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Reducing Insurance Claim Rejections through Lean Six Sigma: A Quality Improvement Initiative at Mediclinic Welcare Hospital, UAE.

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A B S T R A C T

Background: Hospital pharmacies face challenges with insurance claim rejections, affecting revenue cycle management and efficiency. Lean Six Sigma methodologies provide structured frameworks for enhancing process efficiency.

Objective: This study aimed to evaluate the impact of implementing Lean Six Sigma (LSS) principles on reducing insurance claim rejections at Mediclinic Welcare Hospital Pharmacy in Dubai, UAE.

Methods: A quality improvement project framework was applied using the DMAIC (Define, Measure, Analyze, Improve, Control) methodology. Baseline data were collected from January to March 2024, with interventions implemented from April to August 2024. The validated key performance indicators (KPIs) included (1) A percentage improvement in staff competency in handling claims, (2) Reduction in total cost due to claim rejections, and (3) Improvement in the accuracy of pharmacy billing systems. KPIs were mapped, challenges identified, and targeted interventions implemented. Statistical analysis using the Mann-Whitney U test ($P<0.05$) and Sigma-level calculations quantified improvements and process efficiency enhancements.

Results: Implementing LSS interventions significantly increased staff competency in handling claims, from 50% to 93% post-intervention ($P <0.05$). The sigma level also improved from 3.1 to 4.0. KPI (2) saw a 70% reduction in total costs associated with rejections. KPI (3) reflected a 111% improvement in billing accuracy, increasing from 45% to 95% ($P <0.05$). The Sigma level for billing processes improved from 3.1 to 4.1, signifying enhanced process stability and reduced Defects Per Million Opportunities.

Conclusion: Applying Lean Six Sigma at Mediclinic Welcare Hospital Pharmacy improved process accuracy in reducing insurance claim rejections. This approach fostered operational excellence, a culture of continuous improvement, and long-term process efficiency, highlighting LSS as an effective strategy in healthcare.

Keywords: DMAIC, Hospital Pharmacy, Insurance Claim Optimization, Process Improvement, Revenue Cycle Management, Sigma Level.

Introduction

In a hospital setting, the revenue cycle typically includes patient registration, care documentation, coding, billing, cash collection and posting, and handling denial management (1). One indicator of the efficiency of revenue cycle management is the denial rate, which refers to the proportion of insurance claims that payers reject over a specific period (2). The prompt and compelling collection of payments for services provided is a crucial component, allowing healthcare systems to carry out their mission of delivering care to the patients and communities under their care (3). Although it is possible to appeal most insurance claim denials, sorting through and appealing them can be problematic and require significant time and effort (4). In addition, contesting denied insurance claims creates additional work in the revenue cycle, causing delays in collecting revenue (5). To minimize financial losses from denials,

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healthcare organizations must take proactive and innovative steps to tackle this issue (6, 7, 8, 9). Ensuring the accuracy of initial pharmacy claim submissions is crucial for maximizing insurance reimbursements, reducing costs, and increasing revenue (10).

Identifying the reasons for denials and implementing strategies to prevent them allows healthcare organizations to enhance their financial performance (1, 11).

The overarching issue within the global hospital and pharmacy industry, which encompasses hospital pharmacies in the UAE, is that applying Lean Management principles and Six Sigma methodologies essential for addressing operational and business-related challenges has not been fully investigated (12).

Economically, several issues are prominent, including escalating healthcare costs, inefficiencies in revenue cycle management, and financial losses due to insurance claim rejections, significantly straining hospital resources (13). On the operational front, hospitals grapple with claims processing complexities, staff competency variability, and billing system inaccuracies, all of which hinder overall efficiency and patient satisfaction (1).

This work outlines the utilization of Lean Six Sigma to enhance the revenue cycle by reducing insurance claim denials for Mediclinic Welcare Hospital Pharmacy, which can ultimately improve the healthcare organization's financial performance. This study centers explicitly on decreasing pharmacy denials by identifying and enhancing the factors that have the most significant impact on rejections of pharmacy insurance claims.

Background

Managing a hospital pharmacy entails addressing various challenges, including ensuring the safe and prompt distribution of medications, efficiently overseeing inventory, staff, and information systems, and achieving and sustaining quality accreditations (14, 15).

UAE hospital pharmacies can significantly benefit from implementing continuous quality improvement strategies using operations management tools, particularly Lean and Six Sigma (16). Applying Lean principles enables pharmacies to remove redundant tasks, inefficiencies, and waste within medication processes, utilizing various tools to enhance workplace organization (17, 18). At the same time, Six Sigma equips leaders to reduce process variations through statistical analysis, uncovering root causes, and applying error-prevention techniques (19). Using these complementary strategies for ongoing improvement allows pharmacy leaders to optimize workflows, enhance safety and quality, and lower costs in medication management processes (20).

The hospital's revenue flow and profit margins were adversely impacted by the significant amount of insurance claim denials it received. In order to address this problem, the Pharmacy Department, in collaboration with the Revenue Cycle Office and the Senior Management Team, opted to enhance the management of the pharmacy revenue cycle using the Lean Six Sigma methodology.

Lean Six Sigma

Lean originated from Toyota's innovative manufacturing practices in the 1950s, known as the Toyota Production System, which focused on efficiency and waste reduction. Later, in the 1980s, Motorola introduced Six Sigma, a methodology to reduce defects and process variability. Combining these approaches, Lean Six Sigma emerged as a formal methodology and corporate strategy to enhance quality by streamlining processes and minimizing defects, making it a powerful tool for driving efficiency and consistency across industries (21).

Although there have been substantial advancements in medical technology, the healthcare sector has been comparatively slower in tackling cost control, service quality, and efficiency measures (22, 23). With the rise in healthcare costs in recent years, stakeholders have been increasingly interested in improving their operations to manage expenses without compromising effectiveness (24). Many healthcare industry managers have turned to Lean efficiency and Six Sigma to reassess their workflow processes (25). Lean efficiency aims to enhance the competence of a procedure by identifying and eliminating various types of waste, such as defects, overproduction, waiting, non-utilized talent, transportation, inventory, and motion (26, 27). On the other hand, Six Sigma focuses on pinpointing and eliminating errors by addressing variations in a procedure that leads to waste (28). While these management systems can be implemented in various service industries, they have been most prominently successful in manufacturing and production settings (29). The healthcare industry, particularly hospital pharmacies, has not undergone significant process redesign efforts and is often considered a late adopter of evolving technologies and management ideologies. However, incorporating a Lean and Six Sigma management system holds promise for updating the operations of hospital pharmacies through continuous modifications at different levels, ultimately leading the organization toward optimal efficiency (19).

Materials and Methods

This study adopted a quality improvement project framework to explore the effects of applying Lean Six Sigma principles, explicitly utilizing the DMAIC methodology (Define, Measure, Analyze, Improve, Control), on reducing the rate of insurance claim rejections (30). The approach focused on identifying key areas of inefficiency, measuring the baseline performance, and conducting an in-depth analysis to identify the root causes of claim rejections. Subsequent phases aimed to implement targeted improvements and establish control measures to sustain the results. This comprehensive methodology provided insights into the practical implications and effectiveness of Lean Six Sigma in enhancing operational processes within the context of pharmacy insurance claim management.

Study Setting

Mediclinic Welcare Hospital (MWEL) in Dubai, UAE, is a respected healthcare facility accredited by JCI and affiliated with Mediclinic Middle East. MWEL prioritizes a patient-centered approach, focusing on health and safety and upholding high service standards based on ethical principles.

Project Charter

The Project charter is a foundational framework detailing the initiative's scope, goals, and strategic approach. Table 1 provides a comprehensive overview of the project.

Table 1. Project charter.

Element	Description	Specifications					
Project	Name of the project	Reducing Insurance Claims Rejections in MWEL Hospital Pharmacy Through Lean Six Sigma Interventions.					
Project Description and Process Scope	Describe the project scope	Implementing Lean Six Sigma with managerial team support. The project will use the Define, Measure, Analyze, Improve, Control (DMAIC) methodology.					
Business Case	To provide project justification and alignment with organizational strategies and business success	Efficient pharmacy operations support Mediclinic Welcare Hospital's broader initiatives and strategic goals. Implementing Lean Six Sigma (LSS) methodologies to decrease insurance claims rejections directly reflects the hospital's dedication to operational excellence and financial stability. The project focuses on improving the accuracy and efficiency of the claims process, which is particularly important as most of the hospital's patients are insured. This enhancement is anticipated to reduce financial losses from rejected claims, which amounted to nearly United Arab Emirates dirham (AED) 350,000 in the first quarter of 2024. Reducing claims rejections can ensure more sustainable revenue, improve cash flow, enhance operational efficiency, and strengthen relationships with insurance providers. This strategic alignment reinforces the hospital's mission to provide high-quality care efficiently, ultimately enhancing business success and organizational sustainability.					
Problem Statements	To highlight issues or pain points within current hospital pharmacy operations, including lack of Lean practices and process variation	Mediclinic Welcare Hospital Pharmacy has experienced significant insurance claims rejections. In the first quarter of 2024 alone, the pharmacy faced a total of 1,516 claim rejections. These rejections were primarily due to a lack of valid pre-approval, technical errors, and non-medically justified claims. Frequent denials lead to direct financial losses and impact pharmacy operations' efficiency and client satisfaction.					
Goals/ Objectives	What Critical-to-Quality (CTQ) metrics will be improved? What is the average baseline performance of those metrics? Moreover, how much of the improvement is targeted? In the absence of an international benchmark, the baseline accuracy and targeted improvement were determined during the project's Define phase based on an internal process review, historical performance data, and expert consensus, ensuring the goals aligned with the organization's operational priorities and quality improvement objectives	CTQ Metric	KPI	Unit of Measure (UOM)	Baseline	Goal (Target)	% Targeted Improvement
		Staff Training Effectiveness	Percentage of improvement in staff competency in handling claims)KPI 1)	%	0.50	0.90	80%
		Financial Impact of Rejections	Percentage of reduction in total cost due to rejections)KPI 2)	UAE Dirhams (AED)	138,175	70,000	49%
		Pharmacy Approval Outcome Accuracy	Percentage of improvement in accuracy of pharmacy billing system)KPI 3)	%	0.50	0.90	80%

Project Benefits to Internal and External Clients	Details		Stakeholders participated actively in resolving service shortcomings. Gemba walks (a Japanese term meaning the physical workplace) were conducted to closely observe the process, complemented by interviews with internal clients to understand employees' persistent challenges. A collaborative brainstorming session was held to gather staff input, address their concerns, and pinpoint the most effective solutions.	
Project Owners	Project leaders		Pharmacy Manager and Medical Director	
Project Team	Lists the members involved. Ensures team members are not overloaded and project demands do not compromise their regular duties.		A diverse team consisting of the Pharmacy Manager, Medical Director, Revenue Cycle Management (RCM) Manager, and Quality and Patient Safety Officer	
DMAIC Project Milestones	Baseline	Define	Measure / Analyze	Improve / Control
Dates	1 Jan 2024 – 31 March 2024	1 April 2024 – 30 April 2024	1 May 2024 – 31 May 2024	1 June 2024 – 31 August 2024

KPI 1 (Percentage of improvement in staff competency in handling claims) focused on staff training effectiveness, measuring the percentage improvement in staff competency in handling claims. The baseline performance was at 0.50%, with the goal set at 0.90%, targeting an 80% improvement. This KPI emphasized the importance of enhancing staff skills to reduce errors in claim handling and improve overall efficiency. Table 2. outlines potential causes that could contribute to challenges in improving staff competency.

KPI 2 (Percentage of reduction in total cost due to rejections) addressed the financial impact of insurance claim rejections, aiming for a reduction in the total costs associated with these rejections. The initial baseline cost was AED 294,474, intending to lower it to AED 150,000, representing a 49% targeted reduction. The second metric underscored efforts to optimize claim processes and reduce financial losses, ultimately contributing to the financial sustainability of the pharmacy. Table 3. lists key factors that likely contribute to the high costs associated with claim rejections.

KPI 3 (Percentage of improvement in accuracy of pharmacy billing system (concentrated on the accuracy of the pharmacy approval outcomes within the billing system, measuring the percentage improvement in this accuracy. The initial baseline accuracy was 0.50%, with an ambitious goal of 0.90%, reflecting an 80% targeted improvement. This KPI aimed to enhance the reliability of the billing system processes, ensuring more precise and error-free claim approvals, ultimately improving operational efficiency and reducing claim rejections. Table 4. highlights the primary estimated reasons contributing to common issues affecting the enhancement of billing accuracy.

Table 2. Potential challenges affecting staff competency improvement.

Inadequate initial and ongoing staff training programs.
Lack of standardized training materials.
Limited access to updated policies and procedures
Insufficient time allocated for training due to workload.
High staff turnover impacts training continuity.
Inadequate feedback and mentoring systems.
Lack of incentives for continuous professional development.

Table 3. Key factors contributing to high costs from claim rejections.

Insufficient verification and double-check processes.
Frequent errors in insurance claim submission.
Lack of understanding of insurance policies and criteria.
Incomplete or incorrect patient data during claim preparation.
Limited coordination between pharmacy and billing departments.
Delays in processing due to inadequate software and system capabilities
Staff shortages affecting thorough claim checks

Table 4. Common causes impacting billing accuracy enhancement.

Inaccurate data entry due to human error.
Outdated or poorly integrated billing software.
Inadequate training on billing system functionalities.
Frequent changes in insurance policies without proper updates to staff.
Miscommunication between pharmacists and billing personnel.
Poor auditing practices and lack of periodic reviews.
Over-reliance on manual processes instead of automated checks.

KPIs validity

The validity and reliability of the KPIs were confirmed using the Content Validity Index (CVI) The CVI was applied to assess each attribute of the indicators, incorporating expert feedback. A panel of nine experts independently evaluated the attributes using a binary scale (1 = satisfactory, 2 = unsatisfactory) to determine the content validity.

Data source

Data for CTQs and KPIs were gathered from the hospital's pharmacy management records and the hospital information system. The project team collected outputs from each process every month from January to August 2024.

Calculation of Sigma level using DPMO

The Sigma level for the process was calculated using the Sigma level conversion table (Table S1). First, the Defects Per Million Opportunities (DPMO) was determined using the formula: DPMO = (Total Defects/Total Opportunities) ×1,000,000, where total defects represented the observed errors and total opportunities referred to the total chances for a defect to occur. The calculated DPMO value was then matched to the corresponding Sigma level using the conversion table, which aligns DPMO ranges with specific Sigma levels, providing a quantitative measure of process performance.

Define phase

Process flow mapping

A process map was an effective visual tool to illustrate the workflow, enabling employees to understand the actual process better and identify inefficiencies or workflow challenges. A thorough and detailed process mapping of the Mediclinic Welcare Hospital (MWEL) pharmacy operations was conducted to pinpoint bottlenecks impeding efficiency.

SIPOC (Suppliers, Inputs, Processes, Outputs, Clients)

This tool enabled the more efficient implementation of strategies to enhance productivity, minimize waste, and optimize the process.

Measure/Analyze phases

The measure phase was targeted to evaluate the current performance of the process or system under improvement. This phase focused on analyzing the data and process to identify the root causes of observed issues, ensuring that solutions addressed these fundamental problems rather than just their symptoms. Data collection was scrutinized during this stage to determine where and why errors or inefficiencies occurred. Standard tools and techniques used in this phase included Root Cause Analysis (RCA) and Pareto Analysis.

Improve/Control phases

During the Improve phase of a DMAIC project, the Lean Six Sigma team conducted a collaborative brainstorming session to propose solutions for the root causes identified in the analysis stage. These proposed solutions were assessed according to cost, potential to reduce waste, impact on efficiency enhancement, and overall feasibility. Analytical rankings were used to prioritize and select the most effective solutions for implementation (31).

In the control phase, after implementing the identified process enhancements in the pharmacy workflow, teams established monitoring systems to ensure the process maintained successful performance after the changes were integrated into the standard business operations (32). Continuous staff training and clear communication channels were crucial to maintaining adherence to the newly established procedures. Pharmacy leadership facilitated ongoing coaching and knowledge-sharing sessions to reinforce the changes and enable frontline staff to offer feedback for needed adjustments (33).

Data analysis

Data processing and analysis were conducted using Microsoft Excel 2021 (Microsoft Corporation, Seattle, WA, USA), Minitab Statistical Software 22, and IBM Statistical Package for the Social Sciences (SPSS) Version 29.0, with a significance level set at $P<0.05$.

Ethical considerations

Data collection processes adhered to strict quality control measures to maintain the integrity and reliability of the findings. All data were de-identified to protect confidentiality, and only aggregated operational data from the hospital systems were used. Stakeholder engagement was prioritized, with regular training sessions and feedback mechanisms ensuring accurate data recording and adherence to updated processes.

This research did not involve human participants, thus exempting it from the need for ethical approval. Due to the evaluative nature of the quality improvement (QI) study design, Institutional Review Board (IRB) approval was unnecessary. Furthermore, the authors reported no conflicts of interest, and the project was conducted without commercial funding.

Results

DMAIC Cycle - Define Phase

Key performance indicators selection

Three key performance indicators (KPIs) were defined and validated through expert assessments using a binary rating scale. This process demonstrated strong reliability, with each metric achieving an item content validity index (I-CVI) exceeding 0.78, confirming their significance and alignment with the intended quality measures (Table 5).

Table 5. Item content validity index (I-CVI) results for KPIs.

KPI 1: Percentage of improvement in staff competency in handling claims	**(1) Relevance**	**0.93**
	(2) Clarity	0.90
	(3) Accessibility	0.91
	(4) Measurability	0.96
	(5) Practicality	0.86
	(6) Objectivity	0.88
	(7) Generalizable	0.77
	(8) Time-bound	0.92
KPI 2: Percentage of reduction in total cost due to rejections	(1) Relevance	0.91
	(2) Clarity	0.92
	(3) Accessibility	0.90
	(4) Measurability	0.88
	(5) Practicality	0.95
	(6) Objectivity	0.88
	(7) Generalizable	0.89
	(8) Time-bound	0.90
KPI 3: Percentage of improvement in accuracy of pharmacy billing system	(1) Relevance	0.93
	(2) Clarity	0.79
	(3) Accessibility	0.92
	(4) Measurability	0.92
	(5) Practicality	0.93
	(6) Objectivity	0.91
	(7) Generalizable	0.84
	(8) Time-bound	0.86

Process Mapping

The process mapping diagram (Figure 1) outlines the comprehensive workflow for managing medication orders and insurance claims in a hospital pharmacy setting. It begins with the doctor ordering the medication and moves through several critical stages, including order verification, patient insurance validation, pre-authorization, preparation and dispensing, and billing checks conducted by pharmacists and pharmacy clerks. The process continues with claim submission, followed by claim tracking and rejection handling, managed by the RCM (Revenue Cycle Management) team. This sequential approach highlights the collaboration between various healthcare professionals to ensure accuracy and efficiency in processing insurance claims and delivering patient care.

Key Performance Indicators (KPIs) and Critical-to-Quality (CTQs) metrics were defined for the hospital's pharmacy claim denials based on the process mapping outcomes. Supplier, Input, Process, Output, and Customer (SIPOC)

The SIPOC tool is used in the Define phase to provide a high-level view of the process. This structured approach helped identify inefficiencies and align process improvements with stakeholder needs.

DMAIC Cycle - Measure and Analyze Phases

Root cause analysis (RCA)

An Ishikawa diagram, also known as a fishbone diagram (Figure 2), was utilized to pinpoint potential sources and root causes of variations within the process (34). The fishbone diagram (Figure 2) followed the 6M approach, categorizing potential causes of claim rejections into six areas: Machine (technology), Method (processes), Management (policies and leadership), Material (documentation), Milieu (insurance payer environment), and Man (staff competency). This structured analysis provided a comprehensive view of root causes to guide targeted interventions effectively.

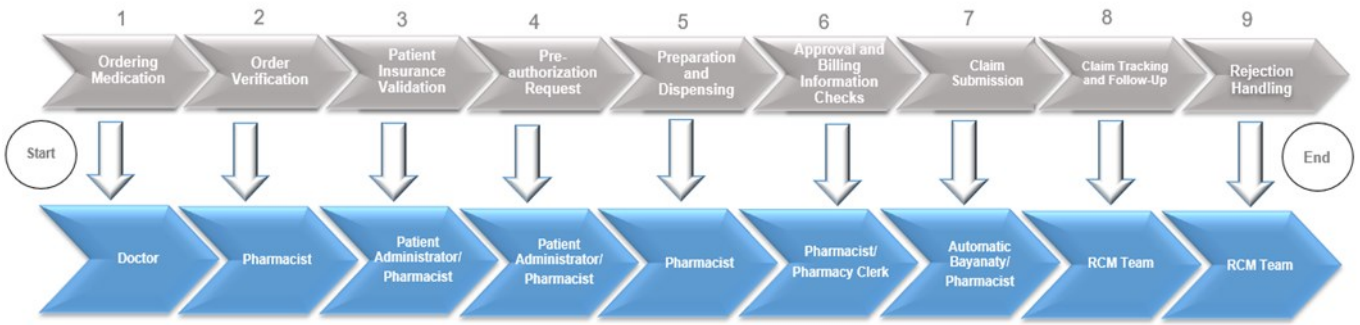

Figure 1. Comprehensive process flow for medication ordering and insurance claim management in MWEL hospital pharmacy.

Table 6. SIPOC diagram for hospital pharmacy.

Supplier	Inputs	Process	Outputs	Customers
Local Regulators Health Information and Communication Technology (ICT) Vendors Insurance Payers	Regulatory Requirements Pharmaceutical Supplies Pharmacy Staff Experience and Skills Patient Information Medication Orders Bayanaty (electronic medical record system)	Order Receipt Order Verification Medication prior authorization (Request authorization code for treatment from insurance provider) Medication Picking Medication Dispensing/Packing Quality Check Patient Counselling Medication Delivery Real-time pharmacy insurance claim submission	Dispensed Medications Patient Instructions Transaction Records Paid insurance claims Follow up	Internal (Physicians, Pharmacy Staff, RCM Team) External Patients and their Families, Insurance companies (payers)
Enablers Dubai Health Authority (DHA) Pharmacy Guidelines Inventory Management System Electronic Health Records (EHR) – Bayanaty Standard Operating Procedures (SOPs) Training Programs and Professional Development				

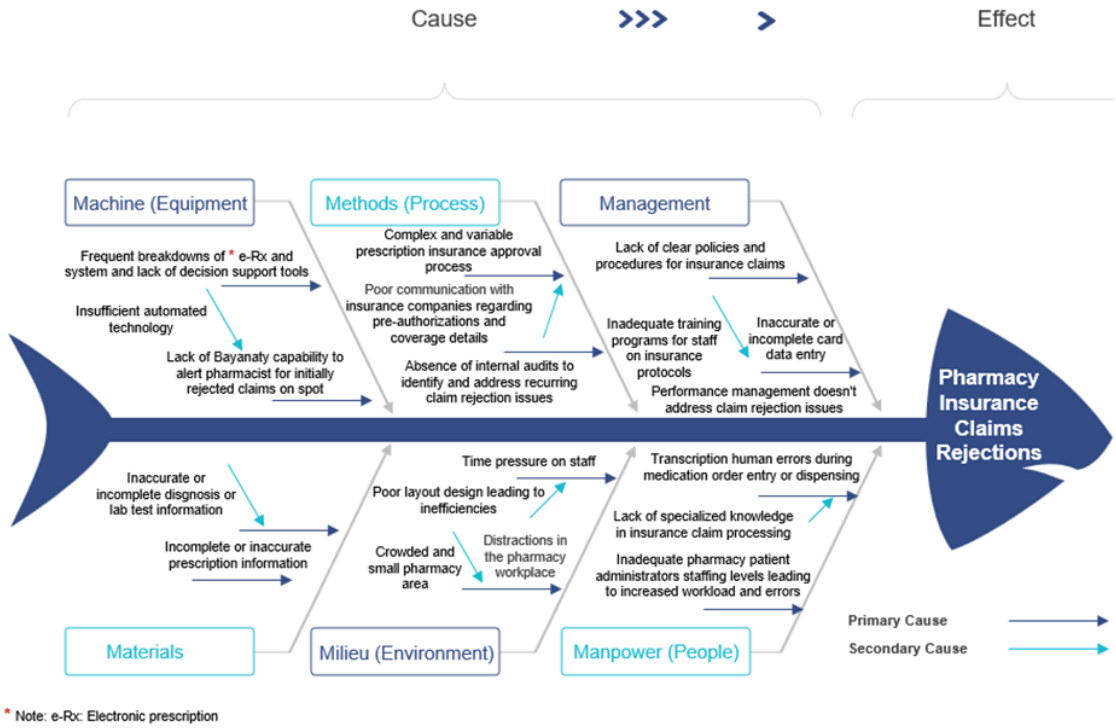

Figure 2. The fishbone diagram (Ishikawa diagram) is used to identify the potential sources and underlying causes of pharmacy insurance claims rejections.

Pareto analysis

The Pareto principle, also known as the 80/20 rule, suggests that a limited number of key factors drive most outcomes. This rule emphasizes focusing on the primary factor with the most significant influence. Figure 3 represents a Pareto chart illustrating the primary reasons for pharmacy insurance claim rejections. The chart shows that most rejections (64%) were due to the lack of valid pre-approval, significantly outweighing other causes. Technical issues related to the prescriber (14%) and claims deemed not medically justified (9%) followed as additional significant contributors. Less common reasons included patient ineligibility (6%) and duplicate pharmacy claims (4%). The cumulative percentage line emphasizes that addressing the top few issues would resolve the majority of claim rejections.

Pareto chart (Figure 4) showing the number of insurance claim rejections associated with different medical specialties. Accident and Emergency had the highest number of rejections at 2,169, followed by Pediatrics with 1,234. Family Medicine, Endocrinology, and Cardiology had fewer rejections, with 683, 664, and 262, respectively. The cumulative percentage line indicates that focusing on the top two specialties, Accident and Emergency, and Pediatrics, would address approximately 68% of all claim rejections. This information was crucial for targeted training efforts, as it allowed management to prioritize training and intervention strategies for the specialties contributing most to claim rejections, thereby enhancing the overall claim approval process.

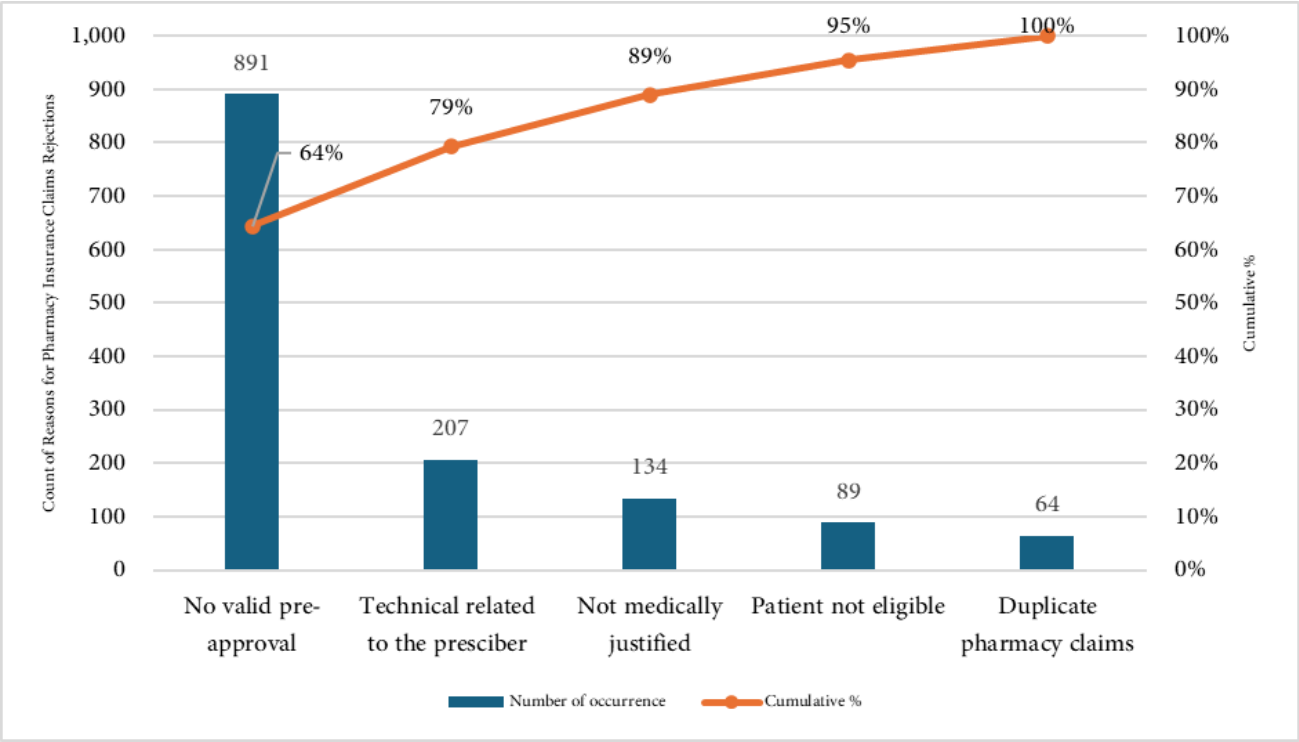

Figure 3. Pareto analysis - reasons for pharmacy insurance claims rejections (Jan-Mar 2024).

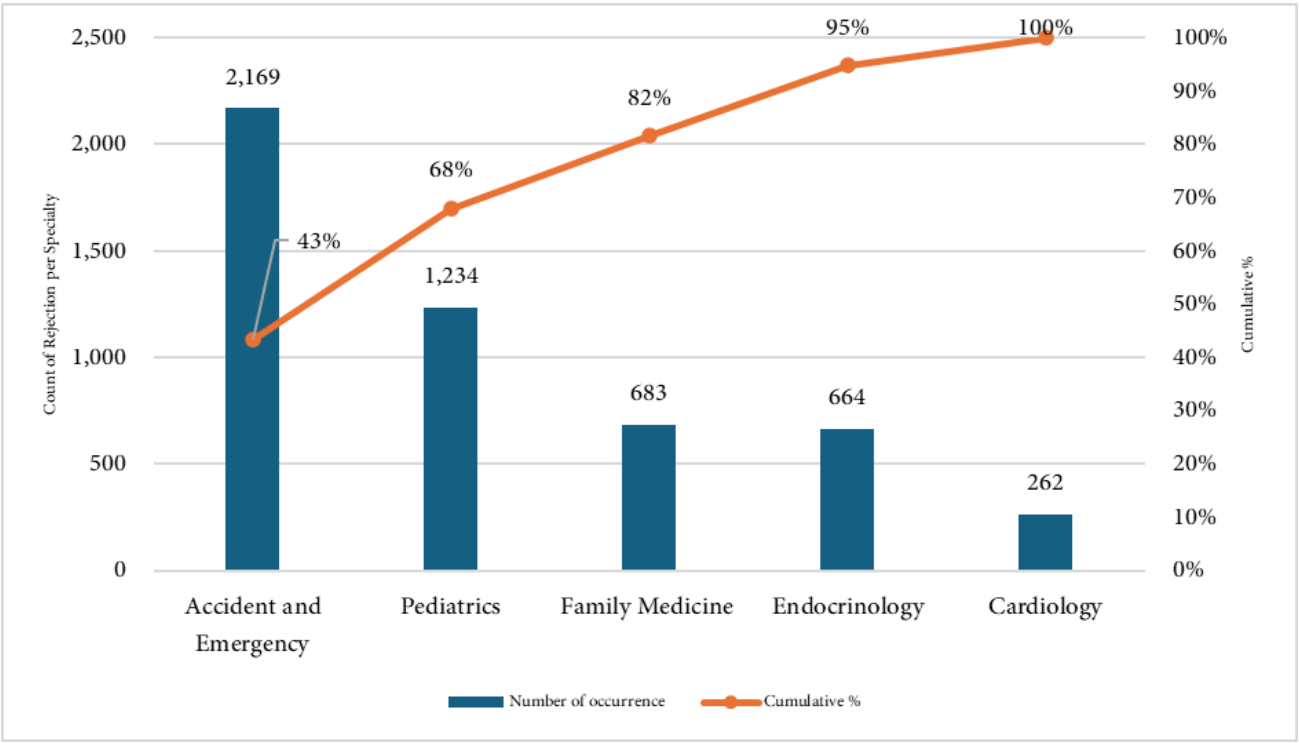

Figure 4. Pareto analysis – rejections per specialty (Jan-Mar 2024).

Figure 5 shows a Pareto chart detailing the number of insurance claim rejections associated with the top five doctors. Doctor A leads with 431 occurrences, followed closely by Doctor B with 429 and Doctor C with 358. Doctors D and E have fewer rejections, at 299 and 266, respectively. The cumulative percentage curve highlights that addressing rejections from the top three doctors would potentially resolve 68% of the total claim issues. This analysis was valuable for targeted training efforts, as focusing on the top contributing doctors significantly reduced rejections, improved claim accuracy, and enhanced claims processing.

Figure 6 displays insurance claim rejections by the top five pharmacists, with Pharmacist A leading at 281, followed by B (269), C (260), D (237), and E (213). The cumulative percentage indicates that addressing the top three pharmacists could reduce 64% of rejections, underscoring these individuals' need for focused training and process improvements.

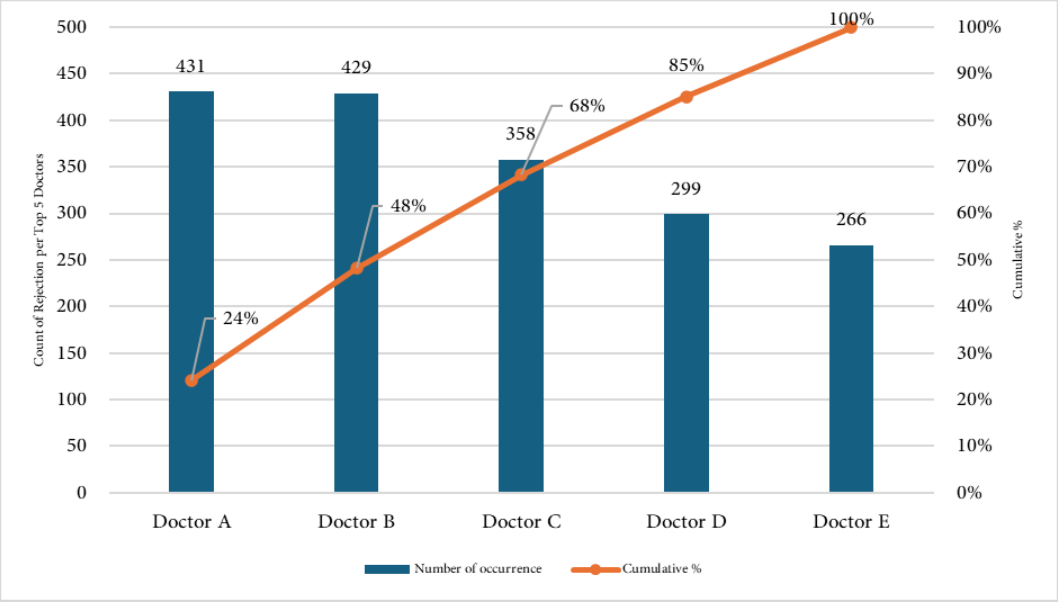

Figure 5. Pareto analysis – rejections per top five doctors (Jan-Mar 2024).

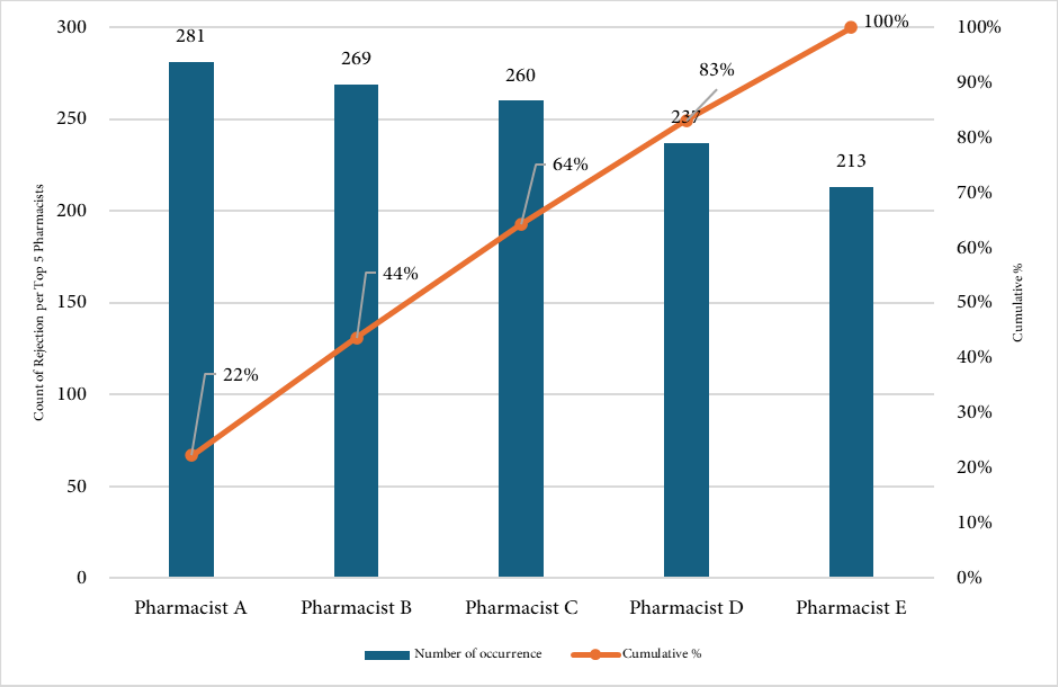

Figure 6. Pareto analysis – rejections per top five pharmacists (Jan-Mar 2024).

The chart (Figure 7) displays the frequency of claim rejections across different insurance payers, with Payor A recording the highest number of rejections at 2,377, followed by Payor B and Payor C with 2,057 and 2,038 occurrences, respectively. The cumulative percentage line shows that addressing issues related to these top three payers could resolve up to 93% of all claim rejections. This analysis is instrumental in prioritizing efforts to work closely with the highest-contributing payers to streamline claim processes, enhance communication, and implement targeted solutions that reduce overall rejection rates.

DMAIC Cycle - Improve and Control Phases

An intervention plan was made against all the issues, and improvements were suggested. It was essential to pinpoint, validate, and execute improvements to address potential challenges. Following the five foundational principles of Lean methodology, recognized as a framework for boosting workplace efficiency—1) defining value, 2) mapping the value stream, 3) ensuring continuous flow, 4) establishing a pull system, and 5) aiming for perfection—the project team identified, prioritized, and implemented strategies to tackle the root causes of the problems (35). An intervention strategy (Table 7) was developed for each issue, and appropriate improvements were proposed.

Critical-to-Quality metrics improvement following LSS interventions

Percentage of improvement in staff competency in handling claims (KPI 1)

For the first KPI (Figure 8), staff competency in handling claims was observed, with the percentage rising from 50% in the baseline/early intervention phase to 93% in the post-intervention phase by August 2024 (P <0.05, Mann-Whitney U test).

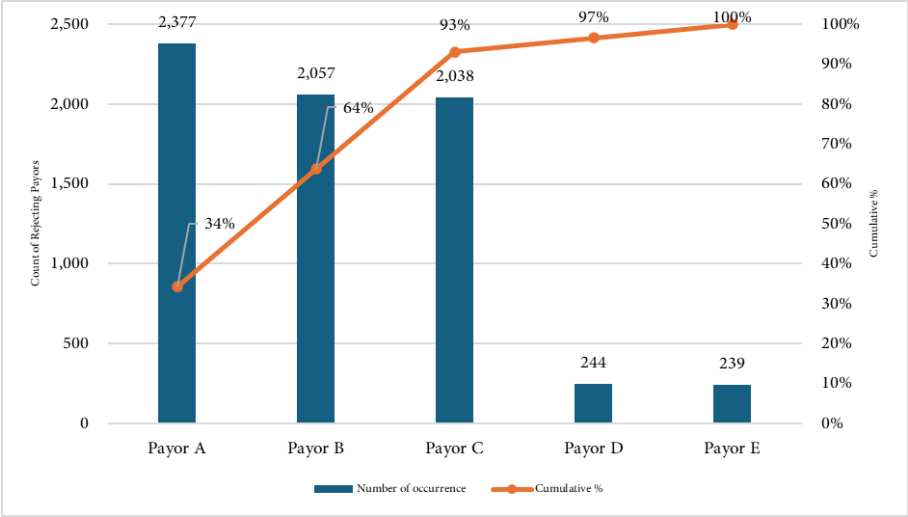

Figure 7. Pareto analysis – rejecting payors (Jan-Mar 2024).

Table 7. Improvement strategies to reduce pharmacy initial insurance claims denials.

Phase	Interventions
Early Intervention	- Enhanced Documentation: Implementing more rigorous documentation standards to ensure accuracy in prescription records. - Staff Training: Conducting intensive training sessions on new procedures and technologies to reduce rejections.
Measure/Analyze	- Process Reengineering: Redesigning workflow processes to eliminate steps where denials most frequently occur. - Technology Upgrades: Integrating advanced Hospital Information System (Bayanaty) solutions that provide real-time checking and alerts for potential prescription discrepancies.
Post-Intervention	- Continuous Monitoring: Establishing ongoing monitoring systems to quickly identify and address any increase or surge in rejection rates. - Feedback Mechanisms: Creating feedback loops that allow staff to report on systemic issues and suggest improvements. - Quality Circles: Implementing quality circles involving staff at all levels to discuss challenges and brainstorm solutions.

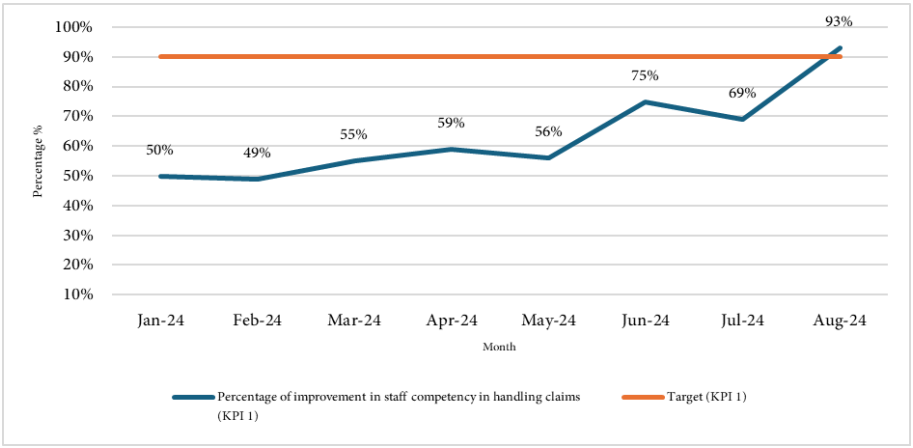

Figure 8. Percentage of improvement in staff competency in handling claims .

Figure 9 illustrates the sigma levels, which improved steadily from 3.1 in January 2024 (baseline) to 4.0 by August 2024 (post-intervention), demonstrating significant process enhancements and reduced errors.

Figure 10 shows a decreasing trend in Defects Per Million Opportunities (DPMO) as Sigma levels increase, featuring improved process quality and efficiency over time.

Percentage of reduction in total cost due to rejections) KPI 2)

The chart (Figure 11) illustrates the trend in the total cost due to insurance claim rejections from January to August 2024. Initially, the rejected amount was AED 138,175 in January, which exhibited fluctuations over the months, peaking at AED 157,677 in March. A notable decline can be seen from March onward, with the most significant reduction occurring in August, where the total rejection cost dropped to AED 41,514.

This trend indicates a substantial improvement in reducing the financial impact of claim rejections, aligning with the targeted KPI goal for cost reduction over the intervention period. The percentage reduction in total cost due to rejections from January 2024 to August 2024 was approximately 70%.

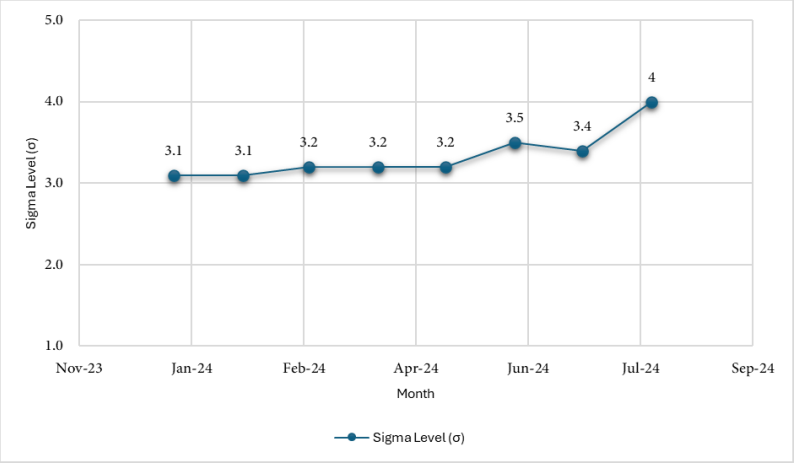

Figure 9. Sigma level for staff competency process improvement .

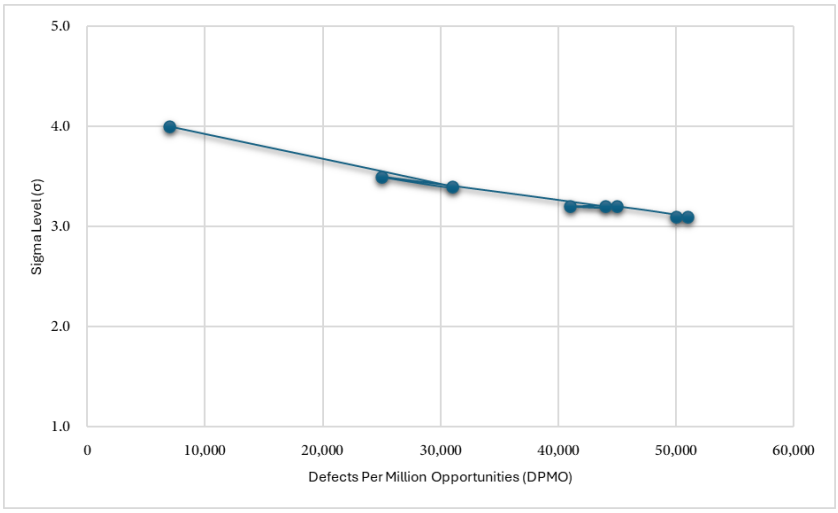

Figure 10. The negative correlation between DPMO and Sigma levels for KPI 1.

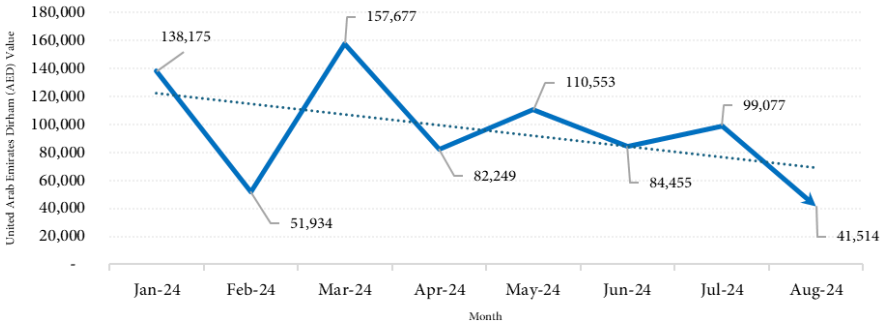

Figure 11. United Arab Emirates Dirham (AED) cost due to rejections over time.

Percentage of improvement in accuracy of pharmacy billing system (KPI 3)

The chart (Figure 12) shows the progressive improvement in the accuracy of the pharmacy billing system (KPI 3) from January 2024 to August 2024. Starting at 45% in January, the accuracy experienced a slight decline to 42% in February but rebounded to reach 50% by March. Subsequent months showed steady gains: 54% in April, 61% in May, and a significant jump to 79% in June. This positive trend continued with further improvements to 85% in July, ultimately reaching 95% in August, surpassing the 90% target set for the period. This upward trajectory highlights the success of the implemented strategies and interventions to enhance billing accuracy, demonstrating substantial progress in achieving and exceeding performance objectives. The percentage climbed from 45% in the baseline/early intervention phase to 95% in the post-intervention phase by August 2024, showing an approximate 111% increase (P <0.05, Mann-Whitney U test).

The Sigma Level chart (Figure 13) indicates a gradual improvement in process performance from January 2024 through August 2024, moving from a Sigma level of 3.1 to 4.1. This progression reflects a positive trend toward reducing defects and increasing the overall efficiency of the pharmacy's billing processes.

Figure 14 represents the relationship between Sigma Level and Defects Per Million Opportunities (DPMO), with inverse correlation, where a higher Sigma level corresponds to a lower DPMO. The decrease in DPMO over time suggests effective interventions that successfully minimize billing errors and optimize performance.

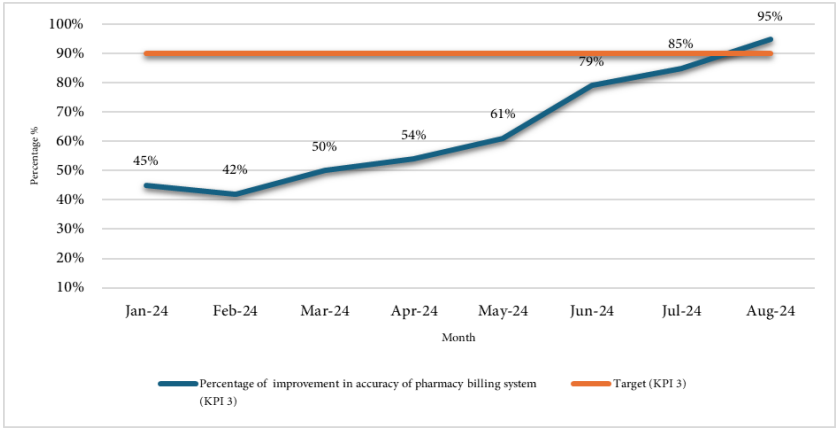

Figure 12. Percentage of improvement in accuracy of pharmacy billing system (KPI 3).

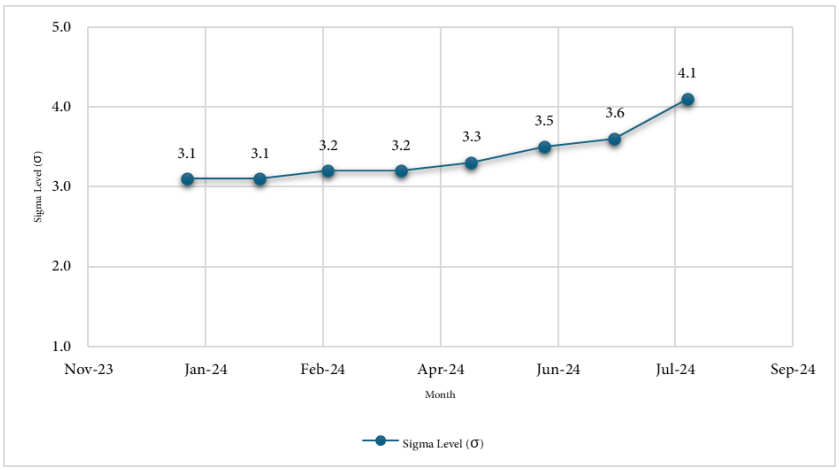

Figure 13. Sigma level for pharmacy billing process improvement.

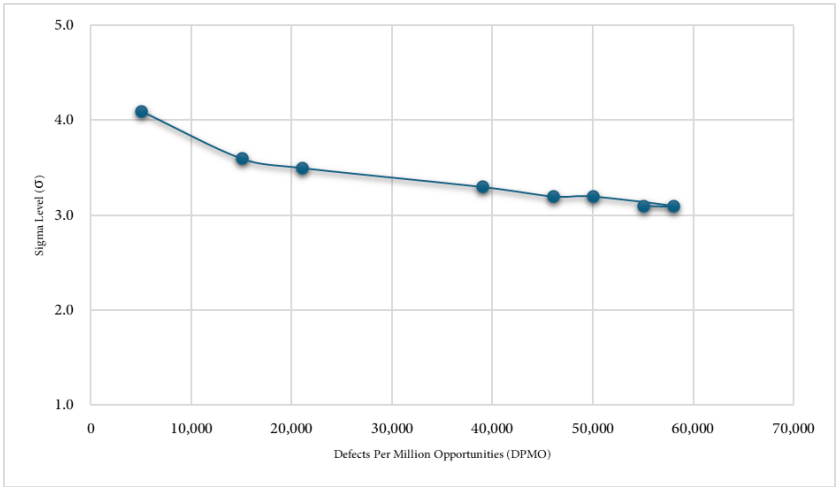

Figure 14. The negative correlation between DPMO and Sigma levels for KPI 3.

Discussion

This study mirrors and complements previous research that demonstrated the effectiveness of Lean Six Sigma in enhancing operational efficiency and reducing process variability in healthcare settings (36, 37, 38, 39, 40, 41).

The DMAIC project significantly reinforced the pharmacy department's Lean Six Sigma (LSS) mindset as a quality tool of choice, showcasing its effectiveness in prioritizing and resolving efficiency challenges with cost-effective solutions (42, 43). This initiative empowered the staff to deliver clear, value-adding outcomes and featured ongoing quality enhancement's importance and positive impact on the pharmacy's operational processes (44).

Implementing Lean and Six Sigma methodologies at Mediclinic Welcare Hospital Pharmacy significantly improved the accuracy of insurance claim submissions and enhanced its key-related operational quality metrics (45).

The Lean Six Sigma initiative in the hospital pharmacy utilized several critical tools (Table S2) to address inefficiencies and root causes of insurance claim rejections (46). The project charter was pivotal in defining the problem statement and setting clear objectives, ensuring the scope was well understood (47). Process mapping provided a visual representation of the current workflow, allowing for the identification of redundancies, inefficiencies, and bottlenecks. The SIPOC diagram offered a high-level view of the inputs, processes, and outputs, which

helped streamline the understanding of essential elements (48). Gemba walks, rooted in direct observation of operations, enabled real-time assessment and identification of issues (49).

Additionally, brainstorming sessions fostered collaboration and the generation of diverse ideas to address challenges, leading to innovative solutions. The Fishbone diagram and Pareto charts were essential for pinpointing primary problem causes and performing in-depth analyses to identify root issues. The Fishbone diagram helped categorize a problem's potential causes to identify its root causes, while the Pareto chart helped prioritize these causes, facilitating effective and targeted interventions (50).

Numerous key metrics are available for tracking a practice's financial health, but when dealing with insurance providers, many consider the clean claims ratio the most critical indicator for achieving success (10). The project significantly impacted the three critical-to-quality (CTQ) metrics with their key performance indicators (KPIs) related to claims processing and billing accuracy, demonstrating the effectiveness of the Lean Six Sigma initiative. For KPI 1, which measured the improvement in staff competency for handling claims, the initial interventions led to a 50%–55% improvement, a significant leap. Progress during the intervention phase, characterized by enhanced training modules, interactive workshops, and a competency checklist, raised this figure to 56%–75%, further reassuring the initiative's effectiveness. Post-intervention efforts such as continuous coaching and performance monitoring culminated in a 93% improvement, a testament to the success of the Lean Six Sigma initiative. For KPI 2, focusing on reducing total costs from claim rejections, early interventions included identifying key rejection causes and implementing basic corrective measures, which initially reduced rejections to AED 138,175 and 157,677. Further targeted training and adherence to billing protocols improved this metric, bringing rejections down to AED 82,249–99,077. The final phase saw the introduction of advanced auditing, automated claim checks, and ongoing review processes, reducing to AED 41,514. The fluctuation in cost over months can be attributed to seasonal variations in patient volumes, variability in claim submissions, staff turnover, updates to insurance policies, training gaps, and occasional system inefficiencies, all of which impact claim rejection rates and associated costs. KPI 3 tracked the accuracy of the pharmacy billing system, a key area where continuous quality improvement was essential. Initial interventions involving system analysis and basic training led to a 45%–50% improvement, setting the stage for continuous improvement. Enhanced measures, such as streamlining procedures and standardizing processes, pushed this to 54%–85%, demonstrating the sustained commitment to quality. Ultimately, integrating automated billing checks and real-time error notifications boosted the accuracy to 95%, a clear indication of the sustainability of the improvements and the efficacy of continuous quality improvements in the pharmacy's workflow.

The success of the Lean Six Sigma initiative at Mediclinic Welcare Hospital Pharmacy highlights its potential to drive positive change, enhance operational efficiency, and ultimately improve patient care in healthcare settings (51).

Smaller or resource-constrained hospitals may face several challenges implementing similar Lean Six Sigma interventions. Limited financial resources could restrict access to advanced technology and software for real-time data collection and analysis. Insufficient staff training programs and high turnover rates may hinder the development of competency in handling claims efficiently. Furthermore, a lack of dedicated quality improvement teams or Lean Six Sigma expertise may hinder the systematic identification and resolution of process inefficiencies. Resistance to change and limited management support can pose significant obstacles, especially in organizations with deeply rooted traditional workflows.

Study limitations

The study had limitations, including its focus on a single hospital pharmacy, which may limit generalizability to other settings, countries, or healthcare systems with differing regulatory frameworks. Internal data reliance could have introduced bias, and the timeframe may not reflect long-term sustainability.

The absence of payer feedback limited a comprehensive view of the impact. Additionally, while Lean Six Sigma effectively improved processes, it did not capture staff experiences or external factors, such as policy changes that could influence results.

Recommendation for future studies

Future research should explore additional pioneering quality improvement methodologies for reducing insurance claim rejections in hospital pharmacies. Future studies should address practical challenges and factors impacting the implementation of Lean Six Sigma in reducing claim rejections and the economic implications of these interventions. Research could further investigate the application of time-driven activity-based costing (TDABC) to optimize insurance claim processes and assess how integrating this approach with visual management systems can enhance efficiency. Additionally, studies should explore the transformative potential of AI and robotics in streamlining insurance claim management within the revenue cycle and pharmacy operations (11, 52).

Conclusion

Implementing Lean Six Sigma at Mediclinic Welcare Hospital Pharmacy has effectively reduced insurance claim rejections and optimized vital operational metrics. This systematic approach has resulted in significant improvements in staff competence, cost efficiency, and billing accuracy, directly contributing to the management of revenue cycles. Lean Six Sigma has not only improved claim acceptance rates but has also established sustainable operational excellence, streamlined processes, minimized errors, and promoted a culture of continuous improvement. The successful implementation demonstrates the potential of Lean Six Sigma as a transformative strategy for healthcare facilities, advocating for a proactive, data-driven problem-solving approach that adapts to the industry's evolving challenges while maintaining high service delivery standards.

Hospital pharmacies can play a vital role in minimizing the impact of claim denials on the broader healthcare system, which is essential for sustaining the long-term gains of Lean Six Sigma and ultimately enabling providers to prioritize their primary mission of delivering quality patient care.

Supplementary Materials

The following supporting information can be downloaded: Table S1. Sigma level conversion table. Table S2. Summary of Lean

Six Sigma DMAIC improvement tools and their outputs; Table S3. Improvement strategies for KPI 1 (Percentage improvement in staff competency in handling claims) ؛Table S4. Improvement strategies for KPI 2 (Percentage reduction in total cost due to rejections); Table S5. Improvement strategies for KPI 3 (Percentage improvement in accuracy of pharmacy billing).

Authors contribution

- Conceptualization: M. Sallam, A. Alkeelani, and A. Alfazari
- Resources: M. Sallam and A. Alkeelani
- Review and editing: M. Sallam and A. Alfazari
- Supervision: A. Alfazari
- Reading and approving the final manuscript: A. Alkeelani, A. Alfazari, and M. Sallam

Conflict of interest

The authors state that they have no financial conflicts of interest or personal connections that could have potentially influenced the work presented in this paper.

Data availability

The data will be made available upon reasonable request.

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