
3. Waiting times (admission to nurse assessment time, admission to doctor assessment time, admission to operating theater for surgery performing time).
4. Patient satisfaction rate.

The expected outcomes are measurable improvements in operational efficiency, hospital outcomes, and patient satisfaction, by aligning structural enablers (e.g., leadership, staff training, resources, and data-driven decision-making) with streamlined processes, LSS is anticipated to generate sustained performance improvements.

The conceptual framework is visualized as follows:

1. Structure: Hospital resources, leadership support, staff training, and Hospital Management Information System (HMIS).
2. Process (Independent Variable): LSS implementation (DMAIC and other tools like VSM, FMEA, Pareto, 5S, fishbone, and control charts).
3. Process Variables: Standardization, waste elimination, and variation reduction.
4. Outcomes (Dependent Variables): No-show rates, cancellation rates, waiting times, and patient satisfaction rate.

Thus, the framework demonstrates the constructed pathway:

LSS implementation >> Process optimization >> Improved KPIs >> Enhanced hospital performance and patient outcomes, as follows.

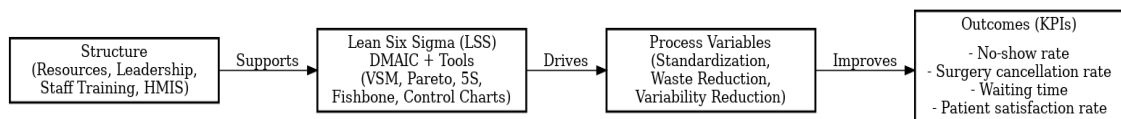


Figure 1.1: Conceptual framework of LSS implementation in day care surgery at Saint Joseph Hospital

This framework is aligning with the findings by Teeling et al. (2023), who demonstrated that applying Six Sigma methodologies in healthcare reduced delays, minimized variability, and improved resource utilization. Their results reinforce the constructed pathway of this study; that LSS through DMAIC and other quality tools optimize peri-operative processes, leading to measurable improvements in KPIs.

1.8 Operational Definitions

To ensure consistency and accuracy in measurement, key variables in this study were operationally defined in alignment with Donabedian's SPO model (Guzman-Leguel & Rodriguez-Lara, 2025). The selected indicators represent core dimensions of peri-operative (before surgery, in surgery, and after surgery) efficiency and patient-centered outcomes in day care surgery. Specifically, no-show and surgery cancellation rates that capture avoidable inefficiencies and visualize throughput and hospital productivity, in addition to the waiting times which measure patient flow across critical

peri-operative phases. Finally, patient satisfaction is measured by standardized hospital surveys which serves as a picture for quality of care from the patient's mouth. These definitions allow for objective, reproducible measurement and facilitate comparisons with findings from international LSS studies (Aiken et al., 2017; Costa & Filho, 2016; McDermott et al., 2022):

1. No-show rate (%): The proportion of patients who were scheduled for day care surgery and did not come to the hospital on their scheduled date.
This is calculated as: $(\text{Number of no-shows in a given month} \div \text{Total scheduled day care surgery in the same month}) \times 100$. Data source: HMIS data and day surgery schedules.
2. Surgery cancellation rate (%): The proportion of scheduled day care surgeries that were canceled on the same day due to clinical, administrative, or patient-related reasons.
This is calculated as: $(\text{Number of canceled day care surgeries in a given month} \div \text{Total admitted day care surgeries in the same month}) \times 100$. Data source: HMIS data and day surgery schedules.
3. Waiting time to nurse assessment: The time (in minutes) from patient registration and admission at admission desk to the start of the nursing assessment, recorded in HMIS.
This is calculated as: $\text{Total time (in minutes) from patient registration and admission at admission desk to the start of the nursing assessment} \div \text{Total number of completed day care surgery in the same month (excluding completed surgeries with hospital length of stay more than 24 hours from nominator and denominator)}$. Data source: HMIS data.
4. Waiting time to doctor assessment: The time (in minutes) from patient registration and admission at admission desk to the start of the doctor assessment, recorded in HMIS.
This is calculated as: $\text{Total time (in minutes) from patient registration and admission at admission desk to the start of the doctor assessment} \div \text{Total number of completed day care surgery in the same month (excluding completed surgeries with hospital length of stay more than 24 hours from nominator and denominator)}$. Data source: HMIS data.

5. Waiting time to operating room and surgery performing: The time (in minutes) from patient registration and admission at admission desk to the entry of patient into the operating room for surgery, recorded in HMIS and medical record.
This is calculated as: Total time (in minutes) from patient registration and admission at admission desk to the entry of patient into the operating room for surgery ÷ Total number of completed day care surgeries in the same month (excluding any completed surgeries with hospital length of stay more than 24 hours, from nominator and denominator). Data source: HMIS data and medical record.
6. Patient satisfaction: Patients' experiences and feedback, measured using Saint Joseph Hospital's standardized patient satisfaction survey, completed after surgery and just before patient discharge (excluding any completed surgeries with hospital length of stay more than 24 hours). Responses were based on a five-point Likert scale and aggregated into an overall percentage score.

1.9 Significance of the Study

Globally, inefficiencies in quality of care are a major driver of avoidable harm, and require system-level improvement approaches beyond isolated interventions, especially in low-resource hospital settings, such inefficiencies lead to compromised outcomes and resources wasting (Kruk et al., 2018). Healthcare systems in resource-constrained regions -like Palestine- must simultaneously deliver high-quality care and efficiently manage its scarce resources (Van Zyl et al., 2021). Within peri-operative pathways, defects such as same-day surgery cancellations and surgery delays are common, which in turn harm patients' experiences, and reduce hospital outcomes (Koh et al., 2021).

The occupied Palestinian territories are known to suffer from resource-constrained and political conflict-affected contexts, with acute challenges in delivering high-quality care amid severe restrictions on resources, movement, and infrastructure (World Health Organization, 2023), Saint Joseph hospital, as located in East Jerusalem, suffers from these challenges. These obstacles affect the hospital operational efficiency and its outcomes; high no-show rates of day surgery patients, high surgery cancellation rate, and long waiting times were noticed. These inefficiencies negatively impact patient satisfaction, hospital outcomes, resource utilization, and institutional reputation. Saint Joseph Hospital, as a general hospital in the center of East Jerusalem, is considered the

second central and referral hospital in Jerusalem for Palestinians, this mandates that the hospital has to provide high quality care while maintaining its resources and daily operations.

Currently, no published studies have documented the application of the LSS methodology in day care surgical services within Palestinian hospitals. This creates both an urgent need and a feasible opportunity to test and adopt the LSS methodology to this unique context, the motivation for this research stands beside the urgent need to move beyond reactive management, and step forward towards structured and data-driven improvements. LSS offers a structured, data-driven route to streamline peri-operative flow, reduce waste and variation, and sustain improvements. Recent reviews document LSS applications in healthcare that improve timeliness, quality, and process reliability when implemented as coherent systems (Talero-Sarmiento et al., 2024).

Implementing LSS in healthcare is not without challenges, barriers like lack of data, staff resistance, limited training, and insufficient leadership engagement had been reported (Laureani & Antony, 2017). This study anticipates such challenges by incorporating leadership support, staff involvement, alignment with local context, and continuous feedback through LSS implementation process. It will identify barriers and constraints at day care surgical services at Saint Joseph Hospital, and find out the opportunities to improve quality of care, patient flow, multidisciplinary care coordination, delays reduction, waste elimination, and variability reduction in patients' preparations, surgery performing, and post-surgery care process.

Beyond improving processes and outcomes at Saint Joseph Hospital, the research contributes an actionable evidence for hospital administrators and policymakers in Palestine, showing how structured quality methodologies like LSS - even under resources limitation- can be adopted, and improvements can be sustained, this study will generate an actionable lessons for day care surgery improvements, as well as a valuable contribution to the global literature on deploying LSS methodologies in underserved healthcare environments.

1.10 Scope of the Study

This study examined the impact of LSS methodology implementation in day care surgical services at Saint Joseph Hospital in Jerusalem over a 16-month period (January 2024 - April 2025). The study population included all patients scheduled for

day care surgery during this timeframe (N = 4,080). Exclusion criteria comprised unscheduled surgeries, emergency surgical cases, and inpatients whose hospital stay exceeded 24 hours.

1.11 Saint Joseph Hospital Background and Description

Saint Joseph's Hospital was founded in 1956 by the Sisters of Saint Joseph of the Apparition, and since then it has functioned as a non-profit general hospital in the Sheikh Jarrah neighborhood in the Eastern part of Jerusalem. It serves the general population of East Jerusalem, West Bank, and the Gaza Strip. The mission of St. Joseph Hospital is to serve the community according to the values of the congregation of the Sisters of Saint Joseph of Apparition by providing high-standard healthcare services through a qualified staff, in parallel with the latest medical advances in technology; providing compassionate healthcare services regardless of religion, race, ethnicity, gender, age, socioeconomic status, and educational level, while preserving the most comfortable safe environment for care, meeting & exceeding customers' expectations as well. Saint Joseph Hospital seeks excellence by expanding and improving our health care services comprehensively and strengthening capacity building, Saint Joseph Hospital consists of 154 beds composed of diverse medical subspecialties like surgical services that cover most of the aspects of the surgical problem including general surgery, gynecology, urology, orthopedic surgery, and ENT, either as inpatient care or day care services, the day care department occupies 20 beds, which represents 13% of total hospital beds. In addition, health services include multiple departments like obstetrics & gynecology complex, neonatal intensive care unit, adult intensive care unit, laboratory, pharmacy, and radiology department. Saint Joseph hospital is currently staffed by 395 employees (Saint Joseph Hospital, n.d.).

Annually, Saint Joseph Hospital treats more than 10,000 patients in inpatient care, more than 25,000 emergency visits, and more than 2000 day-care surgeries, in addition to outpatient services of around 50,000 customers (Saint Joseph Hospital Reports, 2020 - 2023).

1.12 Structure of the Study

This study is structured as follows:

Chapter One: Introduction and Background

This chapter presents the overall background of the study, defines key concepts such as Lean, Six Sigma, LSS and day care surgery, outlines the problem statement, states the research objectives, research questions, hypotheses, and research variables. It explains the significance and scope of the study. It also sets the conceptual framework and introduces the operational definitions guiding the research.

Chapter Two: Literature Review

This chapter summarizes search methodology and reviews relevant theoretical foundations and previous empirical studies on Lean, Six Sigma, and their integration into LSS in healthcare, with a focus in its applications on day care surgical services, strengths, gaps, and limitations in the existing literature are discussed to highlight the research need and position this study within the broader academic context.

Chapter Three: Methodology

This chapter explains the research design, population and sample, and describes the setting of Saint Joseph Hospital. It details the data collection tools (HMIS, medical files, surveys, interviews, workplace observations, and staff feedback). It also explains the statistical methods used, including control charts, descriptive statistics, and hypothesis testing with Minitab, and discusses ethical considerations.

Chapter Four: Data Results and Analysis

This chapter presents the results of the study, including descriptive analysis of key KPIs, comparison of pre-LSS and post-LSS outcomes, and statistical testing, linking LSS implementation with observed improvements in efficiency, variability reduction, and patient satisfaction.

Chapter Five: Discussion and Conclusion

This chapter summarizes the major findings of the study, findings are interpreted in light of the literature, discusses their implications for practice, and offers recommendations for hospital managers and policymakers. It also outlines the study's

limitations, suggests areas for future research, and emphasizes the contribution of this study to improving day care surgical services in resource-constrained hospital settings.

In summary, this chapter provided the background and rationale for this study. It brought the emerging pressures faced by hospitals to provide efficient high-quality patient-centered care with specific reference to the challenges of operations concerning scheduled day care surgical services. LSS was offered as a systematic, data-centered approach to solving inefficiency, diminishing variability, and increasing patient outcomes and satisfaction. The chapter has also presented the problem statement, research objectives, research questions, and hypotheses as well as the conceptual framework based on Donabedian SPO model. Operational definitions have been set, which will make measurements clear and consistent, the significance and scope of the study were emphasized, highlighting the feasibility and necessity of implementing LSS in Saint Joseph Hospital in Jerusalem. Finally, the structure of the study is presented. Next chapter reviews the relevant literature to situate this study within the broader practical and academic context of healthcare quality improvement in day care surgery services in hospital's settings.

Chapter Two: Literature Review

2.1 Introduction

This chapter reviews the present literature on LSS and its implementation in healthcare services, focusing on day care surgical services. The review starts with search methodology, then after definition of day care services, Lean and Six Sigma, outlining the historical background and evolution of LSS, followed by discussing how LSS methodology had been adapted for healthcare services settings. It also elaborates on LSS key concepts, its justifications and use for healthcare services, and the empirical studies that prove LSS effectiveness in healthcare settings. At the end, the chapter highlights the gaps that remain in the field.

2.2 Literature Search Strategy

The literature search was designed to identify peer-reviewed evidence and authoritative definitions relevant to Lean, Six Sigma, and LSS in hospitals during Aug. 2024 and Apr. 2025, with a specific emphasis on day care surgical services in hospitals. The objectives were to summarize foundational concepts (definitions, evolution, and core improvement tools), describe implementation approaches used in healthcare service pathways (e.g., DMAIC, VSM, 5S, Gemba Walk...), and synthesize empirical outcomes directly pertinent to the thesis focus at Saint Joseph Hospital in Jerusalem. Outcomes of interest included no-show rates, surgery cancellation rates, waiting times, and patient satisfaction rate.

Information sources from (Google Scholars, OpenAlex, AIP Publishing, Emerald, Springer, ResearchGate, PubMed, Medline, MDPI and others) comprised the peer-reviewed journal articles and authoritative texts. To enhance completeness within this corpus. Search terms were structured around the thesis keywords and combined method, domain, and setting descriptors, this includes: “Lean”, “Six Sigma”, “Lean Six Sigma”, “LSS”, “DMAIC”, “VSM”, “5S”, “FMEA”, “Gemba Walk”, together with “healthcare” or “hospital” and day-surgery terms which includes “day care surgery”, “day case surgery”, and “day surgery unit”, and NOT “outpatient day surgery” or “medical center”. The time window spanned 2000 - 2025 to capture early healthcare applications through recent studies aligned with day-surgery pathways. Definitions and historical events time window were unlinked to time span.

Eligibility criteria were defined in prior. Inclusion criteria were: (a) healthcare settings; (b) absolute use of Lean, Six Sigma, or LSS (including specific tools such as DMAIC, VSM, 5S, or Gemba Walk), and (c) conceptual, review, or empirical studies that reported or discussed outcomes or process changes relevant to day care surgery pathways. Exclusion criteria were: non-peer-reviewed items which includes editorials, commentaries, and conference abstracts, publications not focused on healthcare services and hospitals (outpatient day surgery or medical centers were excluded), studies without relevance to day care surgery contexts, and articles lacking outcome or process linkage to the thesis aims. Screening proceeded in two stages: title and/or abstract followed by full-text assessment were applying these criteria consistently; where multiple papers addressed similar questions, preferences were given to studies with clearer methods, transparent outcomes, and its definitions aligned with the thesis KPIs.

The search resulted in 1,609 results. during the first screening process the researcher found no more than 494 papers relevant and beneficial for the study. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (Figure 2.1) was used to manage and explain the data collection and evaluation process. PRISMA diagram is based on Page et al., (2021) reference, among the 494 papers and during the second screening process 253 papers were excluded because they were duplicated or discussed metrics unrelated to this thesis, out of the remaining 241 papers, 144 were excluded because they were irrelevant to hospital settings. The researcher could not retrieve 4 papers, and 15 were excluded because they lacked robust research methodology, as a result of the above-followed steps, the review process resulted in the selection of 78 papers.

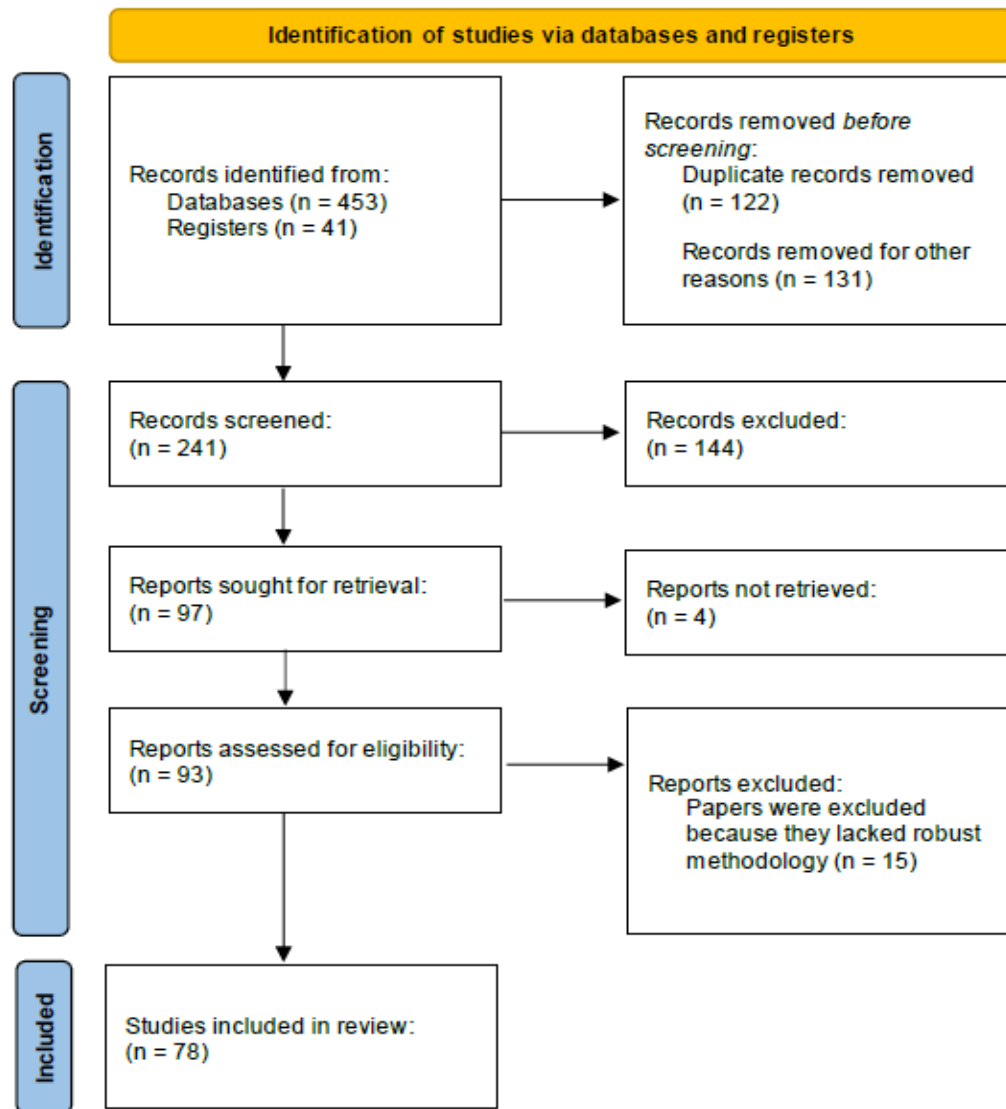


Figure 2.1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses Flow Diagram

Data from included studies were processed and extracted into structured and systematic literature review research methodology (Figure 2.2) capturing authors and year, setting and specialty, study design (e.g., case study, pre-post LSS, empirical review...), LSS approach and tools used (e.g., DMAIC phases; VSM mapping; 5S; Gemba Walk...), reported outcomes and effect direction or size, and salient contextual enablers or barriers (e.g., leadership involvement, training, alignment with service goals). Given heterogeneity in designs and measures, findings were synthesized narratively and organized thematically to mirror chapter two, including: (1) definitions and evolution of Lean, Six Sigma, and LSS, (2) core concepts and tools, (3) empirical evidence grouped into process or time outcomes, surgical or clinical outcomes, and

organizational or people considerations, and (4) knowledge gaps relevant to day care surgery in resource-constrained contexts. The scope is intentionally limited to the sources included in the thesis and their citation networks; non-English and grey literature were not accepted or synthesized.

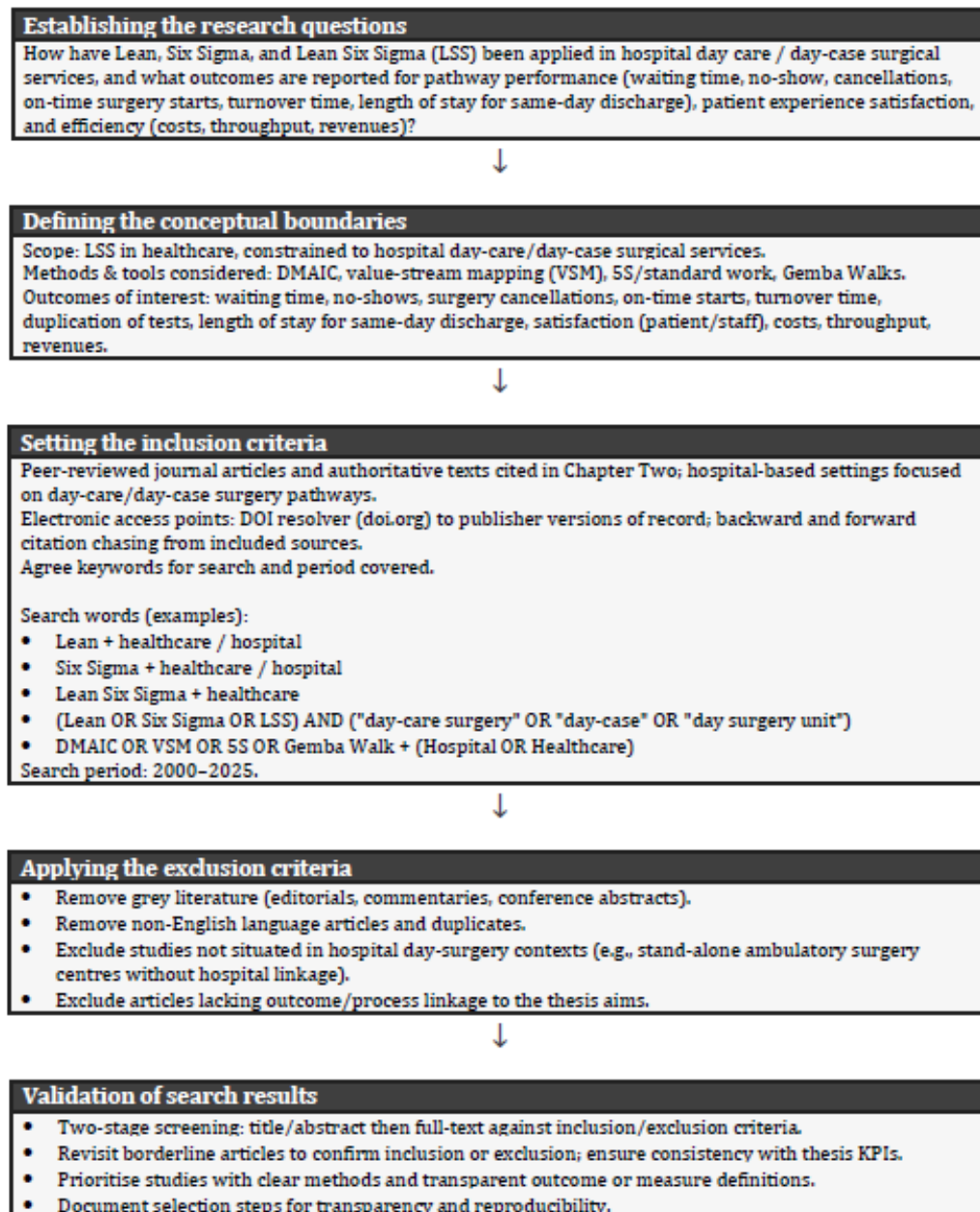


Figure 2.2: Systematic Literature Review Research Methodology Flowchart

2.3 Day Care Surgery

Day care surgery is defined by the Royal College of Surgeons as “when the surgical day-case patient is admitted for investigation or surgery on a planned non-resident basis and who nonetheless requires recovery facilities and complete

perioperative care” (Kakande et al., 2005). Perioperative care refers to the comprehensive, multidisciplinary management provided to a patient before, during, and after surgery, with the goal of ensuring safe preparation, optimal intraoperative management, and effective postoperative recovery (Grocott & Mythen, 2015). The surgery scheduling date is defined by Fixler and Wright (2013) as the decision date (the referral date) for surgery. In addition, they defined the surgery performing time as the on-time start of the actual procedure in the operating theater (Fixler & Wright, 2013).

Day surgery is visualized as a high-speed and high-frequency service, since it includes short and simple surgeries and procedures, for that, variation and waste are the most enemies, that may result in low performance, low revenues, and poor satisfaction of patients and their families (Bailey et al., 2019; Getting It Right First Time, 2024; Koh et al., 2021; Turunen et al., 2018).

Healthcare expenses are quickly rising, and hospitals are under growing pressure to cut costs while also improving service and patient safety, reducing patient waiting times, and reducing errors and related lawsuits (Giese et al., 2024). In hospitals, the total time from the beginning to the finish of a patient journey becomes a significant metric that must be improved (Young, 2014). A study conducted by Mandahawi et al. (2011) on day care surgeries showed that reducing the time a patient spends in the system from around 48 minutes to slightly over 20 minutes improved patient satisfaction, this improvement led to 48% reduction in patients' hospital stay.

Furthermore, Davies et al. (2019) implemented an interventional study using LSS and pre-and post-evaluation at day care services at private hospitals, focusing on nursing time and improving personalized patient care and staff satisfaction, results showed significant improvements in service performance and patient satisfaction as well as staff satisfaction. A reduction in patient turnover times, an increase in nursing care time, and an improvement in the nurse-patient ratio are all examples of significant added value metrics. Costa Jr. et al. (2015) performed a one-year study concluded that delays in the operating room were common and had a significant impact on patient flow and resource use. The non-surgical period was significantly longer than the operating period.

2.4 Lean Six Sigma

LSS is a process improvement method that maximizes stakeholders' value by improving quality and speed while reducing waste and costs of the products or services (Laureani et al., 2013). LSS combines Lean principles, which focus on waste reduction, with Six Sigma, which aims at minimizing variability, this methodology has shown significant improvements in healthcare efficiency (McDermott et al., 2022). LSS is rapidly gaining popularity and is being implemented in the manufacturing sectors as well as service industry to improve the quality performance of organizations (Hess & Benjamin, 2015).

In early 1950s, Taiichi Ohno developed Lean production concept to reduce waste (known as MUDA) from production processing through process standardization and the collaborative approach of all employees in process improvement (Yarbrough, 2025). However, Lean in healthcare is about finding out the critical quality factors concerning the patient and distinguishing between activities that add value to the service quality by catering to the desires of the patients and activities that do not add value, and therefore are considered as waste and ought to be removed (Dahlgaard et al., 2011). Subsequently, on 1987, Motorola had introduced Six Sigma to improve quality through the measurement of quality performance by defects per million opportunities in the manufacturing sector, and errors per million opportunities in the services sector (Ilin, 2023).

The basic idea of Lean thinking is to remove all sorts of waste and create a faster and more efficient operational model, resulting in reduced waste and increased customer satisfaction (Nabiyouni & Franchetti, 2019); these wastes on which Lean is based are eight as follows: (1) Overproduction that produces more than required, (2) Inventory which is the extra conservation of material in all processes, (3) Overprocessing and doing more work, (4) Motion which is the activity not essential for the processes and customers will not pay for, (5) Defects represented by revision and correction of defects, (6) Waiting time that includes activities awaiting completion, (7) Transportation which is the unnecessary waste in the process of transporting equipment or materials, and (8) Non-Utilized Talent which is failure to fully use people's skills, ideas, knowledge, and capabilities within an organization (Alkinaidri & Alsulami, 2018).

Lean tools such as VSM, job standardization, and 5S are among the most widely applied methodologies in service sectors including healthcare (Akdag et al., 2017). VSM is defined by the American Society for Quality (n.d.) as “a lean tool that employs a flowchart documenting every step in the process” and is widely regarded by Lean practitioners as a fundamental method for identifying waste, reducing process cycle times, and driving process improvements. 5S is described by Gapp et al. (2008) as a structured workplace organization system aimed at improving efficiency, safety, and quality by eliminating waste and establishing a standardized, orderly environment.

In addition, VSM incorporates both qualitative and quantitative data; qualitative data as it visually represents workflows, identifying inefficiencies, bottlenecks, and areas for improvement, it includes observations, process descriptions, and insights from Gemba walks (going to see the work) and Voice of the Customer (VoC) feedback, while quantitative data since it also uses numerical metrics such as activity time benchmarking, number of operators needed for each activity, defect rates, and discover process efficiency to measure performance and drive data-driven decisions (Liu & Zhang, 2023).

As for Lean, that applies different tools for quality improvement, Six Sigma relies on a very important quality improvement tool which is known as DMAIC cycle (Define, Measure, Analyze, Improve, and Control). Angmo & Kant (2015) studied this methodology and its application in hospitals; they explained and concluded each step of the DMAIC as follows:

The primary goal of the **define phase** is identifying the customers and their voices or needs. In case of hospitals, customers include surgeons, doctors, patients, staff, and others. it identifies areas where Six Sigma can be applied, and what key performance measures such as waiting time during registration, assessment, and treatment can be improved. Moreover, this phase identifies the important characteristics of quality factors which influences the patient satisfaction level, and identifies the process performance gaps and opportunities.

The **measure phase** aims to plan the data collection methods, collect data, define the relationship between the process variation and process specifications, identify out-of-control quality characteristics such as operation case delay, waiting time, etc., and to identify the trend of the process performance during the study.

The ***analysis phase*** is essential and aims to identify the most significant dimensions or variables that affect the overall satisfaction level, validate the root cause by analyzing the data collected in the previous step using analytical tools, find out the major causes that held back the process from achieving Six Sigma level of quality, and to find the failure modes. Two types of analysis can be formulated in this step, firstly, the process analysis, which includes an in-depth study of the processes to identify NVA activities; which not only a time waste but also a waste of resources and money, and secondly, the data analysis using the data collected in the measure step, differences and variation can be defined and improvement possibilities can be suggested.

The ***improve phase*** consists of methods and techniques to improving and sustaining the improvements made for the processes, various steps are involved, including identification and formulation of the best possible improvement actions, application of advanced technological systems to keep the data intact and easily accessible whenever required without having to delay the case, and optimization of the flow work.

Control phase is the most important step of all; it needs wide attention from the top management team, the control phase activities consist of standardization of improvement plans to sustain the gains of the improvements, maintaining the system which sustains the continuous improvement of the patient satisfaction level, and implementation of control plans.

Six Sigma applies statistical methods to achieve uniformity and preciseness in the processes, it also involves the training and certification of designated process specialists (e.g. green belts, black belts) within the organization to help guide Six Sigma improvement efforts (Barr, & Brannan, 2024). Six Sigma is an enabler to reduce variability and waste, translating to fewer errors, provide better processes, greater customer satisfaction rates, and happier and more productive staff (Rohini & Mallikarjun, 2011).

When Lean and Six Sigma are combined, they can produce better outcomes than either approach could achieve on its own; because it integrates human factors (such as leadership, customer focus, culture change, and so on) and process factors (process capability, process management, and statistical thinking) for improvement (Antony, 2010). Lean philosophy cannot put a process under statistical control, and Six Sigma

alone cannot substantially enhance process speed or lower expenses, a mix of Lean and Six Sigma is required (Rathore & Srivastava, 2020).

LSS has seen a steady growth in adoption within the healthcare sector since the early 2000s, driven by the increasing need for operational efficiency, cost reduction, and improved patient care (McDermott et al., 2022; Rathore & Srivastava, 2020). LSS is one of the most common business management strategies that focuses on minimizing variation to improve business and operational excellence while addressing challenges linked to process flow and waste. In essence, LSS accelerates the transformation of an organization's strategic goals into near-perfect service by attaining the quickest rate of improvement in customer experiences, cost, quality, process speed, and invested capital (Bhat, Gijo & Jnanesh, 2014).

Furthermore, LSS had been extensively adopted by healthcare facilities to boost its performance, outcomes and efficiency, given that fact that most United States healthcare delivery systems are still operating at two to three Sigma levels (Etienne & Etienne, 2021; Galvan-Perez, 2025). However, recent studies have shown LSS efficiency in enhancing surgical outcomes, reducing the cost and improving patients' outcomes and satisfaction (Davies et al., 2019). Teeling et al. (2023) highlighted the importance of redesign and transformation of surgical pathways, which includes engagement of the customer voice, enabling system awareness, and fostering a continuous improvement culture. In addition, Ubaid & Al-Juboori, (2023) focused on the preceding conditions for the successful implementation of LSS initiatives, such as managerial support, high-quality education and training, and alignment with organizational strategy.

In addition to LSS tools, in healthcare settings, SERVQUAL has become a foundational model and added value for evaluating service quality, particularly because of its flexibility and strong empirical support across diverse clinical settings. Unlike technical quality measures such as complication rates or clinical outcomes, SERVQUAL captures the experiential and interpersonal aspects of care that strongly influence patient satisfaction, including communication, responsiveness, reliability, and the physical environment (Rahmatia et al., 2025). Researchers have emphasized that these dimensions are critical in high-throughput services such as day care surgery, where patients undergo rapid transitions between admission, treatment, and discharge,

making perceptions of timeliness, clarity of instructions, safety, and staff professionalism especially salient (Rezaei et al., 2018). Evidence shows that SERVQUAL is sensitive to operational inefficiencies and workflow delays, making it a valuable complement to LSS initiatives that aim to reduce waste and variation (Al-Balas et al., 2024). By aligning patient-perceived service quality with process improvement frameworks, SERVQUAL provides a validated mechanism for identifying service gaps, prioritizing improvement targets, and assessing the impact of interventions designed to enhance the overall patient experience.

By integrating Lean methodologies, Six Sigma tools, and the SERVQUAL model, hospitals are better positioned to achieve comprehensive quality improvement. Together, these approaches enable organizations to identify and eliminate process waste, reduce variation, strengthen workflow reliability, and systematically capture the patient's perspective on service quality. This combined framework supports more efficient, patient-centered, and data-driven care delivery, ultimately enhancing operational performance, clinical outcomes, and overall patient satisfaction.

2.5 Previous Studies of Lean Six Sigma

Healthcare institutions struggle to implement LSS as they aim to deliver high quality of care in a cost-effective manner (Wackers et al., 2022), LSS clearly overcomes healthcare burdens via delays reduction, waste elimination, variation reduction and standardization (Sordan et al., 2023). Studies showed that LSS successfully enhances patient care and optimize workflows in healthcare institutes (Hess & Benjamin, 2015; Laureani et al., 2013; Young, 2014). Through the adoption of the DMAIC methodology of Six Sigma, cost reduction, and quality improvement have long been attainable goals in the healthcare industry (Does et al., 2010). Furthermore, Toyota pioneered the Lean thinking technique in the 1980s, transforming the automobile sector by demonstrating that it is a systematic approach to identifying and eliminating waste (Dave, 2020). Both Lean and Six Sigma combined to form LSS, a powerful methodology that fosters sustainable organizational improvements through continual quality enhancement and efficiency gains (Utama & Abirfatin, 2023).

Empirical evidence suggests that LSS through VSM positively influences both the process time dimension and outcome quality, with demonstrated reductions in NVA time such as waiting time and decreased length of stay (Nowak et al., 2017; Young,

2014). Furthermore, Lima et al. (2021) recommend that the implementation of Lean practices in healthcare should encompass the complete flow of patients, medications, and materials, rather than focusing on isolated initiatives, they emphasize that such implementation should foster cultural transformation within hospitals through structural changes, aligned with new strategic visions and objectives, and supported by real models of continuous, structural, and sustained improvement.

Mason et al. (2015) reviewed the implementation of Lean and Six Sigma systematic approaches in surgery, and they discovered that the wide range of outcomes can be grouped into six goals: improve outpatient efficiency, improve operating room efficiency, reduce operative complications, reduce ward-based complications, reduce mortality, and limit unnecessary cost and length of stay. They concluded that Lean and Six Sigma quality improvement methodologies have the potential to produce clinically significant improvements for surgical patients. Moreover, a systematic review conducted by Wang et al. (2025) demonstrated that Lean-based interventions consistently improve efficiency, care quality, cost-effectiveness, and patient satisfaction, enhancing both clinical performance and the hospital's operational and financial sustainability, which collectively strengthen organizational competitiveness.

According to Rathi et al. (2022), LSS principles in the healthcare industry help hospitals stay competitive, generate cross-trained employees, and create a safe workplace free of mistakes and process variances while cost-effectively treating patients. LSS helps hospitals identify and eliminate wastes quickly and efficiently; reduce costs, improve quality, and provide better patient care.

Schretlen et al. (2021) conducted a 36-months LSS study aimed at helping healthcare organizations deliver safer, timely, effective, efficient, equitable, and patient-centered care, the study demonstrated that LSS is an effective quality improvement approach, with critical success factors including the application of a structured, data-driven problem-solving methodology, focusing on patient value and process flow, strong leadership support, and active engagement of healthcare professionals across the care pathway, furthermore, continuous monitoring of KPIs was identified as essential for fostering ongoing process improvement and ensuring long-term sustainability.

Bhat et al. (2014) studied the application of LSS methodology in the registration process of a hospital, results showed that the cycle time of the process was reduced

from 3 to 1.5 minutes, a 94% reduction in patients' average waiting time, 91% reduction in queue length, and 48% reduction in the percentage of scheduled utilization of staff for the process. Furthermore, Honda et al. (2018) implemented a qualitative analysis of 35 published case-based papers focused on the implementation of Six Sigma and LSS principles in hospitals, results showed that integrating Six Sigma and Lean ideas may greatly improve process performance, including waiting time reduction and patient flow, with a positive influence on patient satisfaction. Simultaneously, these process optimization strategies lower operational expenses and inventory, resulting in considerable cost savings for hospitals, resulting in a win-win situation. Tlapa et al. (2020) conducted a systematic review of the effects of lean healthcare on patient flow in ambulatory surgical care, the findings revealed that Lean Healthcare reduced waiting time and length of stay, owing to its focus on identifying and minimizing NVA activities.

To reduce the incidence of unplanned surgery cancellations, Zhu et al. (2020) conducted a one-year LSS intervention at a large comprehensive tertiary hospital in China, using the process capability index as a primary performance measure -The process capability index is a statistical metric that evaluates the ability of a process to consistently produce output within defined specification limits by comparing the process mean and variability to the allowable tolerances (Montgomery, 2020, pp. 354 - 360)-, following the implementation of LSS, the process capability index (expressed as a Z-score) increased from 1.25 to 1.68, reflecting a significant enhancement in process performance, this improvement corresponded with a reduction in unplanned surgery cancellations from 10.21% to 3.8%, thereby improving patient safety and demonstrating the effectiveness of LSS in addressing complex cross-departmental challenges within the hospital.

Similarly, Kusuma et al. (2016) conducted a study over six months; the study showed that the overall cancellation rate of operations can be reduced by providing back-up for the accessories (instruments) which have multiple uses, the ready availability of cleaning staff, proper operating theater scheduling, monitoring postponement and cancellation of surgeries, and its evaluation, which in turn led to saving time and prevent financial loss to the organization, the number of cases being done in the theater improved by 1 to 2 case per day, it increased to the overall performance of cases per day, which is compared to last year's similar months, there

were evident direct and indirect cost savings with the application of the DMAIC method, cost-saving was approximately 36,028 USD.

Brown et al. (2019) conducted a study focusing on how to improve rates of day surgery admission for all suitable elective thoracic surgery patients using LSS methodology, which has increased from 10% to 75%, duplication of preoperative tests reduced from 83% to <2%. Moreover, staff, and patient surveys show increased satisfaction and improved understanding of enhanced recovery after surgery. In addition, Zimmermann et al. (2020) conducted an integrative literature review to analyze scientific production on the results of LSS methodology in healthcare institutions and found that using LSS methodology is effective in various healthcare settings, indicating a gap in its application in terms of people engagement and training.

2.6 Summary and Knowledge Gaps

Multiple studies have shown the success of LSS application in healthcare settings. For example, Samanta et al. (2022) had found that LSS has improved healthcare operations in multiple hospitals; Case applications demonstrate success in optimizing nursing time and surgical pathways. Bhat et al. (2014) found that boosting the registration process had reduced patient waiting time by 94%. Honda et al. (2018) had reviewed more than 30 cases and found that LSS led to patient flow improvements and cost reduction. In China, Zhu et al. (2020) found that application of LSS significantly reduced the rate of surgical cancellation, other studies shown that gains like reduced duplication of diagnostic test (Brown et al., 2019) and improved patient turnover and staff satisfaction (Davies et al., 2019).

Overall, the previous literature strongly recommends the application of LSS methodologies as successful and practical tools for improving healthcare quality and operational efficiency. Furthermore, it shows how positively LSS implementation affects cost reduction, cutoff time, and enhanced patient outcomes. Nevertheless, challenges and difficulties remain, specifically in staff engagement, gained improvement sustainability over long time especially in healthcare institutions with limited resources (Schretlen et al., 2021; Zimmermann et al., 2020).

Additionally, Rathore and Srivastava (2020) offered a comprehensive overview of LSS in the healthcare industry during the period of 2006 -2018 and how healthcare organizations have implemented LSS methodologies to minimize waste, improve

patient flow, and improve health services quality, although the authors recognize the growing adoption of LSS in different hospitals worldwide, they also point to the existing gap in the literature concerning the systematic order of implementing LSS and the effectiveness of individual tools (e.g., DMAIC, root cause analysis, Lean process mapping) depending on the hospital context-specific circumstances.

These gaps highlight the importance of further research, particularly studies that explore the implementation of LSS strategies in healthcare institutions like Saint Joseph Hospital in Jerusalem, with special conditions concerning limited resources and support, political constraints, and limited patient access of care.

Chapter Three: Research Methodology

3.1 Introduction

This chapter describes and explains the methodology of conducting this research; a thorough strategy and methods are outlined in this chapter to assess the impact of implementing LSS on the day care surgical services at Saint Joseph Hospital in Jerusalem across 2024 - 2025, this includes research design, research population and size, data collection and analysis methods, and LSS principles applied to improve the performance of day care surgical services at Saint Joseph Hospital.

3.2 Research Design

A quasi-experimental non-equivalent groups mixed-methods pre-post design was employed, combining qualitative and quantitative approaches for this research. This design is frequently used in healthcare quality improvement where randomization is not feasible, as it enables comparison of intervention effects while acknowledging validity threats such as history, maturation, and selection bias (Creswell & Plano Clark, 2018, pp. 110 -114; Reichardt et al., 2023). Qualitative data through structured interviews with interested parties including surgeons and different personnel from different management and operational levels, it also includes a thorough review of documented policies and procedures related to patients' journey from admission to discharge, in addition to observations of patients' pathways and workflows via Gemba walk. The quantitative data includes Saint Joseph hospital's HMIS data, medical files, day surgery schedules, and patients' satisfaction surveys which is previously designed by Saint Joseph hospital, based on SERVQUAL dimensions of quality (Parasuraman et al., 1988).

The interviews focused on the voice of business (VoB) and the voice of process (VoP); The VoB reflects an organization's priorities such as profitability, compliance, and long-term sustainability, based on the needs of its customers. In contrast, the VoP indicates how well processes perform through measures like cycle time, defect rates, and capacity, showing whether operations can meet business and customer requirements (Feldman, 2025). VoB is clarified through interviews with hospital managers and surgeons, including the head of finance, medical director, nursing director, and two senior surgeons, while the VoP is clarified through interviews with the key process owners including: the head of the admission office; who is responsible for registration

and admission of patients, the head of operating theater; who manages surgical scheduling and oversees intraoperative workflow, the head nurse of day care unit; who coordinates patient flow within the department, and two surgical resident doctors; who manage the pre-operative and immediate post-operative recovery care and discharge steps.

The adopted methodology is the LSS methodology, guided by its core framework, the DMAIC phases, which support the systematic identification of waste, process variability, and root causes, and facilitate targeted interventions for performance improvement (Ilin, 2023; McDermott et al., 2022). Several LSS and quality improvement tools were employed throughout the analysis and improvement stages, including 5S, Gemba Walks, process flowcharting, VSM, statistical quality control tools, FMEA, and others. These tools were used to visualize workflows, identify NVA activities, uncover sources of variation, and prioritize corrective actions to enhance process effectiveness and efficiency.

Quantitative analysis compared pre-LSS performance (January–August 2024) with post-LSS implementation outcomes (September 2024–April 2025) using performance and outcome indicators such as patients' no-show rates, surgery cancellation rates, patient waiting times, and patient satisfaction score. Data collected from HMIS, medical files, surgery schedules, and hospital satisfaction surveys, in addition to real workplace visits. Qualitative data obtained from semi-structured interviews with managers, surgeons, physicians, staff, and process owners, alongside Gemba Walk observations and review of relevant policies and procedures.

Improvement strategy organized through the DMAIC phases and Lean tools like: VSM, FMEA, Fishbone (Ishikawa) diagram, 5S, and checklists and others. DMAIC and Lean tools enabled the quantification of data into trends with frontline insights to generate credible, actionable conclusions for service redesign. This mixed-methods stance follows established guidance for integrating quantitative and qualitative strands in applied health-services research, where DMAIC provided a proven, data-driven structure for process improvement in healthcare (Ilin, 2023; McDermott et al., 2022). Research design and LSS tools utilized are shown in Figure (3.1).

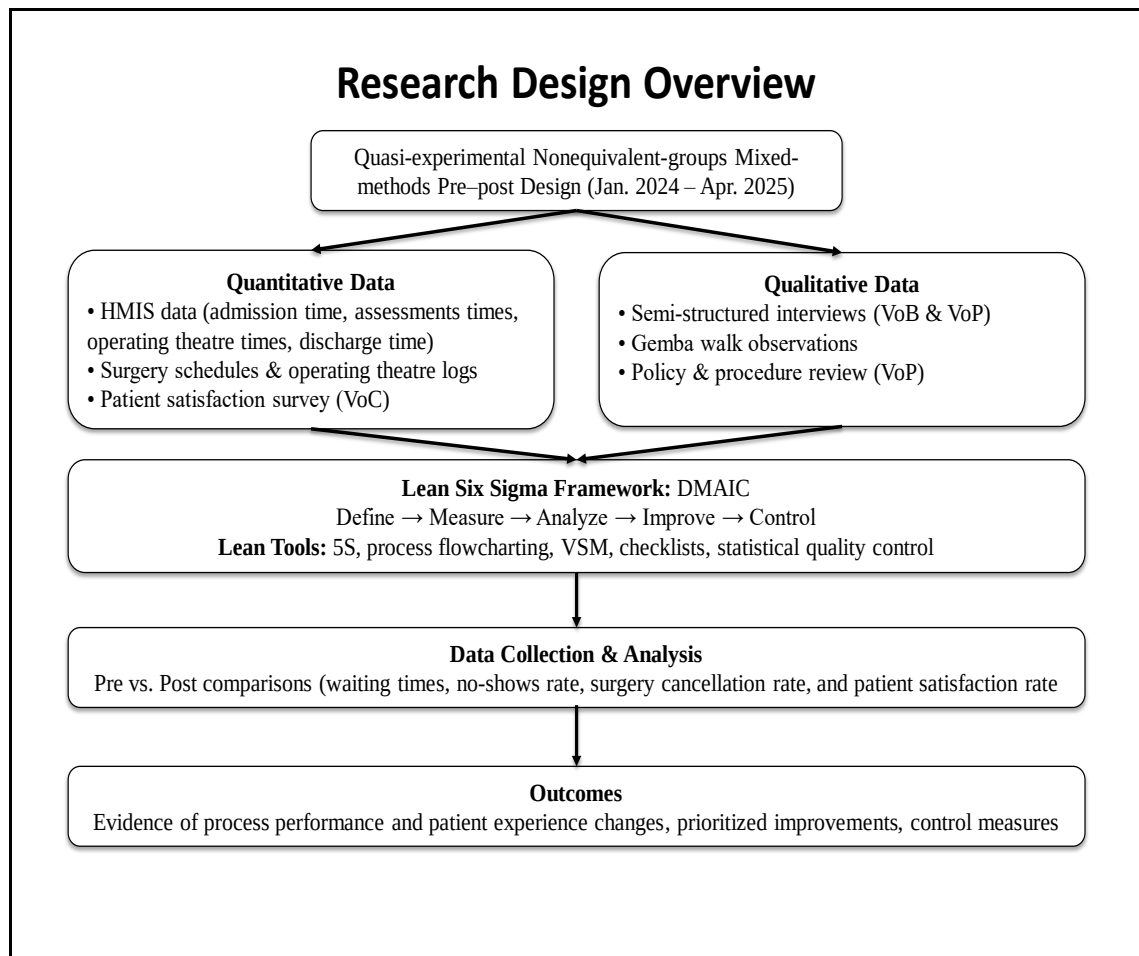


Figure 3.1: Research Design Overview

3.3 Research Population and Sample

3.3.1 Target Population

The study population included all scheduled patients for day care surgery at Saint Joseph Hospital between January 2024 and April 2025 (a 16-month period). This encompasses both the pre- and post-LSS implementation phases (N = 4,080). It is important to note that day care services experience variations during religious feast days, as elective and scheduled surgeries are not performed on these days.

3.3.2 Sampling Strategy and Sample Size

To maximize the power and external validity of the study, a census of all eligible scheduled day surgeries and day care admissions was used based on data extracted from the HMIS and day care surgery schedules (N = 4,080); therefore, no sampling was required. Day surgery schedules and HMIS records were segregated and reviewed on a monthly basis.

For patient satisfaction surveys, a consecutive and systematic sampling strategy was applied to achieve the calculated sample size for each period (pre-LSS and post-LSS), and since collecting survey data from every day care patient was not feasible due to practical and resource constraints, a representative sample from the target population was selected. The required sample size for patient satisfaction surveys is calculated using the Yamane formula as follows: $n = N / [1 + N (e)^2]$ (Kasunic, 2005, p. 30).

Where:

n = required sample size

N = total population size

e = margin of error (as a decimal, e.g., 0.05 for 5%)

This formula uses a population proportion ($p = 0.5$), which maximizes the required sample size, and is applied for a 95% confidence level.

For this study, in particular for patient satisfaction surveys, over the sixteen months period (January 2024 - April 2025), a total of 4,080 day care surgeries were scheduled. Using a 95% confidence level, a sample size calculator recommends at least 365 participants for the study, this calculated sample size of 365 participants was proportionally distributed across the 16-month study period, resulting in approximately 23 participants per month.

3.3.3 Inclusion and Exclusion Criteria

3.3.3.1 Inclusion Criteria

Eligibility criteria for the study includes:

- A. All patients who were scheduled for a day care surgery.
- B. Patients who have a documented details on day surgery schedules and/or HMIS system.
- C. Patients who are able to provide informed consent to participate in the study.

3.3.3.2 Exclusion Criteria

The following patients were excluded from the study:

- A. Emergency surgical procedures.
- B. Patients whom their hospital stay exceeded 24 hours from admission time.
- C. Patients who denied consent to participate in the study.

3.4 Data Collection Methods and Tools

This study employed a mixed-methods approach to capture both quantitative and qualitative aspects of performance pre-LSS and post-LSS implementation in day care surgical services at Saint Joseph Hospital. Data were collected through structured interviews, Gemba Walks, HMIS, medical file, daily surgery schedules, and patient satisfaction surveys. Each method was selected for its relevance, accuracy, and alignment with the study objectives, ensuring a comprehensive and reliable evaluation of changes across the pre- and post-intervention periods. Prior to data collection phase, Hospital's General Director permission (Appendix A), Hospital's Ethical Committee approval (Appendix B), and Institutional Review Board (IRB) approval (Appendix C) were shown to HMIS developers and quality staff.

3.4.1 Qualitative Methods

Qualitative data include the following:

3.4.1.1 Semi-structured Interviews

A. Structure: The development of the semi-structured interview tool was grounded in the study's conceptual and methodological framework, particularly principles derived from LSS. Questions were mapped to fit the core of LSS, this includes: workflow efficiency, sources of variation, waste identification, process outcomes, and opportunities for improvement, so that the interviews will capture required data that is relevant to the study's analytical objectives. This alignment ensured theoretical coherence and strengthened the tool's capacity to generate insights related to operational performance, staff experience, and system-level challenges in the day care surgical pathway. Interviews' findings stand as a guide for the improvement-oriented nature of the research design.

Semi-structured interview questions were developed and organized into five thematic domains: (A) participants' overall experience and satisfaction with day care surgical services, (B) efficiency and outcomes of day care procedures, (C) opportunities for improvement, (D) competitiveness, and (E) additional suggestions or comments (Appendix D). The interview instrument aimed to assess the perceptions of professionals, managers, surgeons, and staff regarding the performance of day care surgery services at Saint Joseph Hospital. It explored key dimensions including service

experience, workflow efficiency, clinical outcomes, operational barriers, and potential areas for enhancement.

B. Content Validity: Interview tool content validity was established through expert peer review. It was evaluated by a panel of four experts, including a senior surgeon who is working in the hospital for more than 10 years, a senior nurse in day surgery unit, a senior admission officer, and a quality officer who is experienced in qualitative methodology. Reviewers were provided a full explanation of research objectives, methodology, benefits, risks, confidentiality and their voluntary participation and withdrawal (Appendix E). Reviewers assessed clarity, relevance, coverage, and alignment with the study aims. They confirmed that the tool language is accessible and that the questions adequately reflected the practical realities of day care surgical services. Their feedback led to refining question wording and improving domain balance before data collection. This step helped confirm that the instrument would be perceived as credible and suitable by the intended participants, reinforcing its acceptability and applicability within the clinical setting.

C. Pilot Testing: A pilot test of the semi-structured interview guide was conducted to ensure the tool's clarity, applicability, and ability to generate rich, meaningful qualitative data. Two staff members participated in the pilot testing phase; one nurse from the surgical department and one surgical doctor, both participants were excluded from the final study sample. The pilot interviews assessed whether the questions were understandable, logically ordered, and capable of eliciting detailed responses related to workflow challenges, efficiency, and day care surgical services. Based on the feedback, minor modifications were made, including rephrasing ambiguous questions, and adjusting the sequence of items to improve flow to ensure consistency across participants. The pilot process therefore contributed to enhancing the usability and effectiveness of the interview tool prior to full implementation.

D. Interviewed Participants: Interviews were conducted with key hospital personnel, including department heads such as head of finance, medical director, nursing director, two senior surgeons, surgical doctors, nursing and admissions staff, to discuss perspectives on patient flow, waste, and safety. Interviews comprehend multiple process owners like: head of the admission office (Patients' reception and admission process), head of operating theater (Surgery scheduling process), two surgical doctors and the

head of day care services (Patient's reception and peri-operative care process). The two senior surgeons were selected based on historical data of day surgeries quantity performed by them.

3.4.1.2 Gemba Walks

Gemba Walks represent a structured Lean method used to visualize the actual workplace and gain firsthand understanding of how care processes are performed in real time. This approach allowed direct observation of operational practices, compare them against established policies/procedures, identify inefficiencies, and understand workflow gaps or deviations that may not be visible through documentation alone. The Gemba Walks conducted in this study focused on three main components: to directly observe care processes, grasp staff feedback, and identify gaps, this includes:

A. Observation of the Actual Implementation of Day Care Policies and

Procedures: This included a systematic review of the day care surgery scheduling workflow, patient admission and registration process, peri-operative assessment and patient care activities, as well as patient education and discharge procedures.

Observations were used to assess the alignment between documented policies/procedures and the real practice with actual time documentation of activities performed by staff, identify sources of waste or variation, and evaluate factors influencing workflow efficiency and patient experience. Policies reviewed were patient reception and admission at admission desk, patient admission and assessment by nurse, doctor assessment, peri-operative care, patient care after surgery, and patient discharge policy.

B. Observation of Staff Behaviors, Notes, and Real-Time Suggestions: During the Gemba Walks, attention was given to how staff interacted with the workflow, the challenges they encountered, and the possible informal modification of processes made by staff to sustain operations. Staff comments, notes, and spontaneous suggestions were documented to capture insights from frontline personnel, as they are the key players regarding practical barriers, efficiency enablers, and potential opportunities for process improvement. Direct observation for real work and staff feedback helped capturing and visualizing the "Voice of the Business" as well as "Voice of the Process" (Teeling et al., 2023).

3.4.2 Quantitative Methods

Quantitative data for this study were obtained from multiple structured institutional sources to ensure a comprehensive and accurate assessment of day surgery workflow performance before and after LSS intervention. The primary source of data was the HMIS, which contains time flow of administrative and clinical entries generated across different points of the patient pathway. Also, hard copy medical file was used, surgery schedules and the institutional patient satisfaction surveys were utilized in the study. Extracted HMIS data were complemented by daily day surgery schedules, which served as a cross-verification of patients' show, case identification and categorization, surgery cancellations, and emergency surgeries. Together, these sources provided a reliable and consistent dataset that enabled the measurement of the study KPIs related to efficiency, timeliness, and clinical processes. The following subsections describe in details HMIS data extraction, validation, and quality-control procedures applied to the quantitative datasets of HMIS data and patient satisfaction surveys as well.

3.4.2.1 Hospital Management Information System

A. HMIS Data Extraction Method: HMIS data was exported by HMIS development department. Exported data contains administrative and medical information. A Structured Query Language (SQL) query was developed by HMIS developer to export relevant variables into an Excel dataset. The exported data did not include patients' sensitive information like identity cards' numbers, rather a unique HMIS serial number was used for every patient. Before data extraction a full explanation of the required information was provided to the HMIS developer. Extracted and processed data were stored in a locked file.

B. Extracted Data Variables and How It Was Captured: HMIS exported data includes the following information:

- Patients who were admitted to day surgery department: Each patient was identified as a single row in exported Excel dataset.
- Date and time of patient admission to hospital: Extracted from admission office module and HMIS transactions logs.
- Date and time of patient admission to day care department: Extracted from nursing admission module and HMIS transactions logs.

- Date and time of pre-operative assessment by nurse: Taken from the nursing assessment sheet (Start time field in the sheet).
- Date and time of pre-operative assessment by doctor: Extracted from doctor assessment sheet (Start time field in the sheet).
- Medical diagnosis (including International Classification of Diseases code and its text; two columns in the exported Excel): Extracted from discharge report module.
- Date and time of actual surgery performed (for post-LSS phase only): Taken from surgery module, specifically, patient transfer time to operating theater.
- Actual surgery performed (including International Classification of Diseases and Procedures code and its text; two columns in the exported Excel): Extracted from discharge report module.
- Date and time of patient discharge: Extracted from nursing discharge module”.

C. Extracted Data Validation, Cleaning, and Quality Control

Data validation was conducted prior to the adoption and analysis of the dataset. Extracted HMIS data were manually cross checked against a 5% random sample (pre-LSS patients’ records; N=1497) of patient medical records (scanned hard copy files stored within the HMIS), representing 75 medical files, to verify the accuracy of timestamps, medical diagnoses and their codes, procedures and their codes, and overall consistency with the study variables described in the preceding section. The validation process confirmed that all required fields were complete and accurate, no missing data, misleading entries, or inconsistencies were found; therefore, no additional data cleaning procedures were required. In addition, records in which patient names were not documented on the day surgery schedule (unscheduled surgery), or patients whom their hospital length of stay exceeded 24 hours (thus, not meeting the definition of day surgery) were removed from the Excel dataset prior to analysis. Validation activities were repeated monthly throughout the study period to ensure ongoing data integrity. The structured SQL data-extraction query was maintained until the completion of the study, with one modification introduced during the post-LSS period to include the surgery start time variable.

Although HMIS databases are primarily designed for clinical and administrative purposes, several features ensured the consistency of the extracted variables. First, all

timestamps used in this study are automatically generated by the HMIS, reducing the risk of manual entry errors. Second, the hospital's admission, assessment and discharge workflows rely on mandatory fields that must be completed before the system allows progression, ensuring completeness of study variables. Finally, the study focused on structured fields rather than narrative text, which enhances reliability, accuracy, and consistency of the extracted dataset.

3.4.2.2 Medical Files (scanned hard copy medical files stored within the HMIS):

At pre-LSS phase, and since there is no electronic documentation of the surgery start data and time, medical files were reviewed, specifically the Surgical Safety Checklist (Sign in component), to identify this variable. Also scanned medical files were continued to be used for the monthly validation of extracted HMIS datasets.

3.4.2.3 Daily Surgery Schedules: These schedules are prepared by the head of operating theater and sent by email to all departments; they were used for comparison with extracted HMIS data in order to identify the No-show patients, emergency surgeries, and cancelled surgeries.

3.4.2.4 Research Instrument for Patients Satisfaction

3.4.2.4.1 Patients Satisfaction Survey Background, Validity, and Structure

A face validity assessment and a comprehensive review of the existing 15-item survey (Appendix F) were conducted in collaboration with the hospital's quality department. The objective of this review was to evaluate the reliability and validity of the current as-is survey tool and determine whether any updates were required.

The analysis indicated that the survey adequately covers key dimensions of service quality and it was developed based on the evidence-based SERVQUAL framework (Parasuraman et al., 1988). Although SERVQUAL traditionally includes five core dimensions -tangibles, reliability, responsiveness, assurance, and empathy- the hospital adapted the model to better align with clinical and organizational needs, which are: access to care, tangibility, patient safety, reliability, professionalism, responsiveness, and timeliness. These dimensions were assessed before LSS implementation using patient satisfaction surveys as part of the VoC assessment to evaluate process changes.

The mapping of survey questions to the SERVQUAL dimensions as follows:

- A. Presence of signs and directions in the hospital (*Access to Care*)
- B. Reception staff treatment (*Reliability*)
- C. Time taken for reception procedures (*Timeliness*)
- D. Time taken for admission to the day surgery unit (*Timeliness*)
- E. Time taken for admission to the operating room (*Timeliness*)
- F. Nursing staff treatment (*Reliability*)
- G. Nursing staff response to calls (*Responsiveness*)
- H. Nursing explanation and answers about patient's health condition (*Professionalism*)
- I. Nursing care during patient's hospital stay (*Reliability*)
- J. Doctors' treatment (*Reliability*)
- K. Doctor's explanation about patient's condition and answers to questions (*Professionalism*)
- L. General hospital cleanliness (*Tangibility*)
- M. Cleanliness of facilities, e.g., bathrooms (*Tangibility*)
- N. The bed I stayed on met my expectations (*Tangibility*)
- O. Discharge instructions were clearly explained (*Patient Safety*)

In addition to grasping the gaps at day care services, these questions grounded the base to measure patient satisfaction and experiences against the impact of LSS implementation in the hospital.

Pilot Study

The primary goal of the pilot study was to assess the validity and reliability of the institutional patient survey questions, and whether the survey format, wording, and overall structure are appropriate to the survey aims. A subset of 64 historical patient satisfaction surveys - approximately 10% of all surveys collected between January 2024 and September 2024 (N = 645) - was selected using a systematic sampling approach (every 10th survey: 10th, 20th, 30th, etc.). The dataset was analyzed in Minitab 19 to evaluate internal consistency (Cronbach's alpha), response completeness, and structural reliability. The Cronbach's alpha value, calculated at 0.8624 (Figure 3.2), which exceeded the minimum acceptable threshold of 0.70; indicating a high level of internal consistency across survey items (Ursachi, Horodnic, & Zait, 2015). This result confirms that the instrument reliably measures the underlying domains of patient satisfaction, including communication, admission procedures, cleanliness, staff responsiveness, and

discharge education. Findings from the pilot study also informed refinement of the Critical-to-Satisfaction elements and supported methodological decisions for the full-scale analysis (Pearson et al., 2020).

Cronbach's Alpha

Alpha
0.8624

Figure 3.2: Historical Patient Surveys' Pilot Study - Cronbach's Alpha Analysis & Result

Concerning Item-Level Insights and Validity Assessment (Figure 3.3), the "Item and Total Statistics" table shows that all items have relatively high mean scores, indicating a generally positive response from patients. The standard deviations (SD) are narrow, suggesting low variability in perceptions across patients. Notably, items like "Reception staff treatment" (Mean = 4.703, SD = 0.609) and "Nursing staff treatment" (Mean = 4.875, SD = 0.378) scored particularly well. Additionally, the "Omitted Item Statistics" data (Figure 3.4) confirms that removing any single item would not significantly improve the Cronbach's Alpha.

Item and Total Statistics

Variable	Total Count	Mean	StDev
General Satisfaction	64	0.969	0.175
Patient Loyalty	64	0.906	0.294
Presence of signs and direction	64	4.797	0.568
Reception staff treatment	64	4.703	0.609
Time taken for reception proced	64	4.609	0.884
Time taken for admission to the	64	4.500	0.926
Time taken for admission to t_1	64	4.328	1.235
Nursing staff treatment	64	4.875	0.378
Nursing staff response to calls	64	4.906	0.344
Nursing explanation and answers	64	4.813	0.467
Nursing care during my hospital	64	4.891	0.362
Doctors' treatment	64	4.813	0.500
Doctor's explanation about my c	64	4.750	0.667
General hospital cleanliness	64	4.766	0.584
Cleanliness of facilities (e.g.	64	4.813	0.467
The bed I stayed on met my expe	64	4.859	0.500
Discharge instructions were cle	64	4.766	0.771
Total	64	73.063	5.957

Figure 3.3: Historical Patient Surveys' Pilot Study - Item-Level Insights and Validity

Further validating the contribution of each item to the overall scale (Figure 3.4). Items such as "Discharge instructions were clear" and "Doctor's explanation about my condition" showed strong corrected item-total correlations (0.6751 and 0.6350, respectively), reinforcing their importance in assessing patient satisfaction.

Omitted Item Statistics

Omitted Variable	Adj. Total		Adj. Item-Adj. Total Corr		Squared Multiple Corr	Cronbach's Alpha
	Mean	StDev	Total	Corr	Corr	
General Satisfaction	72.094	5.890	0.3717	0.6696	0.8621	
Patient Loyalty	72.156	5.845	0.3599	0.7440	0.8607	
Presence of signs and direction	68.266	5.749	0.3227	0.4048	0.8614	
Reception staff treatment	68.359	5.775	0.2520	0.4045	0.8647	
Time taken for reception proced	68.453	5.342	0.6532	0.8191	0.8461	
Time taken for admission to the	68.563	5.321	0.6412	0.8003	0.8472	
Time taken for admission to t_1	68.734	4.945	0.7786	0.8659	0.8417	
Nursing staff treatment	68.188	5.833	0.2988	0.6727	0.8616	
Nursing staff response to calls	68.156	5.818	0.3806	0.7770	0.8598	
Nursing explanation and answers	68.250	5.858	0.1740	0.4223	0.8657	
Nursing care during my hospital	68.172	5.783	0.4570	0.6608	0.8577	
Doctors' treatment	68.250	5.643	0.6020	0.7930	0.8511	
Doctor's explanation about my c	68.313	5.512	0.6350	0.6922	0.8476	
General hospital cleanliness	68.297	5.577	0.6212	0.8503	0.8491	
Cleanliness of facilities (e.g.	68.250	5.704	0.5122	0.5238	0.8547	
The bed I stayed on met my expe	68.203	5.629	0.6310	0.8054	0.8501	
Discharge instructions were cle	68.297	5.409	0.6751	0.7701	0.8447	

Figure 3.4: Historical Patient Surveys' Pilot Study - Omitted Item Statistics

The correlation matrix (Figure 3.5) provides insights into the relationships between survey dimensions. Notably, strong positive correlations are seen between "Doctors' treatment" and "Discharge instructions" ($r = 0.543$). These strong associations indicate that improvements in one aspect of care (e.g., communication during discharge) are likely to enhance patient perceptions in related areas. Meanwhile, variables such as "Presence of signages and direction" showed weak or negligible correlations with other variables (e.g., $r = -0.021$ with Patient Loyalty), suggesting they may be less influential in overall satisfaction and could potentially be revised or rephrased for clarity and relevance.

Correlation Matrix

	General Satisfac	Patient Loyalty	Presence of sign	Reception staff
Patient Loyalty	0.558			
Presence of sign	0.095	-0.021		
Reception staff	0.209	0.108	0.327	
Time taken for r	0.330	0.101	0.155	0.047
Time taken for a	0.098	0.292	0.106	0.014
Time taken for a	0.415	0.611	0.187	0.195
Nursing staff tr	0.180	0.036	0.323	0.250
Nursing staff re	0.214	0.069	0.551	0.396
Nursing explanat	-0.073	-0.130	0.273	0.248
Nursing care dur	0.196	0.051	0.431	0.427
Doctors' treatme	0.113	0.203	0.311	0.179
Doctor's explana	0.475	0.203	0.283	0.205
General hospital	0.082	0.332	0.093	0.114
Cleanliness of f	0.121	0.101	0.153	0.080
The bed I stayed	0.130	0.233	0.065	-0.035
Discharge instru	0.297	0.322	0.107	0.120
	Time taken for r	Time taken for a	Time taken for a	Nursing staff tr
Time taken for a	0.747			
Time taken for a	0.672	0.784		
Nursing staff tr	0.089	0.045	0.157	
Nursing staff re	0.139	0.100	0.223	0.764
Nursing explanat	0.204	0.147	0.108	0.135
Nursing care dur	0.162	0.119	0.295	0.363
Doctors' treatme	0.263	0.274	0.410	0.294
Doctor's explana	0.586	0.411	0.525	0.252
General hospital	0.312	0.455	0.526	0.153
Cleanliness of f	0.396	0.367	0.356	0.135
The bed I stayed	0.484	0.497	0.539	0.074
Discharge instru	0.515	0.456	0.598	0.116
	Nursing staff re	Nursing explanat	Nursing care dur	Doctors' treatme
Nursing explanat	0.383			
Nursing care dur	0.427	0.253		
Doctors' treatme	0.266	0.119	0.587	
Doctor's explana	0.312	-0.051	0.412	0.524
General hospital	0.047	0.011	0.177	0.663
Cleanliness of f	0.087	-0.018	0.253	0.391
The bed I stayed	0.014	0.021	0.177	0.465
Discharge instru	0.095	0.008	0.248	0.543
	Doctor's explana	General hospital	Cleanliness of f	The bed I stayed
General hospital	0.336			
Cleanliness of f	0.459	0.593		
The bed I stayed	0.369	0.756	0.497	
Discharge instru	0.440	0.687	0.449	0.819

Cell Contents
Pearson correlation

Figure 3.5: Historical Patient Surveys' Pilot Study – Correlation Matrix

In conclusion, the high Cronbach's Alpha confirms internal consistency, and the inter-item correlations highlight logical and meaningful relationships among variables, outputs from face validity assessment and pilot analysis demonstrates that the survey instrument is both reliable and valid for evaluating patient satisfaction in the study.

3.5 Data Analysis

A mixed-methods analytical approach was adopted to examine quantitative and qualitative data collected from: HMIS, patient satisfaction surveys, staff interviews, and process observations (Gemba Walk and VSM).

A. Quantitative Analysis:

1. **Descriptive Statistics:** Descriptive statistics: including frequencies, means, and standard deviations, were used to summarize KPIs such as no-show rates, cancellation rates, waiting times, and patient satisfaction
2. **Inferential Statistics:**
 - **Normality Testing (Anderson–Darling Test and p-Value):** The normality of each continuous variable was assessed to determine whether parametric statistical tests were appropriate. The AD test evaluated whether the distribution of KPI deviated significantly from normality.
 - **Equality of Variances (Levene’s and Bonett’s Tests):** These tests were used to assess whether variability between the pre- and post-LSS groups was statistically comparable. Confirming this assumption ensured the suitability of applying the Two-sample t-test.
 - **Two-Sample t-Test:** The Two-sample t-test was used to examine whether statistically significant differences existed between pre- and post-LSS periods for KPIs. This method allowed evaluation of whether the changes are related to the LSS implementation rather than random variation.
 - **Control Charts (XBar and I-MR):** Control charts were utilized to monitor process stability and detect special-cause variation over time. These charts visually displayed trends, outliers, and improvements resulting from LSS initiatives.

B. Qualitative Analysis

Qualitative data from structured interviews were analyzed using inductive thematic analysis, constructed themes related to workflow inefficiencies, communication issues, delays, crowding, and non-standardized practices were identified. Techniques such as content analysis and root cause analysis were used to interpret staff perspectives. A cause-and-effect (fishbone) diagram was developed to visually map contributing factors to inefficiencies and variation in day care surgical services. Qualitative findings were triangulated with quantitative results to deepen understanding of CTS (Critical to Satisfaction) and CTQ (Critical to Quality) elements.

C. Statistical Analysis Software:

Minitab 19 was used to conduct normality testing, equality of variances, two-sample t-tests, correlation analysis, and creation of control charts. These tools supported statistical evaluation across pre- and post-LSS phases.

3.6 Research Phases

3.6.1 Preparation for Lean Six Sigma Application

Prior to the DMAIC cycle, preparatory steps were taken including: engaging hospital leadership for buy-in, conducting primary interviews with brainstorming, This phase established readiness for change and built internal support .

3.6.2 Define Phase: In this phase, the primary problem is waste and variability in day care surgery operations is defined. Key CTQ and CTS elements were identified based on the structure's interviews and stakeholder feedback: delays in patient preparation, canceled surgeries, resource underutilization, and patient dissatisfaction. Tools used: "Supplier-Input-Process-Outcome-Customer" (SIPOC) diagram, process mapping, and initial VoC, VoB, and VoP analysis.

3.6.3 Measure Phase: In this phase, the current performance of the day care surgical process is measured using VSM, Time-motion observations, and HMIS data. Performance indicators included waiting time, turnover time, no-show rate, and cancellation rate, in addition to patient satisfaction surveys.

3.6.4 Analyze Phase: In this phase, Root causes of inefficiency are identified using: Fishbone diagrams, FMEA, Pareto analysis, and control charts. Findings pointed to bottlenecks in patient reception and admission, pre-operative assessments, surgery performing, operating theater utilization, postoperative discharge instructions, inconsistent staff scheduling, and limited coordination between units.

3.6.5 Improve Phase: In this phase, Improvement initiatives are implemented, including: Standardized surgical preparation sheets and discharge instructions, revised workflows, cross-training staff, and real-time dashboards and software development. Lean tools such as VSM, 5S, and checklists were applied (Laureani et al., 2013).

3.6.6 Control Phase: In this phase, the last stage of the DMAIC focuses on making the improvements achieved in the previous stages sustainable by introducing some controls using monitoring plans or visual management tools.

3.7 Research Ethics

This research was conducted in accordance with established ethical standards for health-services research and institutional guidelines. Approval was obtained from Saint Joseph Hospital General Director (Appendix A), Saint Joseph Hospital Ethical

Committee approval (Appendix B), and the Arab American University Institutional Review Board (IRB) (Appendix C). All participants, including employees and patients, were informed about the study's purpose, objectives, methodology, and their voluntary involvement or withdrawal (Appendix E). Interview questions (Appendix D), and patient satisfaction questions (Appendix F) were shown to the participants before participation. Participants signed informed consent (Appendix G), with full and clear explanations regarding confidentiality, the right to withdraw at any time. A clear explanation provided to the interviewee regarding the use of audio recording that is solely for transcription and analysis purposes only.

To ensure participant protection, no identifying information such as names, positions, or personal details were included in transcripts, reports, audio records, or publications. Interview data were anonymized and stored securely in password-protected files accessible only to the researcher. The study posed minimal risk to participants. Interviewees were assured that their responses would not influence their employment, performance evaluation, or professional standing. Observational data collected during Gemba Walks focused exclusively on workflow and system performance rather than individual staff evaluation. The research adhered to principles of beneficence, ensuring that findings would contribute to improving patient care, operational efficiency, and organizational performance without exposing participants to harm.

Quantitative data extracted from the HMIS, medical records, and patient satisfaction surveys contained no personal sensitive data, HMIS uses unique HMIS serial numbers rather than ID card numbers or demographic information. All datasets were handled in compliance with privacy and confidentiality requirements, ensuring that no individual patient could be traced. All extracted and processed data were stored in locked files.

All ethical procedures, including data handling, consent processes, and safeguarding measures, were executed in alignment with Arab American University (AAUP) research protocols and Saint Joseph Hospital's ethical standards to ensure the integrity, safety, legal, and ethical soundness of the entire research process.

In summary, this chapter has presented a comprehensive methodological framework to assess the impact of LSS implementation on day care surgical services at

Saint Joseph Hospital. A quasi-experimental non-equivalent groups mixed-methods pre-post design was employed to integrate quantitative and qualitative findings. It detailed the research population and sample size, data sources, sampling methodology, study instruments, and analytical techniques used to examine the study's KPIs. The structured application of the DMAIC cycle and Lean tools ensured a systematic, data-driven approach to identifying waste, reducing variability, and guiding the study's improvement initiatives.

Building on this methodological foundation, the next chapter provides a critical review of the literature related to LSS in healthcare, quality improvement frameworks, and patient-centered care evaluation. It explores prior empirical findings and theoretical perspectives that inform the study's design and objectives, and highlights gaps that justify the current research. This review establishes the conceptual context for interpreting the results in subsequent chapters and positions the study within the broader dialogue on improving healthcare efficiency, standardization, and patients' experiences in day care surgical services.

Chapter Four: Data Results and Analysis

4.1 Introduction

This chapter presents qualitative and quantitative results, its analysis, and outcomes of applied improvements, aiming to fulfill the objectives of the research, it answers its questions and test research hypotheses. Data had been collected by direct observations, interviewing surgeons, hospital administrators and staff, HMIS data, and patient satisfaction surveys. DMAIC and other LSS tool were utilized in this chapter.

4.2 Define Phase

Define phase established a foundational understanding required to improve day care surgical services at Saint Joseph Hospital. This phase focused on identifying inefficiencies, clarifying interested parties' expectations, and determining the scope and objectives of LSS intervention, based on policies and procedures review, direct observations, structured interviews with processes' owners. These inputs are the milestones to reveal priority concerns related to CTS and CTQ elements, ultimately informing the development of the project charter, which defines the project's boundaries, goals, and improvement focus areas.

It was important to identify key data points while ensuring alignment with research goals, in addition to defining the process issues and stakeholders' expectations. A meeting with Saint Joseph Hospital leadership was held, specifically, with the medical director, nursing director, and the total quality manager. Study overview, objectives and scope were elaborated. The discussion environment was encouraging, and managers were supportive and reassuring for engagement of hospital staff in a quality improvement initiative. Different issues requiring further investigation were identified, including -but not limited to- patient flow and care pathways. All participants agreed that there is an improvement opportunity at the day care surgical services, for the best of the patients, the staff, and for the hospital as well.

4.2.1 Policies and Procedures Review

To grasp full picture of status quo, policies and procedures of day care surgery scheduling, admission and reception procedures, patient flow and care pathways, peri-operative assessment and care, and discharge process were reviewed, highlighting the following: A. Who initiates the process and how? (Supplier), B. What documents or tools are used? (Inputs), C. What are the defined steps? (Process), D. What are the expected outcomes and efficiency measures? (Outputs), E. Who are the intended beneficiaries? (Customers). These components help in aligning the documented processes with the actual operational reality, it serves as a robust base for SIPOC diagram that reflects both formal and informal workflows (Wang et al., 2025). Reviewed policies and procedures showed that patient reception and admission processes, both at the admission desk and day care department, are clearly documented. However, the scheduling process for day care surgeries lacks a defined pathway and is missing several essential components.

Concerning patient reception and admission, there are a well-documented patient reception and admission policy, and a well-organized flowchart, with clear responsibilities and expected outcomes, the HMIS is utilized for the management of patients' files, nevertheless, for new patients, a new file is created by the admission officer on admission time, which in turn, spends more time for patient's registration, and it leads to longer waiting time and bottlenecks. Patient reception and admission policy, and its flowchart were explained by the process owner (admission and reception manager). Obstacles, admission procedure informal modification by staff, and improvement opportunities were noted. Figure (4.1) describes patient reception and admission process, as follows:

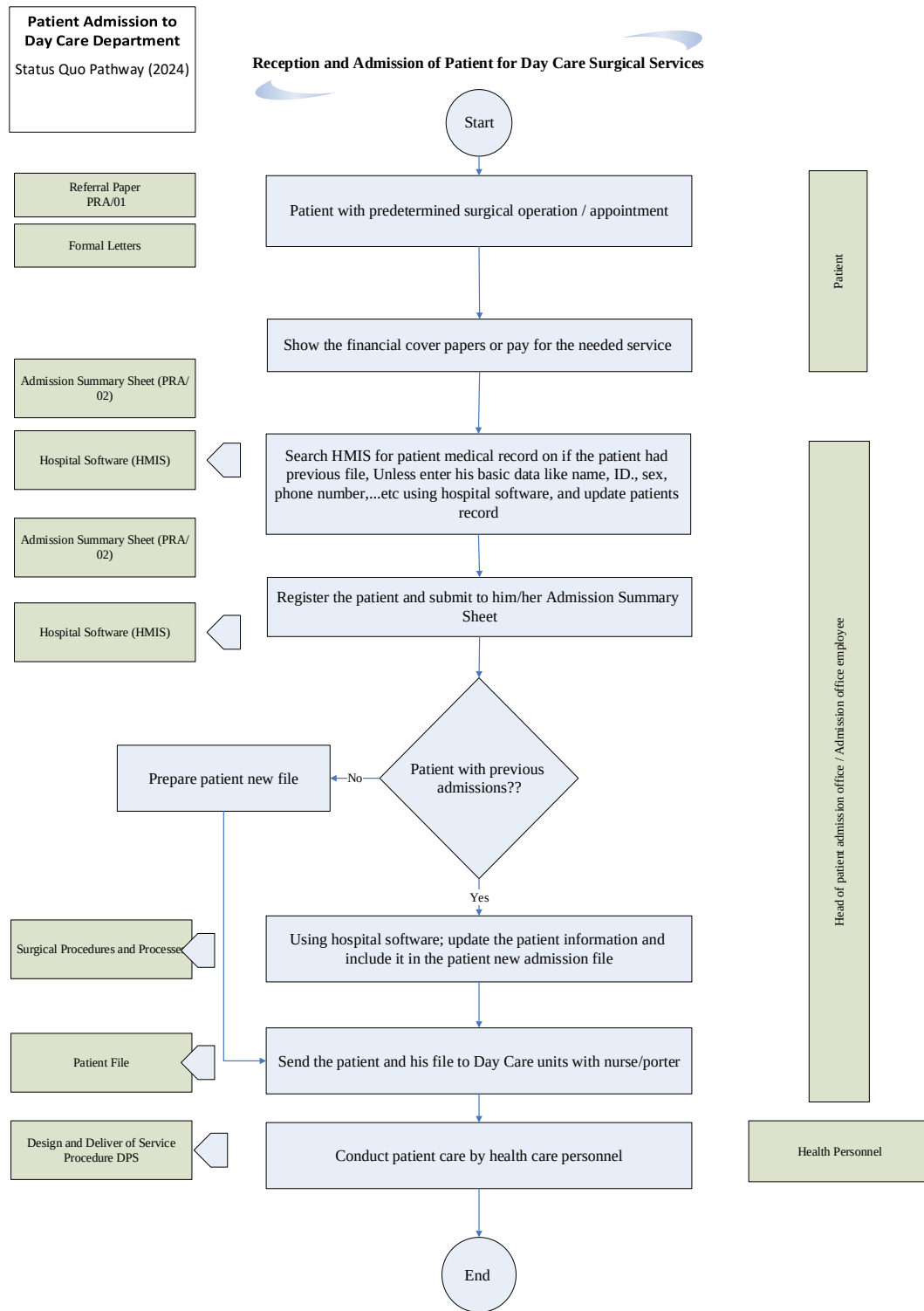


Figure 4.1: Patient Admission and Reception Flowchart

4.2.2 Gemba Walk

In addition to information obtained previous sessions, daily Gemba Walk rounds (real-time workplace observation) were conducted to enrich the understanding of the patient care pathway. Following the formal approval from the Medical Director, workplace rounds were performed over ten consecutive working days in July 2024, between 07:00 and 15:00. The primary objective of these observations was to examine patient's flow, patient-staff communication, staff-staff communication, pre-operative assessment processes, surgery scheduling practices, and potential bottlenecks, either in the admission office, day care department, or the operating theater. The detailed focus of Gemba Walk was categorized in five major components of the surgical care pathway:

- **Patient Registration and Admission:** Review of waiting times, errors in documentation, and delays in registration.
- **Pre-Operative Assessment:** Evaluation of the timeliness and completeness of nursing and medical assessments.
- **Surgery Workflow:** Examination of operating theater efficiency and alignment between patient readiness and surgical scheduling.
- **Post-Operative Monitoring:** Observation of practices used by nurses and physicians to monitor patients after surgery.
- **Discharge Process:** Assessment of the clarity, consistency, and patient understanding of discharge instructions.

Gemba Walk finding were as follows:

A. Patient Flow and Admission Procedures

The observational pathway began at the point of patient reception and admission. Clear signage, directional cues, and adequate waiting areas were noted throughout the corridors. Admission officer verifies patient's documentation, referrals, and payment commitments before registering the planned day care surgery in the HMIS. Registration procedures were aligned with the daily surgery list provided by the operating theater manager one day prior. Following the patient registration and admission process is completed, patients are directed to the day care unit for further evaluation by the nursing and medical teams.

During the Gemba Walk, informal conversations with staff highlighted persistent challenges related to surgery scheduling, timely pre-operative preparation, post-operative monitoring, and clarity of discharge instructions. These issues were repeatedly identified as priority areas for process enhancement and were consistent with findings from hospital managers' notes.

B. Efficiency of Registration and Information Management

The observations revealed that patients who have historical data in database requires less than five minutes to complete registration and admission. Conversely, new patients were observed requiring more than ten minutes for admission; this was due to the additional steps needed to create a new medical record in HMIS. Also, patients who do not have sufficient documents or wrong referral, they have to wait for corrections or even leave home.

. This extended processing time contributed to workflow delays and bottlenecks, particularly because the majority of patients arrive between 07:00 and 09:00, often without their knowledge of the start time of the scheduled surgery. The early clustering of patient arrivals created crowding at the admission counter and bottlenecks in day care department.

C. Coordination Between Departments

Interactions between nurses and admission staff were generally efficient, and communication with patients was observed to be courteous and well-structured. However, delays often resulted from insufficient diagnostic tests, missing consultations, or incorrect referrals; these issues prevented some patients from being admitted or assessed promptly. It was noted that pre-admission instructions were exclusively provided by the referring surgeon, with no pre-operative contact from Saint Joseph Hospital staff, thereby contributing to patient uncertainty and inconsistent preparedness.

D. Operating Theater Dynamics

Walk-and-talk rounds extended into the operating theater, where significant workflow observations were made. The operating theater team typically called patients for surgery only when an operating room became available, following a Pull System rather than a planned schedule. As a result, operating room readiness, rather than a structured timetable, dictated surgical flow. This reactive scheduling approach, combined with early patients' arrival, created bottlenecks and unnecessary queues within the day care unit.

Discussion with the operating theater manager confirmed that the daily surgery list is submitted by surgeons one day prior to day surgery, surgery scheduling information includes only basic patient information (name, planned procedure, and occasionally a phone number). This limited information flow further constrained the ability of team to organize the surgical day in advance, or to communicate with the patient prior to day of surgery, example of surgeries' list as shown in Figure (4.2).

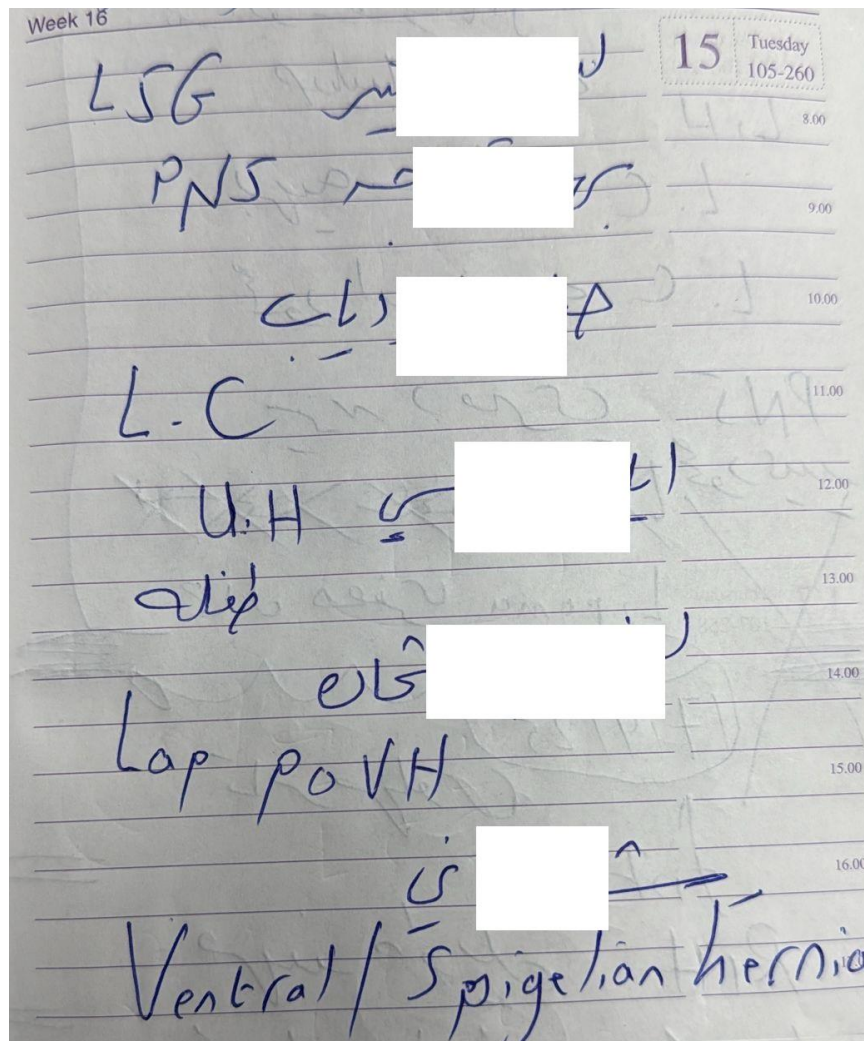


Figure 4.2: Surgeries' List Provided by a Surgeon to Operating Theatre Team (Next Day Planned Surgeries)

It is obvious that there are lots of missing data and patient's information, like: date of birth, gender, and a contact number to communicate with the patient for surgery planning, admission requirements, pre-operative preparation, or even the cancellation of surgery, in case any emergency or exceptional cause occurred.

Based on the previous findings and observations, high-level visualization of the processes was found as a necessity to deeply identify SIPOC elements, allowing a quick understanding of how the system functions from start to finish of the process. This overview aided the clarification of process boundaries, reduce ambiguity, and ensure that there is a consistent understanding of the workflow, therefore, a drafted SIPOC was formulated (Table 4.1), as follows:

Table 4.1: SIPOC for Day Care Surgical Patient Flow at Saint Joseph Hospital

SIPOC Element	Details
Suppliers	- Medical Centers - Private Clinics - Admission Officers - General Doctors - Nurses - Surgeons - Auxiliary Day Care Department staff, like porters
Inputs	- Patient Papers and Registration Forms - Medical History and Assessment Reports - Surgical Equipment and Supplies
Process	1. Patient submits papers and registers at admission office. 2. Patient is assessed by the nurse & surgical doctor. 3. Patient is transferred to the Operating Theater. 4. Surgery is performed. 5. Patient returns to the day care department. 6. Patient is monitored until they are fully conscious. 7. Patient receives verbal discharge instructions and a printed discharge report. 8. Patient is discharged.
Outputs	- Completed Surgery - Pathology Specimen - Discharge Report
Customers	- Patients - Patient Families - Referring Medical Centers - Private and Israeli Sick Funds Clinics - Ministry of Health
SIPOC: Suppliers, Input, Process, Outputs, and Customers	

SIPOC findings showed that the process effectively begins only upon the patient's arrival at the hospital, as no prior communication or pre-admission contact is initiated by Saint Joseph Hospital staff. Additionally, patients receive discharge instructions verbally rather than through standardized printed materials, highlighting an opportunity to enhance patient safety, continuity of care, and overall service quality by implementing written discharge guidance.

Based on the structured SIPOC and previous findings, key players and process owners were determined, structured interviews' scope and aims were clearly defined, challenges were noted, paving the way to better understand the VoB, VoP, and find out

improvement opportunities with clear identification of problems and solution boundaries.

4.2.3 Structured Interviews

It was emphasized to the interviewed participants that the goal is to explore current strengths and weaknesses of the day care surgical services, inefficiencies, patient satisfaction, and improvement opportunities related to the service. Voluntary participation is guaranteed. The participants were the voice of business and process owners; voice of business through the hospital management and surgeons, including: the head of finance, medical director, nursing director, and two senior surgeon doctors, while the voice of process through process owners, including: the head of the admission office, the process owner for patients' reception and admission; head of operating theater, the process owner of surgery scheduling; two surgical resident doctors; who assess patients before surgery, and plan the after surgery care and discharge follow up; and head of day care services; the process owner of patients' reception and admission at day care unit. The interviews key findings are as follows:

A. Experience & General Satisfaction

Most participants expressed their moderate to high satisfaction with day care surgical services' quality and patient outcomes. They noted strengths in team coordination, but raised concerns about communication gaps with patients and lack of education to patients prior to their admission to hospital. Also, they added that patients and families appreciate the care environment, but suggested improvements in pre-operative information and discharge teaching and instructions.

B. Efficiency & Outcomes

Participants mentioned that Saint Joseph Hospital Day care surgery services have an excellent outcomes and high surgical success, with minimal complication or re-admission of patients. Participants explained that excellent surgical outcomes are attributed to that all surgeries are performed by senior surgeons, and there are a dedicated hospital teams and proactive nursing and auxiliary staff.

They added that recurrent barriers to high quality of service include surgery delays and bottlenecks at operating theater, lack of synchronized smart surgery schedules or digital platforms, poor preoperative preparation and communication prior to patient admission to hospital, and insufficient discharge teaching and follow-up.

C. Improvement Opportunities

Participants suggested utilization of standardized checklists and patient's education printouts, digital surgery scheduling tools, early communications by hospital staff with scheduled patients prior to hospital admission, and a pre-defined patients' discharge instruction. Interviewed participants highlighted that lack of digital surgical platform, and lack of staff for the purpose of pre-admission communication with patients are barriers to change and improvements.

D. Competitiveness

Participants believe that Saint Joseph Hospital offers personalized care and strong reputation since it has a compassionate staff and pioneer surgeons with safe and health culture and environment. However, some participants mentioned that the hospital needs to improve its efficiency and innovation, by adopting smart solutions in health, find better communication methods with patients and families, to compete with larger institutions.

E. General Suggestions

Participants suggested the establishment of feedback loops from patients and families, investing in staff training and process standardization, adoption of digital platforms for scheduling the surgeries and run the service, enhancement of patient and families teaching prior to patient admission to hospital and patient discharge.

The interviews revealed significant alignment between perceived inefficiencies and LSS core principles of waste reduction and variation control. Delays and disorganized surgery scheduling, as highlighted by participants, correspond to NVA activities (Muda) in Lean. Likewise, variation in pre-admission and discharge instructions points to a lack of standardized work; a core focus of Six Sigma control tools. These findings align with the CTQ elements as well as CTS issues, and inform the subsequent Measure and Analyze phases.

Interview responses were stratified into three components; strengths, weaknesses/challenges, and opportunity for improvement, allowing for the identification of recurring patterns across participant insights and to capture the most critical issues related to day care surgical services, Interviews findings are shown in Table (4.2).

Table 4.2: Structured Interviews' Findings

Participant	Strengths Identified	Weaknesses / Challenges Mentioned	Opportunities for Improvement
Head of Finance	- Strong reputation and personalized care - Good surgical outcomes supported by experienced surgeons	- Inefficiencies in scheduling and workflow delays - Limited digital systems and scheduling platforms - High surgery cancellation rate	- Investment in digital solutions - Improving efficiency to remain competitive - Early communication with patients
Medical Director	- Strong reputation and personalized care - High surgical success rates - Strong coordination between clinical teams	- Communication gaps with patients - Weak pre-operative education and admission preparation - High no-show rate	- Adopt digital / smart surgery scheduling systems - Implement structured patient education - Strengthen communication pathways
Nursing Director	- Proactive, dedicated nursing team - Good patients' experiences	- Inefficiencies in scheduling and workflow delays - Insufficient discharge teaching and follow-up	- Adopt digital / smart surgery scheduling systems - Staff training and workflow standardization - Standardized discharge instructions
Two Senior Surgeon Doctors	- Excellent surgical outcomes with low complications - Strong clinical expertise and teamwork	- Surgery delays and bottlenecks in operating theatre - Lack of smart scheduling system	- Digital surgery scheduling tools - Earlier communication with patients
Head of Admission Office	- Coordinated admission workflow	- No pre-admission communication with patients - Early arrival of all scheduled patients - Poor patient preparation before arrival	- Establish pre-admission communication unit - Printed guidance for patients
Head of Operating Theater	- Skilled staff supporting smooth operations	- Disorganized surgery scheduling - Lack of synchronized, digital scheduling tools - High no-show rate	- Adopt digital / smart surgery scheduling systems - Earlier communication with patients

		- High surgery cancellation rate	- Investment in digital solutions
Two Surgical Resident Doctors	- Smooth peri-operative care - Good collaboration with nurses	- Gaps in patient and family communication - Poor patient preparation before arrival - Early arrival of all scheduled patients - Inconsistent teaching before discharge	- Adopt digital / smart surgery scheduling systems - Provide printed pre-admission instructions - Standardize discharge teaching
Head of Day Care Services	- Overall good patient satisfaction- Effective coordination inside the unit	- Early arrival of all scheduled patients - Lack of standardized pre-operative information - Variation in instructions and workflow	- Implement checklists and standardized processes - Improve family/patient education before admission and prior to discharge

Interviews findings are summarized and categorized as follows

A. Strengths:

- High surgical success and low complication rates
- Strong teamwork among surgeons, nurses, and support staff
- Good patient experience and appreciation of care environment

B. Weaknesses:

- Communication gaps with patients and lack of pre-admission education
- Surgery scheduling delays and operating theatre bottlenecks
- No digital scheduling platform
- Poor standardization of pre-operative and discharge instructions

C. Opportunities for Improvement:

- Develop digital scheduling and workflow tools
- Standardized checklists and written patient education materials
- Pre-admission communication with scheduled patients
- Strengthened discharge procedures, education, and follow-up
- Investing in digitalization and innovative communication channels

In addition to previous finding, an interview with Saint Joseph Hospital quality team, focusing on a review for previous patient satisfaction feedback and outcomes, to better clarify how previous findings affected patients' experiences, hence better

formulation of the CTQ issues as well as CTS. The review focused on previous finding compared to dimensions of quality that includes: access to care, tangibility, patient safety, reliability, professionalism, responsiveness, and timeliness in accordance to the currently applied patient satisfaction survey.

Data showed that there are excellent responses concerning staff responsiveness and professionalism and patient safety, there are very good responses related to access to care and reliability, on the contrary, timeliness aspect was nearly good, and some patients feeling upset concerning waiting time for admission to hospital or doing the surgery in a satisfactory waiting time.

The quality team emphasized that hard work had been done to overcome long waiting time for surgery, but without dynamic surgery scheduling process, efforts did not make big change, especially in agile department with multiple tasks required in a short time frame. It was concluded that there is a need for creating a teamwork in order to improve the standardization of the process of surgery scheduling, admission process, assessment and caring, and in addition to patient discharge teaching may positively affect the service.

Based on the results, the problems were grouped into main categories, among those problems highlighted, the most prominent problem was the long waiting time. The categories are as follows:

1. Waiting time related.
2. Lack of pre-admission information related.
3. Admission related.
4. Surgery time related.
5. Discharge treating related.

Based on key players' interviews and historical patient satisfaction findings, and in coordination with the quality team, the medical director, and the nursing director, CTS elements were defined, its performance indicators were established, and the assumptions for improvement were clarified. The following CTS elements reflect the most influential factors affecting patient satisfaction and hospital performance, these are used to guide subsequent measurement and process analysis efforts.

CTS 1: Pre-admission complications; mainly related to surgery scheduling, and patient communication and pre and post admission education.

CTS 2: Long waiting time (Admission to hospital, Admission to day care department, and admission to OR).

CTS 3: Safe Surgery, as it can be affected by busy staff, and poor patient preparation or missing data, because of poor pre-admission preparation and patient crowding at early morning.

CTS 4: Patient discharge complications, as a result of poor education prior to discharge and lack of predefined discharge instructions

Table (4.3) summarizes CTS elements, source(s) of data, its key performance indicator name, and the proposed target and achievement.

Table 4.3: Day Care Surgery - CTS Elements

CTS* Code	Critical to Satisfaction (CTS) Element	What Customers Need?	Indicator Name	Proposed Target based on History and observations (Within 6 months)	Source of Assumption for Target
CTS 1	Pre-admission complications	Communication and Education prior to admission	% of no-show patients	Decrease by 5%	Quality team, medical and nursing directors
		Smooth admission process	% of cancelled surgeries before operating room admission	Decrease by 5%	Quality team, medical and nursing directors
CTS 2	Long waiting time for: admission, assessment, or surgery	Short wait for surgery	Average waiting time from admission to day care department	≤ 15 minutes	Quality team, medical and nursing directors
			Average waiting time to assessment	≤ 30 minutes	Quality team, medical and nursing directors
			Average waiting time from admission to operating room	≤ 60 minutes	Quality team, medical and nursing directors

CTS 3	Safe Surgery	Doing the surgery as planned, without complications	% of cancelled surgeries	$\leq 1\%$	Quality team, medical and nursing directors
			% of complicated surgeries	$\leq 5\%$	Quality team, medical and nursing directors
CTS 4	Discharge communication and teaching	Clear discharge instructions	% receiving full discharge information	100%	Quality team, medical and nursing directors

*CTS: Critical to Satisfaction

According to the interviews and discussion with quality team, medical director, and nursing directors, an estimated target was set for each KPI, however, the actual performance -against proposed targets- is to be decided after the Measure phase, a project charter was established (Table 4.4) to serves as the foundational document outlining the project's purpose, scope, objectives, team roles, and boundaries prior to entering the DMAIC phases as follows:

Table 4.4: Project Charter for LSS Implementation in Day Care Surgical Services

Project Sponsor	Medical Director
Team Leader	Head of Operating Theater Department
Project Title	<i>Improving Efficiency and Reducing Waste in Day Care Surgical Services at Saint Joseph Hospital Using Lean Six Sigma Methodology</i>
Date	1 st of August 2024
Issue Version	V.1
1. Problem Definition and Purpose	
Saint Joseph Hospital has experienced inefficiencies in day care surgical services, including long patient waiting times, inconsistent pre-operative preparation, surgery cancellations, and underutilization of operating rooms. These issues have led to increased waste, reduced patient satisfaction and negative impacts on staff performance and hospital outcomes. To improve the efficiency, quality, and reliability of day care surgical services at Saint Joseph Hospital through the application of Lean Six Sigma tools, reducing process variation, eliminating waste, and enhancing patients' and staff satisfaction. Timeline: • Start: August 2024 • DMAIC Implementation: August 2024 – July 2025 • Estimated End: December 2025	
2. Business Case (Issues to be addressed/process to be improved)	
Day care surgeries represent a high-throughput, cost-sensitive, and patient-focused service. Improving the performance of these services directly contributes to: • Better patient outcomes • Higher patient satisfaction	

• Improved resource utilization • Higher staff satisfaction • Increased hospital revenue and reduced operational cost • Competitive advantage and reputation for excellence		
Key Players		Scope
Sponsor	Medical Director	In scope: Patient registration, pre-operative assessment, surgery scheduling, operating room usage, patient discharge
Team Leader	Head of Operating Theater Department	
Team Members	Head of Day Care Services Head of Anesthesia Head of Admission Office	Out of scope: Day Care Nurses, Operating Theater Team, Surgical Doctors, Admission Officers, Software Developers, & IT Officers
Other Key People	Quality Officer	
Enablers/Risk Mitigation		Barriers/Risks
What needs to be in place to ensure the project progresses?		(<u>Not</u> the opposite of enablers) What are the potential barriers to the work?
- Top management commitment & support - Monthly meeting - Availability of resources and staff - Clear guidelines, policies, procedures, and Work instructions - Smart dashboard for tracking the processes and performance		- Scheduling conflicts during operating theatre peak hours - Data extraction limitations from HMIS - Staff resistance to change - Surgeons' resistance to change - Political and access restrictions for patients from Gaza/West Bank - Country lockdown
Improvement Tools Planned		Key Performance Indicators
- SIPOC Diagram - Value Stream Mapping - Pareto Chart - Fishbone Diagram - Control Charts - 5 Whys Analysis - Standard Work Instructions - Patient Satisfaction Surveys		- Average Patient Waiting Time (mins) - No-show Rate (%) - Surgery Cancellation Rate (%) - Patient Satisfaction Score - Staff Satisfaction Feedback - Percentages of No-Shows - Day Care Complication Rate - Re-admission Rate

In the Define phase, the basis for enhancing day care surgery was established with the team of Saint Joseph Hospital. Discussion interviews with managers, surgeons, nursing seniors, and those responsible for the workflow allowed visualization of the VoB and VoP, revealing that providing quality care and addressing inefficiencies were important concerns, mainly in the areas of pre-admission communication, scheduling of surgeries, discharging patients, and post-surgery education and instructions. At the same time, patient satisfaction surveys findings showed that patients valued staff's professional behavior and attention to safety, but they were not happy about long waiting time for surgery, and the way the information and education were shared. A summary of understandable CTS elements and major problem types were highlighted, including long waiting time, having the admission process uncoordinated, and inefficient discharge process. The purpose of the project charter was to set out the scope, objectives, and role of the team for the LSS intervention. Previous findings

mandate actual measurement of day surgery services performance, and its impact on patients' satisfaction. It formulated a cornerstone for the Measure phase.

4.3 Measure Phase

The Define phase made the problems clearer, so the Measure phase starts the data collection process to measure the current status of the day care surgical process. this implies assessing the admission processes' times, surgery time, and discharge phase period, as well as the presence of delay or variation. No-show rate, average waiting time, the proportion of surgery cancellation before surgery, and readiness for discharge will be included as KPIs with records of past data and observations happening in real time, in addition to patients' surveys. This phase is focused on finding an evidence-based starting point and actual numbers that can show if the concerns in the Define phase are correct, help with identifying what went wrong during the Analyze phase, and reveal the exact gaps between how things are and how they should be.

The measure phase includes quantitative information, based mainly on VSM metrics, historical HMIS data, and patients' satisfaction surveys (January 2024 – August 2024).

4.3.1 Value Stream Mapping

Value Stream Mapping as a mixed-method Lean tool, that combines qualitative observation of workflow steps and waste, with quantitative measurement of cycle times, delays, and process performance metrics. VSM data were collected during Gemba Walks. VSM had been adopted to visualize the current process of day care services and measure the actual time of performed activities. VSM allowed visualization of the current process in a diagram, and identify the places where delays, waste, and variation affect the performance of day care department workflow and operations. Based on Gemba Walk observations and VSM diagram, LSS will focus on key areas which leads to a more smooth and uniform process. The following current-state VSM (Figure 4.3) visualizes the patient's journey at day care services, highlighting bottlenecks and inefficiencies.

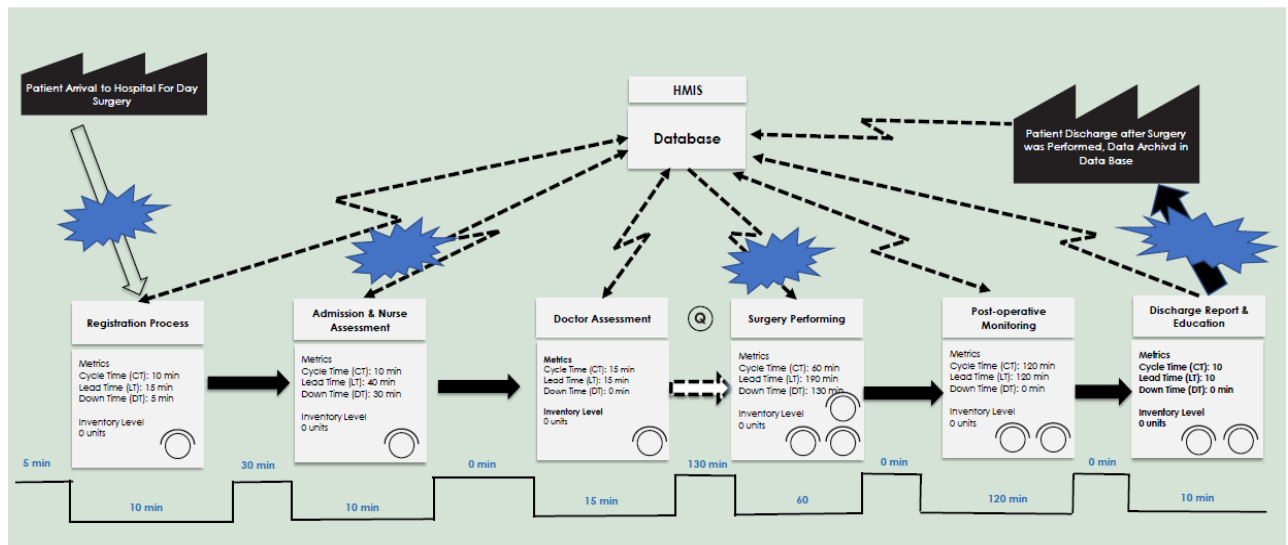


Figure 4.3: Current VSM in Day Care Surgical Services

*Cycle Time (CT) – Time interval between units processed

*Lead Time (LT) – Total elapsed time including wait

*Down Time (DT) – Idle or delay time

As shown in Figure (4.3), day surgery process is starting from patient arrival to hospital and registration till final discharge and education. The process is divided into six major steps: (A) Registration and admission, (B) Admission to Day Care Department & Nurse Assessment, (C) Doctor Assessment, (D) Surgery Performing, (E) Post-operative Monitoring, (F) Discharge Report Creation and Discharge Education. VSM diagram illustrates data flows and handoffs between departments, it identified NVA activities and opportunities for lean improvement, following is the summary of metrics including cycle time, lead time and down time (Table 4.5).

Table 4.5: Current VSM Data in Day Care Surgical Services

Activity	Cycle Time (CT)	Lead Time (LT)	Down Time (DT)
Registration & Admission Process	10 min	15 min	5 min
Admission & Nurse Assessment	10 min	40 min	30 min
Doctor Assessment	15 min	15 min	0 min
Surgery Performing	60 min	190 min	130 min
Post-operative Monitoring	120 min	120 min	0 min
Discharge Report & Education	10 min	10 min	0 min
TOTAL	225 min	390 min	165 min

The Current VSM data (Table 4.5) shows that there is a downtime of 165 minutes at the process of day surgery (from admission to discharge), most of it is waiting to perform the surgery (DT of 130 minutes), also nursing assessment downtime is 30 minutes, which can be decreased if smooth flow of patients to day care department. Total elapsed time from admission to discharge mounted at 390 minutes (6.5 hours). Findings from VSM collectively revealed consistent patterns of inefficiency within the day care surgical workflow at Saint Joseph Hospital. Findings align with previous findings of inefficiencies from structured interviews and patients' feedback.

4.3.2 Hospital Management Information System

To fully understand previous finding of inefficiencies, HMIS data was exported by HMIS development department, after Saint Joseph Hospital ethical committee permission was acquired to use Saint Joseph Hospital patient data, the exported data included all day care surgery patients for the period of January 2024 till August 2024, it did not include patients' sensitive information, like ID's, rather HMIS serial numbers were utilized, HMIS provided information about: Patients who were admitted to day surgery department, date and time of patient, admission to hospital, date and time of patient admission to day care department, date and time of pre-operative assessment by nurse, date and time of pre-operative assessment by doctor, medical diagnosis, date and time of actual surgery performed (for post-LSS phase only), actual surgery performed, date and time of patient discharge.

During the mentioned time period (Jan. 2024 – Aug. 2024), there were 1,497 day care surgery were performed (Table 4.6), where total surgeries mounted for 2,361 surgeries for the same period, in other words, day care surgery represented 63.4% of Operating Theater activity, for that, the impact of day care surgery on the performance of Operating Theater and Day Care Department is high, as well as the hospital as a whole, and it has a high impact on revenues as well as expenses regarding appropriate utilization of resources and waste elimination.

Table (4.6) shows that there are 428 scheduled surgeries did not come for surgery, Also, there are 49 patients who were admitted to hospital, but the admission was cancelled for some reason. A total of 477 scheduled day care surgeries were not performed as scheduled! which represents 21.4% of total scheduled day care surgeries,

this number is considered high, and at the next Analyze Phase, LSS tools will be adopted to define the root causes of these inefficiencies, and then after search for improvement actions together with the hospital teams and interested parties.

Furthermore, the average waiting time from patient's admission to nursing assessment is 41.5 minutes, while the average waiting time from patient's admission to OR admission is 182.6 minutes, Admission-to-assessment time (nurses and doctors) is relatively acceptable compared to admission-to-OR time. Further investigations and observations were required to find out root causes of inefficiencies will be studied.

Table 4.6: HMIS Data (pre-LSS)

Month	#. of All Surgeries (Total)	#. of Day Surgery (Total)	% of Day Surgery (Total)	No-Show # Per Month	No-Show % Per Month	# of Cancelled Admission	% of Cancelled Admission	Admission to Nurse Assessment (Minutes)	Admission to Doctor Assessment (Minutes)	Admission to OR* (Minutes)
2024-01	324	216	66.7%	53	19.6%	2	0.7%	42	38	197
2024-02	305	194	63.6%	84	28.9%	13	4.5%	39	37	145
2024-03	311	192	61.7%	60	23.3%	6	2.3%	41	39	207
2024-04	222	139	62.6%	30	17.0%	7	4.0%	36	42	138
2024-05	293	184	62.8%	60	23.9%	7	2.8%	38	37	195
2024-06	281	195	69.4%	44	18.0%	5	2.0%	46	34	240
2024-07	318	194	61.0%	44	18.0%	6	2.5%	41	41	183
2024-08	307	183	59.6%	53	22.2%	3	1.3%	49	36	156
Total	2,361	1,497	Avg. 63.4%	428	Avg. 21.4%	49	Avg. 2.5%	Avg. 41.5	Avg. 38	Avg. 182.6

*OR: Operating Room

4.3.3 Patient Satisfaction Surveys (Historical)

A 645 patient surveys were studied (January 2024 till September 2024), with a monthly average of 72. The average of averages of patient satisfaction surveys is 92% (calculated as: SUM of scores for all questions ÷ number of questions). It is notable that questions of “Time taken for admission to the operating room”, “Time taken for

admission to the day surgery unit”, “Time taken for reception procedures”, and “Discharge instructions were clearly explained” are the lowest scores (77%, 84%, 85%, and 85% respectively), which in terms aligned with interviews’ findings, observations, Gemba Walk and HMIS data, however, the other parameters scored more than 90% most of the time, as shown in (Table 4.7).

Table 4.7: Historical Patients’ Surveys – (2024.01 – 2024.09)

Month	2024-01	2024-02	2024-03	2024-04	2024-05	2024-06	2024-07	2024-08	2024-09	Total
Monthly #. of Surveys	72	74	72	71	72	68	64	68	84	645
Total Score (Monthly)	91%	91%	92%	91%	93%	89%	93%	93%	93%	92%
Question										
General Satisfaction	94%	100%	100%	100%	100%	100%	100%	100%	100%	99%
Patient Loyalty	94%	100%	100%	99%	99%	99%	100%	99%	100%	99%
Presence of signages and directions in the hospital	94%	92%	92%	88%	93%	85%	93%	94%	92%	91%
Reception staff treatment	91%	84%	91%	91%	94%	84%	94%	94%	93%	91%
Time taken for reception procedures	85%	83%	86%	84%	85%	81%	84%	82%	90%	85%
Time taken for admission to the day surgery unit	84%	85%	83%	85%	87%	80%	83%	80%	84%	84%
Time taken for admission to the operating room	75%	77%	79%	76%	79%	75%	77%	78%	79%	77%
Nursing staff treatment	95%	95%	98%	98%	98%	95%	98%	97%	96%	97%
Nursing staff response to calls	97%	96%	96%	98%	97%	94%	97%	97%	96%	96%
Nursing explanation and answers about my health condition	96%	95%	94%	95%	94%	94%	94%	97%	95%	95%

Nursing care during my hospital stay	96%	96%	98%	97%	98%	94%	97%	98%	96%	97%
Doctors' treatment	94%	94%	96%	95%	97%	91%	97%	95%	97%	95%
Doctor's explanation about my condition and answers to questions	90%	90%	89%	88%	92%	85%	90%	95%	91%	90%
General hospital cleanliness	93%	93%	93%	91%	95%	91%	96%	94%	94%	93%
Cleanliness of facilities (e.g., bathrooms)	94%	91%	93%	90%	94%	91%	93%	94%	94%	93%
The bed I stayed on met my expectations	93%	92%	93%	88%	96%	93%	97%	95%	94%	93%
Discharge instructions were clearly explained	83%	80%	85%	84%	87%	86%	84%	85%	94%	85%

These lower scores directly mirror the findings identified in the qualitative data, including interviews, Gemba Walk observations, and workflow assessments, which highlighted delays in admission and surgery scheduling, inefficiencies in patient flow, and inconsistent discharge teaching. Together, the survey findings reinforce the qualitative evidence, confirming that timeliness and patient communication represent the most prominent areas requiring improvement.

4.4 Analyze Phase

The Analyze phase is used to statistically verify or refute the inefficiencies identified in the Define and Measure phases, and to uncover the root causes affecting day care surgical services at Saint Joseph Hospital. By integrating structured interviews, Gemba Walk observations, VSM, patient satisfaction surveys, and HMIS data, this phase examines process performance using both qualitative evidence and quantitative analysis. The combined findings consistently visualize prolonged waiting times, workflow interruptions, scheduling problems, and communication gaps across consequent steps of the patient journey. HMIS data further confirms the activity benchmarking of day care surgeries, reinforcing the need for systematic root-cause

analysis. Overall, the Analyze phase provides an evidence-based, data-driven backbone for identifying the actual causes of waste and variability, guiding the Improve phase.

4.4.1 Structured Interviews Analysis, and its relation to Gemba Walk, VSM & CTS

Findings of structured interviews are strongly interrelated and compliant with Gemba Walk, VSM & CTS; most participants stressed the inefficient day surgery scheduling and the absence of digital platform to organize, monitor, and control the whole process, Gemba Walk revealed early arrival of patients to the hospital, long waiting time at registration and day care admission, crowding at the admission office and day care department, this also represented in VSM with NVA waiting time and high downtime, in addition to long lead time for surgery performing.

Interviews findings are parallel to CTS problems which are long waiting time, lack of pre-admission information and communication, long waiting time at admission and registration, late surgery performing, and discharge treating inefficiency. All these issues interrupt the patient journey and the workflow, increasing waste and exaggerating expenses, in addition to patients' and their family's dissatisfaction, bad hospital reputation, and losses of market share.

An inductive thematic analysis carried out to clarify the common patterns across interviews with clinical, managerial, and administrative staff who are involved in day care surgical services. Four major themes were categorized, reflecting shared perceptions of strengths, challenges, and focus areas that require improvement.

A. Strong Clinical Performance and Skilled Staff: Participants consistently highlighted the hospital's strong clinical reputation, excellent surgical outcomes, and dedicated nursing and surgical teams. These strengths form a solid clinical foundation and contribute to positive patient experiences within the day care unit.

B. Inefficient Scheduling, Long Waiting Times, and Workflow Interruptions: Most participants frequently highlighted the issue of poor surgery scheduling system; absence of a smart, synchronized, digital scheduling platform resulted in workflow delays, day care and operating theater bottlenecks, unpredictable patient flow, and early arrival of all patients. These issues also contributed to increased no-show and cancellation rates, in addition to bottlenecks at admission office and day care department.

C. Communication Gaps with Patients at pre-admission phase and Poor Pre-

Operative Preparation: Interviewees mentioned a significant communication challenges, including no pre-admission contact with patients from staff, no printed instructions, some missing diagnostic tests, discrepancy in patient readiness upon arrival; patients often do not have clear information about fasting, medications to be taken, or actual surgery time, this in turn affects admission process and surgical workflow.

D. Lack of Standardization in Pre- and Post-Operative Procedures: Participants highlighted variable start times of pre-operative assessment related to patient arrival, verbal discharge teaching, and absence of printouts for patient instructions. The absence of standardized discharge printouts and written guidance creates a risk of patient safety after discharge and leads to inconsistencies in safe care provided.

In summary, the analysis showed that while Saint Joseph Hospital provides high level of quality in clinical care, some operational inefficiencies; particularly in surgery scheduling, communication with patients, and workflow standardization, negatively affect day care surgical workflow and may endanger patient safety. This analysis provided essential insight into root causes of delays and inefficiencies that LSS can resolve.

4.4.2 Value Stream Mapping Analysis

VSM diagram (Figure 4.3) showed successes as well as failures or gaps and variations, bottlenecks are visible and improvement opportunities are shown, example, Operating Theater long waiting time and bottlenecks! it summarizes the processes, the cycle time, lead time and down time, the total process lead time is 390 minutes, while the total actual cycle time is 225, with a total down time of 165 minutes (around 3 hours) of idle time!

The analysis of VSM highlights serious differences in lead times that may point to inefficiency and blockages in processes, while others reveal considerable delays. For example, the Doctor Assessment and Discharge stages have no downtime, indicating a streamlined process. In contrast, the Surgery Performing stage exhibits the largest delay, with a CT of 60 minutes and DT of 130 minutes, leading to a high LT of 190 minutes. At the same time, performing the Admission & Nurse Assessment adds a 30 minutes downtime which is three times longer than the CT. The existence of such long gaps

indicates that patients might be waiting longer, staff members are working less or the system may not be running at its best. Most importantly, during Post-operative Monitoring, there is a balance between CT and LT, demonstrating that care is delivered consistently.

From a Lean perspective, those variations in lead times and bottlenecks stand out as trouble spots, especially for patient care, since they mainly add up to waiting and underused resources (Tlapa et al., 2020). These issues are typical barriers for lean healthcare that result in patients' lead times getting longer but don't create any positive results. Working on these issues using correct surgery scheduling, proper team organization and optimized workflows can lead to more continuous care for patients, shorter waiting lines and increased hospital results (Pierce et al., 2023).

4.4.3 Patient Satisfaction Analysis

During pre-LSS phase, 645 surveys were included (Table 4.7), with monthly average of 72 patients. The average of averages of patient satisfaction is 92%, which is acceptable in total, maximum monthly score stands at 93%, while the lowest is 89% in June 2024 (Figure 4.4). over nine months period of patients' surveys data (pre-LSS) phase, the five lowest average scores (%) were questions related to: Time taken for admission to the operating room (77%), time taken for admission to the day surgery unit (84%), time taken for reception procedures (85%), discharge instructions were clearly explained (85%), and doctor's explanation about my condition (90%) (Table 4.7). Showing the two main issues, which are: (A) Long waiting time; specifically, time taken for admission to the operating room, and (B) poor discharge education.

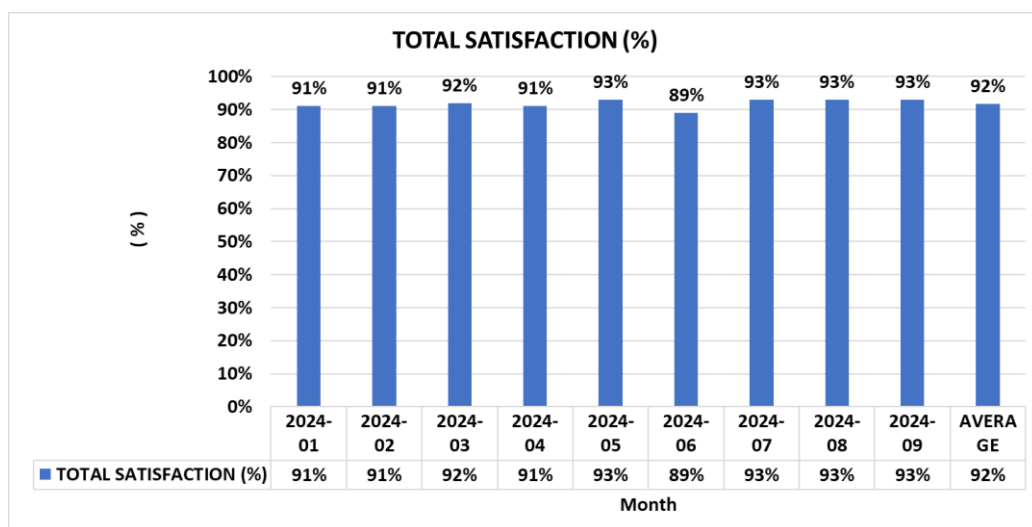


Figure 4.4: Historical Patient Surveys - Total Satisfaction

Pareto Chart is used to statistically represent inefficiencies, Gaps and failures were calculated based on the total averages (Table 4.7) for each question, failures were calculated as follows: $100\% - [\{\text{SUM of (question's score multiplied by total number of surveys for the same month)}\} \div \text{total number of surveys for the nine months period}]$, results showed that most of patients' dissatisfaction are the time from admission to operating theatre (22.76%), and the time from admission to nursing assessment (16.55%), failures and its cumulative percentages are shown in (Table 4.8).

$$100\% - \frac{\sum (\text{Question Score} \times \text{Number of Surveys per Month})}{\text{Total Number of Surveys Over the Nine Months Period}}$$

Table 4.8: Historical Patient Surveys – Cumulative Failures & Gaps Percentages

Question	Gap (%) (100% - Average Score %)	Cumulative (%)
Time (admission - OR)	22.76%	22.76%
Time (Admission - Day Care Unit)	16.55%	39.3%
Time (Registration Process)	15.54%	54.8%
Discharge Teaching	14.65%	69.5%
Doctor's Explanation	9.97%	79.5%
Reception staff treatment	9.29%	88.7%
Signages & Directions	8.52%	97.3%

Pareto Chart and the 80/20 rule (Figure 4.5), shows that the following processes are the main concerns in order to improve patient satisfaction, which includes: long waiting time for admission to operating theatre, long waiting time for admission to day care department, long registration and admission to hospital, and poor discharge teaching, Pareto Chart shows that these issues are the top 20% of issues that cause 80% of dissatisfaction, and they considered as priority areas during the Improve phase.

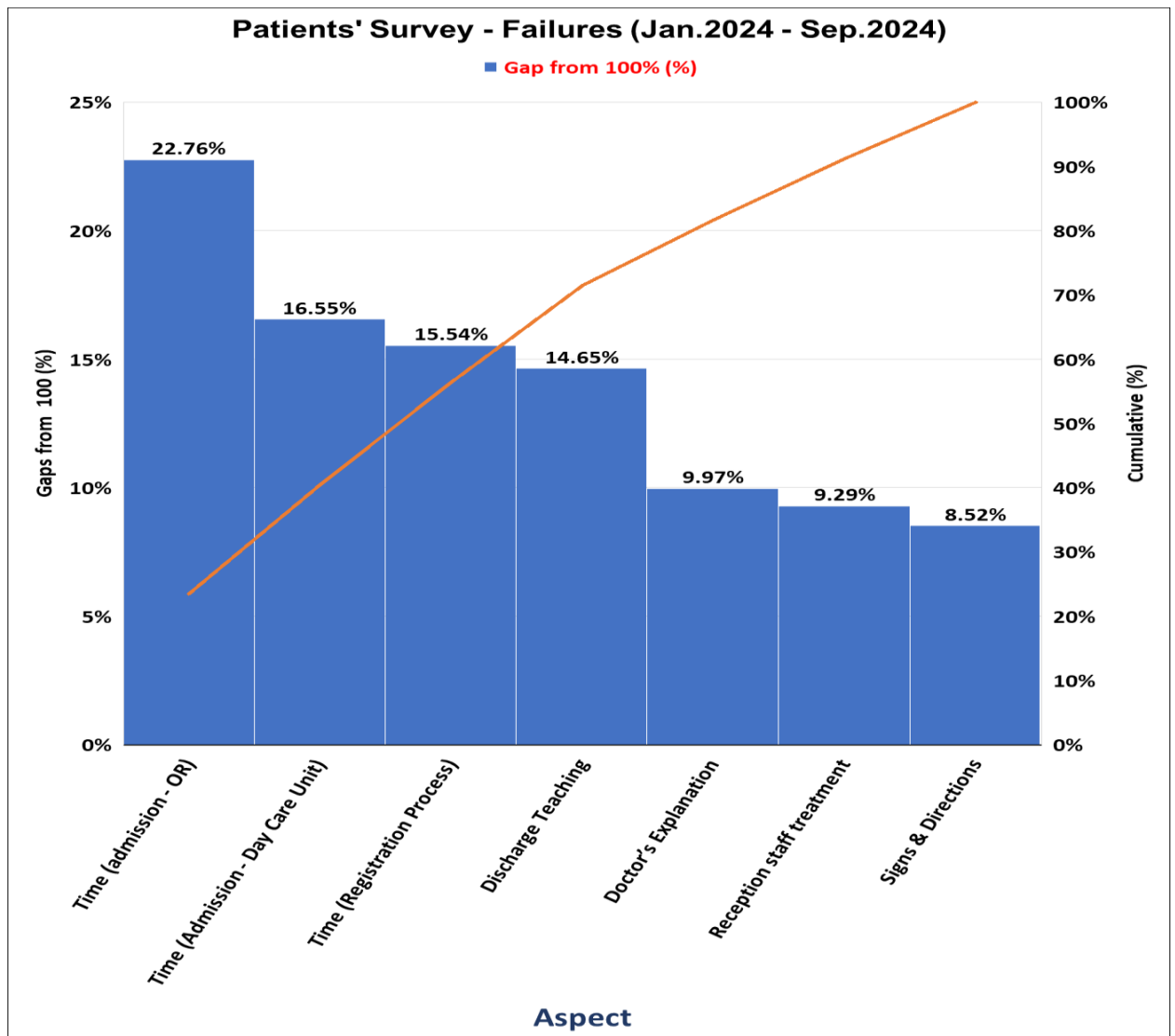


Figure 4.5: Historical Patient Surveys' – Pareto Chart

4.4.4 Hospital Management Information System Analysis

During the period of Jan. 2024 till Aug. 2024, there were 1,497 day care surgeries performed out of 2,361 of total surgeries for the same period (Table 4.6), day care surgery activities represented 63.4% of the total Operating Theater activity for the same period, for that, the impact of day care surgery on the performance of Operating Theater and Day Care Department is high, as well as the hospital as a whole, and also it has a high impact on revenues as well, in addition to expenses regarding appropriate utilization of resources and waste elimination.

Figure (4.6) shows the comparison between all surgeries and day care surgeries; monthly day care surgeries range from 139 (April 2024) to 324 (January 2024).

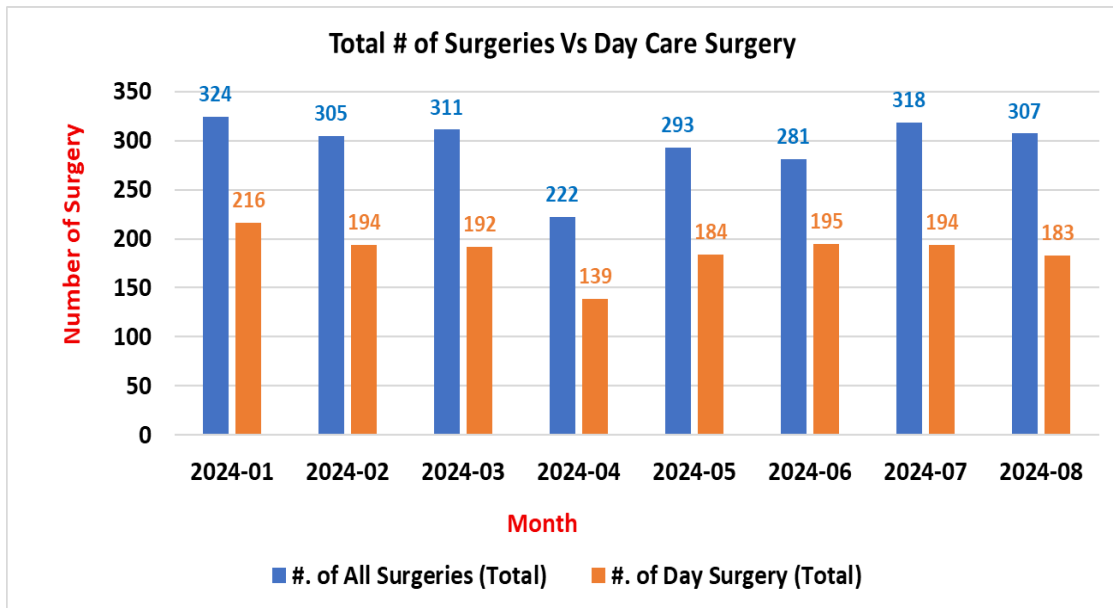


Figure 4.6: Historical HMIS Data – All Surgery Vs Day Care Surgery (#s)

Also, it is well visualized that day care surgeries occupy more than 59 % in the consecutive eight months period (Figure 4.7).

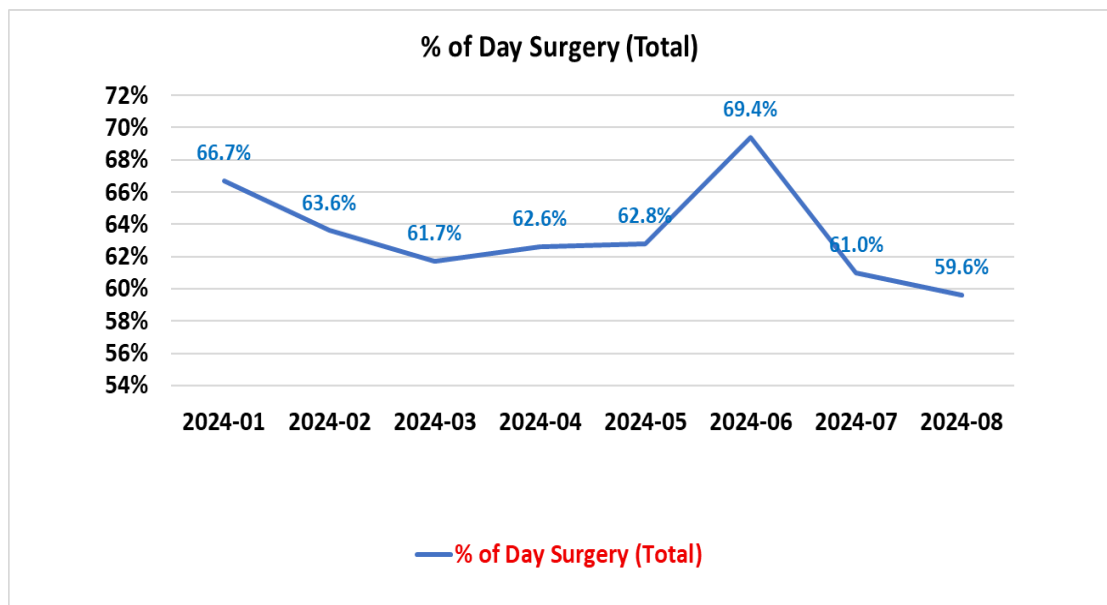


Figure 4.7: Historical HMIS Data – Day Care Surgery (%s) Vs Total Surgery

Based on HMIS data for the period of January to August 2024, trends were identified, mainly high no-shows, surgery cancellations, and waiting times. One important problem is that there are so many day care patients do not show up for their appointments; 84 patients on February 2024 (Figure 4.8), which represents 28.9% of

scheduled day care surgeries for the same month (Figure 4.9), data shows high no-show rates, the lowest score was on April (17.0%), and 18.0% for June and July. On average 21.4% of scheduled day surgeries did not show up for surgery, which means there is a gap between proposed and actual performance of day care services. This means there is unnecessary waste for hospital resources, and there is a need for decreasing this gap.

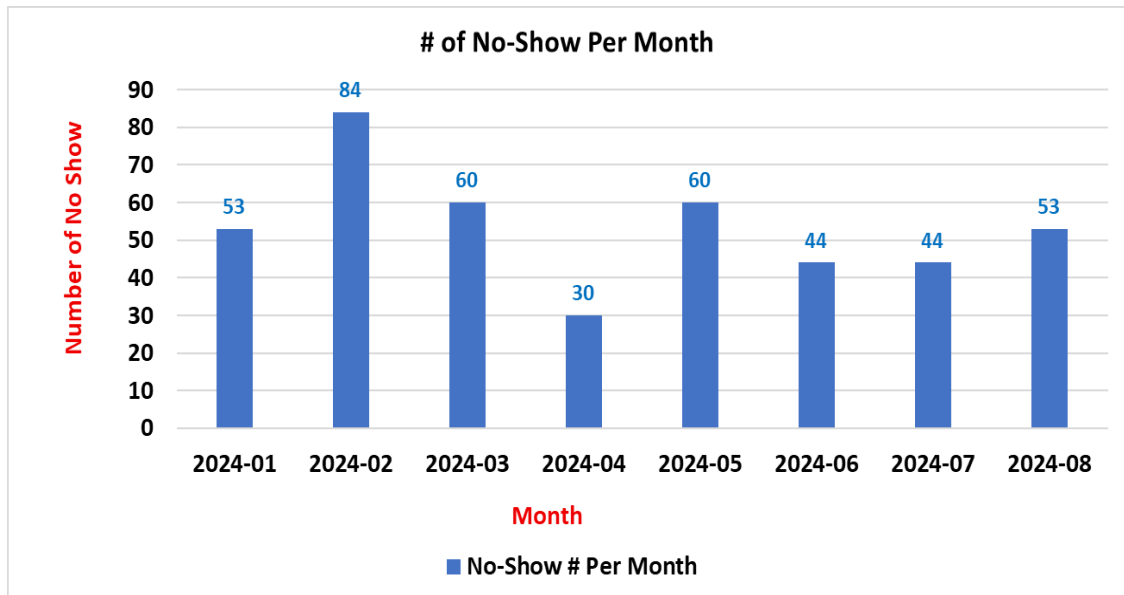


Figure 4.8: Historical HMIS Data – Day Care Surgery No-Show (#s)

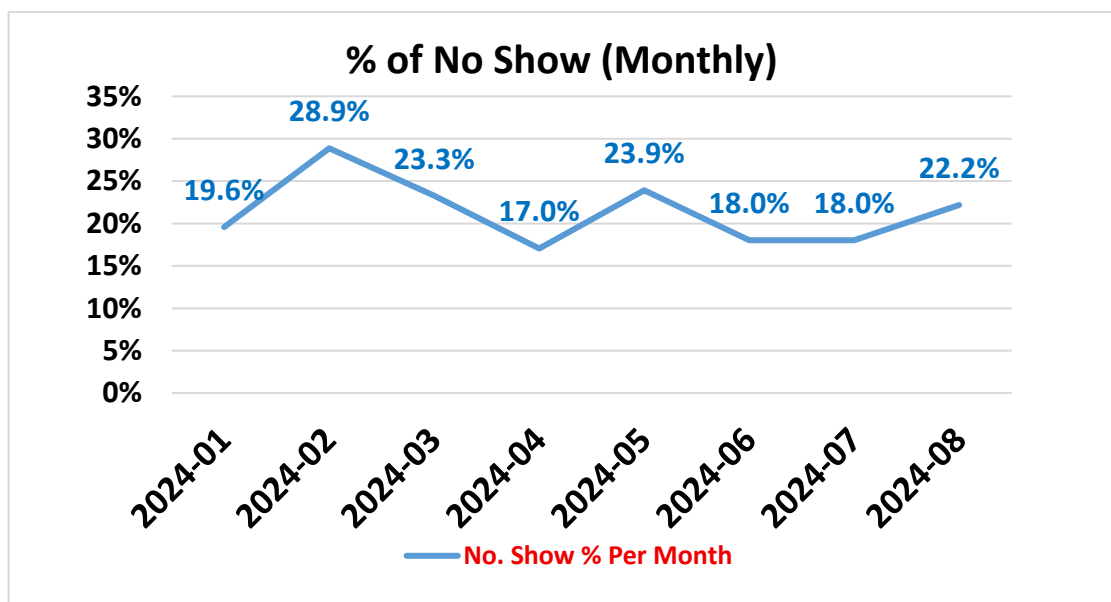


Figure 4.9: Historical HMIS Data – Day Care Surgery No-Show (%)

Also, from the statistics, it is clear that there are surgery cancellations, for example February experienced the most surgery of 13 cases (Figure 4.10) which represents 4.5%, in addition to 4% for April and 2.8% for May (Figure 4.11), Even in months with low percentages of surgery cancellation like January and August (0.7%, 1.3% respectively), these cancellation can be avoided by improving any disorganized preparedness, insufficient documentation, and patients without necessary diagnostic tests or consultations. Because of these failures, many procedures end up getting cancelled close to the surgery start time, interrupting the Day Care Department and Operating Theater schedule and wasting its resources and staff time.

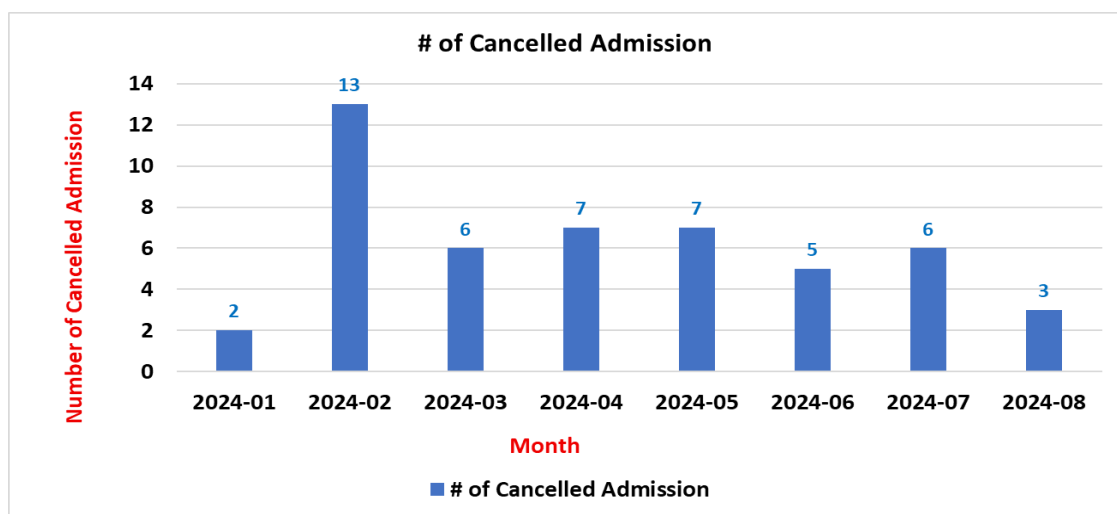


Figure 4.10: Historical HMIS Data – Day Care Surgery Cancelled Admission (#s)

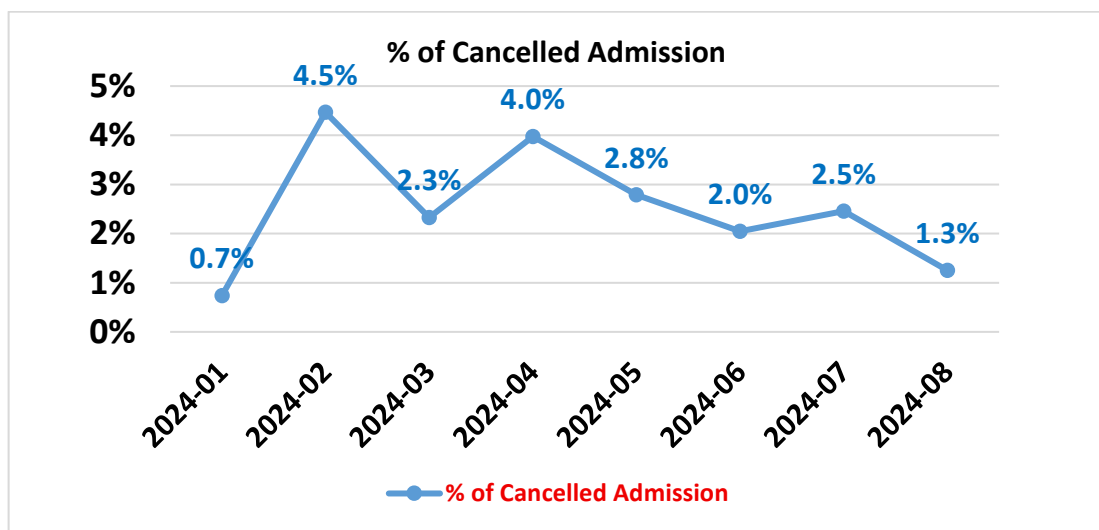


Figure 4.11: Historical HMIS Data – Day Care Surgery Cancelled Admission (%)

Also, data shows that there is a lot of variation in patient waiting times for surgery (Figure 4.12) and many issues that keep surgeries from being performed smoothly. The peak delay for time to the operating room happened in June and took about 240 minutes, while in April, the shortest time was recorded at 138 minutes (Holy Ramadan Days & the lowest number of surgeries performed in this month).

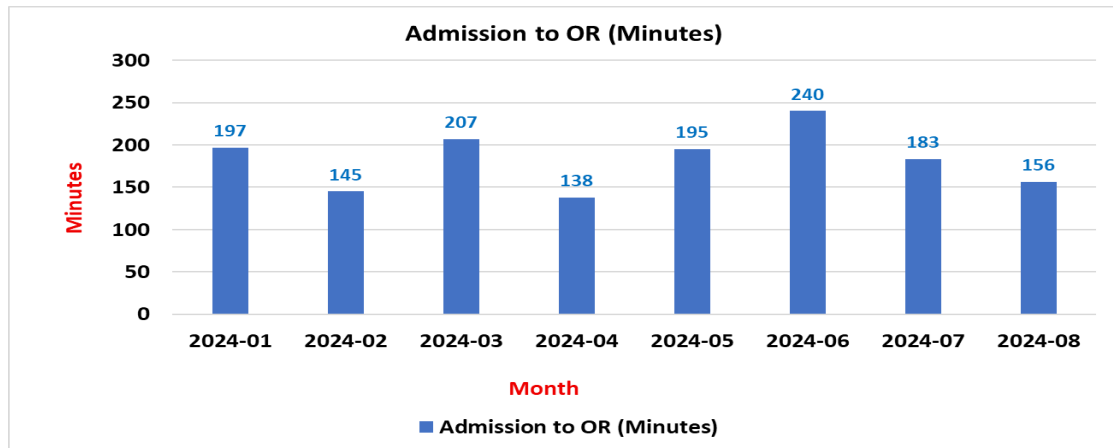


Figure 4.12: Historical HMIS Data – Admission to OR (Minutes)

The variation means that surgical operations are going smoothly when there are no crowding and no early arrival to hospital, hence the staff can quickly respond to patients ready for surgery. Also, the time consumed by nurses to assess their patients after admission was different each month, with 49 minutes in August and just 36 minutes in April (Figure 4.13) on contrary to stable Admission to Doctor Assessment average time of 38 minutes (Figure 4.14). Hence, without a regular and aligned approach to pre-operation, the hospital may experience even more delays that hurt the satisfaction of patients and the functioning of the facility, as well as revenues and reputation.

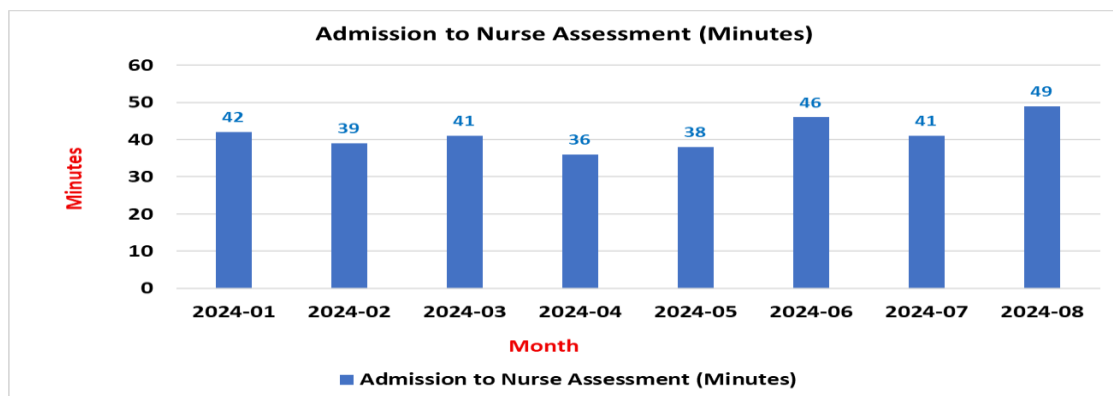


Figure 4.13: Historical HMIS Data – Admission to Nurse Assessment (Minutes)

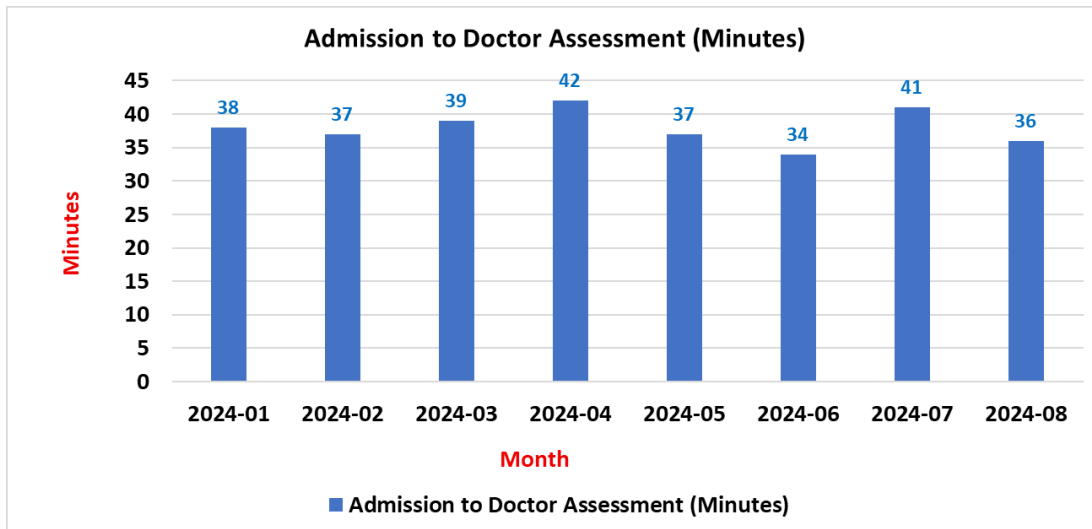


Figure 4.14: Historical HMIS Data – Admission to Doctor Assessment (Minutes)

To better visualize the extent of variation, skewness and discrepancy in day surgery KPIs, a descriptive statistic and analysis is conducted (Figure 4.15), it showed several key operational measures of patient's journey, that may guide the implementation of LSS process in day care surgical services, and improve operational efficiency. As follows:

Statistics

Variable	Mean	StDev	Minimum	Median	Q3	Maximum	IQR
No. of All Surgeries (Total)	295.1	32.5	222.0	306.0	316.3	324.0	32.3
No. of Day Surgery (Total)	187.13	21.90	139.00	193.00	194.75	216.00	11.50
No. Show No. Per Month	53.50	15.80	30.00	53.00	60.00	84.00	16.00
No. of Cancelled Admission	6.13	3.31	2.00	6.00	7.00	13.00	3.50
Admission to Nurse Assessment (	41.50	4.24	36.00	41.00	45.00	49.00	6.75
Admission to Doctor Assessment	38.000	2.619	34.000	37.500	40.500	42.000	4.250
Admission to OR (Minutes)	182.6	34.6	138.0	189.0	204.5	240.0	56.8

Figure 4.15: Historical HMIS Data Analysis - Descriptive Statistics of Day Care Surgery Metrics

Finding and its analysis and possible causes of variations and efficiencies are summarized as follows:

- A. **No. of All Surgeries (Total):** (Mean: 295.1, SD: 32.5, Median: 306.0, IQR: 32.3); Slight negative skew (mean < median), but fairly symmetrical. It indicates

a high volume of surgical activity, which offers evidence for the benefit of LSS process improvement in Surgical Services, particularly for throughput and resource optimization.

- B. **No. of Day Surgery (Total):** (Mean: 187.13, SD: 31.9, Median: 193.0, IQR: 11.5); Day surgeries account for a significant proportion (~63.4%) of all surgeries. Low IQR represents consistency from month to month, which is an evident for standardization and Lean-driven cycle time reduction and waste reduction.
- C. **No. Show No. Per Month:** (Mean: 53.5, SD: 15.8, Median: 53.0, IQR: 16.0); Symmetrical distribution. The numbers are high, which addresses the importance of Lean tools like root cause analysis or patient reminder systems which may improve surgical efficiency.
- D. **No. of Cancelled Admission:** (Mean: 6.13, SD: 3.31, Median: 6.0, IQR: 3.5); almost constant cancellation rate. Most causes related to not well-prepared patients (Not fasting), or lack some documents necessary for admission or care.
- E. **Admission to Nurse Assessment (Minutes):** (Mean: 41.50, SD: 4.24, Median: 41.0, IQR: 6.75); Mean and Median around 41 minutes, these a bit high, which make it a candidate for Lean improvements.
- F. **Admission to Doctor Assessment (Minutes):** (Mean: 38.0, SD: 2.619, Median: 37.5, IQR: 4.25); Very narrow variation, indicating excellent process control.
- G. **Admission to OR (Minutes):** (Mean: 182.6, SD: 34.6, Median: 189.0, IQR: 56.8); IQR is 56.8, it indicates high variation, a critical metric for the workflow, reducing variations via value stream mapping and eliminating NVA time can significantly enhance patient throughput and Operating Theater utilization.

The descriptive and analytic results of day surgery performance indicators revealed several patterns that highlight both strengths and areas requiring LSS intervention. Overall surgical volume was high and relatively stable, with day surgeries consistently comprising more than 60% of total surgeries performed, there is an indication of standardized processes suitable for further Lean optimization. While no-show rates were symmetrically distributed, their magnitude underscores the need for targeted root-cause analyses and patient-engagement strategies. Cancellation rates remained low, and mostly resulted from preventable causes such as inadequate patient preparation or missing referrals or diagnostic tests. Time-based metrics showed mixed

results: nurse and physician assessments exhibited low variability, suggesting good process control, whereas admission-to-operating theater times showed substantial variation, highlighting a critical bottleneck in the current surgical pathway. Collectively, these findings align with earlier qualitative insights and point to specific workflow inefficiencies where LSS methods - such as value stream mapping and variance reduction - can meaningfully enhance operational efficiency and patient flow.

Furthermore, to better understand the variations and to check the normality of data, Anderson-Darling (AD) Test and p-Value were used. The AD Test is a statistical test used to assess whether a given sample of data comes from a specific probability distribution, most commonly the normal distribution. It enhances the sensitivity of the Kolmogorov-Smirnov test by giving more weight to the tails of the distribution, making it particularly effective for detecting deviations in the extremes (Berlinger et al., 2021). The focus is on the test statistic and its corresponding p-value. where:

- A smaller AD statistic suggests that the data closely follows the normal distribution.
- A larger AD statistic indicates a greater deviation from normality.
- The p-value result, as follows:
 - If $p > 0.05$, fail to reject null hypothesis and data can be considered as normally distributed
 - If $p \leq 0.05$, Reject null hypothesis and data is not normally distributed

The results (AD, and p-Value) showed that the plotted points generally follow the red reference line (Figure 4.16), which indicates alignment with a normal distribution and no statistically significant deviation from normality, except number of monthly day surgeries with a p-Value 0.023 (less than 0.05), supporting the assumption of normal distribution of all variables except number of monthly day surgeries, where one minor deviation at the start (near 5 - 10).

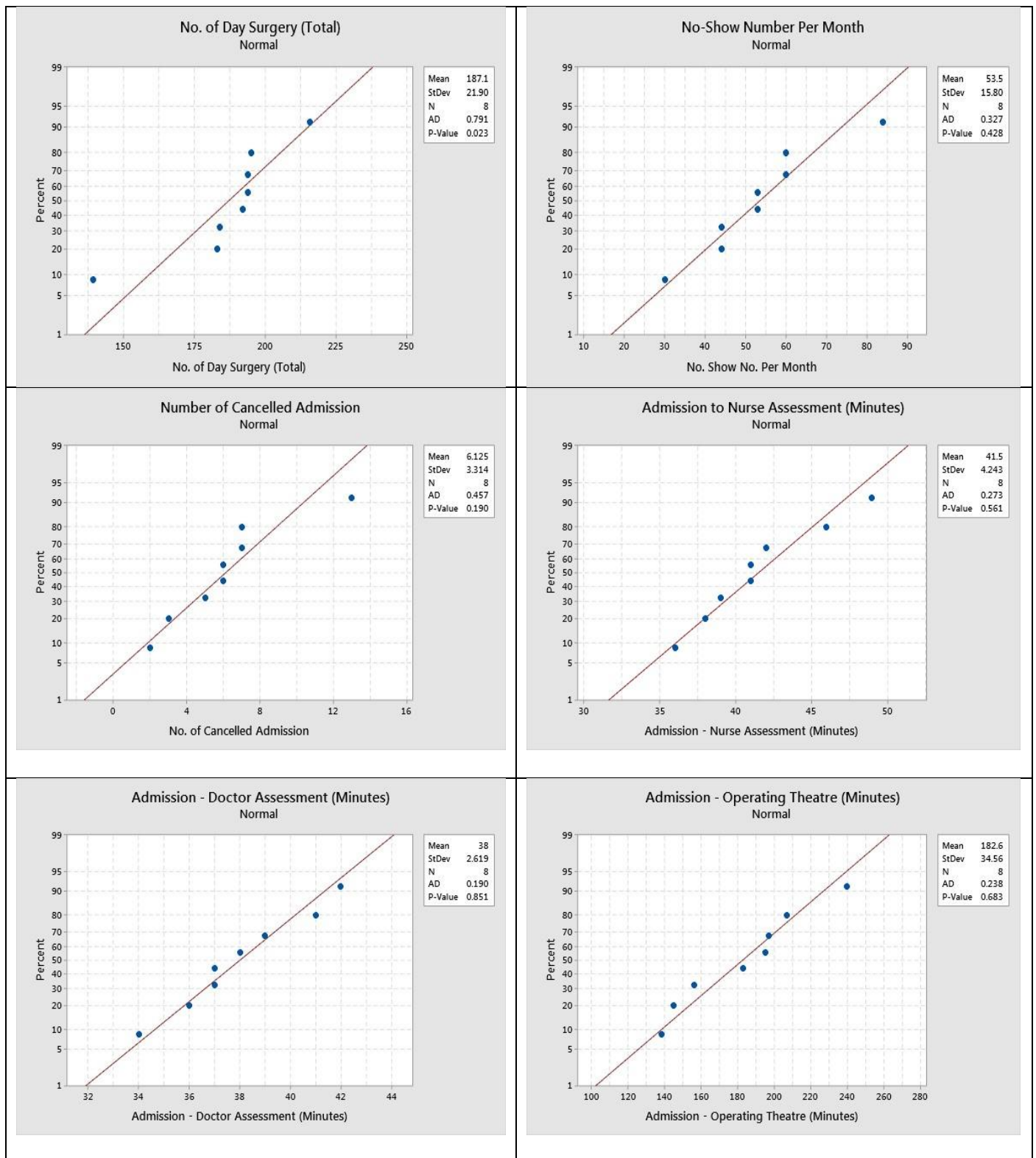


Figure 4.16: Historical HMIS Data – Normality of Data Distribution (pre-LSS)

For advancement of analysis and better understanding of distribution and variations, visual and control tools were used, (Figure 4.17) & (Figure 4.18) represent the distribution and variation of the Number of Day Care surgeries' control charts, which showed that the number of Day Care surgeries across 8 observations (2024.1 – 2024.08),

these charts showed that all data points fall within the control limits; Upper Control Limit (UCL) = 252.8, and Lower Control Limit (LCL) = 121.4, with a mean of 187.1 and SD of 21.9 (Figure 4.17), there is no special cause variation was detected, indicating that the process is statistically stable with minor variations. The Moving Range chart (MR) confirms the previous findings; with all Moving Ranges remaining within the UCL (80.71). This indicates that the variability between time points is consistent and well-managed, these findings align with the need of application of LSS in reducing process variation and improving surgery scheduling standardization.

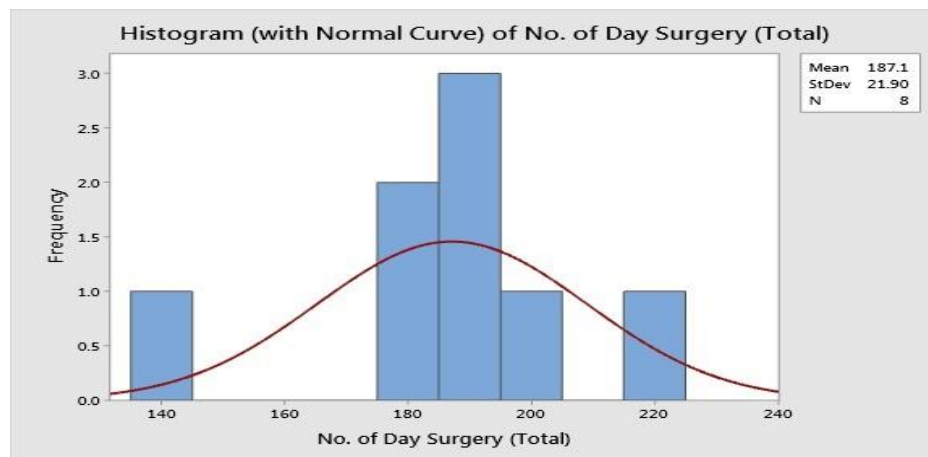


Figure 4.17: Historical HMIS Data – Histogram of Number of Day Care Surgeries

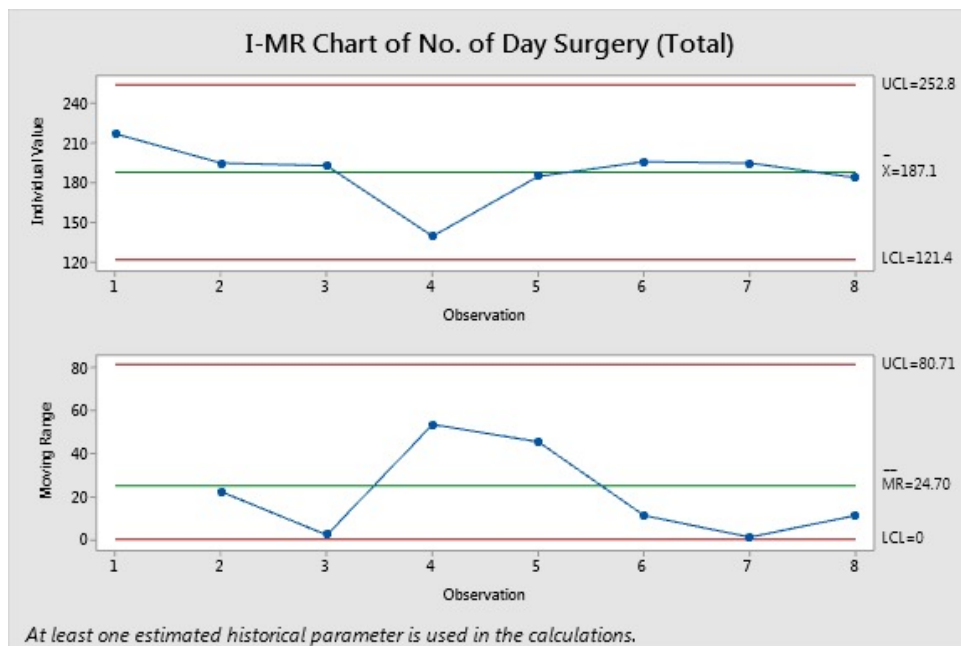


Figure 4.18: Historical HMIS Data – XBar & I-MR Chart of Number of Day Care Surgeries

Concerning No-show Rates, Figure (4.19) shows that there is a roughly normal distribution but with slight skewness to the right due to one high no-show month (80–90 range), most months fall between 40 and 70 no-shows, indicating moderate variability.

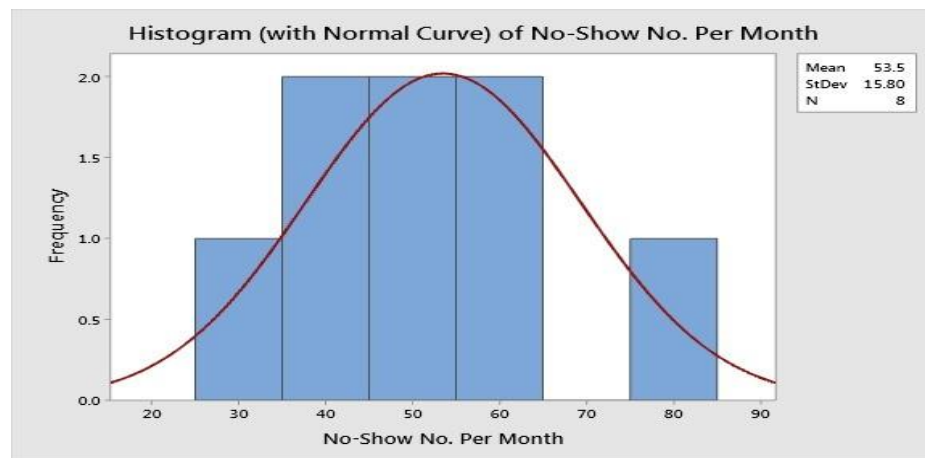


Figure 4.19: Historical HMIS Data – Histogram of No-Show Number of Day Care Surgeries

In addition, No-show control chart (Figure 4.20) shows that all data values fall within control limits (UCL = 100.9, LCL = 6.1), which is an indication of statistically stable process is in existence, and common cause variation only (point 4). Nonetheless, there is larger variation between the monthly frequency of no-shows (between 30 and 84) and the Moving Range plot indicates variability varying over the first part of the data set compared to last three data points (June, July, and August), these findings indicate that, the process is can be optimized, whereas it has moderate variability though it is stable.

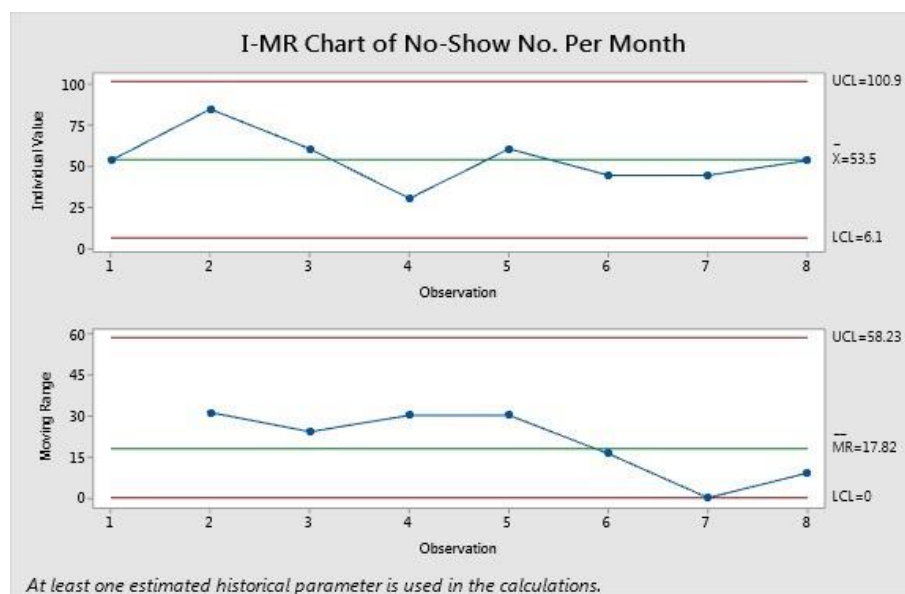


Figure 4.20: Historical HMIS Data – XBar & I-MR Chart of No-Show Number of Day Care Surgeries

Histogram of Number of Cancelled Admission/surgeries (Figure 4.21) shows a slight right (positive) skew, with most months clustering around 4 - 9 cancellations. One month had a significantly higher value (14), which may affect the normality of the distribution

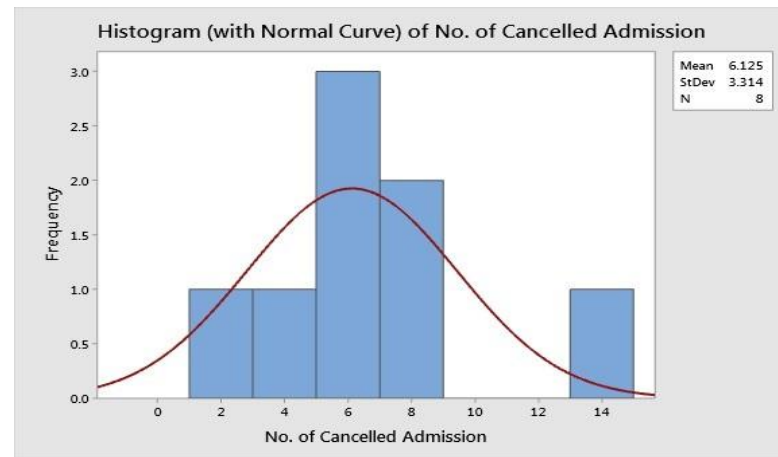


Figure 4.21: Historical HMIS Data – Histogram of No of Cancelled Admission

The monthly cancelled admissions control chart (Figure 4.22) is indicative of the fact that the process is under statistical control and no special cause variation found. The largest count of cancellations was observed in the month of February (13 cases), but still within the control limits showing that it is common cause variability. The Moving Range chart is in agreement with the observation that the variability was higher in earlier months and significant reduction in the later months, these results show that further efforts on consistent standardization are important to minimize cancellations and ensure control of the processes.

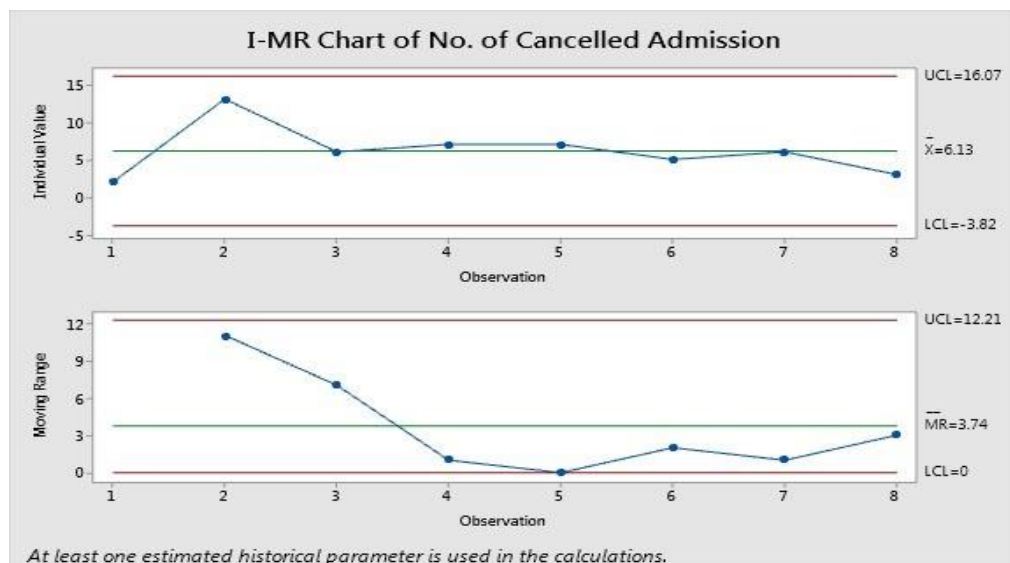


Figure 4.22: Historical HMIS Data – XBar & I-MR Chart of Cancelled Admission

Figure (4.23) shows the process of nurse assessment after admission is stable and normally distributed ($SD = 4.243$), with minimal variation. The average time of 41.5 minutes may serve as a baseline for improvement, particularly if aiming to reduce patient wait time in day surgery services.

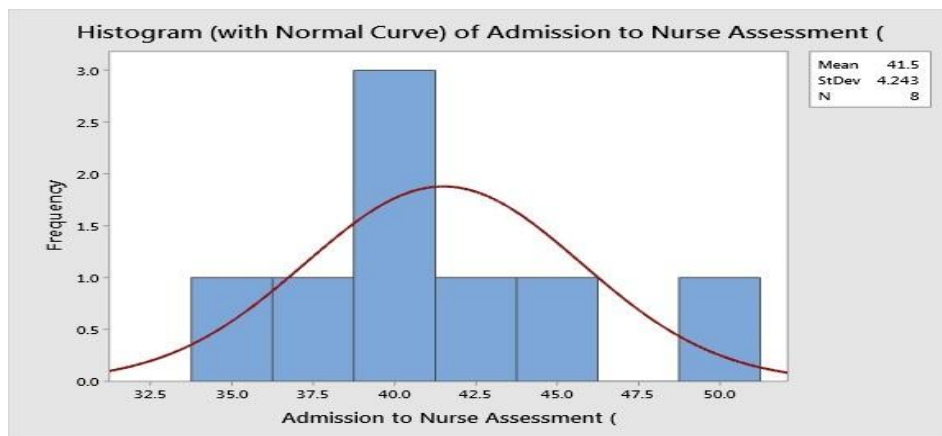


Figure 4.23: Historical HMIS Data – Histogram of Admission to Nurse Assessment Time

The Moving Range chart of measuring time between the admission and the nurse assessment (Figure 4.24) shows that the process is under statistical control since the calculated control limits were within the eight measurements shows that all data values fall within control limits ($UCL = 54.23$, $LCL = 28.77$). The mean equals 41.5 min, and its variation is not big ($SD = 4.243$; Figure 4.23), and varies in an intensity of about 36 min and 49 min. In spite of the process being stable, the consistent monthly fluctuations can be seen, which indicate possibilities of the standardization of the process to minimize the time. The Moving Range chart confirms that the monthly variation is mainly within the desired range, and volatility increased only slightly.

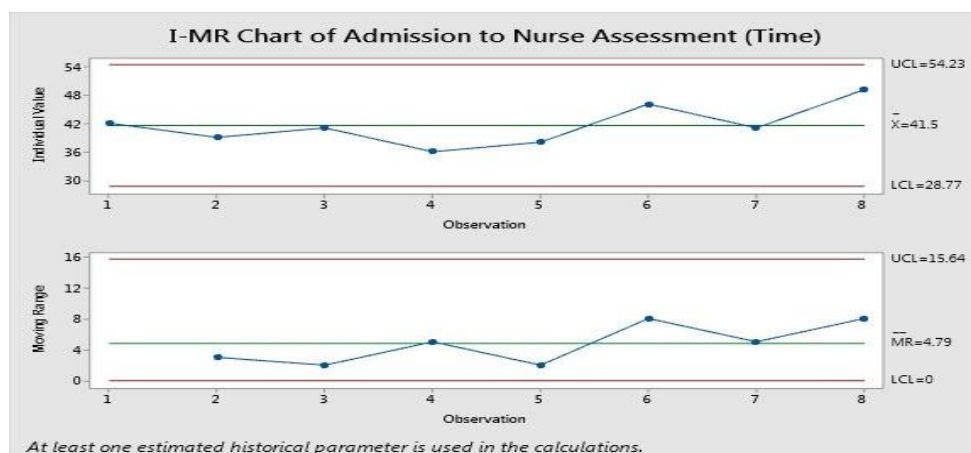


Figure 4.24: Historical HMIS Data – XBar & I-MR Chart of Admission to Nurse Assessment Time

Figure (4.25) represents the time interval (in minutes) from patient admission to doctor assessment, based on 8 observations (monthly), the average time is 38 minutes and the SD equals 2.619, with a normal curve overlay.

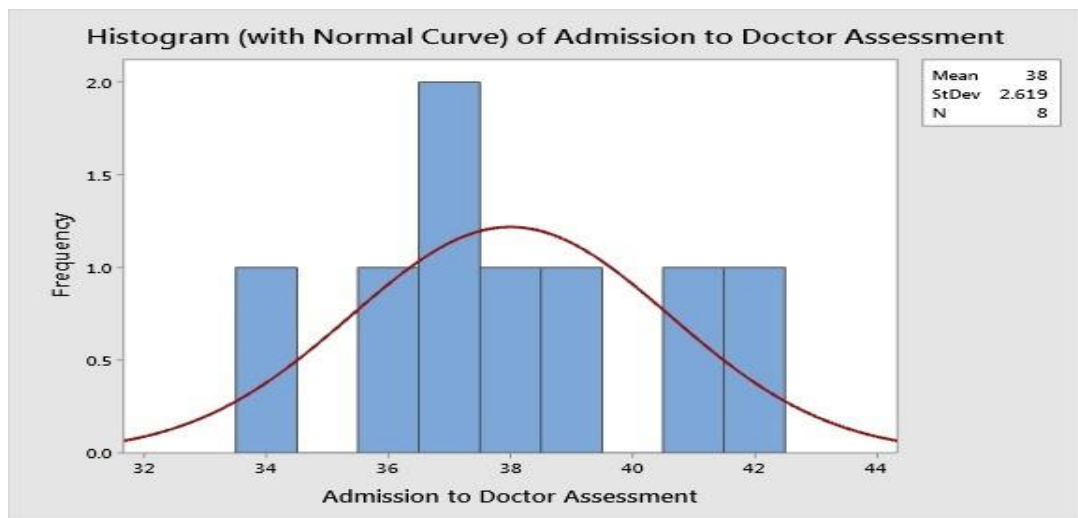


Figure 4.25: Historical HMIS Data – Histogram of Admission to Doctor Assessment Time

The time control chart of admission of patients and examination by the doctor (Figure 4.26) indicates stable process and none of the monthly mean is outside the control limits. The mean evaluation duration is 38 minutes (SD of 2.619; Figure 4.25), and the monthly assessment can be seen at 34 to 42 minutes. This variation is within reasonable ranges as per the acceptable statistical limits. The Moving Range chart upholds that there are mid-range shifts of timing, especially during the last 4 points, but none crosses the higher control limit.

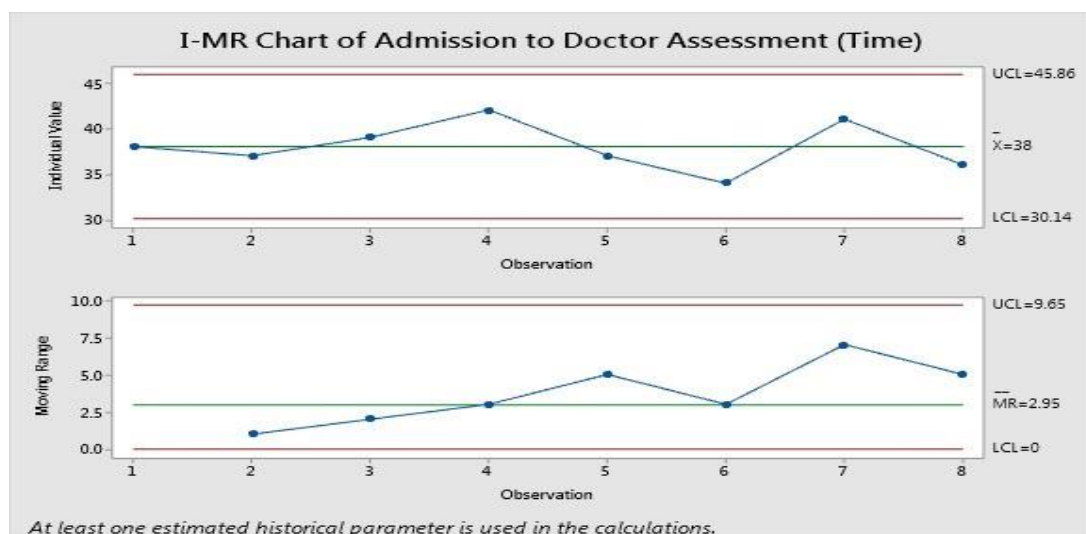


Figure 4.26: Historical HMIS Data – XBar & I-MR Chart of Admission to Doctor Assessment Time

Figure (4.27) shows the process from admission to OR time which shows a wider range and more variation than previous steps, with a mean of 182.6 minutes, SD of 34.56, and a clear positive skew. This may reflect inefficiencies, bottlenecks, or patient condition variability.

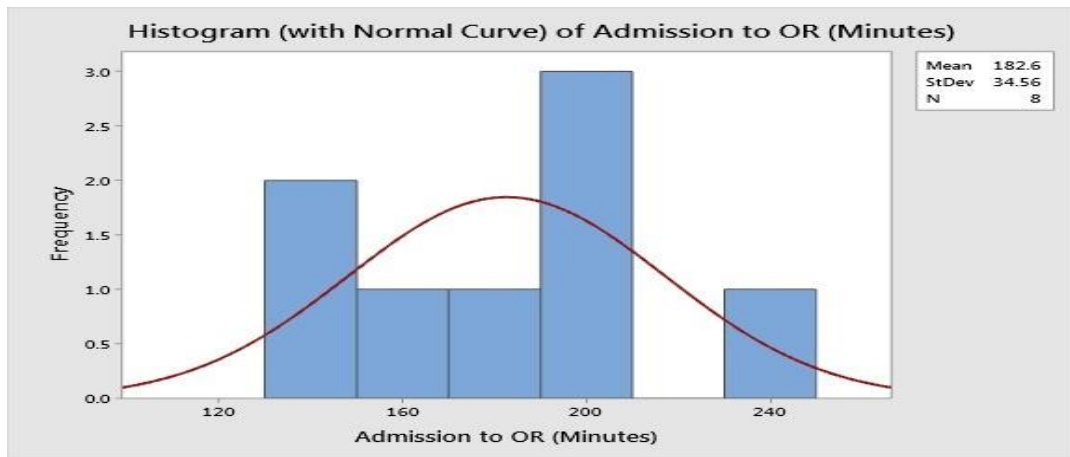


Figure 4.27: Historical HMIS Data – Histogram of Admission to OR Time

The control chart analysis of time from admission to the operating room (Figure 4.28) shows that, while the process is statistically in control, it is marked by significant common cause variation. The monthly average ranges from 138 to 240 minutes, with an overall mean of 182.6 minutes (SD = 34.56; Figure 4.27). These findings suggest the presence of systemic inefficiencies, such as inconsistent surgery scheduling, bottlenecks in admission or pre-operative assessment, or delays in operating room readiness. The stability of the process (as indicated by all values falling within control limits) suggests that no single event is causing outlier behavior. However, the magnitude of variability (102 minutes) between best and worst months indicates an opportunity for process standardization and day surgery scheduling optimization.

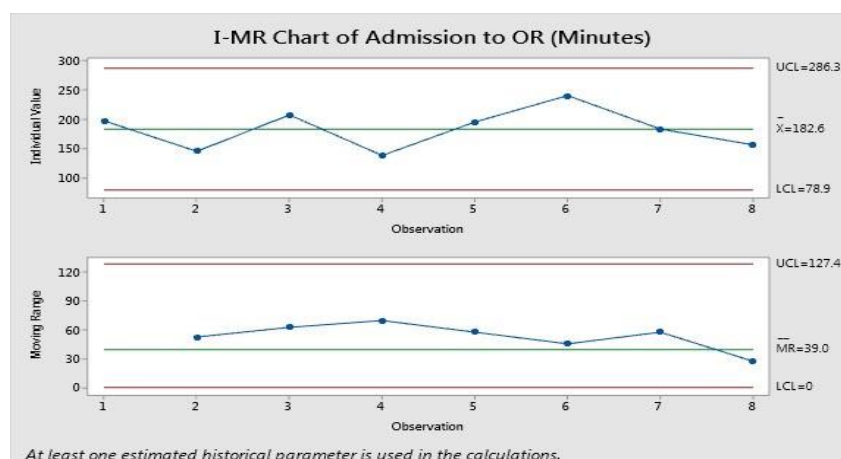


Figure 4.28: Historical HMIS Data – XBar & I-MR Chart of Admission to OR Time

In summary, 63.4% of saint joseph hospital surgical procedures are day care surgeries, for that day care surgery efficiency is crucial for hospital performance, it includes the workflow of admission office, day care unit, operating theater as well as sterilization department, as well as other services like anesthesia, pharmacy and others, for that, no show of day surgery patients and surgery cancellations affect hospital operations and performance outcomes. No show and cancellation even enclose the most of waste, including time, motion, transportation and defects. Also, it is obvious the variations over the months, in addition to long waiting time for admission, assessment, and surgery performing. All these gaps affect patients' satisfaction and hospital outcomes and revenues, in addition to reputation and competitiveness in Jerusalem.

Based on data collected from HMIS, staff interviews, Gemba Walks, and patient surveys, waiting time was selected as the central issue due to its impact on both patient satisfaction and surgical scheduling. A Fishbone (Ishikawa) diagram was used during the Analyze phase to visually organize the potential root causes contributing to prolonged waiting times for day care surgical patients, high no show rates, cancelation rate and poor patient satisfaction. With the project charter team, results were discussed and root causes were aligned and grouped under six major categories: Man, Method, Machine, Material, Measurement, and Mother Environment. While several quality tools were employed, one comprehensive fishbone diagram was sufficient to encapsulate the primary systemic contributors to the delay, patient no show, cancelations, and gaps in patients' satisfaction, it forms the foundation for targeted improvement strategies (Figure 4.29).

Possible Causes for Gaps in Hospital Performance & Patients' Experiences

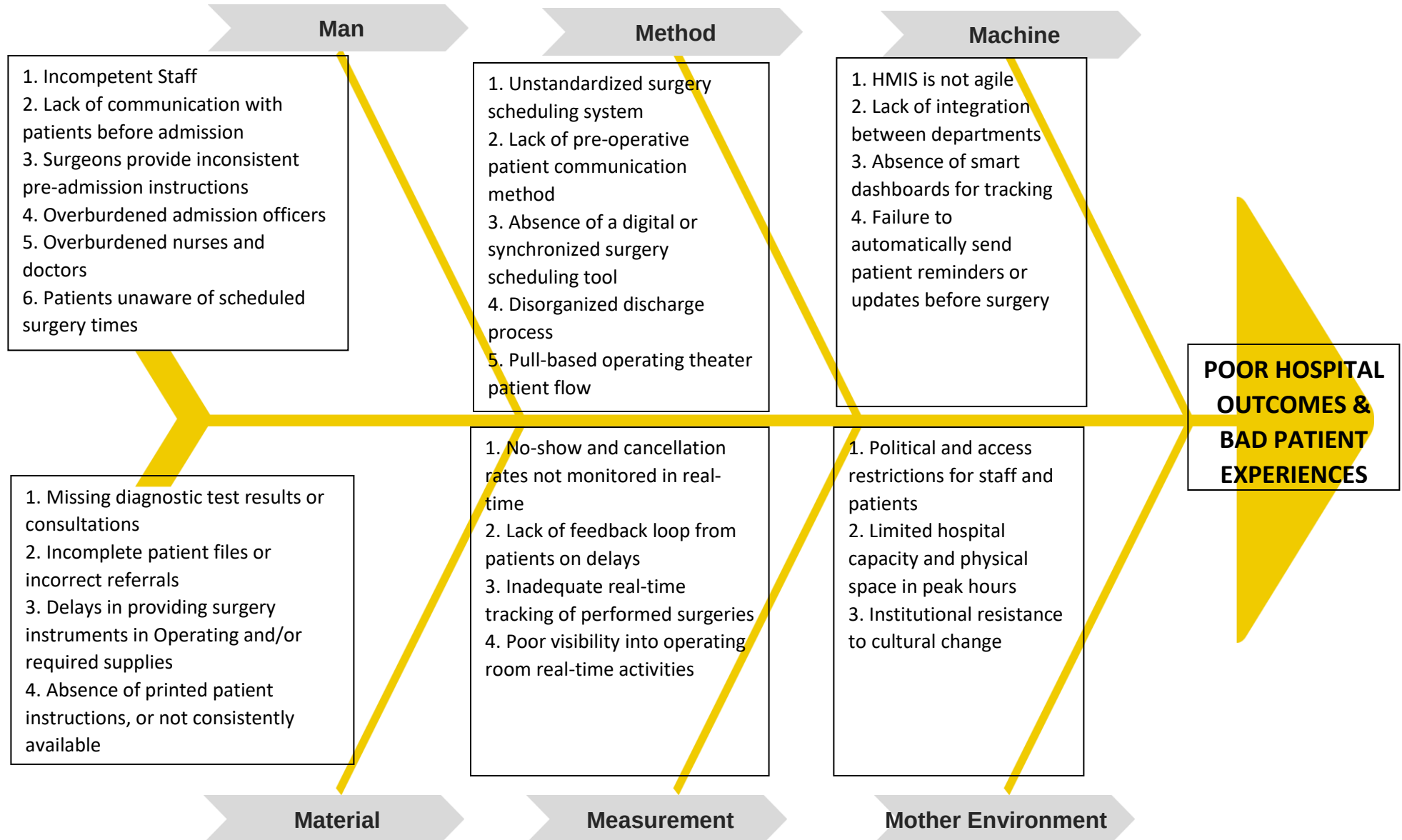


Figure 4.29: Possible Causes for Gaps in Hospital Performance & Patients' Experiences

FMEA tool was adopted to rank possible causes for gaps in performance based on scale 1 - 5 (where 1 = no impact to 5 = extremely high impact) for each criterion (Table 4.9), the criteria are: Frequency (How often does the problem occur?), Severity (How badly does it affect patient care or hospital operations?), Cost (Does it consume significant time or resources?), and Patient Experiences (Does it affect satisfaction, safety, or comfort?), every impact area's criteria (4 criteria) is multiplied with each other, data as below table:

Table 4.9: FMEA & Possible Causes for Gaps in Performance & Patients' Experiences

Each team member ranks each root cause element from 1 to 5 based on each criterion							
	Possible Cause	Frequency	Severity	Cost	Patient Experience	Score & its Percentage	
Category	Description	How often does the problem occur? 1 = Rarely 5 = Frequently	How badly does it affect patient care or hospital operations? 1 = Low impact 5 = Severe impact	Does it consume significant time or resources? 1 = Not at all 5 = Very significantly	Does it affect satisfaction, safety, or comfort? 1 = Not at all 5 = Very significantly	*Total Score	(%)
1. Man	1.1 Incompetent Staff	1	5	1	5	25	0.54%
	1.2 Lack of communication with patients before admission	5	5	4	5	500	10.88%
	1.3 Surgeons provide inconsistent pre-admission instructions	1	5	1	5	25	0.54%
	1.4 Overburdened admission officers	3	5	2	5	150	3.26%
	1.5 Overburdened nurses and doctors	3	5	2	5	150	3.26%
	1.6 Patients unaware of scheduled surgery times	5	5	3	5	375	8.16%
2. Method	2.1 Unstandardized surgery scheduling system	5	5	3	5	375	8.16%
	2.2 Lack of pre-operative patient communication method	5	5	3	5	375	8.16%
	2.3 Absence of a digital or synchronized surgery scheduling tool	5	4	4	4	320	6.96%
	2.4 Disorganized discharge process	5	5	4	5	500	10.88%

	2.5 Pull-based operating theater patient flow	5	3	1	1	15	0.33%
3. Machine	3.1 HMIS is not agile	1	3	2	5	30	0.65%
	3.2 Lack of integration between departments	2	2	3	5	60	1.31%
	3.3 Absence of smart dashboards for tracking	5	4	4	4	320	6.96%
	3.4 Failure to automatically send patient reminders or updates before surgery	5	4	2	5	200	4.35%
4. Material	4.1 Missing diagnostic test results or consultations	1	3	5	5	75	1.63%
	4.2 Incomplete patient files or incorrect referrals	1	5	3	5	75	1.63%
	4.3 Delays in providing surgery instruments in Operating and/or required supplies	1	5	1	5	25	0.54%
	4.4 Absence of printed patient instructions, or not consistently available	5	5	4	5	500	10.88%
5. Measurement	5.1 No-show and cancellation rates not monitored in real-time	1	1	5	1	5	0.11%
	5.2 Lack of feedback loop from patients on delays	1	5	1	5	25	0.54%
	5.3 Inadequate real-time tracking of performed surgeries	5	3	3	1	45	0.98%
	5.4 Poor visibility into operating room real-time activities	5	5	2	5	250	5.44%
6. Mother Environment	6.1 Political and access restrictions for staff and patients	1	5	5	5	125	2.72%
	6.2 Limited hospital capacity and physical space in peak hours	1	5	1	5	25	0.54%
	6.3 Institutional resistance to cultural change	1	3	3	3	27	0.59%
* Total Score = Frequency * Severity * Cost * Patient Experiences					TOTAL	4597	100%

Based on previous, prioritization matrix for possible causes is ranked and formulated, as shown in Table (4.10):

Table 4.10: Pareto Data for FMEA & Possible Causes for Gaps in Performance & Patients' Experiences

Possible Cause	Score	(%)	Cumulative %
1.2 Lack of communication with patients before admission	500	10.88%	10.88%
2.4 Disorganized discharge process	500	10.88%	21.75%
4.4 Absence of printed patient instructions, or not consistently available	500	10.88%	32.63%
1.6 Patients unaware of scheduled surgery times	375	8.16%	40.79%
2.1 Unstandardized surgery scheduling system	375	8.16%	48.94%
2.2 Lack of pre-operative patient communication method	375	8.16%	57.10%
2.3 Absence of a digital or synchronized surgery scheduling tool	320	6.96%	64.06%
3.3 Absence of smart dashboards for tracking	320	6.96%	71.02%
5.4 Poor visibility into operating room real-time activities	250	5.44%	76.46%
3.4 Failure to automatically send patient reminders or updates before surgery	200	4.35%	80.81%
1.4 Overburdened admission officers	150	3.26%	84.08%
1.5 Overburdened nurses and doctors	150	3.26%	87.34%
6.1 Political and access restrictions for staff and patients	125	2.72%	90.06%
4.1 Missing diagnostic test results or consultations	75	1.63%	91.69%
4.2 Incomplete patient files or incorrect referrals	75	1.63%	93.32%
3.2 Lack of integration between departments	60	1.31%	94.63%
5.3 Inadequate real-time tracking of performed surgeries	45	0.98%	95.61%
3.1 HMIS is not agile	30	0.65%	96.26%
6.3 Institutional resistance to cultural change	27	0.59%	96.85%
1.1 Incompetent Staff	25	0.54%	97.39%
1.3 Surgeons provide inconsistent pre-admission instructions	25	0.54%	97.93%
4.3 Delays in providing surgery instruments in Operating and/or required supplies	25	0.54%	98.48%
5.2 Lack of feedback loop from patients on delays	25	0.54%	99.02%
6.2 Limited hospital capacity and physical space in peak hours	25	0.54%	99.56%
2.5 Pull-based operating theater patient flow	15	0.33%	99.89%
5.1 No-show and cancellation rates not monitored in real-time	5	0.11%	100.00%
TOTAL	4597	100%	

As per The Pareto Principle (80/20 rule) says that 80% of problems often stem from 20% of the causes. Figure (4.30) shows that 80% of gaps in Saint Joseph Hospital performance are caused by the following reasons: Lack of communication with patients before admission (10.88%), Disorganized discharge process (10.88%), Absence of printed patient instructions (10.88%), or not consistently available, Patients unaware of scheduled surgery times (8.16%), Unstandardized surgery scheduling system (8.16%), Lack of pre-operative patient communication method (8.16%), Absence of a digital or synchronized surgery scheduling tool (6.96%), Absence of smart dashboards for tracking (6.96%), Poor visibility into operating room real-time activities (5.44%), and Failure to automatically send patient reminders or updates before surgery (4.35%).

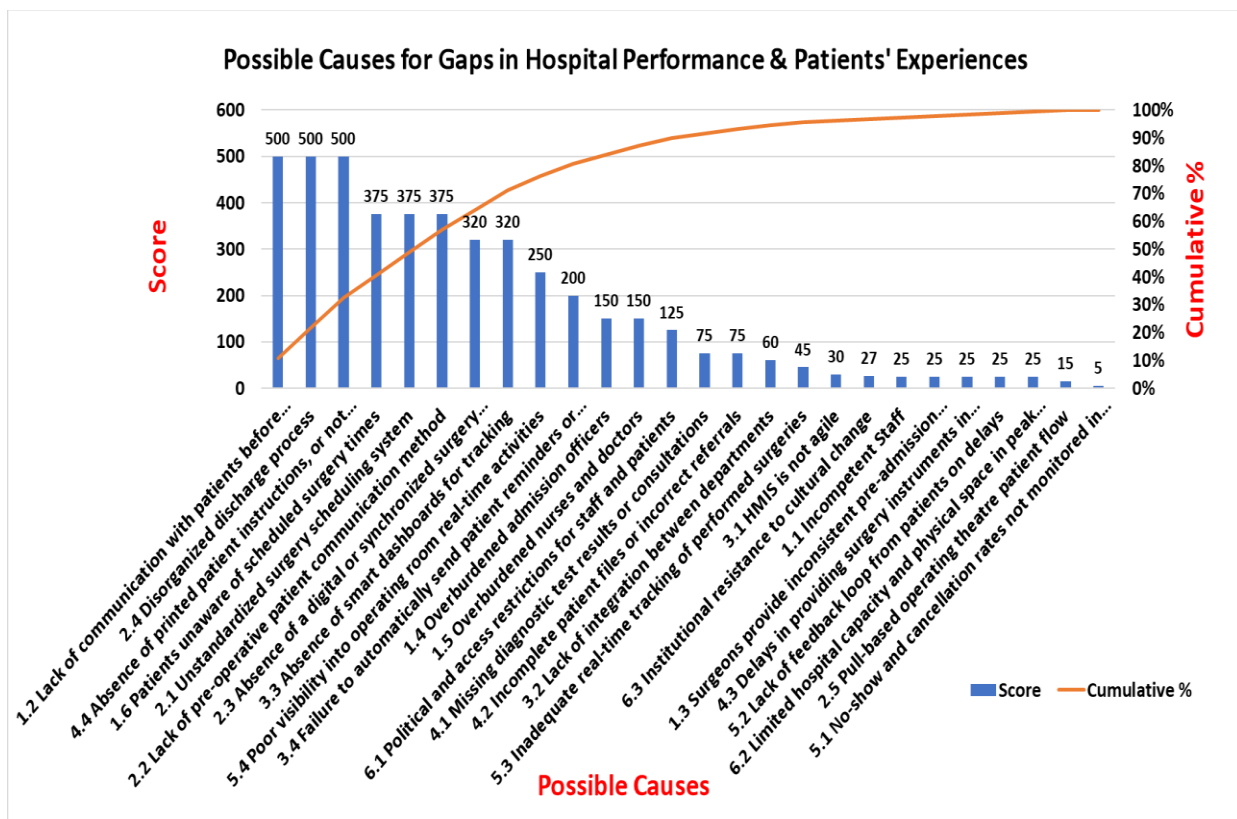


Figure 4.30: Pareto Diagram for FMEA & Possible Causes for Gaps in Hospital Performance & Patients' Experiences

Based on these results, a meeting with quality team, medical and nursing directors was held and findings were presented and discussed, meeting outcomes suggested that it is highly important to prepare a well-organized pre-admission instructions as well as discharge instruction, and to develop a smart digital platform for surgery scheduling, planning of

operating theater rooms, surgery tracking, and KPIs' dashboard for surgery performance at Saint Joseph Hospital.

Also, five main KPIs were set for the first two quarters after launching the improvement initiatives, which are:

1. An increase in day care surgeries of 20% from baseline (reflects OR Utilization),
2. A decrease of 25% of no-show surgeries,
3. A decrease of 50% of waiting time at registration process,
4. A decrease of 50% of admission to surgery performing time,
5. An increase of 10% of patients' satisfaction concerning discharge instructions.

4.5 Improve Phase

The Improve Phase of the DMAIC cycle involved the translation of identified root causes into practical, measurable interventions to address operational inefficiencies, patient dissatisfaction, and variation in day care surgical services at Saint Joseph Hospital.

At this stage, and as the project team and the quality department discussed the implementation of improvements strategies based on the Lean methodology, where waste is categorized into three types: Muda (waste), Mura (unevenness), and Muri (overburden). These concepts originated from the Toyota Production System and are fundamental to improving efficiency and reducing inefficiencies in processes (Dave, 2020).

1. Muda (Waste): Any activity that does not add value to the customer, such as defects, overproduction, or excess inventory. The eight types of Muda include transportation, inventory, motion, waiting, overproduction, overprocessing, defects, and underutilization of talent.
2. Mura (Unevenness): Variability or inconsistency in processes, leading to inefficiencies. For example, fluctuating workloads that cause bottlenecks or idle time.
3. Muri (Overburden): Excessive strain on workers or machines, leading to burnout, errors, and breakdowns.

Following the discussion, two major improvement initiatives were decided, and to be approved by hospital top administration and formulated for implementation, as follows:

4.5.1 Improvement Initiatives

Improvement Initiative I: Digital surgery scheduling and operating theater workflow coordination system development and implementation.

Improvement Initiative II: Standardized Pre-Admission and Discharge Instruction Sheets

These planned interventions were accordingly formulated to be context-specific and aligned with LSS methodologies of waste elimination, process standardization, and value creation for the patient, the staff, and Saint Joseph Hospital as well.

As hospital top administration granted approval for improvement initiative after discussion of the project scope and aims, 5S tools are adapted for achieving the target project of digital surgery scheduling and operating theater workflow coordination system based on the following 5S steps with aims to:

- A. **Sort (Seiri):** To re-fine and remove unnecessary steps in scheduling and admission, in order to ensure only essential tasks are performed to minimize delays.
- B. **Set in Order (Seiton):** To organize patient flow efficiently, ensuring each phase (admission, pre-operative assessment, surgery performing, post-surgery monitoring, and discharge teaching) follows a structured timeline.
- C. **Shine (Seiso):** To optimize time usage by reducing bottlenecks and variations, ensuring smooth transitions between surgical phases, and eliminating delays.
- D. **Standardize (Seiketsu):** To establish clear protocols and pathways for how long each step should take, implementing time checkpoints and streamlined workflows.
- E. **Sustain (Shitsuke):** To regularly review and improve time management practices through audits and staff training to maintain efficiency.

4.5.1.1 Improvement Initiative I: Digital surgery scheduling and operating theater workflow coordination system development and implementation

The surgery scheduling process is manual, fragmented, and reliant on verbal or written communications between surgeons and operating theater staff, and patients were often unaware of their exact surgery time, resulting in overcrowding in the day care unit, inefficient use of nursing resources, and a reactive “pull system” OR entry approach. This led to delays, increased stress on staff, and unnecessary waiting time for patients. After thorough discussion with admission office manager, operating theater manager (Team leader as per the project

charter), and the software development staff. Digitalization of surgery activities were agreed, and the following software modules were specified as follows:

1. Surgery scheduling and registration: For appointment officer operations.
2. Operating Theater Room Distribution: For operating theater operations.
3. Surgery Performing Activities (for surgeons, doctors, and nurses' operation) and including the four surgical safety phases:
 - A. Pre-operative Preparation Phase,
 - B. Sign-In Phase,
 - C. Time-Out Phase, and
 - D. Sign-Out Phase.

The delegated team followed the project development in step by step, and tested the newly created software modules, the output as follows:

1. Surgery Scheduling and Registration Module (Interface One):

The appointment officer will enter all patient data and the surgery information into HMIS at the digital surgery scheduling interface (Figure 4.31), after receiving the Day Surgery list from the Surgeon. The appointment officer will call the patient and an automatic notification will be sent to the patient detailing the surgery details and its appointment, with a link to pre-admission instructions, that were developed by group of nurses and doctors (Improvement Initiative II team), and uploaded to HMIS, for example “Cystoscopy under Local Anesthesia” – Arabic Version (Appendix H):

<https://docs.google.com/document/d/1wbZoCFe2Ts59jOHq7w9RTyaAr448Gcxk/edit?usp=sharing&ouid=110953585190547410449&rtpof=true&sd=true>

or English Version – (Appendix I):

<https://docs.google.com/document/d/1T1QuoPW5taMHnjP9IhgIZhDXIkxi4PGr/edit?usp=sharing&ouid=110953585190547410449&rtpof=true&sd=true>

Patient				Patient Contact Info.		Save
ID Number	Temporary	202011723759068	Card Number	2022	1141	Clear
Patient Name		Test				
Birthday	01/01/1980	Gender	Male	Country	Israel	
			City	Haifa	Permit	
Surgery Request						Requested
Specialists	AdminUser	in	Surgeries Names	Epidural Anesthesia		
Notes		Notes				Add
Location	Operating Theater					
Urgency	Regular					
Planned Surgeries						Proposed Date
Epidural Anesthesia						
Surgeries						Add
AdminUser						
Request Details						
Requested by				Requested on		
Close				Import File Template		Request

Figure 4.31: Screenshot of HMIS Digital Surgery Scheduling Interface

A notification message (Figure 4.32) will be sent automatically to the patient, with all related details like doctor's name, date of surgery, admission time, surgery name, and the related education instructions, in addition to the location of Saint Joseph Hospital.

SMS Text

Saint Joseph Hospital - Jerusalem

Scheduled Appointment Notification

Please Do NOT Reply this SMS!

Dear {Patient},

We are writing to inform you that we had scheduled an appointment for you at Saint Joseph Hospital in Jerusalem.

Date: {Date}

Time: {Time}

For Dr. {Doctor}

For Day Surgery: {Day Surgery}

If you have any questions or need additional information, please feel free to contact us at 02-5911-911.

Our phone lines are open Monday to Saturday, between 7:00 AM and 3:00 PM.

Saint Joseph Hospital Location:
<https://maps.app.goo.gl/qYQviAny7CxMFy26>

We Wish You Good Health

Close

Figure 4.32: Screenshot of HMIS Appointment Scheduling Notification Interface

Also, a notification reminder; as a message, (Figure 4.33) will be automatically sent to the patient's mobile, before 72 hours, before 24 hours, and 2 hours before the admission time.

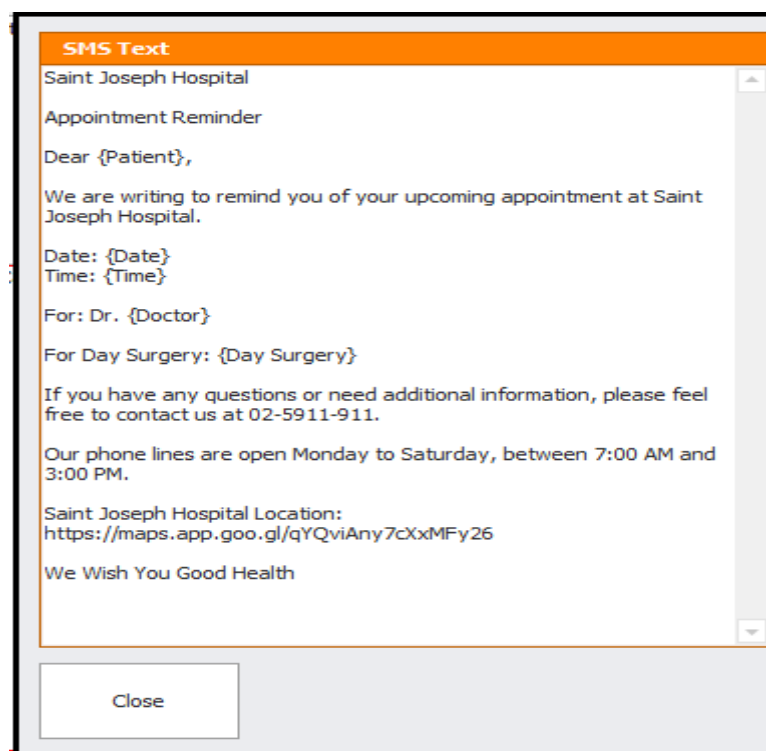


Figure 4.33: Screenshot of HMIS Appointment Reminder Interface

As previously mentioned, these interfaces are used by the appointment officer, who will fill the patient and surgery information, however, as previously noticed the data provided by the surgeons is insufficient, and lacks important information, a new standardized surgery planning sheet (Figure 4.34) was developed, and communicated to the two surgeons (who were interviewed by the researcher during structured interviews step), and explanation was provided about the importance and aim of this sheet, the sheet formulated.



Surgery Planning List

Surgeon Name: _____

Date: ____ / ____ / ____

#.	Patient Name	Patient ID	Gender	Date of Birth	Planned Surgery	Payment Method	Contact Number	Remarks
1.			☐ M ☐ F					
2.			☐ M ☐ F					
3.			☐ M ☐ F					
4.			☐ M ☐ F					
5.			☐ M ☐ F					
6.			☐ M ☐ F					
7.			☐ M ☐ F					
8.			☐ M ☐ F					
9.			☐ M ☐ F					
10.			☐ M ☐ F					
11.			☐ M ☐ F					
12.			☐ M ☐ F					
13.			☐ M ☐ F					
14.			☐ M ☐ F					
15.			☐ M ☐ F					

Figure 4.34: Screenshot of Surgery Planning List

2. Operating Theater Manager Surgery Scheduling and Registration Module (Interface Two):

This interface is for the use of the operating theater manager, who will track all scheduled surgeries (Figure 4.35).

Patients

5a

5b

Test Samer

Patients Details

ID Number

Temporary

2022011722379008

Card Number

2022

1141

Patient Name

Test

Samir

BirthDay

01/01/1980

45

Gender

Male

Marital Status

Married

Patient Serial

262515

Contact Information

No image data

Surgeries

01/10/2024

Planned Surgeries

Epidual Anesthesia

Planned Surgeons

AdminUser

Request Details

Requested by

AdminUser

Requested on

Notes

Dates

Actual Surgeries

Surgeries Types

Close

Issue

Figure 4.35: Screenshot of HMIS Scheduled Surgeries Interface

3. Operating Theater Rooms' Distribution Module

The operating theater manager schedules the operating theater rooms (Figure 4.36) according to the load of scheduled surgeries for the surgeons, also he/she will communicate with the surgeon discussing the scheduled surgeries workflow, as follows:

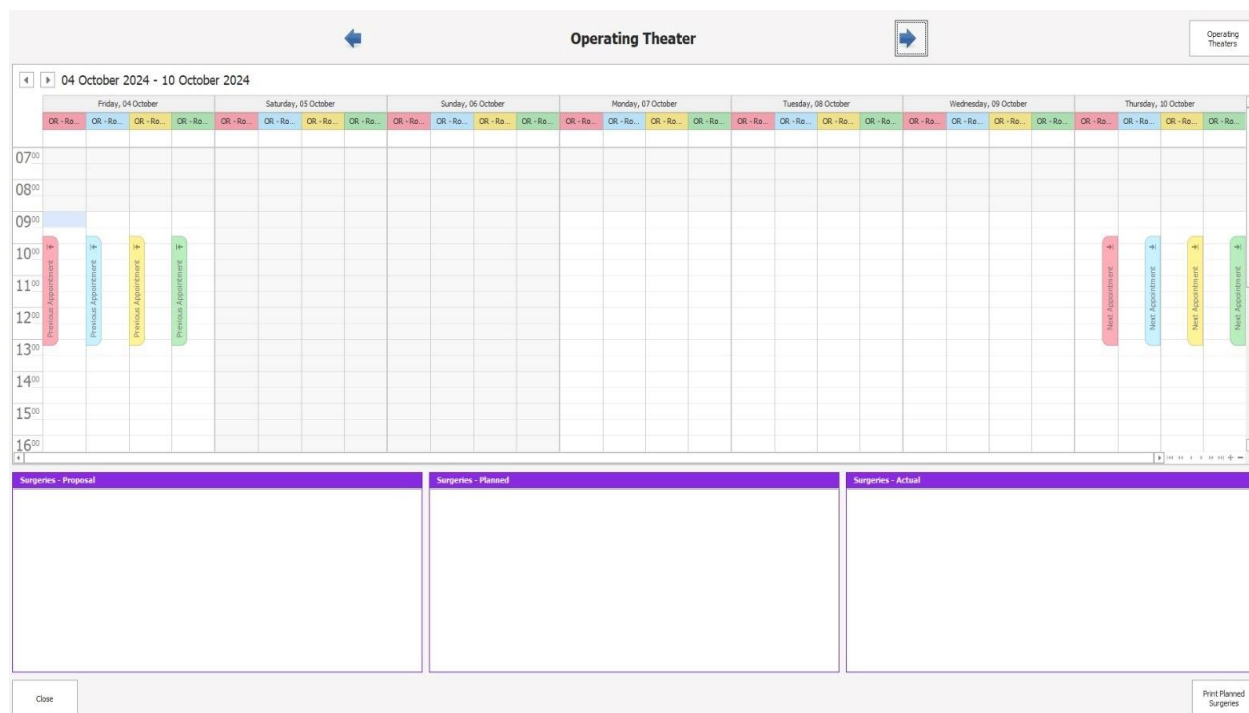


Figure 4.36: Screenshot of HMIS Operating Rooms' Management Interface

4. Surgery Performing Activities HMIS Module

The surgery performing activity passes through different stages including: Pre-operating preparation, and sending the patient to the operating theater, then, Sign-in stage (in which OR staff identifies the patient, his/her surgery, and other related issues), the process proceeds to Time-out phase (final verification before starting the surgery), and finally, the Sign-out stage (after surgery), these interfaces (Figure 4.37) are crucial for smart documentation of the surgery activities, and time benchmarking for efficient and agile operating theater, in addition to its benefit of full compliance to patient safety and high quality of care. These interfaces interchange all data between the circulate nurse, anesthesia doctor, surgeon, and recovery nurse, in addition the other supervising departments. The interface as follows:

The screenshot displays the HMIS Surgery Management Interface. It features a top section for Patient Details, a central section for Anesthesia Types, and a bottom section for Surgical Equipment. The Patient Details section includes fields for Identity, Card Number, Birthday, Full Name, Gender, Age, Surgeries, and Surgeons. The Anesthesia Types section has a table with columns for Added on and Anesthesia Types. The Surgical Equipment section includes buttons for Patient Position, Diathermy, Antiseptic Solutions, Tourniquet Used, Air Condition, Items Count, Catheters & Drains, Bair Hugger, PC Devices, Nerve Simulator, and Close. The interface also includes a sidebar with buttons for Call Next Patient, Pre-Op Dep, Pre-Op OTR, Sign In, Time Out, Intraoperative, Sign Out, Assessment, Preinduction, and Intraoperative.

Patient Details									
Identity	Temporary	20220117223759068	Card Number	2022	1141	Birthday	01/01/1980	Medical History	Patient File
Full Name	Test Samer			Gender	Male	Age	45	5	0
Surgeries	Bronchoscopy - Flexible, Tracheostomy			Surgeons	Gi	b			

Anesthesia Types									
Added on	Anesthesia Types								

Surgical Equipment									
Patient Position	Diathermy	Antiseptic Solutions	Tourniquet Used	Air Condition	Items Count	Catheters & Drains	Bair Hugger	PC Devices	Nerve Simulator

Applied by: Admir un

Figure 4.37: Screenshot of HMIS Surgery Management Interface

The development and implementation of the newly developed modules followed agile principles, with pilot testing and feedback loops. Key steps included:

1. **Requirements Gathering:** Conducted with surgeons, nurses, OR manager, and administrators.
2. **Design Prototyping:** Frames and interfaces were reviewed in feedback sessions with admission office manager and operating theater manager.
3. **Pilot Testing:** A one-day pilot in late September 2024 involving five elective day surgeries.
4. **Full Deployment:** Rolled out in October 2024 with ongoing support from software developers, IT staff and quality teams.
5. **Staff Training:** Workshops and hands-on sessions under full supervision ensured adoption across appointment officers, admission officers, nurses, doctors, and surgeons.

4.5.1.2 **Improvement Initiative II:** Standardized Pre-Admission and Discharge Instruction Sheets

Interviews and observational data revealed significant variability in the information patients received before and after surgery. This inconsistency contributed to:

- A. Poor patient preparation (e.g., missing labs, consultations, referral papers, or patient is not fasting).
- B. Increased rates of surgery delays or cancellations.
- C. Post-discharge confusion, because of non-standardized discharge instructions.
- D. Patient dissatisfaction, due to lack of clarity of discharge instructions.

Two structured documents were developed for the top five Day Care Surgeries, which are:

- A. **Pre-Admission Instructions Sheet:** Provided to patients at the time of scheduling and delivered via email or WhatsApp by the appointment officer (Appendix H and Appendix I).
- B. **Discharge Instructions Sheet:** Printed and discussed by the discharging nurse, containing personalized details alongside general recovery guidelines (Appendix J and Appendix K).

Each sheet was designed in Arabic and English, content included:

- A. Pre-operative fasting and medication guidance.
- B. Arrival timing and what to bring on surgery day.
- C. Post-operative care and follow-up, activity restrictions, medication instructions.
- D. Other special notes.

Teamwork and administration's commitment and support were the cornerstone for the success of the two improvement initiatives at Saint Joseph Hospital, following are the hospital performance and patient satisfaction data after the implementation process.

4.5.2 **Post-LSS Implementation Data Results & Analysis**

This section presents the results and analysis of data collected following the implementation of LSS improvement initiatives in the day care surgical services. Post-LSS implementation findings are examined across pre-LSS findings to assess changes in workflow efficiency, process variation, and patient satisfaction. The analysis is based on HMIS data, patient surveys, and operational metrics to provide an evidence-based understanding of how the redesigned processes performed during the post-LSS phase.

4.5.2.1 Hospital Management Information System

HMIS data (Table 4.11) represents pre & post-LSS implementation data, it shows enhanced hospital metrics and performance after September 2024. During post-LSS phase, total surgeries increase of 99 surgeries, while Day Care surgeries increased 250 surgeries (8%) for the same period, in other words, Day Care surgeries compensated the decline of non-day care surgeries (if Day Care surgery subtracted). No-show rate declined of 5.1% (decline of 83 Day Care Surgery). Furthermore, number of cancelled Day Care surgeries declined of about 35 cases (improved 1.8%). The implementation of LSS have a tremendous impact on waiting time, either on activity of registration and admission to nursing assessment (average decline of 28 minutes), or activity of registration and admission to Operating Theater and surgery performing (Average decline of 69 minutes). Data is very optimistic and encouraging for staff, administrators, and project team for continuing improvement and sustain the gain.

Table 4.11: HMIS Data (pre & post-LSS)

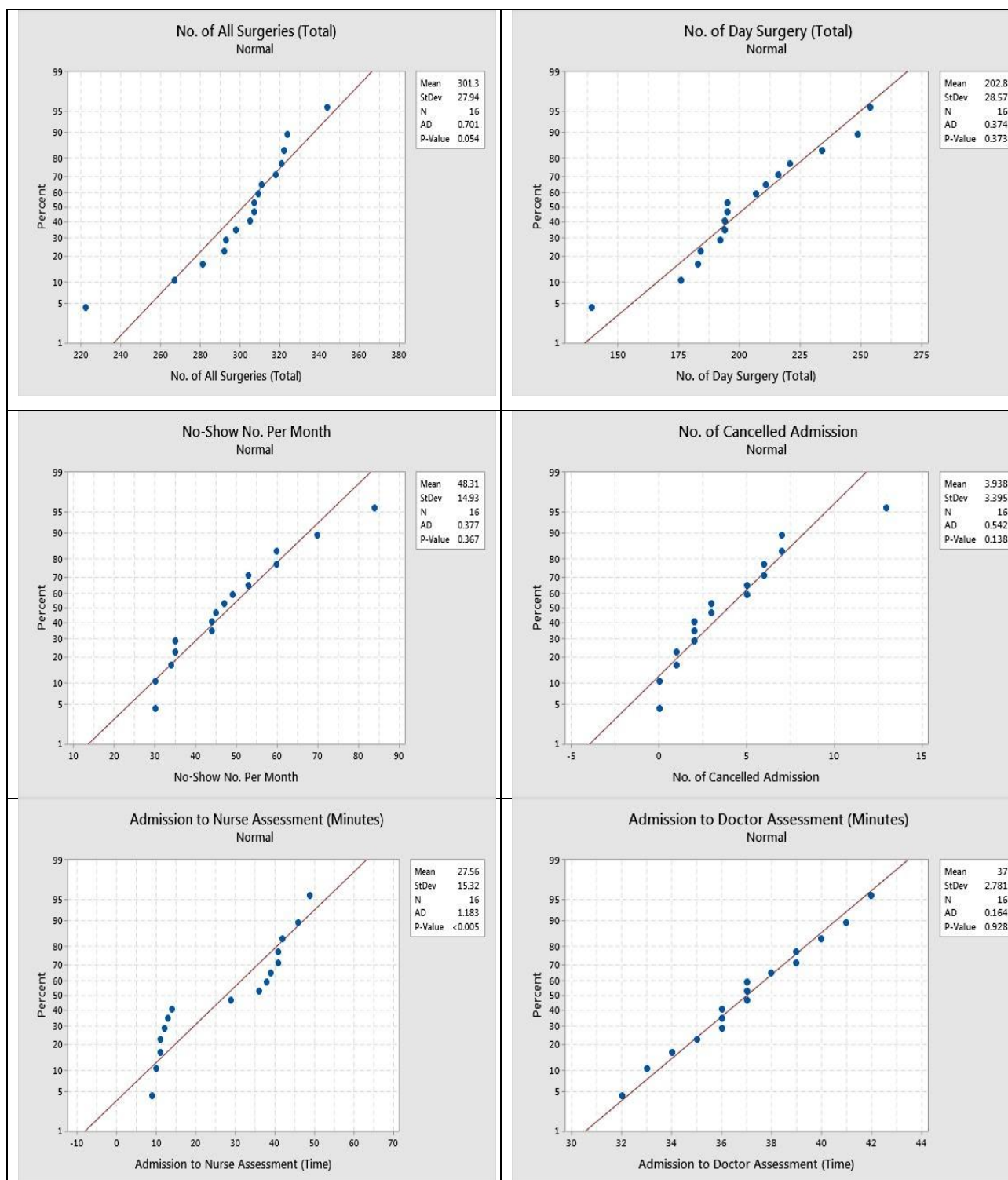
Month	#. of All Surgeries (Total)	#. of Day Surgery (Total)	%. of Day Surgery (Total)	No-Show # Per Month	No-Show % Per Month	# of Cancelled Admission	% of Cancelled Admission	Admission to Nurse Assessment (Minutes)	Admission to Doctor Assessment (Minutes)	Admission to OR* (Minutes)
2024-01	324	216	66.7%	53	19.6%	2	0.7%	42	38	197
2024-02	305	194	63.6%	84	28.9%	13	4.5%	39	37	145
2024-03	311	192	61.7%	60	23.3%	6	2.3%	41	39	207
2024-04	222	139	62.6%	30	17.0%	7	4.0%	36	42	138
2024-05	293	184	62.8%	60	23.9%	7	2.8%	38	37	195
2024-06	281	195	69.4%	44	18.0%	5	2.0%	46	34	240
2024-07	318	194	61.0%	44	18.0%	6	2.5%	41	41	183
2024-08	307	183	59.6%	53	22.2%	3	1.3%	49	36	156
2024-09	321	195	60.7%	47	19.3%	2	0.8%	29	35	171
2024-10	309	221	71.5%	70	23.8%	3	1.0%	14	33	130
2024-11	298	234	78.5%	49	17.3%	0	0.0%	11	37	107
2024-12	267	176	65.9%	35	16.2%	5	2.3%	10	39	126
2025-01	344	254	73.8%	45	15.0%	1	0.3%	9	36	103
2025-02	322	249	77.3%	34	12.0%	1	0.4%	12	36	91
2025-03	292	211	72.3%	30	12.3%	2	0.8%	11	40	98
2025-04	307	207	67.4%	35	14.5%	0	0.0%	13	32	86
Total (PRE)	2,361	1,497	Avg. 63.4%	428	Avg. 21.4%	49	Avg. 2.5%	Avg. 42	Avg. 38	Avg. 182.6
Total (POST)	2,460	1,747	Avg. 71%	345	Avg. 16.3%	14	Avg. 0.7%	Avg. 14	Avg. 36	Avg. 114
Difference (Post – Pre)	99	250	8%	-83	-5.1%	-35	-1.8%	-28	-2	-69
Impact	Improved	Improved	Improved	Improved	Improved	Improved	Improved	Improved	Improved	Improved

*OR: Operating Room

Furthermore, to better understand the variations and to check the normality of data, Anderson-Darling (AD) Test and p-Value were used. The AD Test is a statistical test used to assess whether a given sample of data comes from a specific probability distribution, most commonly the normal distribution. It enhances the sensitivity of the Kolmogorov-Smirnov test by giving more weight to the tails of the distribution, making it particularly effective for detecting deviations in the extremes (Berlinger et al., 2021). The focus is on the test statistic and its corresponding p-value. where:

- A smaller AD statistic suggests that the data closely follows the normal distribution.
- A larger AD statistic indicates a greater deviation from normality.
- The p-value result, as follows:
 - If $p > 0.05$, fail to reject null hypothesis and data can be considered as normally distributed
 - If $p \leq 0.05$, Reject null hypothesis and data is not normally distributed

Normality of Data Distribution (AD, and p-Value) for HMIS data (Figure 4.38) showed that the plotted points generally follow the red reference line, which indicates alignment with a normal distribution and no statistically significant deviation from normality, except admission to nursing assessment with a p-Value < 0.005 (less than 0.05), supporting the assumption of normal distribution of all variables except admission to nursing assessment, where deviations appear lower or upper to the red line as a trend of consecutive plotted points.



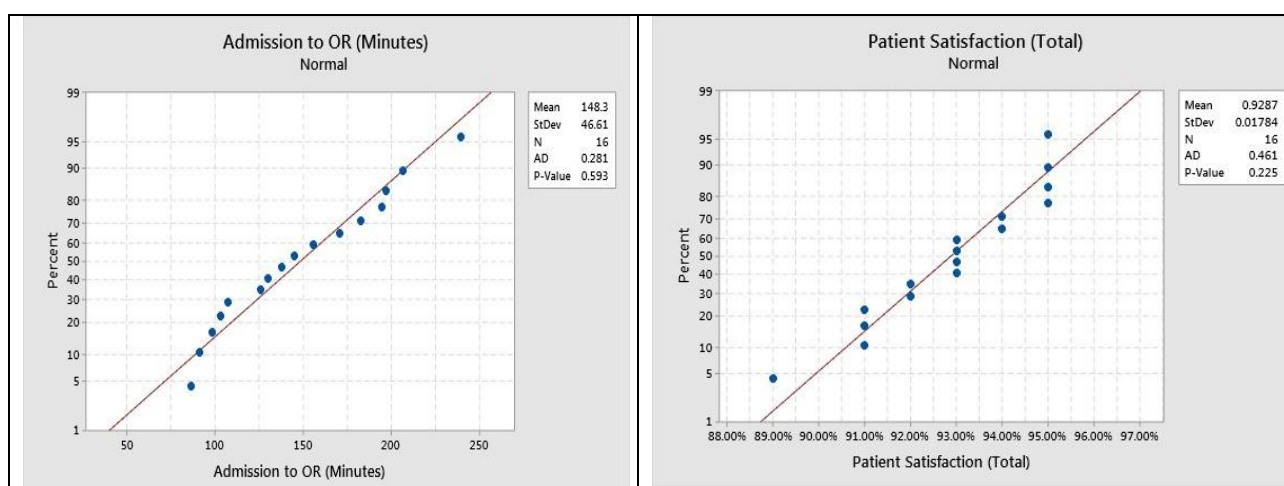


Figure 4.38: HMIS Data – Normality of Data Distribution (pre-LSS & post-LSS)

Figure (4.39) shows that From January 2024 to April 2025, the hospital maintained a constant volume of surgeries, with day care surgeries consistently making up a large proportion of total surgeries (averaging around 65–70%). A significant decline occurred in April 2024 (holidays) followed by a rise in early 2025 as the new year. The consistency in day care surgeries supports their importance in hospital surgical services delivery.

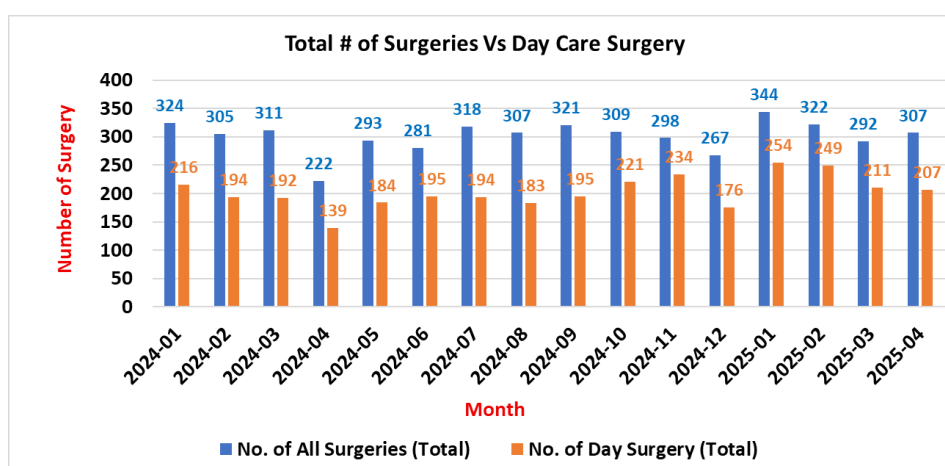


Figure 4.39: HMIS Data – All Surgery Vs Day Care Surgery (#s) (pre-LSS & post-LSS)

Total number of surgeries I-MR chart (Figure 4.40) shows that the surgical process is statistically within control since it has all the data within the set control limits. The mean of number of surgeries is 301, with its lower and upper control being 217.5 and 385.1 respectively. This opposite statistical fact implies that the process was stable and predictable. As it can be seen, there are some minor fluctuations such as the decrease of the trend around

the observation 4 and the increase around the observations 13 however these are within acceptable ranges and they do not represent the special cause variance. The Moving Range chart also augments stability on the process as most fluctuations between one month and the other are less than average range of 31.5. All in all, this chart indicates that implementation of LSS has assisted in the achievement of consistent surgical workflow with a low level of variability.

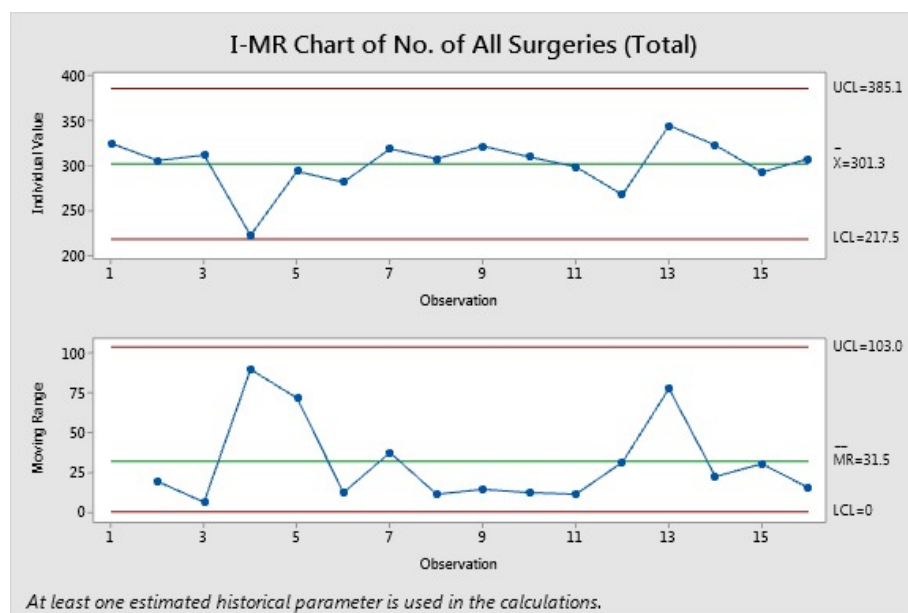


Figure 4.40: HMIS Data – XBar & I-MR Chart of Number of All Surgeries

Figure (4.41) shows that Day Care surgery percentages raised from 63.4% to 70.9% for the last 8 months, which represents 7.5% increase during the post-LSS implementation.

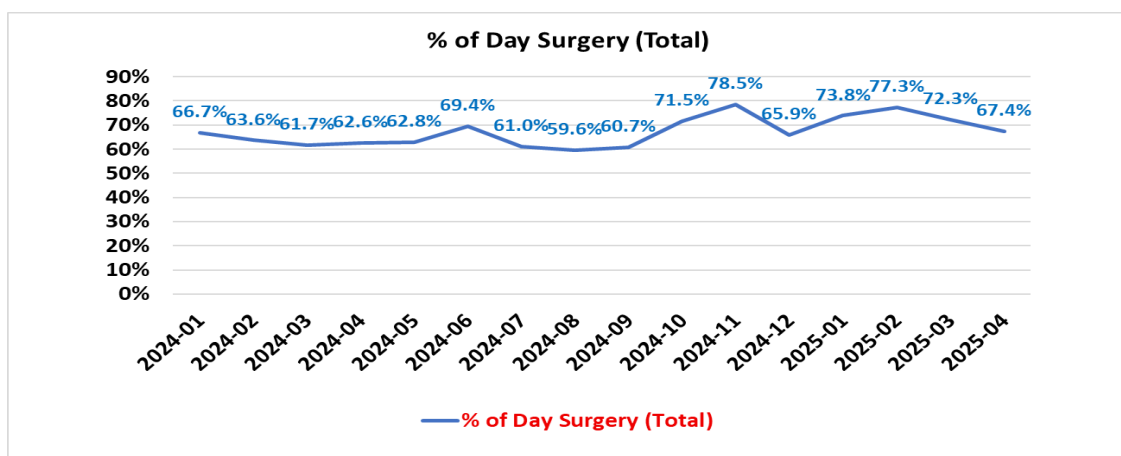


Figure 4.41: HMIS Data – Day Care Surgery (%) Vs Total Surgery

The I-MR Control Chart for number of day surgeries (Figure 4.42) as total shows that the method is indeed in statistical control as all data points and the Moving Ranges fit into their individual control limits. Mean of day surgeries is 202.8, and it falls between UCL of 288.5 and LCL of 117.1, implying that the process is stable. However, some minimal and moderate variations in general (especially an apparent decline at Observation 4 and increase near Observation 13, the variations cannot be considered as significant and, therefore, can be regarded as common cause (In our case, Holy Ramadan and Feast Days). This stability is assisted by the Moving Range chart whose majority of the difference in adjacent observations lies below the average mark of 32.2. This stability in operative activity is evidence of a properly controlled and predictable process of day surgeries, probably boosted due to LSS approach.

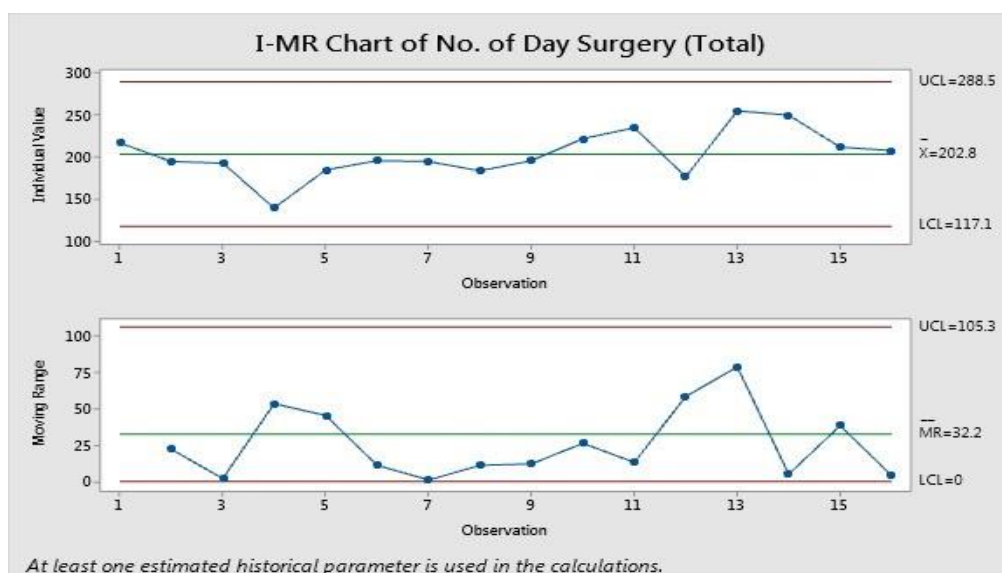


Figure 4.42: HMIS Data – XBar & I-MR Chart of Number of Day Care Surgeries

Data shown in Figures (4.43 & 4.44) shows a decrease of 83 cases (5.1%) of no-show rates for the last eight months (from avg. 21.4% to avg. 16.3%), which represents the positive effect of implementation of LSS on Day Care Services.

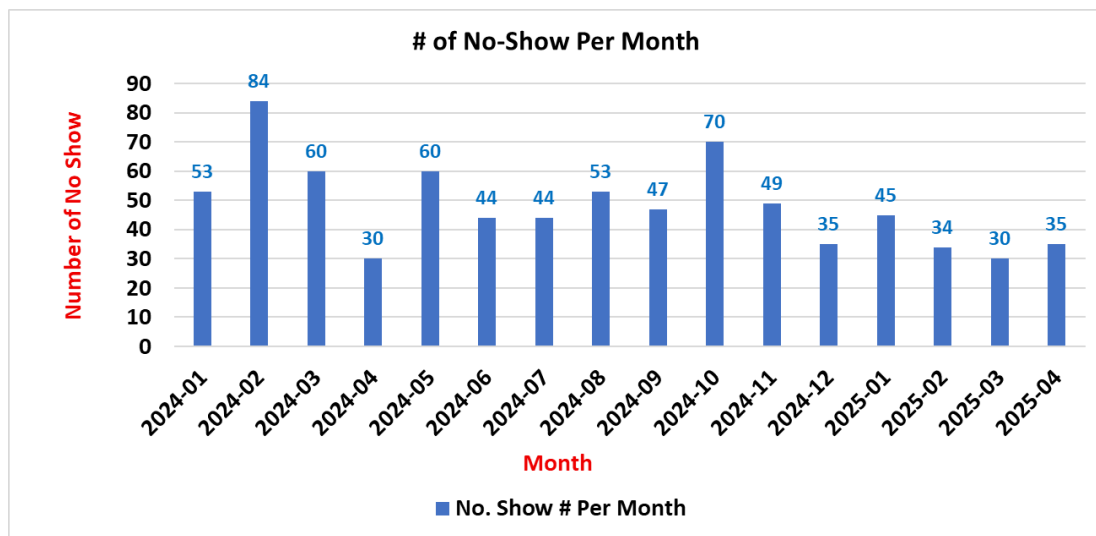


Figure 4.43: HMIS Data – Histogram of No-Show Number of Day Care Surgeries

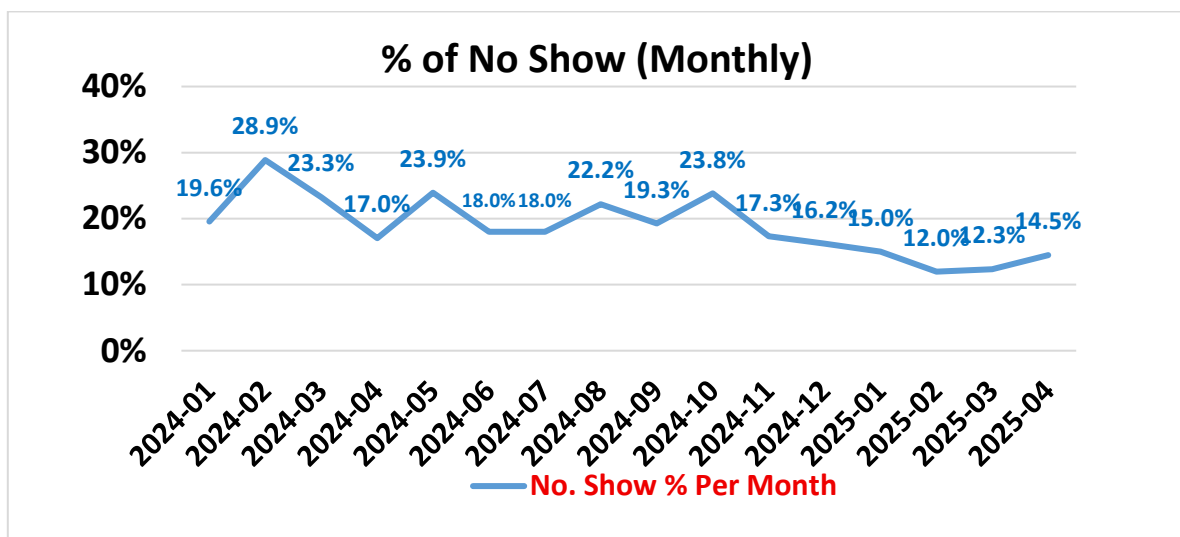


Figure 4.44: HMIS Data – No-Show Percentage of Day Care Surgeries

Based on the I-MR chart of the monthly count of no-show patients (Figure 4.45), the process is statistically under control since all the points are within the confidence boundaries. The mean of the no-show is 48.3, and the UCL is equal to 93.1, and the LCL is 3.5, and the variation is moderate. Although the observed volume of no-shows was higher at the points of initial observations (especially at point 3), a decline trend is observed in the later observations, which may indicate that the adherence level improved among patients. The Moving Range chart indicates that the month to month variability has been decreasing and mostly is below the mean Moving Range and this is prevalent in the last half of the

observations (post-LSS). The findings also indicate that interventions that have the potential to be associated with LSS strategies might have reduced the variance in no-show and held them to the same down sloping over the time.

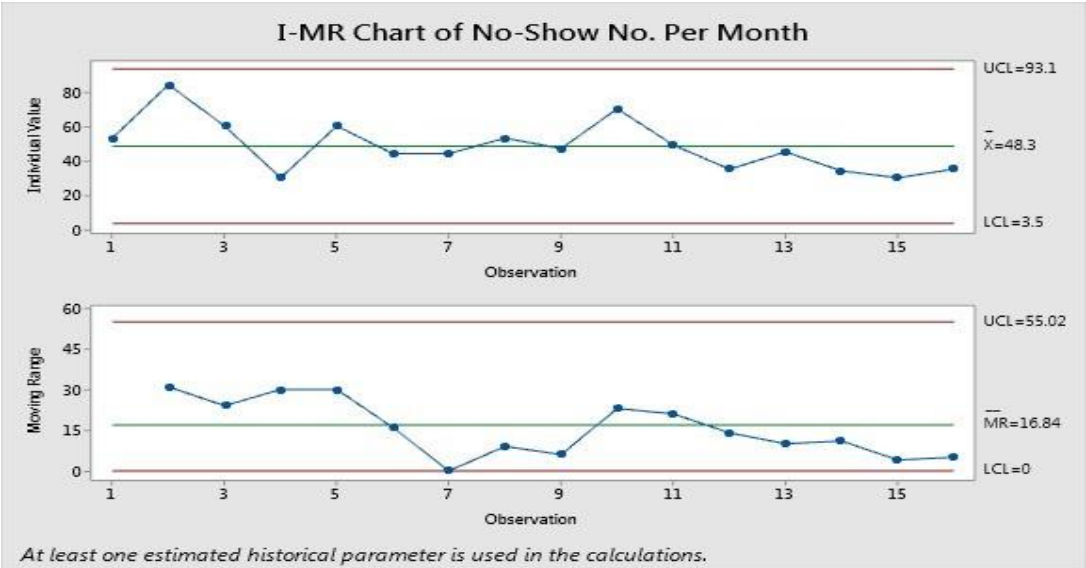


Figure 4.45: HMIS Data – XBar & I-MR Chart of No-Show Number of Day Care Surgeries

Figures (4.46 & 4.47) show change in cancelled admissions/surgeries, it shows a decrease of about 1.8% from pre-LSS stage (decline of 35 cases in eight months), Total of 14 cases post-LSS intervention compared to a total of 49 cases at pre-LSS intervention (Decline 35 cases).

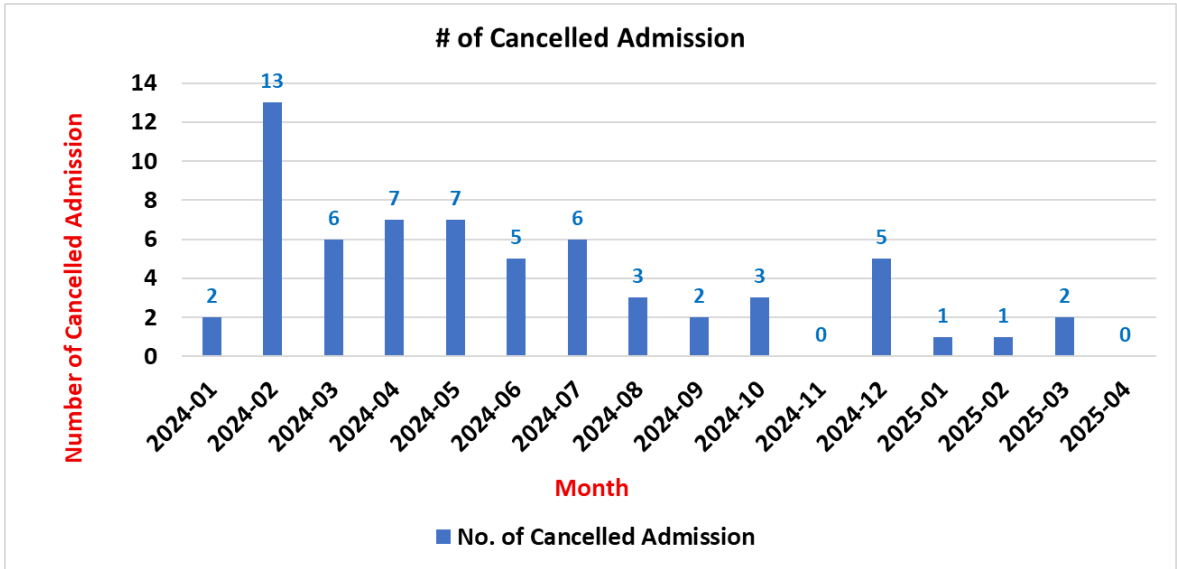


Figure 4.46: HMIS Data – Day Care Surgery Cancelled Admission (#s)

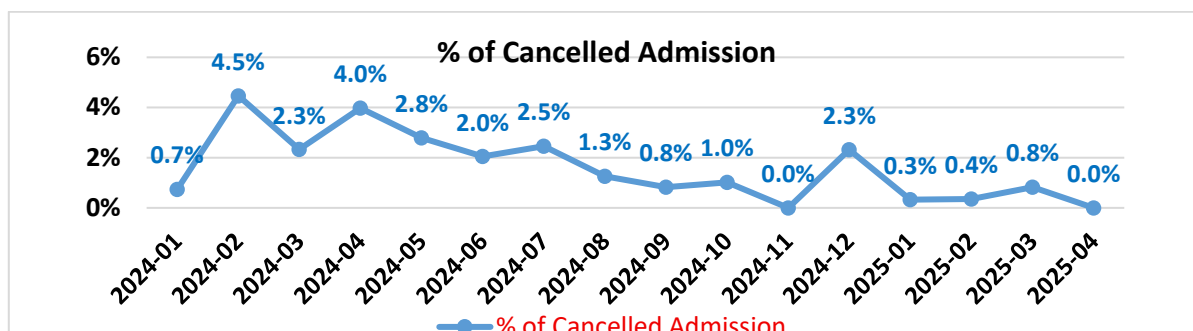


Figure 4.47: HMIS Data – Day Care Surgery Cancelled Admission (%)

The I-MR chart of the number of cancelled admissions per month (Figure 4.48) implies that the process is statistically controlled, which all points fall within control limits (UCL = 14.12, LCL = 0). The monthly cancellations have an average of 3.94 and cancellation decreases over time especially after observing a peak during the initial observation. The graph indicates possible decrease in the variability, as it can be observed in the Moving Range graph, where the average of Moving Range is 3.83, with a majority of those fluctuations under 3.83, particularly in the last set of observations (last three months). This reduction and stabilization of cancellations means that the process of admission has also improved and most probably due to influence of designed quality improvement program including LSS. The lack of special cause variation as well as the trending combination point toward the increased dependability in both admission scheduling and execution.

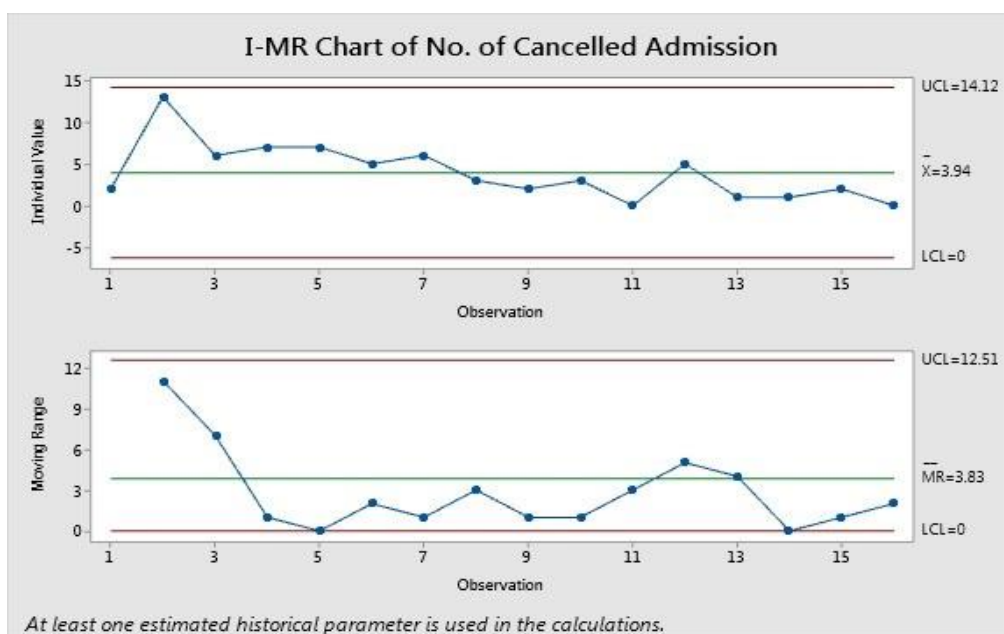


Figure 4.48: HMIS Data – XBar & I-MR Chart of Cancelled Admission of Day Care Surgeries

Data shown in Figure (4.49) shows a great effect of LSS implementation on waiting time of admission to day care department and nursing assessment, on average a decline of average of 28 minutes (post-LSS); decline from an average of 42 to average an average of 14 minutes, in which it is considered satisfactory for regular practices in nursing assessment processes.

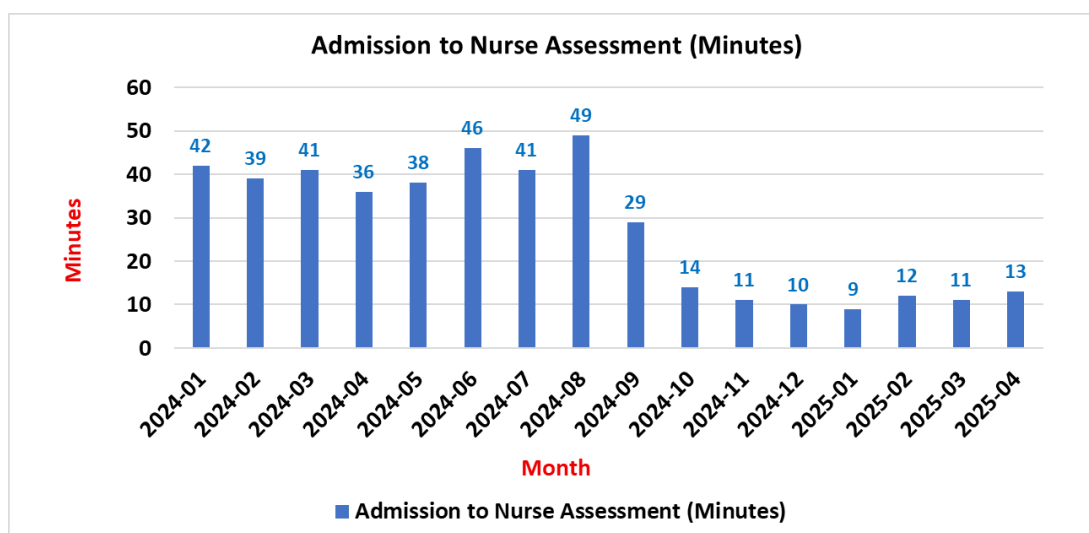


Figure 4.49: HMIS Data – Admission to Nurse Assessment (Minutes)

The I-MR chart of Admission to Nursing Assessment (Figure 4.50) shows a statistically equivalent process with very positive progress. It is 27.6 on an average, and it is all within control limits ($UCL = 73.5$, $LCL = 0$) publicizing the absence of a special cause variation. Remarkably, the evaluation periods in Observations 1-9 have a mean within the range of 35-50 minutes. Nonetheless, at an Observation 10, there exists an observable steady decline, with the times settling on about 20 minutes, indicating a change of process. This trend is backed by the Moving Range chart as after Observation 10, variation decreases and values are far below the average MR of 17.28. The trend is also a strong indication that an effective intervention of LSS took place around Observation 9 and that more consistent and faster nurse assessments. The trend is a good indication of the operation efficiency and the responsiveness of patient care.

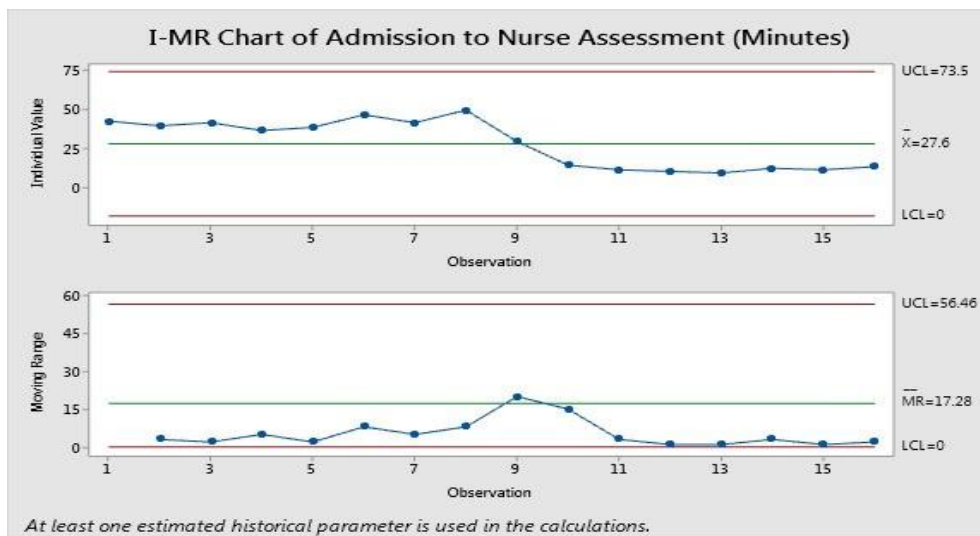


Figure 4.50: HMIS Data – XBar & I-MR Chart of Admission to Nurse Assessment Time

Data shown in Figure (4.51) shows time from admission to doctor's assessment, minor change can be observed; a decline of an average of 2 minutes, and this is because this metric is in a good condition since pre-LSS, and seems LSS interventions resulted in fine improvements.

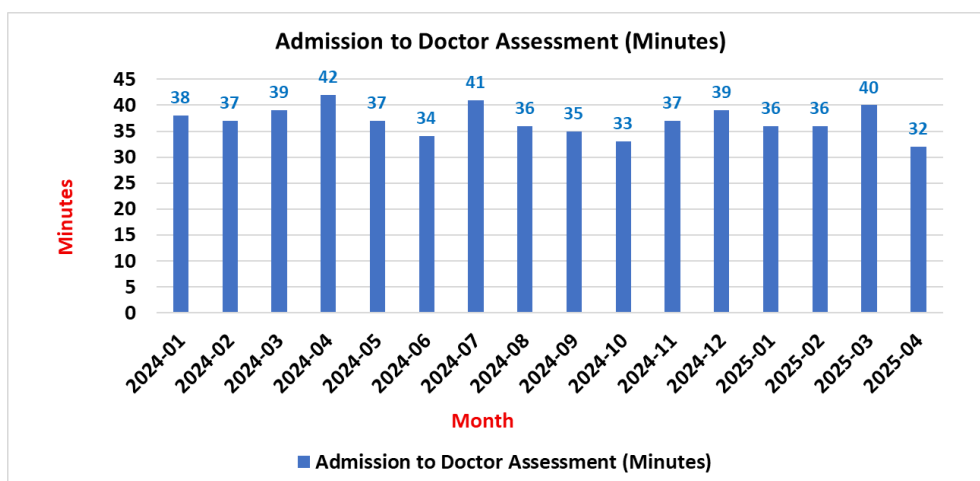


Figure 4.51: HMIS Data – Histogram of Admission to Doctor Assessment Time

The admission to doctor assessment Moving Range chart (Figure 4.52) indicates a stable process in terms of the statistical tests, and all the points within the monitoring range of the process (UCL = 45.34 minutes, LCL = 28.66 minutes). The average time taken to start assessment by doctor is 37 minutes, and the observations are quite close to this average indicating uniformity of assessment process. The Moving Range chart average is 3.14, which proves that there is low variation among consecutive readings, the final observation has an

excellent decrease in variation (assessment within 32 minutes of admission), there is no sign of the special cause variation in the process on aggregate, and the measured performance in timeliness of doctor assessment is predictable and controlled. These results prove the benefits of standardization of processes and optimization of workflow.

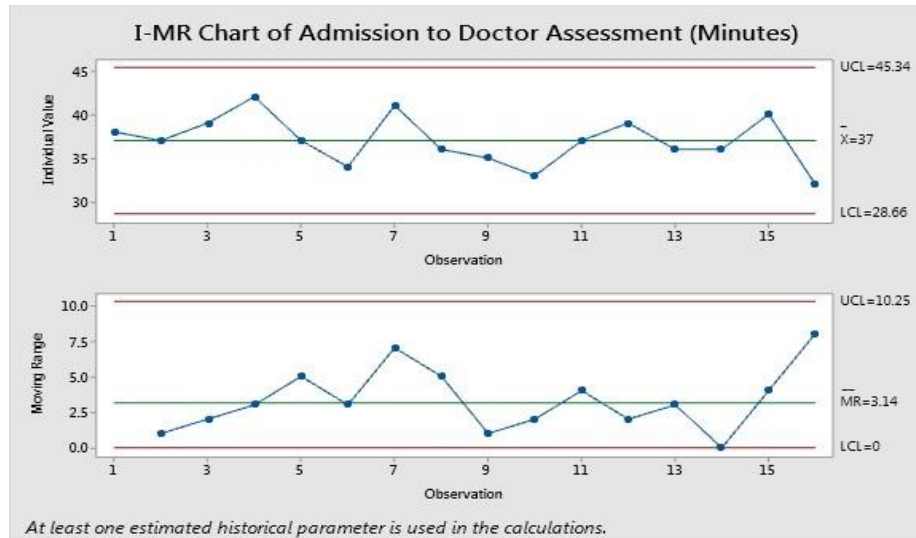


Figure 4.52: HMIS Data – XBar & I-MR Chart of Admission to Doctor Assessment Time

On the top of metrics, admission to operating theater and surgery performing (Figure 4.53), this KPI had been improved strongly, a decline in average of 69 minutes; post-LSS average 114 minutes, compared to 183 minutes at pre-LSS stages, variations over months decreased during post-LSS; last three months 91, 98, 86 minutes respectively, and this may be as a result of process standardization and optimization.

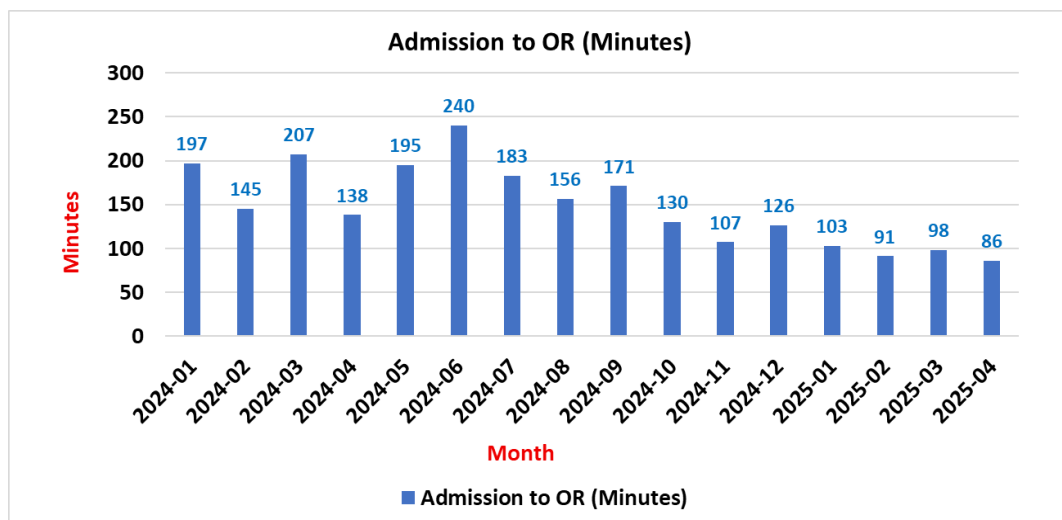


Figure 4.53: HMIS Data – Histogram of Admission to OR Time

The admission to operating room (OR) time moving range chart (Figure 4.54) shows a statistically controlled and better process. The mean time is 148.3 minute and the control limits are: UCL = 288.1, LCL = 8.5, all the data points are within these limits. It is noticeable that after the 6th or 7th observation, particular indicators of a trend going down appear as the time to OR was continuously declining during the following observations, which implies a positive outcome of the process optimization. This observation is corroborated by the Moving Range MR chart, which indicates a decreased variability during the course of time where initially the fluctuations are large (MR 0 = 52.6), but later they become tight in the second half of the period. Such a negative trend and the decrease in range indicate the increased efficiency of the processes and its stability, and it proves the benefits of implementation of LSS focusing on scheduling surgeries before admission for the surgery, and the reduction of preoperative delays and bottlenecks.

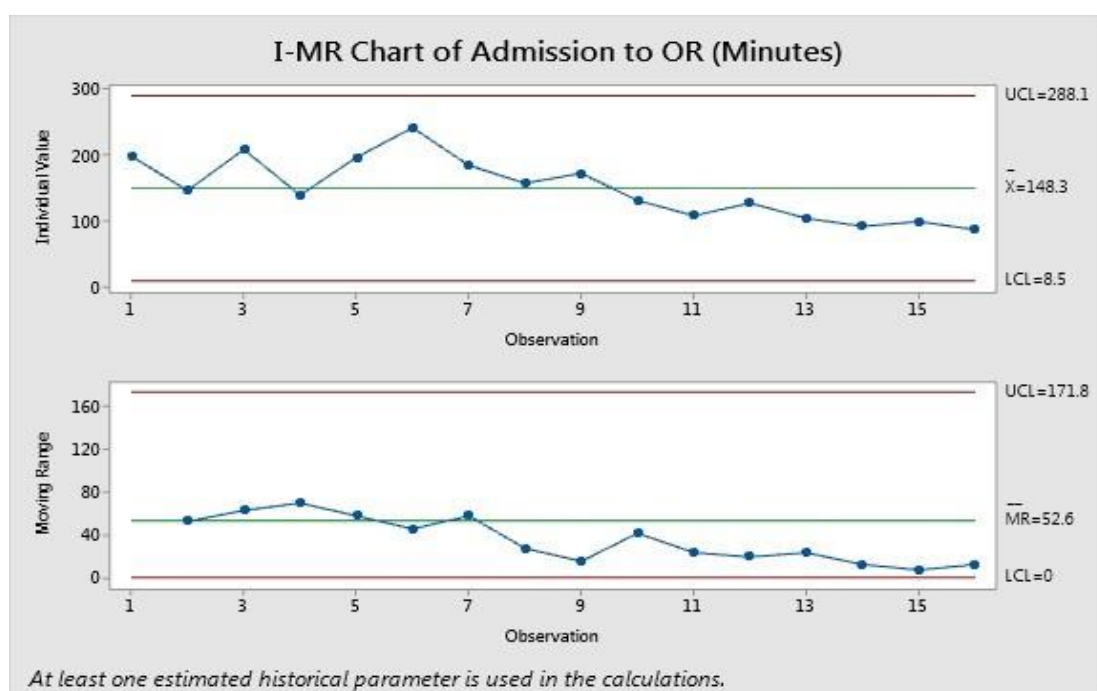


Figure 4.54: HMIS Data – XBar & I-MR Chart of Admission to OR Time

Patient Satisfaction figure (Figure 4.55) shows an increase on average of 2% during post-LSS intervention; avg. 94.1% compared to 91.6% at pre-LSS, this reflects how operations' efficiency affected patients' experiences.

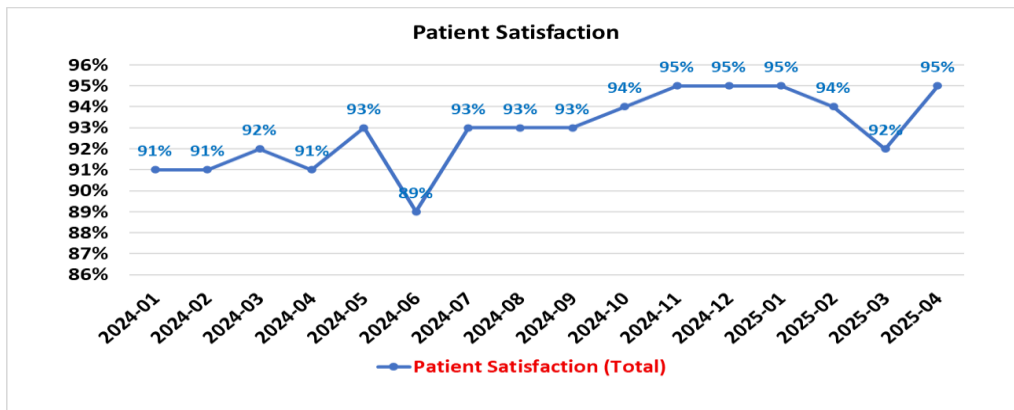


Figure 4.55: Patient Satisfaction Surveys – Patient Satisfaction Rate

The I-MR chart of total patient satisfaction (Figure 4.56) indicates that the process is under strong control with all the values falling within the limits of control (UCL = 100% and LCL = 39.35%) and with the mean being upwards of 92.87%. According to the chart, there are no special causes of variation and there are slight fluctuations that are constant which is subject to common cause variation only. Moving Range MR chart also backs up this to be steady: comparisons amongst subsequent observations are in the majority of cases very insignificant and far beneath the average MR of 20.12% and all values are well satisfying their control limits. The findings indicate that the patient satisfaction process is not only statistically stable as the curve remains flat but also of high evidence of the benefits of standardization of care practices, better communication and quality improvement activities that aimed to improving patient experience and sustainability in high quality in providing day care services.

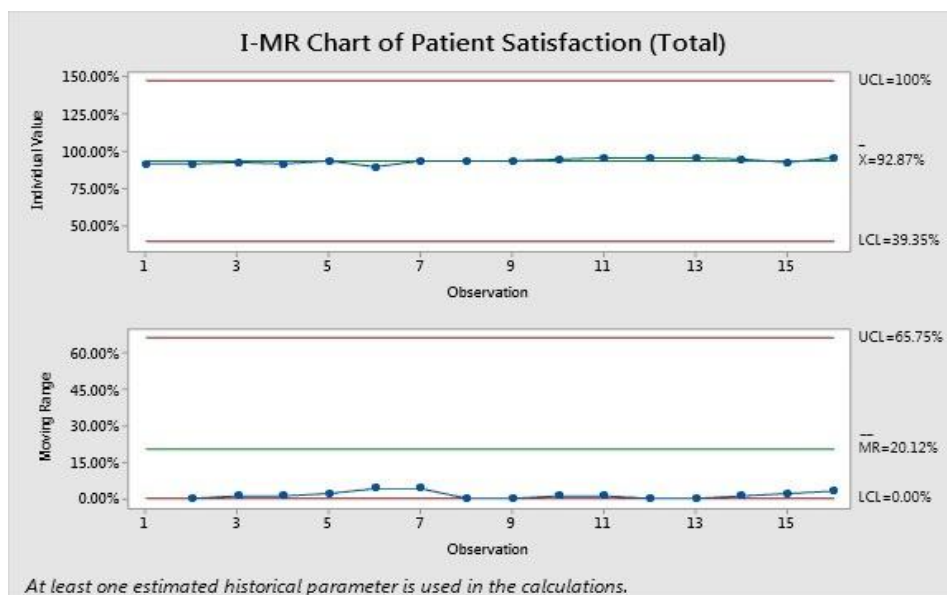


Figure 4.56: Patient Satisfaction Surveys – XBar & I-MR Chart of Patient Satisfaction

In conclusion, numbers and percentages shows a positive effect of the implementation of LSS on day care services at Saint Joseph Hospital during the period of October 2024 till April 2025), except for the time of admission to doctor assessment, since it was short during the pre-LSS phase and minor changes occurred, post-LSS interventions had positively affected hospital performance as well as patient satisfaction and experiences.

4.5.2.2 Updated VSM (with improvement)

Based on previous improvements, and in order to grasp staff feedback and patients' experience, another Gemba Walks were conducted, and a newly updated VSM is updated, showing the improvements and its effect on cycle time, lead time and down time (Figure 4.57).

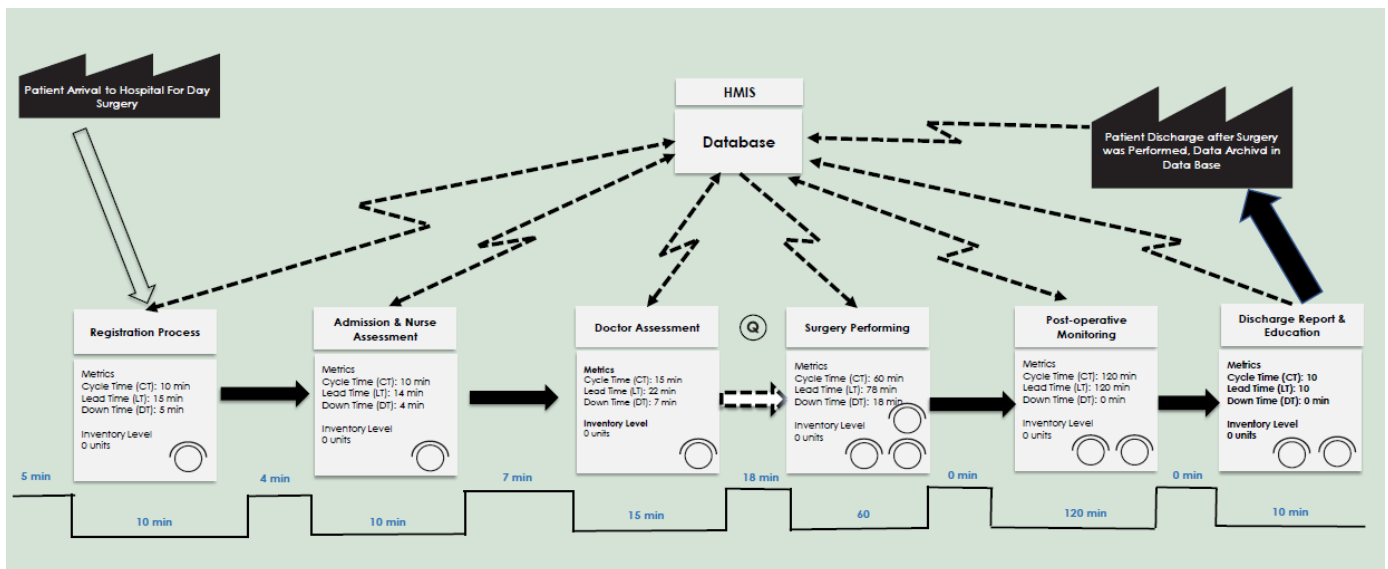


Figure 4.57: Updated VSM in Day Care Surgical Services

Table (4.12) summarizes the processes, the cycle time, lead time and down time, the total process lead time shortened from 390 minutes to 259 minutes (decline of 131 minute), the total actual cycle time remained at 225 minutes, with a decline at total down time from 165 minutes to 34 minutes at the updated VSM after the application of LSS methodology.

Table 4.12: Updated VSM Data in Day Care Surgical Services

Activity	Cycle Time (CT)	Lead Time (LT)	Down Time (DT)
Registration & Admission Process	10 min	15 min	5 min
Admission & Nurse Assessment	10 min	14 min	4 min
Doctor Assessment	15 min	22 min	7 min
Surgery Performing	60 min	78 min	18 min
Post-operative Monitoring	120 min	120 min	0 min
Discharge Report & Education	10 min	10 min	0 min
TOTAL	225 min	259 min	34 min

After the application of LSS, SIPOC is updated, with adding the new activities to the process which includes: Preoperative Instructions & Printed Document and Postoperative Care Instructions & Printed Document at INPUTS, and Patient Education Materials and Postoperative Care Instructions & Printed Document at OUTPUTS.

The SIPOC (Figure 4.13) is updated based on new workflow and activities, outlining the key elements of day care surgery process, helping hospital teams to ensure and sustain quality and efficiency at all steps and activities. Added the Preoperative Instructions & Printed Document, and the Postoperative Care Instructions & Printed Document.

Table 4.13: Updated SIPOC Diagram for Day Care Surgical Patient Flow at Saint Joseph Hospital

SIPOC Element	Details
Suppliers	- Medical Centers - Private Clinics - Admission Officers - General Doctors - Nurses - Surgeons - Auxiliary Day Care Department staff, like porters
Inputs	- Patient Papers and Registration Forms - Medical History and Assessment Reports - Surgical Equipment and Supplies - Preoperative Instructions & Printed Document
Process	1. Patient submits papers and registers at admission office. 2. Patient is assessed by the nurse and surgical doctor. 3. Patient is transferred to the Operating Theater. 4. Surgery is performed.

	5. Patient returns to the day care department. 6. Patients are monitored until they are fully conscious. 7. Patient receives printouts of discharge instructions , and a printed report. 8. Patients is discharged.
Outputs	- Completed Surgery - Pathology Specimen - Discharge Report - Postoperative care instructions and printed documents
Customers	- Patients - Patient Families - Referring Medical Centers - Private and Israeli Sick Funds Clinics - Ministry of Health

4.5.2.3 Saint Joseph Hospital Patients' Satisfaction

The same patient satisfaction survey which was used for the historical patient satisfaction review continued till April 2025, monthly there was around 70 patient satisfaction surveys over the whole period. During post-LSS phase , patient satisfaction surveys showed an increase from around 91% to 95% (Table 4.14); it highlights specific areas of improvement showing significant improvement over time: (A) Time to admission to the day surgery unit rose from 84% in June 2024 to 92% by March 2025, (B) Time to admission to the operating room improved from 75% in January 2024 to 92% by January 2025, (C) Discharge instructions clarity increased from 83% in January 2024 to 94% in April 2025 (Figure 4.58). These improvements noticed particularly after September 2024, it aligns with the implementation of LSS practices, which focused on reducing delays and standardizing communication and discharge teaching processes. The data clearly demonstrate that these quality improvement measures had a direct and positive impact on patient satisfaction, especially in timeliness and discharge-related domains.

Table 4.14: Percentages of Patient Surveys (2024.1 – 2025.04)

Question	2024-01	2024-02	2024-03	2024-04	2024-05	2024-06	2024-07	2024-08	2024-09	2024-10	2024-11	2024-12	2025-01	2025-02	2025-03	2025-04
Total satisfaction	91%	91%	92%	91%	93%	89%	93%	93%	93%	94%	95%	95%	95%	94%	92%	95%
General Satisfaction	94%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Patient Loyalty	94%	100%	100%	99%	99%	99%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%

Presence of signs and directions in the hospital	94%	92%	92%	88%	93%	85%	93%	94%	92%	92%	93%	92%	92%	91%	90%	93%
Reception staff treatment	91%	84%	91%	91%	94%	84%	94%	94%	93%	93%	94%	95%	94%	95%	92%	93%
Time taken for reception procedures	85%	83%	86%	84%	85%	81%	84%	82%	90%	93%	93%	94%	92%	92%	89%	92%
Time taken for admission to the day surgery unit	84%	85%	83%	85%	87%	80%	83%	80%	84%	85%	86%	88%	87%	90%	89%	92%
Time taken for admission to the operating room	75%	77%	79%	76%	79%	75%	77%	78%	79%	83%	84%	87%	86%	88%	90%	91%
Nursing staff treatment	95%	95%	98%	98%	98%	95%	98%	97%	96%	97%	98%	96%	97%	96%	94%	96%
Nursing staff response to calls	97%	96%	96%	98%	97%	94%	97%	97%	96%	98%	97%	96%	97%	97%	95%	95%
Nursing explanation and answers about my health condition	96%	95%	94%	95%	94%	94%	94%	97%	95%	96%	96%	95%	97%	94%	93%	94%
Nursing care during my hospital stay	96%	96%	98%	97%	98%	94%	97%	98%	96%	97%	98%	97%	98%	96%	93%	98%
Doctors' treatment	94%	94%	96%	95%	97%	91%	97%	95%	97%	97%	97%	97%	98%	96%	93%	97%
Doctor's explanation about my condition and answers to questions	90%	90%	89%	88%	92%	85%	90%	95%	91%	94%	92%	93%	92%	93%	90%	94%
General hospital cleanliness	93%	93%	93%	91%	95%	91%	96%	94%	94%	95%	94%	94%	96%	92%	91%	94%
Cleanliness of facilities (e.g., bathrooms)	94%	91%	93%	90%	94%	91%	93%	94%	94%	94%	94%	94%	95%	92%	90%	93%
The bed I stayed on met my expectations	93%	92%	93%	88%	96%	93%	97%	95%	94%	95%	96%	94%	94%	94%	93%	94%
Discharge instructions were clearly explained	83%	80%	85%	84%	87%	86%	84%	85%	94%	95%	96%	95%	97%	92%	90%	94%

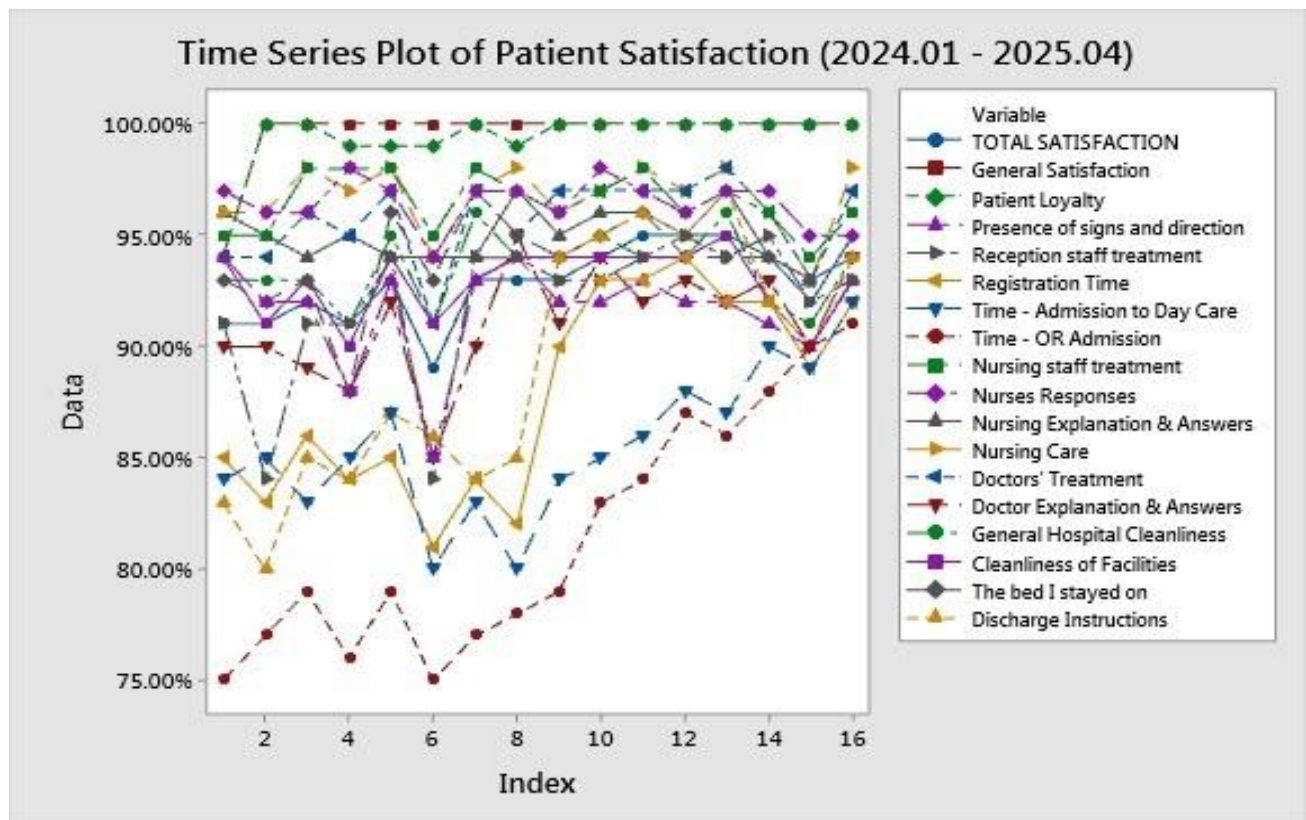


Figure 4.58: Patient Surveys – Time Series (2024.01 – 2025.4)

At the end, the post-LSS data analysis shows clear and consistent improvements across multiple operational, workflow, and patient-related metrics within the day care surgical services. Trends observed in HMIS indicators, control charts, updated VSM results, and patient satisfaction surveys altogether showed reduced waiting times, low rates of no-shows and surgery cancellations, more sustainable workflows, and better alignment of activities and standardized procedures. The implementation of LSS, especially digital scheduling, pre-defined patient instructions, and a well organized communication with patients contributed to a more efficient care process from admission through discharge.

4.5.3 Hypothesis Testing

To quantitatively assess the effect of LSS implementation on day care surgical services at Saint Joseph Hospital, this stage uses statistical tests of hypothesis to determine whether the changes in key performance metrics observed should be considered as statistically significant. This is to determine objectively whether standardization, waste reduction, and variability reduction that are focused objectives of the LSS philosophy is due to the intervention itself, and is not a chance occurrence.

According to research hypotheses proposed above in this study, the hypothesis testing part will involve a comparison of performance measurements before and after the implementation of LSS methodologies, over the period of 16 months, equally divided between the pre-LSS (January 2024 August 2024) and post-LSS (September 2024 April 2025).

H1: Implementation of LSS Methodology on day care surgical services have a positive effect on hospital outcomes and patient experiences.

H1 proposes that “Implementation of LSS Methodology on day care surgical services have a positive effect on hospital outcomes and patient experiences”, in other words, KPIs of hospital performance, including no-show rate, cancelation rate, and various waiting times, in addition to patients’ satisfaction rate, had been improved after the implementation of LSS methodology.

In order to test H1, the Two-sample t-test is utilized to for this purpose; the selection of this test (Two-sample t-test) because data has independent observations (pre-LSS and post-LSS), data is normally distributed (AD, and p-Value), and there is homogeneity of variances between the two groups (Figure 4.38). Confirming this assumption ensures the appropriateness of applying the standard Two-sample t-test for testing H1. This test is a widely used parametric statistical method to compare the means of two independent groups, and determine whether the difference between the two independent groups outputs is statistically significant. In healthcare quality improvement studies, such as those involving LSS, the Two-sample t-test is often employed to compare pre- and post-intervention performance metrics, such as waiting times, complication rates, or patient satisfaction scores, under the assumption of normally distributed data (Montgomery, 2020, pp. 354 - 360).

The null hypothesis is: $H_0: \mu_1 - \mu_2 = 0$; Where μ_1 refers to post-LSS mean, and μ_2 is the pre-LSS mean, while the Alternative hypothesis is: $H_1: \mu_1 - \mu_2 \neq 0$. Equal variances are not assumed for this analysis because collected data refers to two independent groups (pre and post LSS intervention).

Following are the in-depth statistical analysis and discussion of each KPI of the study:

H1: Metric 1: Two-Sample T-Test and CI: No. of Day Surgery (Total), Phase

Method

μ_1 : mean of No. of Day Surgery (Total) when Phase = Post_LSS

μ_2 : mean of No. of Day Surgery (Total) when Phase = Pre_LSS

Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics: No. of Day Surgery (Total)

Phase	N	Mean	StDev	SE Mean
Post_LSS	8	218.4	26.7	9.4
Pre_LSS	8	187.1	21.9	7.7

Estimation for Difference

	95% CI for
Difference	Difference
31.3	(4.9, 57.6)

Test

Null hypothesis $H_0: \mu_1 - \mu_2 = 0$

Alternative hypothesis $H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
2.56	13	0.024

This analysis supports Hypothesis H1 by demonstrating a significant increase in the number of day surgeries performed after LSS implementation. The average number rose from 187.1 surgeries per month (SD = 21.9) to 218.4 surgeries per month (SD = 26.7), with a mean difference of 31.3 surgeries, a 95% confidence interval of (4.9, 57.6), and a p-value of 0.024. These results indicate enhanced service capacity and efficiency, contributing positively to hospital performance and patient access to day care surgery.

H1: Metric 2: Two-Sample T-Test and CI: % of Day Surgery (Total), Phase

Method

μ_1 : mean of % of Day Surgery (Total) when Phase = Post_LSS

μ_2 : mean of % of Day Surgery (Total) when Phase = Pre_LSS

Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics: % of Day Surgery (Total)

Phase	N	Mean	StDev	SE Mean
Post_LSS	8	0.7095	0.0598	0.021
Pre_LSS	8	0.6342	0.0319	0.011

Estimation for Difference

Difference	95% CI for Difference
0.0752	(0.0218, 0.1286)

Test

Null hypothesis	$H_0: \mu_1 - \mu_2 = 0$		
Alternative hypothesis	$H_1: \mu_1 - \mu_2 \neq 0$		
T-Value	DF	P-Value	
3.14	10	0.011	

This analysis further supports Hypothesis H1 by revealing a significant increase in the percentage of day surgeries following LSS implementation. The average percentage rose from 63.42% (SD = 0.0319) to 70.95% (SD = 0.0598), with a mean difference of 7.52 percentage points, a 95% confidence interval of (2.18%, 12.86%), and a p-value of 0.011. These findings confirm enhanced utilization of day care surgery services, reflecting improved hospital performance and patient service accessibility after the intervention, in addition to improved hospital revenues.

H1: Metric 3: Two-Sample T-Test and CI: No-Show % Per Month, Phase

Method

μ_1 : mean of No-Show % Per Month when Phase = Post_LSS
 μ_2 : mean of No-Show % Per Month when Phase = Pre_LSS
Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics: No-Show % Per Month

Phase	N	Mean	StDev	SE Mean
Post_LSS	8	0.1630	0.0388	0.014
Pre_LSS	8	0.2136	0.0398	0.014

Estimation for Difference

Difference	95% CI for Difference
-0.0506	(-0.0931, -0.0081)

Test

Null hypothesis	$H_0: \mu_1 - \mu_2 = 0$		
Alternative hypothesis	$H_1: \mu_1 - \mu_2 \neq 0$		
T-Value	DF	P-Value	
-2.57	13	0.023	

This analysis supports Hypothesis H1 by demonstrating a significant decrease in the percentage of no-shows of scheduled day surgeries after LSS implementation. The average percentage decreased from 21.36% (SD = 0.0398) to 16.3% per month (SD = 0.0388), with a mean difference of minus 0.0506%, and a p-value = 0.023. The 95% confidence interval for the mean difference was (-9.31%, -0.81%), indicating a meaningful improvement in patient attendance following the LSS initiative. This metric aligns with H1.

H1: Metric 4: Two-Sample T-Test and CI: % of Cancelled Admission, Phase

Method

μ_1 : mean of % of Cancelled Admission when Phase = Post_LSS

μ_2 : mean of % of Cancelled Admission when Phase = Pre_LSS

Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics: % of Cancelled Admission

Phase	N	Mean	StDev	SE Mean
Post_LSS	8	0.00708	0.00754	0.0027
Pre_LSS	8	0.0251	0.0126	0.0044

Estimation for Difference

Difference	95% CI for Difference
-0.01800	(-0.02939, -0.00661)

Test

Null hypothesis $H_0: \mu_1 - \mu_2 = 0$

Alternative hypothesis $H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-3.48	11	0.005

The analysis shows a statistically significant decrease in the mean percentage of cancelled admissions from 2.51% (SD = 0.0126) to 0.708% (SD = 0.00754). The mean difference of -1.8%, and a p-value of 0.005. These results reflect improved hospital outcomes and more reliable patient experiences following LSS implementation and supports Hypothesis H1.

H1: Metric 5: Two-Sample T-Test and CI: Admission to Nurse Assessment (, Phase

Method

μ_1 : mean of Admission to Nurse Assessment (when Phase = Post_LSS

μ_2 : mean of Admission to Nurse Assessment (when Phase = Pre_LSS

Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics: Admission to Nurse Assessment (

Phase	N	Mean	StDev	SE Mean
Post_LSS	8	13.63	6.41	2.3
Pre_LSS	8	41.50	4.24	1.5

Estimation for Difference

Difference	95% CI for Difference
-27.88	(-33.80, -21.95)

Test

Null hypothesis $H_0: \mu_1 - \mu_2 = 0$

Alternative hypothesis $H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-10.25	12	0.000

This analysis strongly supports Hypothesis H1 by demonstrating a significant reduction in the average time from admission to nurse assessment; from 41.50 minutes (SD = 4.24) to 13.63 minutes (SD = 6.41). The mean difference of minus 27.88 minutes, with a 95% confidence interval of (-33.80, -21.95) and a P-value of 0.000, confirms a highly statistically significant improvement. These results reflect enhanced workflow efficiency and faster patient processing, directly improving hospital outcomes and patient experience.

H1: Metric 6: Two-Sample T-Test and CI: Admission to Doctor Assessment, Phase

Method

μ_1 : mean of Admission to Doctor Assessment when Phase = Post_LSS

μ_2 : mean of Admission to Doctor Assessment when Phase = Pre_LSS

Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics: Admission to Doctor Assessment

Phase	N	Mean	StDev	SE Mean
Post_LSS	8	36.00	2.73	0.96
Pre_LSS	8	38.00	2.62	0.93

Estimation for Difference

	95% CI for
Difference	Difference
-2.00	(-4.89, 0.89)

Test

Null hypothesis	H ₀ : μ ₁ - μ ₂ = 0		
Alternative hypothesis	H ₁ : μ ₁ - μ ₂ ≠ 0		
T-Value	DF	P-Value	
-1.50	13	0.158	

This analysis does not show a statistically significant difference in the average time from admission to doctor assessment between the two phases. The mean decreased slightly from 38.00 minutes (SD = 2.62) to 36.00 minutes (2.73), with a mean difference of -2.00 minutes, a 95% confidence interval of (-4.89, 0.89), and a p-value of 0.158. While the trend suggests a minor improvement, the result is not statistically significant, indicating that this specific metric may not have been substantially impacted by LSS implementation. Given the fact that even before the implementation of LSS, a time of 38 minutes from patient registration to assessment by a doctor is considered a short time!

H1: Metric 7: Two-Sample T-Test and CI: Admission to OR (Minutes), Phase

Method

μ_1 : mean of Admission to OR (Minutes) when Phase = Post_LSS
 μ_2 : mean of Admission to OR (Minutes) when Phase = Pre_LSS
Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics: Admission to OR (Minutes)

Phase	N	Mean	StDev	SE Mean
Post_LSS	8	114.0	27.7	9.8
Pre_LSS	8	182.6	34.6	12

Estimation for Difference

	95% CI for
Difference	Difference
-68.6	(-102.5, -34.8)

Test

Null hypothesis	H ₀ : μ ₁ - μ ₂ = 0		
Alternative hypothesis	H ₁ : μ ₁ - μ ₂ ≠ 0		
T-Value	DF	P-Value	
-4.38	13	0.001	

This analysis provides strong evidence in support of Hypothesis H1, showing a significant reduction in the time from admission to the operating room following LSS

implementation. The average time decreased from 182.6 minutes (SD = 34.6) to 114.0 minutes (SD = 27.7), with a mean difference of -68.6 minutes, a 95% confidence interval of (-102.5, -34.8), and a p-value of 0.001. These statistically significant results confirm that LSS improved surgical workflow efficiency, contributing to better hospital outcomes and enhanced patient experiences.

H1: Metric 8: Two-Sample T-Test and CI: Patient Satisfaction (Total %), Phase

Method

μ_1 : mean of Patient Satisfaction (Total) when Phase = Post_LSS
 μ_2 : mean of Patient Satisfaction (Total) when Phase = Pre_LSS
 Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics: Patient Satisfaction (Total)

Phase	N	Mean	StDev	SE Mean
Post_LSS	8	0.9413	0.0113	0.0040
Pre_LSS	8	0.9162	0.0141	0.0050

Estimation for Difference

Difference	95% CI for Difference
0.02500	(0.01123, 0.03877)

Test

Null hypothesis	$H_0: \mu_1 - \mu_2 = 0$	
Alternative hypothesis	$H_1: \mu_1 - \mu_2 \neq 0$	
T-Value	DF	P-Value
3.92	13	0.002

This analysis offers clear support for Hypothesis H1 by showing a statistically significant increase in overall patient satisfaction following the implementation of LSS. The average satisfaction score rose from 0.9162 (SD = 0.0141) to 0.9413 (SD = 0.0113), with a mean difference of 0.0250, a 95% confidence interval of (0.01123, 0.03877), and a p-value of 0.002. These results confirm that the intervention positively influenced the patient experience, reinforcing the effectiveness of LSS in improving service quality and patient-centered care. Previous results showed that surgery scheduling and short admission to assessment time in addition to short time for admission to operating theater positively impacted total patient satisfaction.

Table (4.15) summarizes the Two-sample t-test analysis for H1, as follows:

Table 4.15: Two-Sample t-Test Results for Hypothesis 1 (pre-LSS vs. post-LSS)

Measure	Pre-LSS M (SD)	Post-LSS M (SD)	Mean Differenc e	t-value	t(df)	p-value	95% CI	Result
Number of Day Surgeries	187.1 (21.9)	218.4 (26.7)	+31.3	2.56	13	0.024	4.9, 57.6	Increased, Significant, Improved
Percentage of Day Surgeries vs Total	0.6342 (0.0319)	0.7095 (0.0598)	0.0752	3.14	10	0.011	0.0218, 0.1286	Increased, Significant, Improved
Percentage of No-Show	0.2136 (0.0398)	0.1630 (0.0388)	-0.0506	-2.57	13	0.023	-0.0931, -0.0081	Decreased, Significant Improved
Percentage of Cancelled Admissions or Surgery	0.0251 (0.0126)	0.00708 (0.00754)	-0.018	-3.48	11	0.005	-0.02939, -0.00661	Decreased, Significant, Improved
Admission to Nurse Assessment (minutes)	41.5 (4.24)	13.63 (6.41)	-27.87	-10.25	12	0.000	-33.80, -21.95	Decreased, Significant, Improved
Admission to Doctor Assessment (minutes)	38 (2.62)	36 (2.73)	-2.00	-1.5	13	0.158	-4.89, -0.89	Minor change, Non- significant change
Admission to Operating Theatre (minutes)	182.6 (34.6)	114.0 (27.7)	-68.6	-4.38	13	0.001	-102.5, -34.8	Decreased, Significant Improved
Patient Satisfaction (%)	0.9162 (0.0141)	0.9413 (0.0113)	+0.0251	3.92	13	0.002	0.01123, 0.03877	Increased, Significant, Improved
M: Mean, SD: Standard Deviation, t: t-value, df: Degrees of Freedom, CI: Confidence Interval								

Summary of H1 Analysis:

H1, which is “Implementation of LSS Methodology on day care surgical services have a positive effect on hospital outcomes and patient experiences” is strongly supported by statistical analysis of the eight metrics; significant improvement was observed in the operation efficiency and performance, in addition to improved patient experiences and satisfaction, for that the analyzed metrics strongly support that LSS led to meaningful enhancements in both service delivery and patient experience. For that, and since most of the statistical analysis

(except metric number 06 with p-value = 0.158) showed a statistically significant difference ($p < 0.05$), allowing the rejection of the null hypothesis, and so, **H1 is accepted**, and

Implementation of LSS Methodology on day care surgical services have a positive effect on hospital outcomes and patient experiences.

H2: Implementation of LSS Methodology on day care surgical services have a positive effect on generating standardization, waste reduction, and variability reduction.

This hypothesis (H2) aimed to investigate whether the implementation of LSS at Saint Joseph Hospital led to a statistically significant reduction in variability across multiple key metrics (pre-LSS variance differ from post-LSS variance). Test for Two Variances” (Levene’s and Bonett’s tests) to compare pre- and post-LSS phases, assessing changes in variability to validate the standardization impact of LSS (Table 4.16), Levene’s test was adopted to assess whether the variance of key performance indicators differed significantly between the pre-LSS and post-LSS groups (i.e., to test homogeneity of variances), while Bonett’s method to provide a more robust estimation of the ratio of variances together with confidence intervals, which enhances the sensitivity and interpretability of variance comparisons (Petropoulou et al., 2023).

In both tests, Levene’s and Bonett’s tests, the null hypothesis states that the variances of the two groups are equal. A p-value < 0.05 leads to rejection of the null hypothesis, indicating that variability changed significantly post-LSS implementation. This interpretation is consistent with recent empirical evaluations of variance-equality tests, which demonstrate that Levene’s test performs reliably under normal and mildly non-normal conditions, whereas Bonett’s test provides superior robustness when data contain skewness, outliers, or unequal sample sizes (Zielinski, 2024).

Table (4.16) shows a summary of variance analysis for HMIS data & patient satisfaction surveys, it includes the Bonett p-value and Levene p-value, as follows:

Table 4.16: Summary of Variance Analysis for HMIS Metrics & Patient Surveys

Metric	Estimated Ratio (σ_1/σ_2)	Levene p-value	Bonett p-value	Interpretation
Number of Day Surgeries (Total)	1.22	0.321	0.643	Slight increase in variability; not statistically significant
No-Show Per Month	0.82	0.820	0.671	No significant change in variability
Number of Cancelled Admissions	0.50	0.362	0.220	Decrease in variability, but not statistically significant
Admission to Nurse Assessment	1.51	0.871	0.590	Variability increased, but not significantly
Admission to Doctor Assessment	1.04	1.000	0.902	No significant change in variability
Admission to Operating Theatre (Minutes)	0.80	0.466	0.581	Slight decrease in variability, not statistically significant
Patient Satisfaction (Total)	0.80	0.513	0.616	No statistically significant reduction in variability

Although several metrics showed numerical reductions in standard deviation after the LSS intervention, particularly in the cancelled admissions and time for admission to the OR, none of them reached the required statistical significance ($p > 0.05$). This implies that, although there are trends which can be observed towards better standardization and possible reduction of wastes, the findings do not provide significant statistical evidence to support the reduction of variability. These results are aligned with literature on how variability is usually reduced with the help of LSS and that in many cases, it may take longer execution times, larger sample groupings, and more profound process control measures (Antony et al., 2017; Mason et al., 2015).

Although, there is positive effect on generating standardization and waste reduction, as previous **H1** and visualized in quality charts, variation reduction can't be statistically

proven despite the improvements in KPIs, the changes were not statistically significant. Therefore, based on the data analysis, it was failed to reject the null hypothesis and **H2 is not Accepted**, specifically concerning variation reduction.

H3: Performance metrics before LSS implementation differ from those after LSS implementation in day care services.

H3 proposes that pre-LSS KPIs differs from post-LSS in day care services at Saint Joseph Hospital. KPIs of **H3** are the same set of KPIs examined for H1 (number of day surgery performed, no-show and cancellation rates, waiting times, and patient satisfaction), it was compared between the pre-LSS and post-LSS phases using two-sample t-tests. As shown in previous section (Table 4.15), there are a statistically significant differences (p-Value < 0.05) for seven of the eight indicators, with only admission to doctor assessment, which showed a small and non-significant change. These findings confirm that pre-LSS and post-LSS performance metrics differ, allowing the rejection of the null hypothesis, and **H3 is Accepted.**”

Summary of Hypotheses Testing Results

H1: Implementation of LSS methodology on day care surgical services have a positive effect on hospital outcomes and patient experiences.

Accepted; the study found statistically significant improvements in KPIs such as reduced day surgery cancellations, shorter waiting times (to nurse and OR), and increased patient satisfaction. These findings confirm that LSS implementation positively influenced both clinical efficiency, patient-centered care, and patients’ experiences.

H2: Implementation of LSS methodology on day care surgical services have a positive effect on generating standardization, waste reduction, and variability reduction.

Statistically Not Accepted; while visual trends and practical improvements suggested reduced process variation, statistical tests (Levene’s and Bonett’s) failed to reject the null hypothesis. Thus, no significant evidence was found to confirm that variability was meaningfully reduced across all metrics.

H3: Performance metrics before LSS implementation differ from those after LSS implementation in day care services.

Accepted; the results of two-sample t-tests showed statistically significant differences in several process and outcome measures before and after LSS implementation, supporting the hypothesis that LSS brought measurable change to performance metrics.

Overall Decision

Based on the results of hypothesis testing, H1 and H3 were accepted, demonstrating that LSS implementation has positive impact on hospital outcomes and patient satisfaction, while H2 failed to reject the null hypothesis, indicating no statistically significant reduction in process variability or standardization was observed despite the fact that hospital and patients' KPIs were improved dramatically, and the variations were declined, but not to that limit to makes them as statistically significant.

However, in this research, our case Saint Joseph Hospital, the hypotheses were tested using the solid mixed-methods design, as it combines both qualitative perspectives (Gemba walks, VSM, interviews) and quantitative measures of the hospital performance (HMIS data and patient surveys) before and after the LSS implementation. The evidence collected in the hospitals HMIS indicated that positive trends were observed after implementation in terms of reduction in average time of admission-staff assessment time, doctor assessment time, and time before going to operating room, the number of no-shows and surgeries cancellations decreased significantly. The nature of these KPIs was statistically verified by control charts (above section) that proved the shifting of means in the processes and a decrease in variation. Also, a decrease in the standard deviations of the waiting times was shown after LSS implementation, which is an indication of a higher process stability and control.

The observed changes are unlikely to be as a chance phenomenon. Instead, they indicate a systemic enhancement in operational efficiency and high quality performance, which have been caused by standardized work directions, VSM, redesign of the process flows, and reinforced discharge process and patient education.

4.6 Control Phase

The last DMAIC phase is the Control phase. Its objective is to make sure that improvements, which were made in the process in the Improve phase are sustainable over time and aligned with the daily activities of Saint Joseph Hospital, it ensures that these improvements become equivalent to long-term objectives based on quality and performance.

In Saint Joseph Hospital, the Control phase included making standard operating procedure, software development and deployment, implementing real-time performance dashboard, training and on-going digital monitoring systems. They aimed at avoiding regression, smoothing resistance of staff, reinforcing the standardized work processes and institutionalization of the culture of continuous improvement in the field of day care surgery services.

In order to ensure sustainability and continuous improvement, in addition to smart dashboard, control mechanisms were implemented including:

4.6.1 Standard Procedure and Work Instructions

Policies and procedures were updated concerning the new work activity for the appointment office, admission office, and operating theater scheduling pathway.

The process mapping for patient reception and admission is updated and NVA activities like creating new medical file for the patient had been removed, since the patient will have a reservation for his/her day surgery, the new updated process mapping (Figure 4.59). this update enabled the admission officer to quickly admit the patient as he/she has an old data in the database, for that the admission time became shorter, and there is no crowding at the admission office, which in turn enhanced the patients' satisfaction.

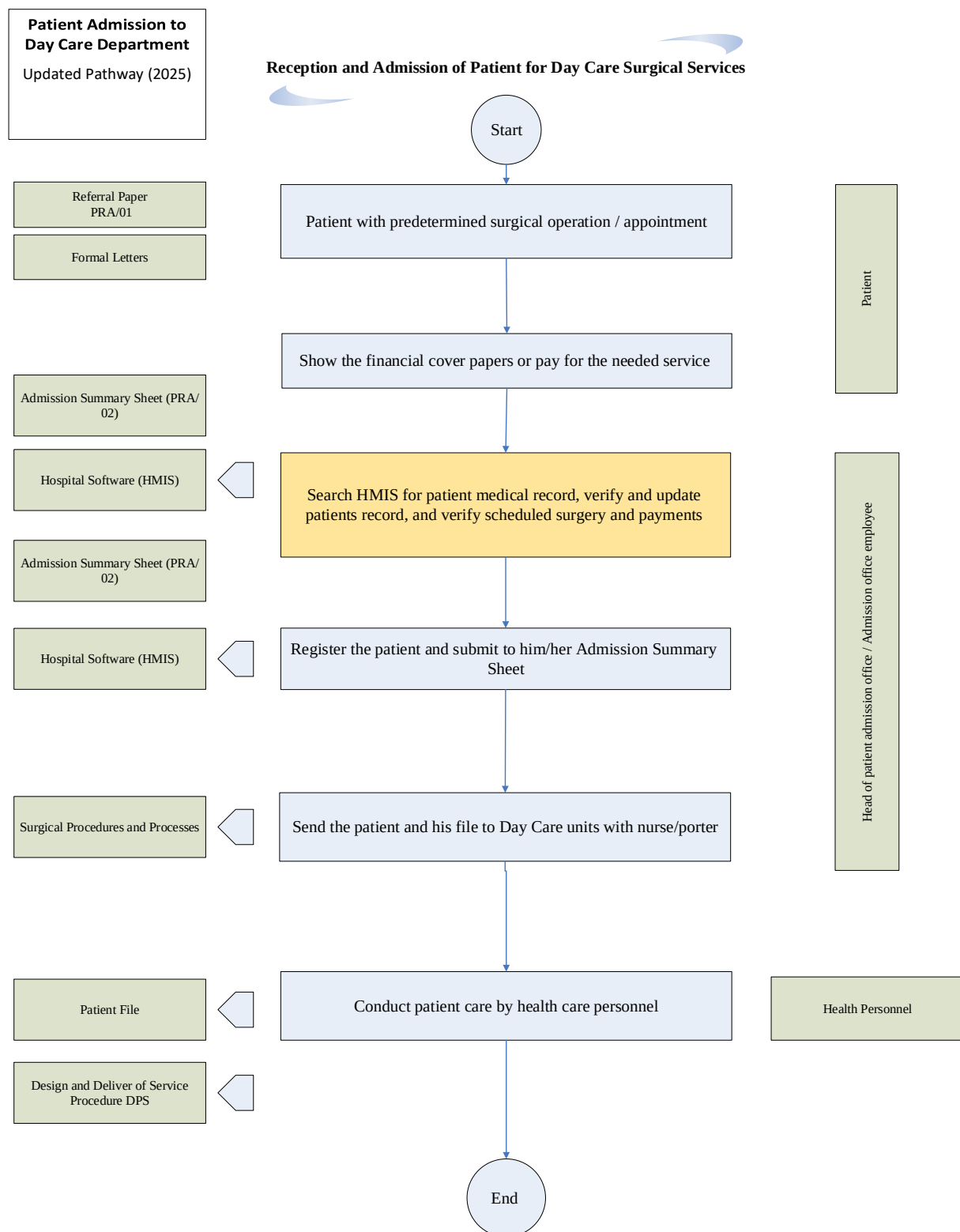


Figure 4.59: Updated Patient Admission and Reception Flowchart

Furthermore, a new flowchart and process mapping was established for the newly created day care surgery scheduling (Figure 4.60), this flowchart enabled the staff to easily understand the new process and its activities, responsibilities became clearer, as follows:

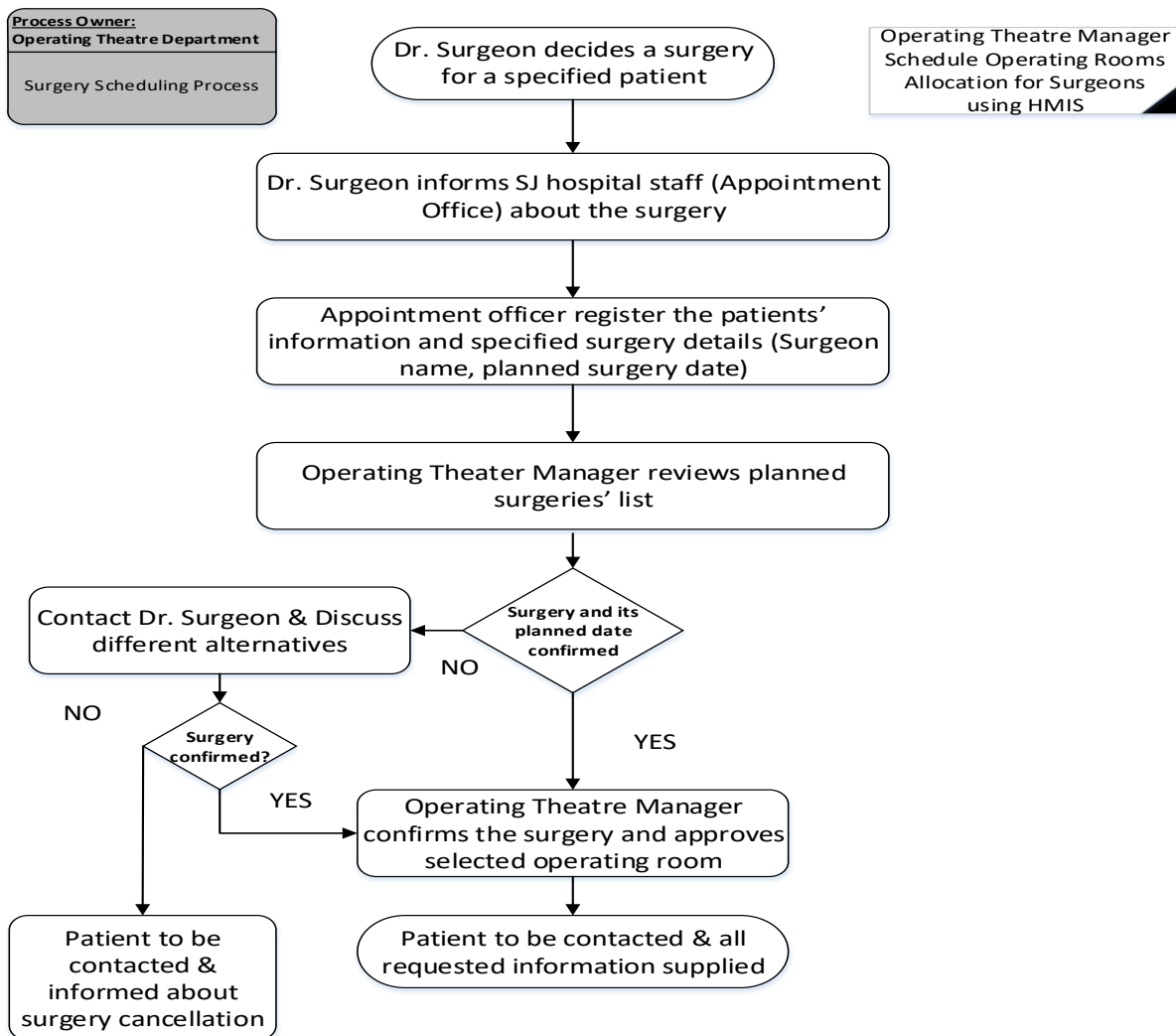


Figure 4.60: New Surgery Scheduling Flowchart

4.6.2 HMIS Software, Smart Dashboard and Visual Controls

The developed HMIS interfaces includes operating theater rooms distribution, day surgery scheduling, surgical safety phases, and patient's monitoring system. a custom-built key performance dashboard was developed, that displays a smart real-time performance indicator including:

- Patient waiting times at day care department (nurses and doctors)
- No-show rate

- Surgery cancellation rates
- Operating room utilization activities
- Discharge compliance rate, transfer, or
- Complication or long stay rate

These metrics is accessible by head units and managers and performance discussed on monthly basis with total quality department.

Also, the developed software allows smart visualizing tool for nurses and doctors to monitor patient's flow and bottleneck, either at admission office, day surgery department, operating theater rooms or at the post-surgery department.

4.6.3 Ongoing Training and Staff Engagement

The new processes and activities were included in staff orientation and training programs, either for admission officers, appointment officers, nurses and doctors. Refreshment sessions scheduled quarterly or at any new software update accordingly.

4.6.4 Quality Audit & Monitoring KPIs

Quality department scheduled regular quality audits and rounds, either daily, weekly or monthly, according to the scope of audit, it includes the compliance with hospital standards, and the newly establish procedures and work instructions, in addition to monitoring patients crowing or long waiting times.

Patient satisfaction surveys were continued post-intervention, using the 15-question tool, a digital form was created during the implementation of LSS at Saint Joseph Hospital.

In summary, the Control phase at the Saint Joseph Hospital ensured that the advantages of implementing LSS at the day care surgical unit were institutionalized in policies, staff practices, and hospital culture, in addition to the developed software and smart dashboards. With the help of newly created pathways and policies, updated software, smart dashboards, constant training, and audits. The efficiency of workflow was improved, as well as the appropriate utilization of day care and operating theater departments, patient satisfaction, furthermore, the rate of no show and complications, improved dramatically, also, bottlenecks were resolved, either at admission office, day care department or at operating theater.

Chapter Five: Discussion and Conclusion

5.1 Introduction:

This chapter discusses the key findings of the study, interprets their significance in the context of LSS and existing literature, and evaluates the extent to which the intervention achieved its intended objectives. It summarizes the findings of the study that projected the effects of LSS implementation approach on the day care surgical services in the Saint Joseph Hospital in Jerusalem, specifically on the hospital results, patient experiences, standardization of the processes, reduction of wastes and controlling of variability. The results indicated that several significant aspects of improvements have been observed under LSS implementation, and provided information on the pitfalls in which the statistical significance of the improvement was not observed, which gives an understanding of the strengths and weaknesses of the intervention.

5.2 Discussion

This study aimed to assess the impact of LSS implementation on day care surgical services at Saint Joseph Hospital in Jerusalem, for the period of January 2024 till April 2025 (16-months period), focusing on hospital performance, patient experiences, waste and variations reduction, and standardization of processes. This study guided by Donabedian's Structure-Process-Outcome model and adopted a mixed-methods quasi-experimental nonequivalent pre-post design, the intervention combined structural changes (digitalization of surgery scheduling, smart dashboards, new procedures, pre-admission and discharge instruction for patients) with processes enhancement via DMAIC, VSM, Gemba walks, 5S, Pareto, control charts and other LSS tools. The discussion below interprets the main findings, challenges and the improvement initiatives adopted to improve hospital outcomes and patient's satisfaction as well as staff, surgeons and other stakeholders.

Main issues clarified were the high no-show rates of patients, high surgery cancellation rates, long waiting times across patient assessment and surgery performing, crowding environments and unsteady workflow. Analysis of the causes of these inefficiencies showed that the absence of digital solutions, limited resources, and policies refinement to fulfill customer requirements were the main root causes. A healthy work environment and

strong leadership support were key enablers of reducing variation and waste, given the fact that, Saint Joseph Hospital as a not-for-profit hospital, located in East Jerusalem, with limited resources, is in need for improvements that help reducing cost while maintaining high quality standards and safety, enhancing patients' satisfaction and outcomes, and increases its market share.

LSS implementation led to substantial improvements, A statistically significant reduction of no-show rates, it declined from 21.4% (SD = 0.0398) to 16.3% (SD = 0.0388), with a decline of 5.1% over eight months ($p = 0.023$), in addition, the percentage of cancelled admissions decreased from 2.5% (SD = 0.0126) to 0.7% (SD = 0.00754) after LSS ($p = 0.007$). That indicates an increase in the efficiency of operations and reliability of planning and is in line with what Antony et al. (2017) discovered, namely the ability of LSS to minimize the waste of procedures and presence of NVA patient pathways. In the same manner, there was a marked improvement in the average time of admission to nurse assessment, which fell drastically from 42 (SD = 4.24) to 14 minutes (SD = 6.41), ($p = 0.000$) and average time of operating room admission decreased from 183 to 114 minutes (SD from 34.6 to SD 27.7) ($p = 0.001$).

These decreases are in line with the previous results indicating that LSS interventions can be used to simplify peri-operative processes as well as minimize wait times of the patients (Teeling et al., 2023). These improvements align with McDermott et al. (2022) who emphasized that LSS is effective in reducing NVA activities, eliminating waste, and improving operational performance in healthcare. Also, Mason et al. (2015) similarly concluded that LSS in surgical settings can reduce cancellations, delays, and unnecessary length of stay. Dantas et al. (2018) highlighted no-shows as a major contributor to inefficiency in scheduling systems.

The study findings reflect a positive effect of LSS implementation, and they support more efficient sequencing of administrative and clinical steps, appropriate preparation before surgery, smooth transition of patients, and better communication between day care and operating theatre teams. The observed reductions in waiting times are consistent with several studies; Teeling et al. (2023) and Mandahawi et al. (2011) showed that Lean and Six Sigma applications in surgical services can shorten cycle times and length of stay by reorganizing patient flow and reducing bottlenecks. Nowak et al. (2017) and Young (2014) reported that

VSM, when applied to healthcare, can significantly reduce NVA time and streamline care pathways.

Patient satisfaction also improved significantly, with scores increasing from 91.6% (SD = 0.0141) to 94.1% (SD = 0.0113) and ($p = 0.002$), reinforcing the perspective that LSS positively influences the patient experience. According to Rathi et al. (2022), such improvements in clinical process reliability often correlate with increased patient satisfaction due to more predictable and timely care. The observed rise in both the number and percentage of day surgeries further suggests improved scheduling efficiency and throughput, as supported by Laureani et al. (2013), who found that surgical departments implementing LSS reported substantial gains in operating room utilization and case volume. These findings are aligned with the SERVQUAL and Donabedian's SPO models. Parasuraman et al. (1988) conceptualized service quality as the gap between expectations and perceptions across dimensions such as tangibles, reliability, responsiveness, assurance, and empathy. In healthcare adaptations of SERVQUAL, timeliness, clarity of instructions, and professionalism are particularly salient in high-speed service settings like day care surgery. Rezaei et al. (2018), emphasize that responsiveness and timeliness are critical for patient satisfaction in busy environments.

The findings of this study demonstrate how the structured implementation of LSS methodology can meaningfully improve the performance of day care surgical services at Saint Joseph Hospital by highlighting the long-standing inefficiencies in workflow. The results must be interpreted in the context of the baseline challenges identified during the Define and Measure phases, where healthcare systems face persistent gaps in timeliness, reliability, and service quality due to waste and process variation (Costa & Godinho Filho, 2016; Wackers et al., 2022).

By integrating LSS tools such as VSM, Gemba Walks, root-cause analysis, and standardized work procedures, the hospital was able to reduce NVA activities, improve waiting times, decrease no-show and cancellation rates, and enhance patient satisfaction in alignment with the improvements reported by McDermott et al. (2022), Rosa et al. (2024), and Marin-Garcia et al. (2021). Interpreting these outcomes holistically illustrates how the combined Lean and Six Sigma approach - with the support of SERVQUAL's focus on

patient-perceived quality – can create measurable improvements in both operational performance and patient experiences, confirming the relevance of the LSS framework for complex, resource-constrained hospital environments like Saint Joseph Hospital.

The first hypothesis (H1) proposed that implementation of LSS in day care surgical services would have a positive effect on hospital outcomes and patient experiences. The results provide a robust support for this hypothesis. After LSS interventions, the average number of day surgeries per month increased from 187.1 (SD = 21.9) to 218.4 (SD = 26.7), with a statistically significant mean difference of 31.3 surgeries ($p = 0.024$). Similarly, the proportion of day surgeries among all surgeries rose from 63.4% (SD = 0.319) to 70.9% (SD = 0.0598) and ($p = 0.011$). These changes indicate improved capacity utilization and a higher share of cases being managed through the more efficient day care pathway, consistent with the conceptual aim of LSS to increase throughput by eliminating waste and optimizing processes. Equally important and mirroring the total day surgeries performed, are the reductions in no-shows and same-day surgery cancellation rates. The no-show percentage decreased from 21.3% (SD = 0.0398) to 16.3% (SD = 0.0388), ($p = 0.023$), and the percentage of cancelled admissions/surgeries fell from 2.5% (SD = 0.0126) to 0.7% (SD = 0.00754) and ($p = 0.005$). These findings suggest that the new digital scheduling platform and the automated notification reminders, in addition to pre-admission instructions and improving discharge education, were the enablers to improve hospital processes and patients' outcomes. These structural modifications are consistent with recommendations in the literature emphasizing managerial commitment, training, and digital infrastructure as prerequisites for successful LSS initiatives (Gardim et al., 2024; Ubaid & Al-Juboori, 2023).

Patient satisfaction represents the experiential dimension of quality and was central in this study. Overall satisfaction increased from an average from about 91.6% to 94.1%, with a mean difference of 0.025 and a p-value of 0.002, confirming a statistically significant improvement after LSS implementation. This supports H1 with respect to patient experience and reinforces previous literature indicating that more reliable and timely clinical processes are associated with higher satisfaction. Rathi et al. (2022) noted that improvements in process reliability and timeliness often translate into better patient perceptions of care.

Qualitative data offered important context; Structured interviews, Gemba walks, and VSM conducted in the Define and Analyze phases showed early patient arrival, crowding at

admission, long NVA waiting times, and a lack of digital coordination tools as major root causes of inefficiency. These inefficiencies were represented in the historical patient satisfaction surveys that showed the lowest scores were consistently related to time taken for patient registration and admission, time spent for admission to the day surgery department, and time taken for admission to the operating room for surgery, with percentages between 75% and 85%, while most other items exceeded 90% of satisfaction. Findings justified focusing the LSS intervention on process redesign, digital scheduling, and standardization of admission workflows, that resulted in improvements in patient satisfaction and hospital performance

Together, these findings strongly support the first hypothesis (**H1**), which proposed that **“Implementation of LSS Methodology on day care surgical services have a positive effect on hospital outcomes and patient experiences”**. The practical implication is that structured process improvement methodologies like LSS can yield tangible clinical benefits when appropriately contextualized within a hospital’s operations. Also, the results of this study strongly support (**H3**), which proposed that **“Performance metrics before LSS implementation differ from those after LSS implementation in day care services”**. Across all major operational indicators, the data demonstrated clear and statistically significant pre-post differences.

However, while the results support improvements in standardization and waste reduction, the statistical evidence regarding variability is more nuanced; when analyzing process variability and standardization - key components of the second hypothesis, (**H2: “Implementation of LSS Methodology on day care surgical services have positive outcomes including standardization, waste reduction, and variability reduction”**), the results were mixed. Although some metrics, such as time to nurse assessment and time to operating room, showed reductions in standard deviation post-LSS, Levene's and Bonett's tests did not indicate statistically significant changes in variability (p-values > 0.05) leading to failure to reject the null hypothesis for variance equality. These results align with Bhat et al. (2014), who noted that while LSS can improve average process performance, its effect on variability is often contingent on deeper cultural integration and staff engagement in standardized practices.

This finding underscores an important nuance: improvements in mean performance indicators may not always coincide with reductions in variation. In practical terms, the hospital may have succeeded in shifting average performance in a positive direction without fully stabilizing the processes involved. This might be due to undiscovered persistent bottlenecks, hidden human factors, or external factors (like political situation in our case) or variations in patient case mix. Furthermore, the sample size ($N = 8$ per phase) is relatively small, likely constrained the statistical power to detect impactful variability improvements, Mason et al. (2015) highlighted such concerns in LSS healthcare evaluations. In addition, Antony et al. (2017) noted that although LSS can produce substantial improvements in mean performance and throughput, achieving stable low-variation processes often requires longer implementation periods, deeper cultural change, and larger datasets.

Nonetheless, even no significant reductions in variation may have some operational relevance. Control chart analyses and visual inspection of trend lines showed fewer outliers and special-cause variations post-LSS in several metrics (like number of day care surgery at the beginning of 2025), indicating improved process reliability. This suggests that practical improvements occurred even if not statistically confirmed. This is aligned with the view of Antonacci et al. (2018) who argued that qualitative and visual process-level observations are essential for understanding and sustaining quality improvement, beyond p-values alone.

For that, the analysis offers partial support for H2: strong evidence for standardization and waste reduction as seen in improved means and redesigned pathways, but inconclusive statistical evidence regarding variability reduction. This nuance is important for interpreting LSS performance honestly and realistically in complex healthcare settings.

In summary, this study provides evidence that LSS implementation in day care surgical services led to significant improvements in outcomes and experiences, while partially fulfilling the objective of reducing process variability. The results support the broader literature on LSS in healthcare, demonstrating that the methodology can serve as a valuable tool for achieving strategic performance goals. However, future studies should involve larger datasets, longer follow-up periods, and multi-dimensional variance analysis to better capture the subtleties of process standardization. With sustained leadership commitment and staff engagement, LSS can become a foundational pillar of quality improvement in healthcare.

5.3 Conclusion

Overall, the findings of this study demonstrate that the structured implementation of LSS produced meaningful improvements across several dimensions of day care surgical services at Saint Joseph Hospital. The intervention successfully reduced no-show and cancellation rates, shortened waiting times, increased throughput, and enhanced patient satisfaction, thereby fulfilling the main objectives of improving efficiency, reliability, and patient experience. While improvements in process standardization were evident, the results regarding variability reduction were mixed, highlighting areas where deeper cultural and operational stabilization are still required.

From a practical standpoint, the study provides clear evidence that LSS can be effectively applied in resource-constrained hospital environments to optimize patient flow, strengthen coordination between clinical and administrative teams, and enhance service quality. The successful application of digital scheduling, standardized workflows, and real-time monitoring tools demonstrates tangible value for Saint Joseph Hospital, offering a sustainable foundation for ongoing quality improvement efforts. These results also underscore the importance of leadership commitment, staff engagement, and continued use of data-driven decision-making to maintain and expand these gains.

Despite the strengths of the intervention, several limitations must be acknowledged. The relatively small sample size per period ($N = 8$ months) may have limited the statistical power to detect changes in process variability. External contextual factors, fluctuations in case mix, and human-factor influences may also have contributed to residual variations in performance.

Future research should consider longer periods of study and larger datasets to more accurately evaluate process stabilization and variability reduction. Expanding the scope of analysis to include qualitative assessments of staff culture, communication patterns, and adherence to standardized work may provide deeper insight into the relationship between organizational behavior and performance outcomes. Further studies could also explore integrating predictive analytics into scheduling and admission workflows, examining patient segmentation strategies, and evaluating cross-departmental LSS applications to strengthen continuity of care.

5.4 Recommendations

Building upon the findings and discussion presented in this chapter, it is essential to translate the study's insights into actionable guidance for both practice and research. Although the LSS intervention demonstrated substantial improvements in operational performance, patient satisfaction, and process standardization within the day care surgical services of Saint Joseph Hospital, several areas still require sustained attention and strategic development. Therefore, the following section provides two complementary sets of recommendations.

5.4.1 Practical Recommendations for Saint Joseph Hospital in Jerusalem

These suggestions are founded on the results regarding the LSS thesis implementation in the day care surgical services of Saint Joseph Hospital.

- A. Keep tracking Day Surgery key performance indicators on a regular basis: Encourage the application of measures to track regularly using control charts (such as I-MR) should include: % of Keep day surgeries, no-show rates, cancelled admissions, and waiting times to both nurse and doctor assessment, time to operating room and patient satisfaction scores. Monitoring on an ongoing basis will keep track of the process drift early and help in driving processes continuously.
- B. Standardization of patient flow across all services: Monitor care pathways of all patients in order to eliminate delays and errors. This facilitates easy adjustments into admission, assessment, surgery and release with minimal variation of staff and shift.
- C. Train multidisciplinary teams on LSS tools: Give some LSS training details to nurses, physicians, and administrators. Constructing a capacity building inside the hospital will allow frontline teams to solve problems within a short period of time and the use of data to make decisions.
- D. Use LSS on other departments: Apply the DMAIC model in other hospital departments like inpatient surgery, medical, obstetrics, neonates, emergency department, or outpatient clinics. This fosters the hospital-wide culture of efficiencies and quality.
- E. Maintenance of gains through standard work and 5S: Encourage quality tools such as standardized work instructions, and 5S (Sort, Set, Shine, Standardize, Sustain) to sustain the quality of care, such tools are used to minimize wastes and afford success.

- F. Add variability analysis to quality reviews: Besides averages, incorporating standard deviation and range in the performance reviews. this provides an incentive to not only pay attention to the outcomes, but also consistency, which is the key to providing effective care to patients.
- G. Encourage collecting qualitative feedback from staff and patients: Structured interviews or surveys will help you realize the experience of the staff and the perception of patients regarding LSS when done. This will make sure that the human aspect of process improvement is captured and dealt with.

5.4.2 Recommendations for Future Studies

- A. Expand Study Period and Sample Size: Future research should involve a longer observation period and a larger dataset to improve statistical power and allow more robust subgroup analysis across different surgical procedures and patient categories.
- B. Evaluate Cost-Effectiveness of LSS Interventions: In this research study, short-term benefits after LSS were measured. Future research encouraged to look into the extent of process improvement lasting 12 to 24 months or longer.
- C. Explore Staff Engagement and Training Role: Future studies encouraged to study the impact of the degree of staff participation and the effectiveness of LSS training on the success of implementation in terms of compliance with standard procedures and long-term results.
- D. Assess the Cost- Effectiveness of LSS Interventions: Future studies encouraged to measure the financial implication of LSS implementation in terms of direct cost savings, resource optimization and Return on investment. It is particularly important to decision-makers in resource-limited care settings.
- E. Conduct Comparative Studies Across Institutions: In the future, scholars recommended to empirically compare across multiple hospitals or even centers to determine the effect of contextual issues (e.g. size of the hospital, leadership style, infrastructure), on the success of LSS. It is possible to execute benchmarking performance that could validate the results and enhance generalizability.

5.5 Study Limitations

For the last five years, starting from March 2020 and the world health crisis of COVID-19 pandemic, followed by the October 2023 war on Palestine, Saint Joseph hospital

day care surgical services were greatly affected and multiple interruptions occurred to Palestinians' access of care to East Jerusalem health care services; the patients can hardly manage to get the needed permissions to enter Jerusalem, limitation on Palestinians access to care, especially day care surgeries, had limited the study population to be mostly from Palestinians who live in East Jerusalem, and not West Bank or Gaza Strip.

Internally, and before the implementation of LSS, Saint Joseph Hospital lacked a fully digitized HMIS for day surgery services; data concerning surgery scheduling and peri-operative care activities were documented on paper records. This necessitates the researcher to manually review patients' medical files and surgeries' schedules in order to track some performance metrics like no-show and cancelled surgeries rates, which resulted in slowing down pre-LSS data collection process and negatively impacted its efficiency. Furthermore, resistance for change from senior surgeons and care providers had been faced by the researcher, which resolved by showing the quantification of inefficiencies in numbers, and emphasizing the necessity for improving patient satisfaction and declining the no-show and surgery cancellation rates.

While the study's findings support the proposed strategic improvements, their sustained implementation and advancement may face challenges arising from internal organizational issues like the need for additional LSS trainings, further logistics and resources, or external disruptions such as political instability and country lockdown.

References

- Abate, S., Chekole, Y., Minaye, S., & Basu, B. (2020). Global prevalence and reasons for case cancellation on the intended day of surgery: A systematic review and meta-analysis. *International Journal of Surgery Open*, 26, 55–63. <https://doi.org/10.1016/j.ijso.2020.08.006>
- Aiken, L. H., Sloane, D., Griffiths, P., Rafferty, A. M., Bruyneel, L., McHugh, M., Maier, C. B., Moreno-Casbas, T., Ball, J. E., Ausserhofer, D., & Sermeus, W. (2017). Nursing skill mix in European hospitals: Cross-sectional study of the association with mortality, patient ratings, and quality of care. *BMJ Quality & Safety*, 26(7), 559–568. <https://doi.org/10.1136/bmjqs-2016-005567>
- Akdag, H., Oduncu, M., Saglam, G., & Canturk, N. (2017). Lean management application and process design at research hospital outpatient clinics. *PressAcademia Procedia*, 3, 323–336. <https://doi.org/10.17261/Pressacademia.2017.417>
- Al Amin, M., Baldacci, R., & Kayvanfar, V. (2025). A comprehensive review on operating room scheduling and optimization. *Operational Research*, 25, Article 3. <https://doi.org/10.1007/s12351-024-00884-z>
- Al-Balas, S. M., Al-Maqableh, H. O., Athamneh, S., & Odeibat, A. M. (2024). Quality status: A SERVQUAL approach to evaluate the effect of the quality of healthcare services on patient satisfaction in Jordan. *International Journal of Healthcare Management*. <https://doi.org/10.1080/20479700.2024.2310375>
- Alkiayat, M. (2021). A practical guide to creating a Pareto chart as a quality improvement tool. *Global Journal on Quality and Safety in Healthcare*, 4(2), 83–84. <https://doi.org/10.36401/JQSH-21-X1>
- Alkinaidri, A., & Alsulami, H. (2018). Improving healthcare referral system using Lean Six Sigma. *American Journal of Industrial and Business Management*, 8(2), 193–206. <https://doi.org/10.4236/ajibm.2018.82013>
- American Society for Quality. (n.d.). What is value stream mapping (VSM)? In *ASQ Quality Glossary*. Retrieved April 9, 2025, from <https://asq.org/quality-resources/lean/value-stream-mapping>
- Angmo, D., & Kant, S. (2015). Six Sigma implementation in healthcare industry: Past, present, and future. *International Journal of Engineering Research & Technology (IJERT)*, 4(06), 1078–1082. <https://www.ijert.org/research/six-sigma-implementation-in-healthcare-industry-past-present-and-future-IJERTV4IS060950.pdf>
- Antonacci, G., Reed, J. E., Lennox, L., & Barlow, J. (2018). The use of process mapping in healthcare quality improvement projects. *Health Services Management Research*, 31(2), 74–84. <https://doi.org/10.1177/0951484818770411>
- Antony, J. (2010). Six Sigma vs Lean: Some perspectives from leading academics and practitioners. *International Journal of Productivity and Performance Management*, 60(2), 185–190. <https://doi.org/10.1108/17410401111101494>

- Antony, J., Snee, R., & Hoerl, R. (2017). Lean Six Sigma: Yesterday, today and tomorrow. *International Journal of Quality & Reliability Management*, 36(8), 1494-1510. <https://ilssi.org/wp-content/uploads/2018/06/IJQRM-LSS-Yesterday-Today-and-Tomorrow.pdf>
- Bailey, C., Ahuja, M., Bartholomew, K., Bew, S., Forbes, L., Lipp, A., Montgomery, J., Russon, K., Potparic, M., & Stocker, M. (2019). Guidelines for day-case surgery 2019. *Anaesthesia*, 74(6), 778–792. <https://doi.org/10.1111/anae.14639>
- Barr, E., & Brannan, G. (2024, January 11). Quality Improvement Methods (LEAN, PDSA, Six Sigma). *National Library of Medicine*. <https://www.ncbi.nlm.nih.gov/books/NBK599556/>
- Berlinger, M., Kolling, S., & Schneider, J. (2021). A generalized Anderson–Darling test for the goodness-of-fit evaluation of the fracture strain distribution of acrylic glass. *Glass Struct Eng* 6, 195–208 <https://doi.org/10.1007/s40940-021-00149-7>
- Bhat, S., Gijo, E., & Jnanesh, N. (2014). Application of Lean Six Sigma methodology in the registration process of a hospital. *International Journal of Productivity and Performance Management*, 63(5), 613–643. <https://doi.org/10.1108/IJPPM-11-2013-0191>
- Brown, R., Grehan, P., Brennan, M., Carter, D., Brady, A., Moore, E., Teeling, S., Ward, M., & Eaton, D. (2019). Using Lean Six Sigma to improve rates of day-of-surgery admission in a national thoracic surgery department. *International Journal for Quality in Health Care*, 31(Supplement 1), 14–21. <https://doi.org/10.1093/intqhc/mzz083>
- Cholewa, J., Kaneriy, A., & Anderson, M. (2024). *Data driven insights to operating room inefficiencies: What's next? Part I. Journal of Orthopaedic Experience & Innovation*, 5(2). <https://doi.org/10.60118/001c.117196>
- Cohen-Yatziv, L., Cohen, M., Halevy, J., & Kaliner, E. (2019). No-shows in ambulatory clinics and non-utilized appointments for elective operations in selected surgical departments at a tertiary hospital in Israel. *Israel Journal of Health Policy Research*, 8(1), 13. <https://doi.org/10.1186/s13584-019-0333-5>
- Costa Jr, A. S., Leao, L. E. V., Novais, M. A. P., & Zucchi, P. (2015). An assessment of the quality indicators of operative and non-operative times in a public university hospital. *Einstein (Sao Paulo)*, 13(4), 594-599. <https://doi.org/10.1590/S1679-45082015GS3289>
- Costa, L., & Filho, M. (2016). Lean healthcare: Review, classification and analysis of literature. *Production Planning & Control*, 27(10), 823–836. <https://doi.org/10.1080/09537287.2016.1143131>
- Creswell, J., & Plano Clark, V. (2018). *Designing and conducting mixed methods research (3rd ed.)*. SAGE Publications. pp. 110-114. <https://bayanbox.ir/view/236051966444369258/9781483344379-Designing-and-Conducting-Mixed-Methods-Research-3e.pdf>

- Dahlgaard, J., Pettersen, J., & Dahlgaard-Park, S. (2011). Quality and Lean healthcare: A system for assessing and improving the health of healthcare organizations. *Total Quality Management & Business Excellence*, 22(6), 673–689. <https://doi.org/10.1080/14783363.2011.580651>
- Daniell, B. (2024, September 23). *Ultimate guide to patient access KPIs for healthcare organizations for 2025*. Dialog Health. <https://www.dialoghealth.com/post/patient-access-kpis>
- Dantas, L., Fleck, J., Cyrino Oliveira, F., & Hamacher, S. (2018). No-shows in appointment scheduling—A systematic literature review. *Health Policy*, 122(4), 412–421. <https://doi.org/10.1016/j.healthpol.2018.02.002>
- Dave, P. Y. (2020). The history of Lean manufacturing by the view of Toyota–Ford. *International Journal of Scientific and Engineering Research*, 11(9), 933–939. https://www.researchgate.net/publication/344460563_The_History_of_Lean_Manufacturing_by_the_view_of_Toyota-Ford
- Davies, C., Lyons, C., & Whyte, R. (2019). Optimizing nursing time in a day care unit: Quality improvement using Lean Six Sigma methodology. *International Journal for Quality in Health Care*, 31, 22–28. <https://doi.org/10.1093/intqhc/mzz087>
- Dixit, A., & Sun, E. (2024). *Improving patient care and enhancing surgical efficiency: Strategies to reduce same-day surgical cancellations*. *Anaesthesia*, 79(6), 573–575. <https://doi.org/10.1111/anae.16282>
- Dixon-Woods, M. (2019). How to improve healthcare improvement: An essay by Mary Dixon-Woods. *BMJ*, 367, l5514. <https://doi.org/10.1136/bmj.l5514>
- Does, R., Van den Heuvel, J., De Mast, J., & Niemeijer, G. (2010). Improving quality in healthcare while reducing costs. *Quality Management Forum*, 36(3), 12–15. https://www.researchgate.net/publication/239856760_Improving_quality_in_healthcare_while_reducing_costs
- Etienne, E., & Etienne, M. (2021). Six-Sigma and lean thinking in healthcare: A comprehensive literature review and critical assessment. *Review of Contemporary Business Research*, 9(1-2), 15–35. https://rcbr.thebrpi.org/journals/rcbr/Vol_9_No_1_2_December_2021/2.pdf
- Feldman, K. (2025). *Voice of the business: Benefits and uses for your organization*. iSixSigma. Retrieved July 7, 2025, from <https://www.isixsigma.com/dictionary/voice-of-the-business-vob/>
- Fixler, T., & Wright, J. (2013). Identification and use of operating room efficiency indicators. *Journal of Perioperative Practice*, 23(12), 328–333. <https://doi.org/10.1503/cjs.020712>
- Galvan-Perez, Y., Herrera-Polo, M., Hernandez-Paez, D. A., Neira Rodado, D., Salas-Navarro, K., Rueda-Olivella, A. M., Beltran-Venegas, T., Lozada-Martinez, I. D., & Delgado, P. (2025). Six Sigma applied to healthcare: A global scientometrics analysis.

International Journal of Health Care Quality Assurance.
<https://doi.org/10.1177/11786329251352018>

- Gapp, R., Fisher, R., & Kobayashi, K. (2008). Implementing 5S within a Japanese context: An integrated management system. *Management Decision*, 46(4), 565–579.
<https://doi.org/10.1108/00251740810865067>
- Gardim, L., Rodrigues dos Santos, F., Moreno Dias, B., Barrionuevo El Hetti Fuentes, L., de Campos Pereira Silveira, R. C., & Bernardes, A. (2024). Lean and/or Six Sigma for process optimization in the perioperative period: An integrative review. *Revista Brasileira de Enfermagem*, 77(2), e20230431. <https://doi.org/10.1590/0034-7167-2023-0431>
- Getting It Right First Time. (2024, September). *National Day Surgery Delivery Pack* (Version 2.0). <https://www.gettingitrightfirsttime.co.uk/wp-content/uploads/2024/09/National-Day-Surgery-Delivery-Pack-V2.0-September-2024.pdf>
- Giese, A., Khanam, R., Nghiem, S., Rosemann, T., & Havranek, M. (2024). Patient-reported experience is associated with higher future revenue and lower costs of hospitals. *The European Journal of Health Economics*, 25(6), 1031–1039.
<https://doi.org/10.1007/s10198-023-01646-y>
- Gilliard, N., Eggli, Y., & Halfon, P. (2006). A methodology to estimate the potential to move inpatient to one-day surgery. *BMC Health Services Research*, 6, Article 78.
<https://doi.org/10.1186/1472-6963-6-78>
- Glowka, L., Tanella, A., & Hyman, J. B. (2023). Quality indicators and outcomes in ambulatory surgery. *Current Opinion in Anaesthesiology*, 36(6), 624–629.
<https://doi.org/10.1097/ACO.0000000000001304>
- Grocott, M., & Mythen, M. (2015). Perioperative medicine. *Anesthesiology Clinics*, 33(4), 629–644. <https://www.sciencedirect.com/science/article/pii/S1932227515000683>
- Guzman-Leguel, Y. M., & Rodriguez-Lara, S. Q. (2025). Assessment of patients' quality of care in healthcare systems: A comprehensive narrative literature review. *Healthcare*. Advance online publication. <https://doi.org/10.3390/healthcare13141714>
- Hess, J. D., & Benjamin, B. A. (2015). Applying Lean Six Sigma within the university: Opportunities for process improvement and cultural change. *International Journal of Lean Six Sigma*, 6(3), 249–262. <https://doi.org/10.1108/IJLSS-12-2014-0036>
- Honda, A., Bernardo, V., Gerolamo, M., & Davis, M. (2018). How Lean Six Sigma principles improve hospital performance. *Quality Management Journal*, 25(2), 70–82.
<https://doi.org/10.1080/10686967.2018.1436349>
- Ilin, M. (2023). Six Sigma method. In *StatPearls*. StatPearls Publishing.
<https://www.ncbi.nlm.nih.gov/books/NBK589666>

- Kakande, I., Nassali, G., & Kituuka, O. (2005). Day care surgery: The norm for elective surgery. *East and Central African Journal of Surgery*, 10(1), 17–21. <https://www.researchgate.net/publication/239801737>
- Kam, A. W., Collins, S., Park, T., Mihail, M., Stanaway, F. F., Lewis, N. L., Polya, D., Fraser-Bell, S., Roberts, T. V., & Smith, J. E. H. (2021). Using Lean Six Sigma techniques to improve efficiency in outpatient ophthalmology clinics. *BMC Health Services Research*, 21(1), 38. <https://doi.org/10.1186/s12913-020-06034-3>
- Kanabar, B., Piparva, K. G., Pandya, D., & Kanabar, R. B. (2024). The impact and challenges of the implementation of 5S methodology in healthcare settings: A systematic review. *Cureus*, 16(7), e64634. <https://doi.org/10.7759/cureus.64634>
- Kasunic, M. (2005). *Designing an effective survey* (CMU/SEI-2005-HB-004). Carnegie Mellon University, Software Engineering Institute. https://www.sei.cmu.edu/documents/1611/2005_002_001_14435.pdf
- Knox, C., Harper, J., McMillan, L., Vining, B., & White, T. (2024). Increasing first case on time starts in the operating room using an electronic readiness dashboard: A quality improvement project. *Perioperative Care and Operating Room Management*, 35, Article 100412. <https://doi.org/10.1016/j.pcorm.2024.100412>
- Koh, W., Phelan, R., Hopman, W., & Engen, D. (2021). Cancellation of elective surgery: Rates, reasons and effect on patient satisfaction. *Canadian Journal of Surgery*, 64(2), E155–E161. <https://doi.org/10.1503/cjs.008119>
- Koushan, M., Wood, L., & Greatbanks, R. (2021). Evaluating factors associated with the cancellation and delay of elective surgical procedures: A systematic review. *International Journal for Quality in Health Care*, 33(2). <https://doi.org/10.1093/intqhc/mzab092>
- Kruk, M. E., Gage, A. D., Arsenault, C., Jordan, K., Leslie, H. H., Roder-DeWan, S., Sylvester, M., Adeyi, O., Barker, P., Daelmans, B., Doubova, S. V., English, M., García-Elorrio, E., Guanais, F., Gureje, O., Hirschhorn, L. R., Jiang, L., Kelley, E., Lemango, ... Pate, M. (2018). High-quality health systems in the Sustainable Development Goals era: Time for a revolution. *The Lancet Global Health*, 6(11), e1196–e1252. [https://doi.org/10.1016/S2214-109X\(18\)30386-3](https://doi.org/10.1016/S2214-109X(18)30386-3)
- Kusuma, M., Babu, R., & Judith, M. N. (2016). Six Sigma applications in reducing cancellation of operative procedure in operation theatre of a tertiary care hospital. *IOSR Journal of Dental and Medical Sciences*, 15(6), 01–07. <http://doi.org/10.9790/0853-1506030107>
- Laureani, A., Brady, M., & Antony, J. (2013). Applications of Lean Six Sigma in an Irish hospital. *Leadership in Health Services*, 26(4), 322–337. <https://doi.org/10.1108/LHS-01-2012-0002>
- Laureani, A., & Antony, J. (2017). Leadership and Lean Six Sigma: A systematic literature review. *Total Quality Management & Business Excellence*, 30(1–2), 53–81. <https://doi.org/10.1080/14783363.2017.1288565>

- Lima, R., Dinis-Carvalho, J., Souza, Th., Vieira, E., & Gonçalves, B. (2021). Implementation of Lean in Healthcare environments: an update of systematic reviews. *International Journal of Lean Six Sigma (IJLSS)*. <https://doi.org/10.1108/IJLSS-07-2019-0074>
- Liu, C., & Zhang, Y. (2023). Advances and hotspots analysis of value stream mapping using bibliometrics. *International Journal of Lean Six Sigma*, 14(1), 190-208. <https://doi.org/10.1108/IJLSS-12-2021-0219>
- Mandahawi, N., Al-Araidah, O., Boran, A., & Khasawneh, M. (2011). Application of Lean Six Sigma tools to minimise length of stay for ophthalmology day case surgery. *International Journal of Six Sigma and Competitive Advantage*, 6(3), 156 - 72. <https://doi.org/10.1504/IJSSCA.2011.039716>
- Marin-Garcia, J., Vidal-Carreras, P., & Garcia-Sabater, J. (2021). The role of value stream mapping in healthcare services: A scoping review. *International Journal of Environmental Research and Public Health*, 18(3), 951. <https://doi.org/10.3390/ijerph18030951>
- Mason, S. E., Nicolay, C. R., & Darzi, A. (2015). The use of Lean and Six Sigma methodologies in surgery: A systematic review. *Surgical Endoscopy*, 29(10), 2565–2576. <https://doi.org/10.1016/j.surge.2014.08.002>
- McDermott, O., Antony, J., Bhat, S., Jayaraman, R., Rosa, A., Marolla, G., & Parida, R. (2022). Lean Six Sigma in healthcare: A systematic literature review on motivations and benefits. *Processes*, 10(1910). <https://doi.org/10.3390/pr10101910>
- Micieta, B., Howaniec, H., Binasova, V., Kasajova, M., & Fusko, M. (2021). Increasing work efficiency in a manufacturing setting using Gemba walk. *European Research Studies Journal*, 24(Special Issue 4), 601–620. <https://doi.org/10.35808/ersj/2792>
- Montgomery, D. C. (2020). *Introduction to Statistical Quality Control* (8th ed.). John Wiley & Sons. (pp. 354 - 360)
- Nabiyouni, N., & Franchetti, M. (2019). Applying Lean Six Sigma methods to improve infectious waste management in hospitals. *International Journal of Six Sigma and Competitive Advantage*, 11(1), 1–22. <https://doi.org/10.1504/IJSSCA.2019.098706>
- Nowak, M., Pfaff, H., & Karbach, U. (2017). Does Value Stream Mapping affect the structure, process, and outcome quality in care facilities? A systematic review. *Systematic Reviews*, 6, Article 170. <https://doi.org/10.1186/s13643-017-0563-y>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- Parasuraman, A., Zeithaml, V., & Berry, L. (1988) SERVQUAL: A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality. *Journal of Retailing*, 64(1), 12–

40. https://www.researchgate.net/publication/200827786_SERVQUAL_A_Multiple-item_Scale_for_Measuring_Consumer_Perceptions_of_Service_Quality
- Pearson, N., Naylor, P.-J., Ashe, M. C., Fernandez, M., & others. (2020). Guidance for conducting feasibility and pilot studies for implementation trials. *Pilot and Feasibility Studies*, 6, Article 167. <https://doi.org/10.1186/s40814-020-00634-w>
- Petropoulou, M., Rücker, G., Weibel, S., Efthimiou, O., & Schwarzer, G. (2023). Model selection for component network meta-analysis in connected and disconnected networks: A simulation study. *BMC Medical Research Methodology*, 23, 140. <https://doi.org/10.1186/s12874-023-01959-9>
- Pierce, A., Teeling, S. P., McNamara, M., O'Daly, B., & Daly, A. (2023). Using Lean Six Sigma in a private hospital setting to reduce trauma orthopedic patient waiting times and associated administrative and consultant caseload. *Healthcare*, 11(19), 2626. <https://doi.org/10.3390/healthcare11192626>
- Rahmatia, S., Basri, M., Ismail, I., Adi, S., Nasrullah, N., & Ahmad, A. (2025). Service quality in hospital inpatient care: SERVQUAL model approach. *Health SA Gesondheid*, 30, Article 3055. <https://doi.org/10.4102/hsag.v30i0.3055>
- Rathi, R., Vakharia, A., & Shadab, M. (2022). Lean Six Sigma in the healthcare sector: A systematic literature review. *Materials Today: Proceedings*, 50, 773–781. <https://doi.org/10.1016/j.matpr.2021.05.534>
- Rathore, R., & Srivastava, A. (2019). Application of Lean Six Sigma for quality improvement in healthcare: A review. *International Journal of Six Sigma and Competitive Advantage*. <https://onlinejournals-heb.pennic.in/cass/admin/freePDF/ph001y48mra7hv0r3osz.pdf>
- Rathore, R., & Srivastava, A. (2020). A decade of Lean Six Sigma (LSS) in healthcare: Past review, current state and future perspective. *International Journal of Engineering Research & Technology (IJERT)*, 9 (6). <https://doi.org/10.17577/ijertv9is060387>
- Reichardt, C., Storages, D., & Abraham, D. (2023). Quasi-experimental research. In A. Field, J. Miles, & Z. Field (Eds.), *The Cambridge Handbook of Research Methods and Statistics for the Social and Behavioral Sciences* (pp. 292–313). Cambridge University Press. <https://doi.org/10.1017/9781009010054.015>
- Rezaei, S., Hajizadeh, M., Zandian, H., Fathi, A., & Nouri, B. (2018). Service quality in Iranian hospitals: A systematic review and meta-analysis. *Medical Journal of the Islamic Republic of Iran*, 32, 59. <https://doi.org/10.14196/mjiri.32.59>
- Rohini, R. & Mallikarjun, J. (2011). Six Sigma: Improving the Quality of Operation Theater. *Procedia - Social and Behavioral Sciences*. (25), 273-280. <https://doi.org/10.1016/j.sbspro.2011.10.547>
- Rosa, A., Capolupo, N., Romeo, E., McDermott, O., Antony, J., Sony, M., & Bhat, S. (2024). Assessing Lean Six Sigma and quality performance improvement in Italian public healthcare organizations: A validated scale. *TQM Journal*, 36(9), 392–412. <https://doi.org/10.1108/TQM-10-2023-0350>

- Roseen, E. J., Natrakul, A., Kim, B., & Broder-Fingert, S. (2024). Process mapping with failure mode and effects analysis to identify determinants of implementation in healthcare settings: A guide. *Implementation Science Communications*, 5(110). <https://doi.org/10.1186/s43058-024-00642-4>
- Saint Joseph Hospital. (n.d.). *Official website of Saint Joseph Hospital*. Data retrieved on October 15, 2024. <https://stjoseph.cc/>
- Saint Joseph Hospital Reports. (2020-2023). *Hospital Performance and Statistics Reports*. Annual Release.
- Samanta, A., Varaprasad, G., & Gurumurthy, A. (2022). Implementing Lean Six Sigma in health care: A review of case studies. *International Journal of Lean Six Sigma*, 14(1), 31–50. <https://doi.org/10.1108/IJLSS-08-2021-0133>
- Schouten, A., Flipse, S., van Nieuwenhuizen, K., Jansen, F., van der Eijk, A., & van den Dobbelsteen, J. (2023). Operating room performance optimization metrics: A systematic review. *Journal of Medical Systems*, 47(1), 19. <https://doi.org/10.1007/s10916-023-01912-9>
- Schretlen, S., Hoefsmit, P., Kats, S., Merode, G., Maessen, J., & Zandbergen, R. (2021). Reducing surgical cancellations: a successful application of Lean Six Sigma in healthcare. *BMJ Open Quality*, 10(1342). doi:10.1136/bmjoq-2021-001342.
- Sordan, J. E., Marinho, C. A., Oprime, P. C., Pimenta, M. L., & Andersson, R. (2023). Characterization of Lean Six Sigma projects in healthcare settings: empirical research. Benchmarking: An International Journal, 30(10), 4058-4075. <https://doi.org/10.1108/BIJ-03-2022-0183>
- Spanos, S., Agapidaki, E., & Kerasidou, E. (2024). Healthcare leaders navigating complexity: A scoping review of future trends. *BMC Medical Education*, 24, Article 389. <https://doi.org/10.1186/s12909-024-05689-4>
- Tagaram, S., & Chen, C. (2024). Quality tools and techniques (Fishbone diagram, Pareto chart, process map). In StatPearls. *StatPearls Publishing*. <https://www.ncbi.nlm.nih.gov/books/NBK607994/>
- Talero-Sarmiento, L., Escobar-Rodriguez, T., Gomez-Avila, A., & Parra-Sanchez, A. (2024). A literature review on Lean healthcare. *Cogent Engineering*, 11(1), 2411857. <https://doi.org/10.1080/23311916.2024.2411857>
- Teeling, S. P., McGuirk, M., McNamara, M., McGroarty, M., & Igoe, A. (2023). The utilization of Lean Six Sigma methodologies in enhancing surgical pathways and surgical rehabilitation. *Applied Sciences*, 13(12), 6920. <https://doi.org/10.3390/app13126920>
- Tlapa, D., Zepeda-Lugo, C. A., Tortorella, G. L., Baez-Lopez, Y. A., Limon-Romero, J., Alvarado-Iniesta, A., & Rodriguez-Borbon, M. I. (2020). Effects of Lean Healthcare on patient flow: A systematic review. *Value in Health*, 23(2), 260–273. <https://doi.org/10.1016/j.jval.2019.11.002>
- Toker, K., Atas, K., Mayadagli, A., Gormezoglu, Z., Tuncay, I., & Kazancıoglu, R. (2024). A solution to reduce the impact of patients' no-show behavior on hospital operating

- costs: An artificial intelligence-based appointment system. *Healthcare*, 12(21), 2161. <https://doi.org/10.3390/healthcare12212161>
- Turunen, E., Miettinen, M., Setälä, L., & Vehviläinen-Julkunen, K. (2018). Financial cost of elective day of surgery cancellations. *Journal of Hospital Administration*, 7(6), 30–36. <https://doi.org/10.5430/jha.v7n6p30>
- Ubaid, A., & Al-Juboori, L. (2023). The critical success factors of the Lean Six Sigma implementation: A systematic literature review. *International Journal of Business Excellence*. Advance online publication. Retrieved from <https://www.researchgate.net/publication/372622192> The critical success factors of the Lean Six Sigma implementation a systematic literature review
- Ursachi, G., Horodnic, I. A., & Zait, A. (2015). How reliable are measurement scales? External factors with indirect influence on reliability estimators. *Procedia Economics and Finance*, 20, 679–686. [https://doi.org/10.1016/S2212-5671\(15\)00123-9](https://doi.org/10.1016/S2212-5671(15)00123-9)
- Utama, D. & Abirfatin, M. (2023). Sustainable Lean Six-sigma: A new framework for improve sustainable manufacturing performance. *Cleaner Engineering and Technology*, 17(4), Article 100700. <https://doi.org/10.1016/j.clet.2023.100700>
- Van Zyl, C., Badenhorst, M., Hanekom, S., & Heine, M. (2021). Unravelling ‘low-resource settings’: A systematic scoping review with qualitative content analysis. *BMJ Global Health*, 6(6), e005190. <https://doi.org/10.1136/bmjgh-2021-005190>
- Wackers, E., Stadhouders, N., Heil, A., Westert, G., van Dulmen, S., & Jeurissen, P. (2022). Hospitals bending the cost curve with increased quality: A scoping review into integrated hospital strategies. *International Journal of Health Policy and Management*, 11(11), 2381–2391. <https://doi.org/10.34172/ijhpm.2021.168>
- Wang, J., Lv, H., Chen, M., Liu, C., Ren, W., Jiang, H., & Zhang, L. (2025). A systematic review of Lean implementation in hospitals: Impact on efficiency, quality, cost, and satisfaction. *International Journal of Health Policy and Management*, 14 (8974). <https://doi.org/10.34172/ijhpm.8974>
- Wang, X., Li, H., Zhang, Y., & Chen, J. (2025). A systematic review of Lean implementation in hospitals: Impact on efficiency, quality, cost, and satisfaction. *International Journal of Health Policy and Management*. (14)8974. https://www.ijhpm.com/article_4774_d973f82b58417c1473076efef06f128c.pdf
- World Health Organization. (2023). Health conditions in the occupied Palestinian territory, including east Jerusalem, and in the occupied Syrian Golan: Report by the Director-General. *World Health Assembly*, 76. https://apps.who.int/gb/ebwha/pdf_files/WHA76/A76_15-en.pdf
- Xu, Y., Sun, H., Liu, Q., & Liang, P. (2025). Optimizing efficiency and safety in day surgery: Perspectives from China. *Anesthesiology and Perioperative Science*, 3, Article 53. <https://doi.org/10.1007/s44254-025-00132-3>
- Yarbrough, A. C. (2025). Developing Taiichi Ohno’s mental model for waste identification in nontraditional applications. *Open Engineering*. <https://doi.org/10.1115/1.4054037>

- Yoon, E., Tharakan, A., Johnson, C., Metz, C., & Granger, B. B. (2025). Statistical process control charts to improve health care: Hypertension case. *AACN Advanced Critical Care*, 36(2), 197–204. <https://doi.org/10.4037/aacnacc2025608>
- Young, F. Y. F. (2014). The use of 5S in healthcare services: A literature review. *International Journal of Business and Social Science*, 5(10)(1), 240–248. https://ijbss.thebrpi.org/journals/Vol_5_No_10_1_September_2014/30.pdf
- Zhu, L. F., Qian, W. Y., Zhou, G., Yang, M., Lin, J. J., Jin, J. L., Dong, S. J., Zhu, L. H., & Chen, H.-X. (2020). Applying Lean Six Sigma to reduce the incidence of unplanned surgery cancellation at a large comprehensive tertiary hospital in China. *Inquiry: The Journal of Health Care Organization, Provision and Financing*, 57, Article 0046958020953997. <https://doi.org/10.1177/0046958020953997>
- Zielinski, W. (2024). Determine robust procedure for testing variance equality using Type I error rate and power. ResearchGate. https://www.researchgate.net/publication/380785018_Determine_Robust_Procedure_f_or_Testing_Variance_Equality_Using_Type_I_Error_Rate_and_Power
- Zimmermann, G. D. S., Siqueira, L. D., & Bohomol, E. (2020). Lean Six Sigma methodology application in health care settings: An integrative review. *Revista Brasileira de Enfermagem*, 73(Suppl. 5), e20190861. <https://doi.org/10.1590/0034-7167-2019-0861>

Appendices

Appendix A: Hospital's General Director Approval

Arab American University
Faculty of Graduate Studies



الجامعة العربية الأمريكية
كلية الدراسات العليا

2022-5-24

الأستاذ جميل كوسا المحترم

المدير العام لمستشفى مار يوسف (الفرنسي) القدس

تسهيل مهمة بحثية

تحية طيبة وبعد،

تهديكم كلية الدراسات العليا في الجامعة العربية الأمريكية أطيب التحيات، وبالإشارة إلى الموضوع أعلاه، تشهد كلية الدراسات العليا في الجامعة أن الطالب سامر إبراهيم جابر دعييس والذي يحمل الرقم ال جامعي 201912764 هو طالب ماجستير في برنامج إدارة الجودة الشاملة ويعمل على رسالة الماجستير الخاصة به بعنوان:

"تقييم أثر تطبيق منهجية الإدارة الخالية من الهدر ومنهجية الستة سيجما على خدمات الجراحة اليومية في مستشفى مار يوسف في القدس تحت إشراف الدكتور أشرف عبد الوهاب عبد الرحمن الميمى، نأمل من حضرتكم الإيعاز لمن يلزم لمساعدته للحصول على المعلومات اللازمة للدراسة، علماً أن المعلومات ستستخدم لغاية البحث فقط وسيتم التعامل معها بغاية السرية، وقد أعطي هذه الرسالة بناءً على طلبه.

وتفضلوا بقبول فائق الاحترام

عميد كلية الدراسات العليا

د. نوار قطب



Approved
St. Joseph Hospital
Mr. Jamil Koussa
General Director

Page 1 of 2

Jenin Tel: +970-4-2418888 Ext.:1471,1472 Fax: +970-4-2510810 P.O. Box:240
Ramallah Tel: +970-2-2941999 Fax: +970-2-2941979 Abu Qash - Near Alrehan
E-mail: FGS@aaup.edu ; PGS@aaup.edu Website: www.aaup.edu

Appendix B: Saint Joseph Hospital Ethics Committee Permission (1/2 Pages)

St. Joseph Hospital 91192 P.O. Box 19264 Tel. 02-5911911 Fax +972 2 5819598		مستشفى مار يوسف 91192 القدس ص.ب 19264 تلفون 02-5911911 فاكس +972 2 5819598
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Saint Joseph Hospital
Ethics Committee
Sheikh Jarrah, East Jerusalem
Phone: +972-5911-911 | Email: mdeeb@stjoseph.cc

Ref No.: SJH-EC/2024/01
Date: July 02, 2024

TO WHOM IT MAY CONCERN

Subject: Ethics Approval for Research Study

The Ethics Committee of Saint Joseph Hospital, Jerusalem, hereby confirms that it has reviewed the research proposal submitted by Samer Ibrahim Jaber Da'ibes, a postgraduate student at the Arab American University, entitled:

“Assessing the Impact of Lean Six Sigma Methodology Implementation on Day Care Surgical Services at Saint Joseph Hospital in Jerusalem”

The committee reviewed the study protocol, data collection tools, patient involvement procedures, and consent strategy during its scheduled meeting held on June 12, 2024.

After thorough review and deliberation, the committee found the study to be ethically sound and compliant with institutional and international research ethics standards, including:

- Respect for patient autonomy and informed consent
- Protection of patient confidentiality and data security
- Minimization of risk and burden to participants
- Scientific and social value of the research

Approval Decision: APPROVED

This approval is granted for the period of 2024 – 2026, commencing from the date of this letter. The investigator is requested to:

- Report any protocol amendments to the Ethics Committee for re-approval

Page 1 of 2

Appendix B: Saint Joseph Hospital Ethics Committee Permission (2/2 Pages)

St. Joseph Hospital 91192 P.O. Box 19264 Tel. 02-5911911 Fax +972 2 5819598		مستشفى مار يوسف 91192 القدس ص.ب 19264 تلفون 02-5911911 فاكس +972 2 5819598
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- Notify the committee of any serious adverse events or ethical concerns

- Submit a brief final report upon study completion

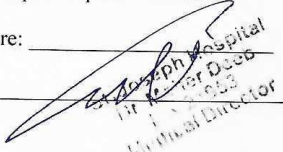
We wish the researcher success in the execution of this important quality improvement initiative.

For and on behalf of the
Saint Joseph Hospital Ethics Committee

Dr. Maher Deeb
Chair, Ethics Committee
Saint Joseph Hospital – Jerusalem

Signature: _____

Date: _____


Dr. Maher Deeb
Medical Director

2/7/2024.

Appendix C: Arab American University Institutional Review Board (IRB) Approval



IRB Approval Letter

Study Title: "Assessing the Impact of Lean Six Sigma (LSS) Methodology Implementation on Day Care Surgical Services at Saint Joseph Hospital in Jerusalem".

Submitted by: Samer Ibrahim Jaber Da'beis

Date received: 25th June 2025

Date reviewed: 25th June 2025

Date approved: 1st July 2025

Your Study titled "Assessing the Impact of Lean Six Sigma (LSS) Methodology Implementation on Day Care Surgical Services at Saint Joseph Hospital in Jerusalem" with the code number "R-2025/A/47/N" was reviewed by the Arab American University Institutional Review Board - Ramallah and it was approved on the 1st of July 2025.

Sajed Ghawadra, PhD
IRB-R Chairman
Arab American University of Palestine



General Conditions:

1. Valid for 6 months from the date of approval.
2. It is important to inform the IRB-R with any modification of the approved study protocol.
3. The Board appreciates a copy of the research when accomplished.

رام الله - فلسطين

Tel: 02-294-1999

E-Mail: IRB-R@aaup.edu

Website: www.aaup.edu

Appendix D: Structured Interview Questions for Participants – Page 1/2 (Arabic Version)

المسمى الوظيفي/المهنة: _____ التاريخ: ____ / ____ / ____

القسم الأول: التجربة والرضا Experience and Satisfaction

1. بشكل عام، كيف تقيم الجودة والكفاءة لخدمات الجراحة اليومية في مستشفى مار يوسف؟ ولماذا؟
2. ما هو مستوى رضاك عن خدمات الجراحة اليومية المقدمة في مستشفى مار يوسف؟ ولماذا؟
3. برأيك، ما مدى رضا الطاقم عن خدمات الجراحة اليومية وسير العمل الحالي؟ ولماذا؟
4. برأيك، ما مدى رضا المرضى وعائلاتهم عن خدمات الجراحة اليومية وسير العمل الحالي؟ ولماذا؟

القسم الثاني: الكفاءة والنتائج Efficiency and Outcomes

5. برأيك، ما هي العوامل / المحيقات التي تؤثر بشكل سلبي على سيرورة عمل خدمات الجراحة اليومية في المستشفى؟ والتي قد تكون مصدر للتأخير أو الهدر في العملية الحالية؟
6. برأيك، ما هي العوامل التي تؤثر بشكل إيجابي على سيرورة عمل خدمات الجراحة اليومية في المستشفى؟
7. كيف تقيم نتائج العمليات الجراحية في مستشفى مار يوسف؟

القسم الثالث: فرص التحسين Improvement Opportunities

8. برأيك، هل يمكن تحسين خدمات الجراحة اليومية في المستشفى؟ إذا كان الجواب نعم؛ كيف؟
9. هل هناك أي عوامل أو محيقات قد تؤثر بشكل سلبي على إجراء تحسينات الخدمات الجراحية في المستشفى؟

القسم الرابع: المنافسة Competitiveness

10. هل تعتقد أن خدمات الجراحة اليومية في مستشفى مار يوسف تتنافس المؤسسات الصحية الأخرى؟ إذا كان الجواب نعم؛ كيف؟

القسم الخامس: اقتراحات أخرى Suggestions

Appendix D: Structured Interview Questions for Participants – Page 2/2 (English Version)

Position/Profession: _____ Date: ____ / ____ / ____

Section A: Experience and Satisfaction

1. Overall, how would you evaluate the quality and efficiency of day care surgical services at Saint Joseph Hospital? Please explain.
2. What is your level of satisfaction with the day care surgical services provided at the hospital? Why?
3. In your opinion, how satisfied is the staff with the current workflow and day care surgical services? Please explain.
4. In your view, how satisfied are patients and their families with day care surgical services and the current workflow? Why?

Section B: Efficiency and Outcomes

5. What factors or barriers negatively affect the workflow of day care surgical services? Which of these may cause variability or waste in the current process?
6. What factors positively influence the workflow of day care surgical services?
7. How do you evaluate the outcomes of day care surgical procedures at Saint Joseph Hospital?

Section C: Improvement Opportunities

8. Do you believe day care surgical services can be improved? If yes, how?
9. Are there any factors or barriers that might negatively affect the implementation of service improvements?

Section D: Competitiveness

10. Do you think day care surgical services at Saint Joseph Hospital are competitive compared to other healthcare institutions? If yes, how?

Section E: Additional Suggestions

11. Do you have any other comments or suggestions?

Appendix E: Participant's Information - Page1/2

Arab American University
Institutional Review Board - Ramallah



الجامعة العربية الأمريكية
مجلس أخلاقيات البحث العلمي – رام الله

نموذج معلومات المشاركين

AAUP-IRB-R Code No.:

AAUP-IRB-R Date:

عنوان الدراسة:

تقييم أثر تطبيق منهجية اللين ستة سيجما (Lean Six Sigma) على خدمات الجراحة اليومية في مستشفى مار يوسف في القدس

يسرنا دعوتك للمشاركة في دراسة بحثية. قبل أن نقرر ما إذا كنت ستشارك أم لا، عليك أن تفهم سبب إجراء البحث وماذا يمكن أن يتضمن. خذ وقتاً كافياً لقراءة المعلومات التالية بعناية، يمكنك التحدث مع الآخرين حول هذه الدراسة إذا أردت. يمكنك سؤالنا عما إذا كان هناك شيء غير واضح أو في حال كنت ترغب بالمزيد من المعلومات. خذ وقتك لتقرير ما إذا كنت ترغب في المشاركة أم لا.

1. ما الهدف من هذه الدراسة؟

تهدف هذه الدراسة إلى تقييم فعالية منهجية اللين ستة سيجما في تحسين الكفاءة التشغيلية، ورضا المرضى، وجودة الخدمة في الجراحات اليومية في مستشفى مار يوسف. كما تهدف إلى تحديد أوجه القصور في سير العمل الجراحي وتقييم التحسينات بعد تطبيق نموذج DMAIC (التحديد – القياس – التحليل – التحسين – التحكم).

2. لم تعتبر هذه الدراسة مهمة؟

تعالج هذه الدراسة التحديات الحرجة المحتملة في تدفق المرضى، وتأخيرات العمليات الجراحية اليومية، والإلغاءات. وهي الأولى من نوعها في فلسطين التي تطبق اللين ستة سيجما في بيئة جراحية وتهدف إلى تطوير نموذج لتحسين الجودة يمكن تطبيقه في مؤسسات صحية أخرى.

3. ما هي الاجراء الذي يتم اختياره؟ (ان كان ينطبق)

تقيم الدراسة تطبيق مبادئ اللين ستة سيجما باستخدام منهجية DMAIC. يتضمن ذلك رسم خرائط سير العمليات، وجمع البيانات من أنظمة المستشفى، واستطلاعات المرضى، ومقابلات مع الموظفين ومثراء الأقسام والجراحين، ومراقبة مباشرة لسير العمل.

4. لم تمت دعوتي للمشاركة في هذه الدراسة؟

تمت دعوتك للمشاركة لأنك شخص أساسي يشارك في خدمات الجراحة اليومية بمستشفى مار يوسف. آراؤك وملاحظاتك ضرورية لفهم تأثير جهود تحسين الجودة.

5. من يجب أن لا يشارك في الدراسة؟

الأشخاص الذين لا يشاركون بشكل مباشر في خدمات الجراحة اليومية، أو أي شخص غير مستعد لتقديم موافقة مستنيرة يجب ألا يشارك.

6. هل يمكنني رفض المشاركة في الدراسة؟

نعم. المشاركة في هذه الدراسة طوعية تماماً. يمكنك رفض المشاركة أو الانسحاب في أي وقت دون أي عقوبة أو تأثير على وضعك/عملك.

7. ماذا سيحدث لي إذا شاركت؟

سيُطلب منك المشاركة في مقابلة أو تعبئة استبيان عن سير العمل في خدمات الجراحة اليومية. لن يتم ربط هويتك أو التعريف عنك بأي من النتائج.

8. كم المدة التي سأكون فيها مشاركاً في هذه الدراسة؟

ستقتصر مشاركتك المباشرة على نشاط لمرة واحدة يستمر ما بين 15 إلى 30 دقيقة. تستمر الدراسة بشكل عام لعدة أشهر، لكن لا يتطلب منك أي متابعة.

رام الله – فلسطين

Tel: 02-294-1999

E-Mail: IRB-R@aaup.edu

Website: www.aaup.edu

9. ما هي الاضرار والمخاطر المحتملة؟
هناك مخاطر طفيفة فقط. قد يشعر بعض المشاركين بعدم الارتياح عند مناقشة تحديات سير العمل الجراحي أو تجارب الخدمة. لا توجد إجراءات تداخلية أو جراحية، وسيتم الحفاظ على الخصوصية وسرية جميع المعلومات.
10. ما هي الفوائد المحتملة لي؟
قد لا تكون هناك فائدة شخصية مباشرة، ولكن مشاركتك ستساهم في تحسين الخدمات الصحية في مستشفى مار يوسف وقد تساعد في تحسين رعاية المرضى للمجتمع الأوسع.
11. من سيكون لديه صلاحية الوصول لسجلاتي الطبية وبيانات البحث؟
فقط الطلاب والمشراف على البحث سيكون لديهم إمكانية الوصول إلى البيانات المجهولة الهوية التي تم جمعها لهذه الدراسة. سيتم معالجة جميع المعلومات وفقاً لمعايير السرية.
12. هل سيتم الحفاظ على سرية بياناتي؟
نعم. سيتم ترميز جميع البيانات وتخزينها بأمان. لن تظهر هويتك في أي تقارير أو منشورات.
13. ماذا سيحدث لأي عينات أقوم بتقديمها؟ (إذا كان يطبق)
غير قابل للتطبيق. هذه الدراسة لا تتضمن جمع عينات بيولوجية.
14. ماذا سيحدث إذا لم أرغب في مواصلة الدراسة؟
يمكنك الانسحاب من الدراسة في أي وقت دون إبداء سبب ودون أي عواقب سلبية.
15. ماذا سيحدث لنتائج الدراسة البحثية؟
سيتم استخدام النتائج لأغراض أكاديمية، وقد يتم نشرها في مجلات علمية أو تقديمها في مؤتمرات. ستبلغ جميع البيانات بشكل إجمالي دون أي معلومات تعريفية.
16. هل سأحصل على مكافئة مقابل المشاركة في هذه الدراسة؟
لن يتم تقديم أي تعويض مالي. ومع ذلك، فإن مساهمتك الطوعية ذات قيمة كبيرة وستساعد في تحسين جودة الرعاية الصحية.
17. بمن يجب أن أتصل إذا كانت لدي أسئلة إضافية أو حدثت مشاكل أثناء الدراسة؟
تفاصيل الاتصال للباحث:
سامر إبراهيم جابر دعبس
البريد الإلكتروني: s.dabeis@student.aaup.edu
الهاتف المحمول: 00972585911900 - 00970599769729
18. بمن يجب أن أتصل إذا لم أكن راضياً عن كيفية إجراء الدراسة؟
مجلس أخلاقيات البحث العلمي - رام الله
الجامعة العربية الأمريكية
البريد الإلكتروني: IRB-R@aaup.edu

Appendix F: Patients Satisfaction Survey

St. Joseph Hospital
91192
P.O. Box 19264
Tel. 02-5911911 Fax +972 2 5819598



مستشفى مار يوسف
91192 القدس
ص.ب 19264
تلفون 02-5911911 فاكس +972 2 5819598

استبيان لقياس رضا المرضى وذويهم قسم الجراحة اليومية (تحبئة الاستبيان تتم بشكل طوعي)

عزيزي المريض / المريضة،

نسعى إدارة مستشفى مار يوسف (الفرنسي) في القدس جاهدة لتقديم أفضل خدمات الجراحة اليومية في المستشفى، لذلك الرجاء الإجابة على الأسئلة التالية، إذ أن تقييمكم لجودة الخدمات واقتراحاتكم مهمٌ لنا من أجل راحتكم ولإرتقاء بالخدمة في قسم الجراحة اليومية في المستشفى.

تاريخ دخول المستشفى: ____/____/____

ملاحظات	ممتاز 5	جيد جداً 4	جيد 3	مقبول 2	غير مقبول 1	البند
						1. تواجد الإرشادات والإرشادات في المستشفى
						2. معاملة موظفي الإستقبال كانت
						3. الوقت الذي إستغرقته إجراءات الدخول في قسم الإستقبال كان
						4. الوقت الذي إستغرقته إجراءات الدخول إلى قسم الجراحة اليومية كان
						5. الوقت الذي إستغرقته إجراءات الدخول إلى قسم العمليات كان؟
						6. معاملة طاقم التمريض كانت
						7. استجابة طاقم التمريض لمتطلباتي كانت
						8. الشرح والإجابة وعن الأسئلة عن حالتي الصحية من قبل التمريض
						9. العناية التمريضية خلال فترة مكوثي في المستشفى
						10. معاملة الأطباء
						11. شرح الطبيب عن حالتي الصحية والإجابة عن أي سؤال
						12. النظافة بشكل عام في المستشفى
						13. نظافة المرافق الخاصة مثل الحمامات وغيرها
						14. السرير الذي أقمته عليه كان حسب توقعاتي
						15. تم الشرح عن الإرشادات الخاصة بمغادرة المستشفى

❖ في حال إحتياجي لتلقي الرعاية الصحية (لا سمح الله)، سأختار هذا المستشفى: ☐ نعم ☐ لا

❖ سأوصي أصدقائي وأقاربي باختيار هذا المستشفى في حال احتياجهم (لا سمح الله): ☐ نعم ☐ لا

اقتراحات أخرى تشعر/ين بأنها مهمة لضمان حقوقك:

مستشفى مار يوسف (الفرنسي) في القدس يتمنى لكم ولعائلاتكم دوام الصحة والعافية... شكراً جزيلاً لكم

Appendix G: Informed Consent Form – Page 1/3 (AAUP)

Arab American University
Institutional Review Board - Ramallah



الجامعة العربية الأمريكية
مجلس أخلاقيات البحث العلمي – رام الله

نموذج الموافقة

AAUP-IRB-R Code No.:

AAUP-IRB-R Date:

أنا (اسم المشارك / اختياري)
أوافق بموجبه على المشاركة في البحث السريري (الدراسة السريرية / دراسة الاستبيان / تجربة الأتوية) المحددة أدناه:
تقييم أثر تطبيق منهجية اللين ستة سيجما (Lean Six Sigma) على خدمات الجراحة اليومية في مستشفى مار يوسف في القدس
لتحقيق درجة: الماجستير، في برنامج: إدارة الجودة، في الجامعة العربية الأمريكية.
تم شرح وتفسير طبيعة الدراسة وهدفها عن طريق الباحث: **سامر إبراهيم جابر دعيس**
لقد تم إخباري عن طبيعة البحث من حيث المنهجية والآثار السلبية المحتملة والمضاعفات (حسب ورقة معلومات المشارك).
بعد معرفة وفهم جميع المزايا والعيوب المحتملة لهذا البحث، أوافق طواعية بمحض إرادتي على المشاركة في البحث السريري المحدد أعلاه.
أفهم أنه يمكنني الانسحاب من هذا البحث في أي وقت دون إبداء أي سبب على الإطلاق.
التاريخ: إهداء المشارك:
في حضور:
اسم:
التسمية / اللقب: إهداء:
(شاهد على توقيع المشارك)
أؤكد أنني أوضحت للمشارك طبيعة وهدف البحث المذكور أعلاه.
تاريخ: إهداء:
(الباحث)

Informed Consent Form for Interview Participation

Special Note: 1. Saint Joseph Hospital General Director had approved the completion of the research at Saint Joseph Hospital (Attached - Page 3)

2. This informed consent composed of two pages only.

Title of Research Study: Assessing the Impact of Lean Six Sigma Methodology Implementation on Day Care Surgical Services at Saint Joseph Hospital in Jerusalem

Affiliation: Arab American University

Student: Samer Ibrahim Jaber Da'ibes

Student Contact: email: s.dabeis@student.aaup.edu, Mobile: +972599769729, +972585911900

Introduction

This interview is part of data collection efforts for the completion of the research and the thesis for the above-mentioned student. The student invites you to take part in the research study conducted at Saint Joseph Hospital in Jerusalem. Before you decide whether to participate, it is important for you to understand why the research is being done and what it involves. Please take time to read the following information carefully.

Purpose of the Study

The purpose of this study is to assess the effects of implementing Lean Six Sigma (LSS) methodology on the operational efficiency and quality of surgical services in the day care department at Saint Joseph hospital in Jerusalem. Your perspective is vital to understanding the day care services at the hospital and the real-world implications of this quality improvement approach.

Procedures

If you agree to participate:

- You will be invited to a one-on-one interview lasting approximately 15–20 minutes.
- The interview will be audio-recorded (with your permission) to ensure accurate data collection.
- The interview will focus on your experiences, perceptions, and observations related to the changes introduced by the LSS initiative.

Appendix G: Informed Consent Form – Page 3/3 (Institutional)

Voluntary Participation

Participation is entirely voluntary. You may withdraw from the study at any time without giving a reason and without any consequences. Declining or discontinuing participation will not affect your relationship with the hospital or your employment in any way.

Risks and Benefits

- **Risks:** There are no expected physical or psychological risks associated with this study. You may skip any question you do not feel comfortable answering.
- **Benefits:** While there may be no direct benefit to you, your input will contribute to enhancing hospital services and improving patient care.

Confidentiality

- All information collected will be kept strictly confidential.
- Your name and identifying details like your title will not appear in any reports or publications resulting from this study.
- Data will be stored securely and accessed only by the research team.

Use of Data

The information gathered may be used in research presentations, academic publications, and internal quality improvement reports. All data will be presented anonymously.

Consent Statement

By signing below, you confirm that:

- You have read and understood the information provided above.
- You voluntarily agree to participate in the research.
- Decline to answer specific questions
- You understand that you may withdraw at any time without consequences.
- You consent to the interview being recorded.

Participant Name: _____

Participant Title: _____

Signature: _____

Date: _____

Interviewer Name: _____

Signature: _____

Appendix H: Patient Leaflet Before Procedure - Cystoscopy under Local Anesthesia (Arabic)

St. Joseph Hospital
91192
P.O. Box 19264
Tel. 02-5911911 Fax +972 2 5819598



مستشفى مار يوسف
91192 القدس
ص.ب 19264
تلفون 02-5911911 فاكس +972 2 5819598

تشرة إرشادية للمريض - تنظير المثانة تحت التخدير الموضعي

مقدمة:

سنقوم بإجراء تنظير المثانة تحت التخدير الموضعي. نود أن نوضح لك ما يجب فعله قبل دخول المستشفى، وما سيحدث أثناء الإجراء، والتعليمات بعد الخروج لضمان راحتك وسلامتك.

أولاً: التحضيرات قبل دخول المستشفى

- لا حاجة للصيام، يمكنك تناول طعامك وشرايك بشكل طبيعي.
- استمر في تناول أدويةك المعتادة ما لم يُطلب منك غير ذلك. استشر طبيبك بخصوص أدوية زيادة سيولة الدم مثل الأسبرين أو الوارفارين.
- أخبر الطبيب والممرض عن أي حساسية تجاه الأدوية، أو الطعام، أو أي شيء آخر.
- أحضر الأدوية التي تتناولها.
- من الأفضل أن يكون معك مرافق في يوم الإجراء.

ثانياً: ماذا يحدث أثناء الإجراء؟

- سيتم تنظيف المنطقة التناسلية.
- يُوضع مخثر موضعي داخل مجرى البول.
- يُدخل أنبوب رفيع (المنظار) عبر مجرى البول لفحص المثانة.
- قد تؤخذ عينة إذا لزم الأمر.
- الإجراء يستغرق 10-15 دقيقة تقريباً.

ثالثاً: تعليمات الخروج من المستشفى

- قد تشعر بحرقة بسيطة عند التبول.
- وجود دم بسيط في البول طبيعي.
- اشرب كميات كبيرة من السوائل.
- يمكنك العودة لأنشطتك اليومية.
- اتصل بالطبيب في حال حدوث حرارة، ألم شديد أو دم غزير.

ملاحظات أخرى

عليك التأكد من إحضار ما يلي:

1. تحويلة الطبيب
2. الفحوصات الطبية الخاصة بك، أو أية استشارات طبية سابقة
3. الهوية الشخصية
4. التغطية للمادة

Appendix I: Patient Leaflet Before Procedure - Cystoscopy under Local Anesthesia (English)

St. Joseph Hospital
91192
P.O. Box 19264
Tel. 02-5911911 Fax +972 2 5819598



مستشفى مار يوسف
91192 القدس
ص.ب 19264
تلفون 02-5911911 فاكس +972 2 5819598

Patient Leaflet – Cystoscopy under Local Anesthesia

Introduction

You are scheduled to undergo a cystoscopy under local anesthesia. This leaflet provides you with pre-hospital instructions, what to expect during the procedure, and post-discharge care to ensure your comfort and safety.

1. Pre-Hospital Preparation

- No need to fast; you may eat and drink normally unless advised otherwise.
- Continue your regular medications unless told otherwise.
- Inform your doctor of any allergies to medications, food, or any other material. Consult your doctor about blood thinning medications such as aspirin or warfarin.
- Bring your current medications.
- It is recommended to have a companion with you on the day of the procedure.

2. What Happens During the Procedure?

- The genital area will be cleaned.
- A local anesthetic (gel) will be inserted into the urethra.
- A thin scope will be passed through the urethra into the bladder.
- A sample (biopsy) may be taken if needed.
- The procedure usually takes 10–15 minutes.

3. Discharge Instructions

- You may feel slight burning when urinating.
- Mild blood in the urine is normal.
- Drink plenty of fluids (2-3 liters/day).
- Resume normal activities unless instructed otherwise.
- Contact your doctor if you experience fever, severe pain, or heavy bleeding.

Other Notes

You must make sure to bring the following:

1. Your doctor's referral
2. Your medical examinations or any previous medical consultations
3. Your personal ID
4. Your financial coverage

Appendix J: Patient Leaflet After Procedure - Cystoscopy under Local Anesthesia (Arabic)

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91192
P.O. Box 19264
Tel. 02-5911911 Fax +972 2 5819598



مستشفى مار يوسف
91192 القدس
ص.ب 19264
تلفون 02-5911911 فاكس +972 2 5819598

تعليمات الخروج من المستشفى

تنظيف المثانة تحت التخدير الموضعي

عزيزي المريض / عزيزتي المريضة،
لقد خضعت لإجراء تنظيف المثانة تحت التخدير الموضعي. نرجو منك اتباع التعليمات التالية بعد الخروج من المستشفى لضمان سلامتك وتسريع عملية التعافي:

التعليمات بعد الإجراء:

- قد تشعر بحرقاة خفيفة عند التبول خلال اليوم الأول، وهذا أمر طبيعي.
- من الطبيعي أيضًا ملاحظة وجود دم بسيط في البول.
- ينصح بشرب كميات كبيرة من الماء (2-3 ليتر يوميًا) لمدة يوم أو يومين.
- يمكنك العودة إلى أنشطتك اليومية الاعتيادية ما لم يُنصح بخلاف ذلك.
- تجنب الجماع لمدة 48 ساعة بعد الإجراء أو حسب تعليمات الطبيب.

متى يجب عليك مراجعة الطبيب، أو طاقم مستشفياتنا، أو الرجوع إلى قسم الطوارئ:

- إذا استمر وجود دم في البول لأكثر من 48 ساعة.
- إذا شعرت بألم شديد أو مستمر في أسفل البطن.
- إذا أصبت بحمى أو قشعريرة.
- إذا لاحظت صعوبة شديدة في التبول أو انقطاع البول.

ملاحظات عامة:

- يُنصح بإكمال المضاد الحيوي إذا وُصف لك من قبل الطبيب.
- لا تتردد في الاتصال بنا إذا كان لديك أي استفسار أو أعراض غير مُعتادة.

ملاحظات أخرى:

Appendix K: Patient Leaflet After Procedure - Cystoscopy under Local Anesthesia (English)

St. Joseph Hospital
91192
P.O. Box 19264
Tel. 02-5911911 Fax +972 2 5819598



مستشفى سانت يوسف
91192 القدس
ص.ب 19264
تلفون 02-5911911 فاكس +972 2 5819598

Hospital Discharge Instructions **Cystoscopy under Local Anesthesia**

Dear Patient,

You have undergone a cystoscopy under local anesthesia.

Please follow these instructions after discharge to ensure a safe and smooth recovery:

1. Post-Procedure Instructions:

- You may feel slight burning while urinating during the first day. This is normal.
- Mild blood in the urine is also expected.
- Drink plenty of water (2-3 liters per day) for the next one to two days.
- You may resume normal daily activities unless otherwise advised.
- Avoid sexual intercourse for 48 hours or as advised by your doctor.

2. When to Contact Your Doctor, Our Staff or Come Back to Hospital:

- If blood in the urine persists for more than 48 hours.
- If you experience severe or continuous lower abdominal pain.
- If you develop fever or chills.
- If you have difficulty or inability to urinate.

3. General Notes:

- Complete your course of antibiotics if prescribed.
- Do not hesitate to contact us if you experience any unusual symptoms or have questions.

4. Other Notes

عنوان الدراسة: تقييم أثر تطبيق منهجية اللين ستة سيغما (LSS) على خدمات الجراحة اليومية في مستشفى مار يوسف في القدس

سامر إبراهيم جابر دعبس

د. أشرف عبد الوهّاب الميمي

د. سامي سمير صدر

د. إباء عبد الرازق ديسان

الملخص

تسعى المستشفيات بشكل متزايد إلى تبني أساليب فعّالة لتحسين جودة الرعاية الصحية مع الاستخدام الأمثل للموارد المتاحة. وقد برزت منهجية اللين ستة سيغما كإطار منهجي قادر على تقليل عدم الكفاءة (الهدر والتباين) وتحسين الرعاية الصحية. في مستشفى مار يوسف في القدس، تأثرت خدمات الجراحة اليومية بالعديد من أوجه عدم الكفاءة؛ من بينها ارتفاع معدلات عدم حضور المرضى، ارتفاع معدلات إلغاء العمليات الجراحية، زيادة في أوقات انتظار المرضى لإجراء العملية الجراحية، وتباين في مستويات رضا المرضى. هدفت هذه الدراسة إلى تقييم وتحسين هذه المؤشرات من خلال تدخّل مُنظّم يعتمد على مبادئ اللين ستة سيغما على مدار ستة عشر شهراً (كانون الثاني 2024 ولغاية نيسان 2025). استخدمت الدراسة تصميمًا شبه تجريبي من نوع المجموعات غير المتكافئة، بالاعتماد على منهجيات مختلفة (كميّة ونوعية). شملت الدراسة جميع مرضى الجراحة اليومية ($N = 4,080$). تمّ جمع البيانات الكميّة والنوعيّة من أنظمة المعلومات المُحوسبة في المستشفى، جداول العمليات الجراحية، إستبيانات رضا المرضى، وآراء الطاقم الصحي والإداري.

إشتملت التحليلات الإحصائية على الإحصاءات الوصفية، مخططات الضبط والمراقبة، وإختبارات الفرضيات باستخدام برنامج ميني تاب (Minitab)، وقد تضمّن تطبيق اللين ستة سيغما تحديث في أنظمة المعلومات المحوسبة، وتوحيد إجراءات التثقيف الصحي للمرضى. مما أدى إلى تحسّن ملحوظ في مؤشرات الأداء؛ إذ انخفض معدّل عدم حضور المرضى من 21.4% إلى 16.3%، وتراجع معدل إلغاء العمليات الجراحية من 2.5% إلى 0.7%، وتحسّنت أوقات الانتظار في مختلف مراحل تقديم الرعاية الصحية، حيث إنخفضت الفترة الزمنية من وقت دخول المريض للمستشفى الى وقت دخوله إلى غرفة العمليات من 183 إلى 114 دقيقة، كما إرتفع رضا المرضى من 91.6% إلى 94.1%. ومع

ذلك، أظهرت تحليلات التباين انخفاضاً غير متناسق في التباين في هذه المؤشرات، مما يشير إلى فرص إضافية لمزيد من التحسين.

تخلّص الدراسة إلى أن منهجية اللين ستة سيغما تُمثّل أسلوباً فعالاً في تعزيز الكفاءة التشغيلية في خدمات الجراحة اليومية في المستشفيات. وتُوصي الدراسة بالإستمرار في مراقبة الأداء باستخدام مؤشرات الأداء، تدريب العاملين على مبادئ اللين ستة سيغما، وإجراء دراسات مستقبلية على مدى زمني أطول، مع تعزيز عنصر التغذية الراجعة من العاملين في المستشفى. تُسهم هذه النتائج في تطوير جودة الرعاية الصحية، وتدعم دمج منهجية اللين ستة سيغما كنهج مُستدام في المستشفيات.

الكلمات المفتاحية: اللين، ستة سيغما، اللين ستة سيغما، المستشفيات، الجراحة اليومية.