WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Enhancing Outpatient Registration Efficiency using Lean Six Sigma: A Case Study of a Secondary Care Hospital in Sri Lanka

Baminy N[1], Thahira Safiudeen SL[2]

[1]Dr Navaratnam Baminy, MD Trainee in Medical Administration, Post Graduate Institute of Medicine, University of Colombo, BDS, MSc in Medical Adminisration, MSc in Community Dentistry, PG Diploma in Health and Social Care Management, PG Diploma in Project Management, Lean Six Sigma (Yellow Belt), Sri Lanka

[2]SL Thahira Safiudeen, MBBS, MSc in Medical Administration, PG Diploma in Healthcare Quality and Patient Safety, Deputy Director, Base Hospital, Kalmunai North, Sri Lanka

DOI : https://doi.org/10.55248/gengpi.6.0225.0708

A B S T R A C T

This study explores the application of Lean Six Sigma methodologies to address the persistent issue of prolonged waiting times at a secondary care hospital's registration counter, a critical factor impacting patient satisfaction and operational efficiency in healthcare settings. Using the Define, Measure, Analyze, Improve, and Control (DMAIC) framework, the study systematically identifies and addresses inefficiencies in the registration process. Data was collected through direct observation, patient surveys, focus group discussion, and process mapping at a high-volume hospital. Analysis revealed that non-value-added activities, uneven staff distribution, and process variability were the primary causes of delays. Lean tools, such as value stream mapping and 5S, were employed to eliminate waste and streamline workflows, while Six Sigma techniques, including root cause analysis and statistical process control, were used to reduce variability and enhance process reliability. The implementation of targeted interventions led to a 56% reduction in average waiting time, while maintaining service quality and accuracy. Additionally, a cost saving of Rs 17,862 per month. This study demonstrates the effectiveness of Lean Six Sigma as a structured, data-driven approach to optimizing healthcare processes, reducing inefficiencies, and improving patient experiences. The findings offer valuable insights for healthcare administrators aiming to enhance operational performance and deliver patient-centered care in resource-constrained environments.

Keywords: Waiting time, registration process, Lean Six sigma, process improvement, Healthcare

1. Introduction

1.1 Healthcare in Sri Lanka

The healthcare sector constitutes a significant and rapidly expanding global industry (Bhat et al., 2014). It encompasses the assessment, management, and prevention of illnesses, injuries, and other physical and mental conditions, as well as primary, secondary, tertiary care, and public health initiatives. Healthcare policies and accessibility exhibit variability across nations, influenced by both macro-level and micro-level environmental factors(Wijewardana & Rupasinghe, 2016).

Sri Lanka is widely recognized for its universal healthcare system, providing coverage to all citizens and, in some instances, non-citizens, regardless of their socioeconomic status (De Alwis et al., 2022). In 2018, Sri Lanka's total health expenditure constituted 3.8% of its Gross Domestic Product (GDP) (National Health Accounts, 2022) . The public healthcare sector, comprising 73% of inpatient admissions, encompasses a diverse network of institutions ranging from specialized tertiary care centers, such as the National Hospital, to Primary Medical Care Units(PMCU) (National Health Accounts, 2022). However, significant state expenditure has not translated into commensurate improvements in healthcare capacity (Rannan-Eliya & Sikurajapathy, 2009). The nation faces challenges in adequately resourcing the health sector, particularly concerning investments in medical technology and equipment (De Alwis et al., 2022). Limited access to essential medicines and resources further exacerbates these capacity constraints. Operational inefficiencies, including resource wastage, inadequate health information systems, and a fragmented health referral system, hinder optimal utilization of existing healthcare resources (Rannan-Eliya & Sikurajapathy, 2009). To enhance healthcare delivery within existing resource limitations, Sri Lanka must explore and implement innovative and practical solutions (Wijewardana & Rupasinghe, 2016) . Moreover, in the contemporary healthcare landscape, heightened competition necessitates that service providers prioritize market viability. Within the hospital setting, patient satisfaction serves as a critical indicator of both service quality outcomes and overall service delivery effectiveness. Enhancing patient satisfaction and well-being consistently constitutes an overarching objective (Moreno et al., 2009).

The healthcare domain demands a high degree of precision, as even minor errors can have significant ramifications, potentially impacting numerous individuals and resulting in fatalities (Rathi et al., 2021). According to the Journal of Healthcare Finance, medical errors incurred costs exceeding

nineteen point five billion dollars in the United States during 2008 (Rathi et al., 2021) . The Institute of Medicine's 1998 report estimated that approximately 98,000 deaths could have been averted that year due to preventable medical errors. By 2008, this figure had alarmingly increased to an estimated 200,000 deaths annually, translating to over 548 fatalities per day, or nearly one death every two minutes, within the United States alone (Dall et al., 2008).

As healthcare providers consistently strive to enhance patient satisfaction, the patient experience commences with their initial interaction upon hospital entry (Moreno et al., 2009) . Within the hospital setting, patient registration constitutes a mandatory preliminary step, requiring patients to complete necessary documentation before medical consultations (Deshmukh et al., 2019) . The efficiency of hospital registration and admissions departments significantly influences the overall patient care experience and facilitates smooth patient flow within the healthcare facility (Deshmukh et al., 2019). In the Sri Lankan healthcare system, patient registration at the Emergency and Accident Service or Outpatient Department marks the initiation of the treatment process (Wijewardana & Rupasinghe, 2016).

From the patient's perspective, timeliness is paramount, emphasizing the critical role of efficient hospital management in minimizing delays associated with these initial procedures (Deshmukh et al., 2019). Patient behavior and understanding at the registration desk can provide valuable insights into the challenges they encounter while completing registration details (Deshmukh et al., 2019) . While queuing systems may appear to offer a structured approach, their value diminishes significantly if patient care is compromised due to delays in accessing essential medical services (Deshmukh et al., 2019).

1.2 Lean Six Sigma (LSS)

Lean Six Sigma represents a synergistic approach that integrates the principles of Lean manufacturing and Six Sigma methodologies. Lean is renowned for its focus on waste elimination, while Six Sigma is recognized for its emphasis on process improvement (Kaswan & Rathi, 2019) . Given that Six Sigma signifies standard deviation, the combined application of these philosophies aims to enhance process efficiency and quality by simultaneously minimizing waste and reducing variability (Hseng-Long Yeh, 2011) . The implementation typically commences with Lean methodologies to eliminate waste, followed by the application of Six Sigma tools to address process variation, demonstrating a complementary relationship between these two approaches in contemporary practice (Singh et al., 2023). The integration of Lean and Six Sigma has proven effective in optimizing process flow (Abu-Salim et al., 2023) . Furthermore, the principles of Six Sigma and Lean exhibit significant overlap, facilitating their concurrent implementation. Both methodologies ultimately contribute to the delivery of enhanced value to both customers and businesses (Rathi & Singh, 2021).

While both Lean and Six Sigma have their origins in manufacturing, particularly within the automotive industry, their applicability has expanded considerably. Today, these methodologies are widely adopted in various sectors, including public service, customer service, and healthcare. The concept of Lean thinking can be traced back to the early days of mass production, with Henry Ford pioneering its implementation through the integration of standardized parts, conveyors, and optimized workflow. Subsequently, Kiichiro Toyota introduced innovative concepts such as value stream mapping and Kanban, culminating in the development of the renowned Toyota Production System in the 1990s (Rathi et al., 2017).

Lean principles, pioneered by James Womack at the Lean Institute, have gained widespread recognition as an effective approach to process improvement within manufacturing. Lean methodologies emphasize the utilization of qualitative tools, making them relatively more intuitive and thus often serving as the foundational element for Lean Six Sigma initiatives. While the concepts underlying Lean and Six Sigma are relatively straightforward to comprehend, their successful implementation can present challenges (Rathi et al., 2016).

Lean Six Sigma integrates Lean principles, centered on value stream mapping and waste elimination, with the Six Sigma focus on variation reduction and customer satisfaction. This synergistic approach yields a powerful, data-driven framework for problem-solving and ultimately, cost reduction (Niñerola et al., 2020) . The adoption of Lean Six Sigma within healthcare settings has demonstrated significant potential for improving clinical outcomes, reducing patient waiting times, minimizing errors, optimizing costs, and enhancing resource utilization (Honda et al., 2018; Zimmermann et al., 2020) . However, existing literature pertaining to the application of waiting time reduction strategies within outpatient clinics remains relatively limited. This paucity of research stands in stark contrast to the persistent challenge of prolonged waiting times in hospital outpatient departments, a common issue encountered globally (Naiker et al., 2018).

1.3 Background and Justification

The District General Hospital Nuwara Eliya, a public healthcare institution situated in Nuwara Eliya, Sri Lanka, serves a population of approximately 800,000 residents within its catchment area. The hospital offers a comprehensive range of medical services, encompassing both inpatient and outpatient care, emergency services, and specialized care in areas such as surgery, paediatrics, and obstetrics. Equipped with modern facilities and staffed by a team of qualified medical professionals, the hospital plays a vital role in providing healthcare services to the surrounding community.

The implementation of the Hospital Health Information Management System (HHIMS) at the District General Hospital Nuwara Eliya commenced in 2018, aligned with the national strategy for digitalizing healthcare services and driven by the objectives of enhancing patient care and operational efficiency. Recognizing the Outpatient Department (OPD) as the primary point of patient interaction, it was selected as the initial focus for HHIMS implementation.

Given that secondary data revealed a high patient recurrence rate (exceeding 80%), the hospital identified an opportunity to streamline patient registration by initiating personal health card (ID) issuance prior to the full activation of the OPD-level HHIMS. This proactive measure involved a three-month pre-implementation phase during which ID cards were issued to all patients visiting the hospital, accompanied by a public awareness campaign to encourage card acquisition.

This proactive approach resulted in approximately 40% ID card coverage by the time the OPD-level HHIMS became operational. The anticipated reduction in overall patient waiting time, which previously averaged 2 hours and 15 minutes, was realized. Within three months of HHIMS implementation at the OPD, a significant decrease in waiting time to 1 hour and 32 minutes was observed. This reduction encompassed the entire patient journey, from hospital entry to treatment completion, including registration, consultation, investigations, and medication collection. The implementation of the Hospital Health Information Management System (HHIMS) at the District General Hospital Nuwara Eliya commenced in 2018, aligned with the national strategic plan for digital healthcare and driven by the objectives of enhancing patient care and operational efficiency. Recognizing the Outpatient Department (OPD) as the primary patient interface, it was selected as the initial focus for HHIMS implementation.

Given the high patient recurrence rate, exceeding 80%, the hospital proactively initiated patient ID card issuance prior to full-scale HHIMS implementation in the OPD. This proactive measure aimed to streamline future patient registration processes. A three-month preparatory period was dedicated to issuing ID cards to all hospital attendees, accompanied by a public awareness campaign to encourage widespread adoption. This proactive approach resulted in a 40% ID card coverage rate by the time the OPD commenced utilizing the HHIMS.

The anticipated reduction in patient waiting times, initially averaging two hours and fifteen minutes, was a key objective of the HHIMS implementation. Following three months of HHIMS operation within the OPD, a notable decrease in waiting times was observed, with the average reduced to one hour and thirty-two minutes. This reduction encompassed the entire patient journey, from hospital entry to treatment completion, including registration, consultation, investigations, and medication collection.

The implementation of the Lean methodology, specifically the Ohno Cycle, was employed at various stages within the OPD department, encompassing the registration desk, pre-consultation waiting area, consultation rooms, laboratory, radiology department, and pharmacy. Through observation, a critical bottleneck was identified at the registration counter, characterized by an average patient waiting time of 5.13 minutes and significant overcrowding, which has not being improved over the last four years. This observation underscores a key area requiring process optimization within the OPD workflow.

The 2017 report by Awards Help Set Standards for Healthcare Excellence highlighted prevalent gaps within healthcare systems and outlined potential solutions, with many emphasizing Six Sigma as a viable approach to achieving these improvements (Honda et al., 2018). By leveraging the structured framework of the DMAIC methodology, Six Sigma offers a powerful means of enhancing existing processes through the minimization of process variability and the establishment of well-defined performance targets. Furthermore, the integrated application of Lean and Six Sigma methodologies facilitates the development of robust succession planning strategies, empowering organizations to address leadership deficiencies and cultivate a culture of process ownership (Honda et al., 2018).

1.4 Literature review

The initial interaction between patients and hospitals occurs during the registration procedure. Perceptions of hospitals will be shaped by the quality of the registration experience. Waiting time is a crucial performance indicator for the registration procedure. Sabry (2014) , emphasizes the critical importance of error-free processes in healthcare, given the potential for even minor errors to have life-threatening consequences. This necessitates a relentless pursuit of zero defects, making Six Sigma an ideal framework for healthcare organizations. Furthermore, the inherent ability of Six Sigma to concurrently enhance quality and reduce costs strengthens its appeal as a viable solution to the financial challenges faced by healthcare providers (Heuvel et al., 2005).

Bush et al. (2007) conducted a study at Charleston Area Medical Center that investigated the implementation of Six Sigma principles within the obstetrics department. The study demonstrated significant improvements, including a reduction in new patient wait times from 38 to 8 days, a decrease in patient time spent in the clinic from 3.2 to 1.5 hours, and a notable increase in mean patient satisfaction scores from 5.75 to 8.54 on a 10-point scale. The researchers attributed these positive outcomes to a collaborative team-based approach to addressing the department's productivity challenges. Fischman (2010) , through the application of LSS methodologies in an internal medicine residency clinic, achieved a significant reduction in patient waiting times, from 14 minutes to 5 minutes, representing a 64% decrease. Similar substantial reductions in patient waiting times have been documented in other studies. Shreeranga, Gijo, and Jnanesh reported a 94% decrease in average patient waiting times, while Gijo and Antony (2014) observed a 57% reduction, with patient waiting times decreasing from 56.95 minutes to 24.5 minutes. A systematic review reveled that, the five most frequent departments for Six Sigma or Lean Six Sigma (LSS) implementation were: a) surgery; b) administrative and operations; c) imaging and radiology; d) pharmacy; and e) emergency and traumatology, collectively accounting for nearly 75% of all case studies analyzed. Within the administrative and operations departments, improvements in patient waiting times emerged as the most prevalent outcome (Honda et al., 2018).

1.5 Objectives

General Objective

To enhance the efficiency and effectiveness of the Outpatient Department (OPD) registration counter at District General Hospital, Nuwara Eliya.

Specific Objectives

1.To Identify the gaps in the existing OPD registration system

2. To apply DMAIC methodology to address the gaps in the OPD registration system

3. To measure the performance after the interventions

2. Methodology for DMAIC

A mixed method comprising both quantitative and qualitative data was used to conduct a descriptive case study in the District General Hospital in Nuwara Eliya. Between October 2024 and January 2025, this study was conducted.

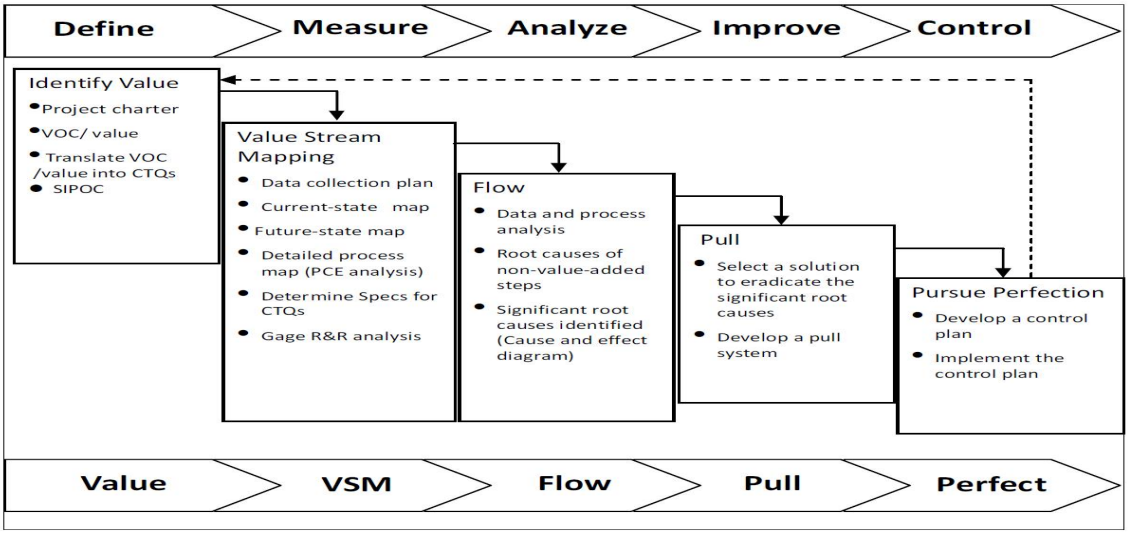

Figure 1: Conceptual Framework of the LSS Methodology

Defining Phase

The persistent challenge of long patient wait times at the registration counter of the hospital has been identified as primarily attributable to the frequent re-issuance of personal health cards. This recurring need for card replacement creates a significant bottleneck in the registration process, impacting both patient flow and staff efficiency. Thus, this was initially considered the main focus.

Project Charter: Addressing Duplicate Card Issuance at District General Hospital Nuwara Eliya Number of Duplicate cards issued from 5th of October to 5th of November, 2024

Table 1: Summary of Duplicate Health Card Issuance

Total Duplicate cards issued	994
Number of days studied	32
Mean	31.06
Standard deviation	12.78

Step 1:

i. Voice of customers:

As a critical component of quality assurance within the state-owned hospital, quarterly satisfaction surveys are mandated for both patients (external customers) and staff members (internal customers). These surveys serve as valuable indicators of service quality and patient experience. Furthermore, a rigorous analysis of patient complaints submitted through designated complaint boxes is conducted on a regular basis.

ii. Hierarchy and Source

Hierarchy:

Level 1: District General Hospital Nuwara Eliya (Director/ deputy director/ Administrative Officer)

Level 2: Card Issuance unit (registration desk)

Level 3: IT department/ planning and development unit/ quality management and safety unit

Source:

Card Issuance Records (detailed logs of all card issuances)

Customer Complaints (formal and informal)

Employee Observations and Interviews

Existing Standard Operating Procedures (SOPs)

IT System Logs

Step 2: Convert into service characteristics

Patients:

"I am frustrated with the long wait times just to get a new ID card."

"Why do I need multiple ID cards? It's confusing and a waste of time."

"I wish there was an easier way to get a ID card."

Outpatient Department registration desk staff:

"Issuing multiple ID cards is time-consuming and causes delays in patient registration."

"We need a more efficient system to handle patient IDs."

Administrative department:

“Increasing cost”

Service characteristic

% of complaints

% of spending on cards

% of waiting time improvement

% of reduced ID card re-issuance

Step 3: Identify the gap between the current and expected situation

Table 2: Performance Gap Analysis of Registration Metrics

Indicator	**Expected level**	**Current level**
Waiting time	1 minute	5.03 minutes
Complaints	0%	30%
Number of re-issuances of cards per day	5	31.06 (SD 12.78)
Reduction of cost	Rs 150.00 (5*30)	Rs 29,820 (30*994)

Step 4: Problem Statement

During October 2024- November 2024, the re-issuance of the ID cards at the OPD registration counter was 31.06 (+/- 12.78). There is an opportunity/ gap of 26 cards per day (83%) that could result in a saving of Rs 29,670 per month. My Yellow Belt Project is to overcome this.

Step 5: Understand the project stakeholders and project boundaries- Using the SIPOC model

S (Suppliers): Hospital Registration System/ IT Department/ Card Supplier

I (Inputs): Patient Information/ Blank ID Cards/ Ribbons/Inks for Card Printers/ Staff Knowledge and Training

P (Process): Patient Arrival & Registration/ Data Entry/ Card Printing, Card Verification & Handoff

O (Outputs): Single ID Card per Patient/ Reduced Wait Times/ Cost Savings/ Increased Patient Satisfaction/ Enhanced Staff Efficiency

Customers: Patients/ Outpatient Department Registration Desk Staff/ Hospital Administration

Step 6: SWOT analysis

Strength	**Weakness**
Existing digitalization High patient volume (can take data-driven decision-making) Committed staff	Multiple ID card issuance Patient awareness and compliance Administrative bottlenecks
Opportunities	**Threat**
Educational campaigns Technology integration Cost savings	Patient non-compliance Technological challenges Change management

Figure 2: SWOT Analysis of Outpatient Registration Process

Step 7: Project Charter: Enhancing Patient ID Management at District General Hospital, Nuwara Eliya

Project Title

Enhancing Patient ID Management at District General Hospital, Nuwara Eliya

Project Purpose and Objective

This project aims to address the issue of patients failing to present their ID cards during subsequent hospital visits, resulting in the issuance of duplicate cards. The primary objective is to achieve an 80% reduction in duplicate card issuance within a six-month timeframe. This reduction is anticipated to yield several positive outcomes, including:

- Cost Reduction**:** Minimizing the resources expended on re-issuing cards, such as materials, labor, and system resources.
- Enhanced Patient Satisfaction**:** Diminishing patient frustration and inconvenience caused by the need to re-obtain cards.
- Improved Efficiency: Streamlining the registration process and reducing delays associated with duplicate card issuance.

By successfully addressing this issue, the hospital can enhance patient experience, optimize operational efficiency, and contribute to a more streamlined and cost-effective healthcare delivery system.

Problem Statement

From October 2024 - November 2024, the re-issuance of ID cards at the OPD registration counter was 31.06 (+/- 12.78) per day. There is an opportunity/gap of 26 cards per day (83%) that could result in a saving of Rs 29,670 per month. The project aims to overcome this issue.

Project Scope

  - artment (OPD) registration process.
  - Technological solutions for automated reminders and digital ID management.
  - Training and educational campaigns for staff and patients.
- Excluded:
  - Inpatient Department processes.
  - Other unrelated administrative processes within the hospital.

Project Goals

- Reduce the average waiting time for ID card issuance to 1 minute.

- Decrease patient complaints related to ID cards from 30% to 0%.
- Reduce the number of duplicate ID cards issued from 6.66% to 0%.
- Achieve monthly cost savings of Rs 29,670.

Key Performance Indicators (KPIs)

- Reduced Wait Times: Average waiting time for ID card issuance.
- Single ID Card System: Number of duplicate ID cards issued.
- Enhanced ID Card Reminders: Percentage of patients receiving reminders.
- Efficient ID Card Issuance: Time spent on ID card issuance per patient.
- Improved ID Management System: Number of registration errors related to ID cards.

Stakeholders

- Hospital Administration
- IT Department
- Outpatient Department Registration Desk Staff: Handles patient registration and ID card issuance.
- Patients
- Project Team
- External Consultants (ICTA)

Project Boundaries

- Timeframe: November 10, 2024 – December 10, 2024 (One-month duration).
- Resources: Project team members, IT staff, OPD registration staff, budget for technological solutions, and training materials.
- Geographic Boundaries: Limited to District General Hospital, Nuwaraeliya.

Deliverables

- Automated Reminder System: SMS/email reminders to patients to bring their ID cards.
- Educational Campaign: Posters, flyers, and digital communication to inform patients about the importance of bringing their ID cards.
- Streamlined Check-In Process: Efficient ID verification and issuance process.
- Mobile App Integration: App for digital ID cards and appointment details.
- Introducing an iris scanner or fingerprint scanner

Project Budgets

C9 fx

	A	B	C	D	E	F	G	H	I
1	**Expense Item**	**Estimated Cost**	**Justification**						
2	Staff Training	50,000	2-day training program for 10 registration staff, including materials, instructor fees, and refreshments.						
3	System Upgrades (if applicabl	100,000	Potential costs for software updates, hardware upgrades (e.g., faster printers), or integration with existing hospital systems.						
4	Stationery and Consumables	10,000	Costs for new ID cards, ribbons/inks for printers, and other office supplies.						
5	Consultancy Fees (if required)	50,000	Fees for external consultants to assist with process analysis, system implementation, or data analysis.						
6	Contingency	20,000	Buffer for unforeseen expenses.						
7	Total	230,000							
8									

Figure 3: Project Budget

Project Schedule

E8 fx

	A	B	C	D
1	Task	Duration	Responsible	
2	Project Kick-off Meeting	1 day	Project Manager	
3	Process Analysis & Documentation	3 days	Process Analysis Team	
4	Root Cause Analysis	3 days	Root Cause Analysis Team	
5	Solution Design & Evaluation	5 days	Solution Design Team	
6	System Implementation & Testing	2 days	IT Department	
7	Go-Live & Monitoring	1 week	Project Team	
8	Evaluation & Reporting	1 week	Project Manager	
9				
10				

Figure 4: Project Schedule

Risks and Mitigation Strategies

- Patient Non-compliance: Continuous education and reminder systems.
- Technological Challenges: Regular maintenance and support from the IT department.
- Change Management: Training and engagement activities for staff and patients to ensure smooth adoption of new processes.

Approval Signatures

- Project Sponsor: _____
- Project Leader: _____
- IT Department Head: _____
- Nursing Staff Representative: _____
- Administration Staff Representative: _____

Measuring phase

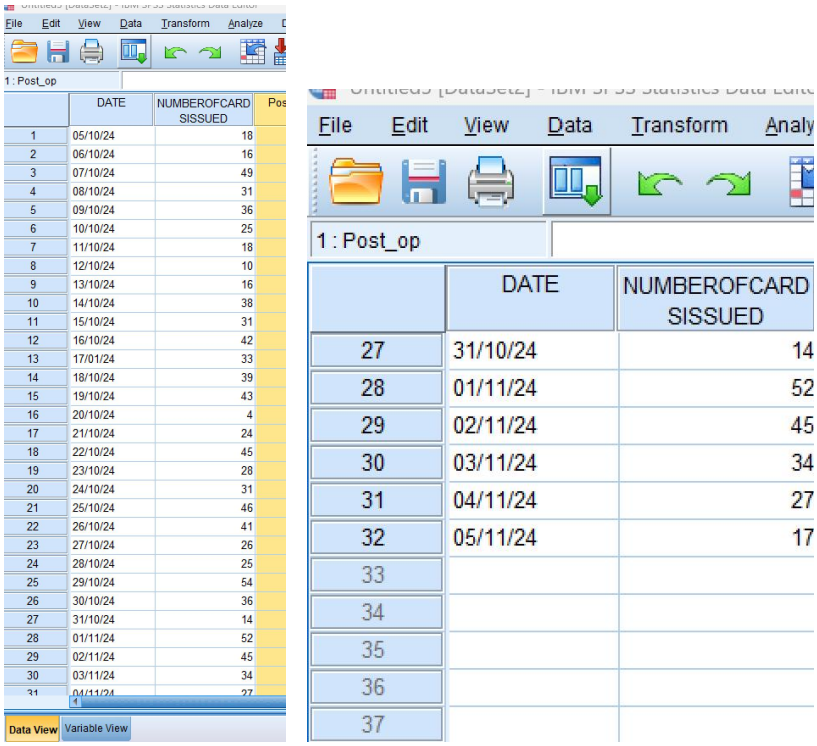

Figure 5: Raw data describes the number of ID cards re-issued according to the date

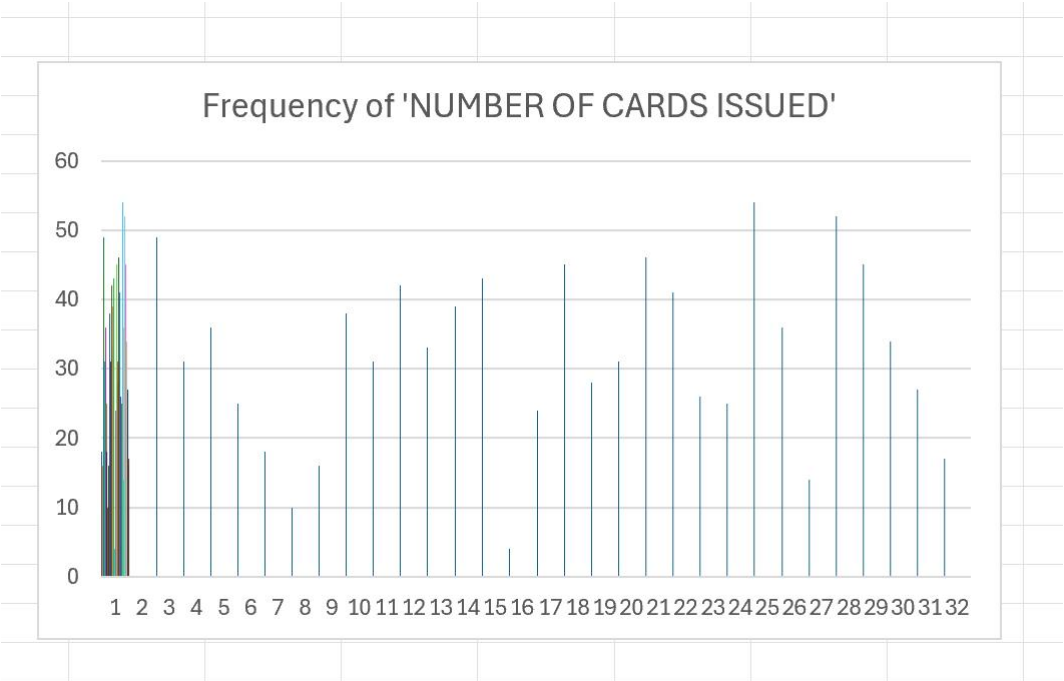

Figure 6: Simple bar chart shows the number of ID cards issued according to the date

ACCORDING TO REASONS

CARD MISPLACED	FORGOT THE CARD	NID UNAVAILBLE	NOT MARKED
770	198	2	24

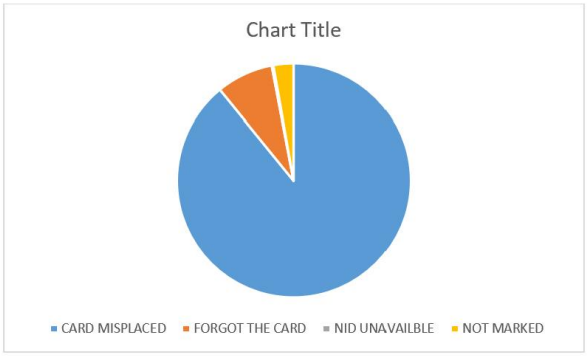

Figure 7: Figure shows the reasons for the re-issuance of ID cards

Statistics

		NUMBER OF CARDS ISSUED	DATE
N	Valid	32	32
	Missing	0	0
Mean		31.06	
Mode		31	
Std. Deviation		12.783	
Variance		163.415	
Range		50	
Minimum		4	
Maximum		54	
Sum		994	

Figure 8: Descriptive statistics of card re-issuance

Analysis phase

i. Brainstorming:

Session Summary:

- **Participants**: Hospital Administration, IT Department, OPD Staff, Patients, External Consultants
- **Ideas Generated**:
  - Lack of patient awareness about the importance of bringing ID cards.
  - No effective reminder system in place.
  - Patients forget to bring their ID cards.
  - Patients were not motivated to bring the card since, there is no advantages over bringing the card
  - Long waiting times discourage patients.
  - Inefficient registration process.
  - Poor communication about ID card policies.
  - Unpredicted health issues

ii. Six Thinking Hats

Session Summary:

- **White Hat (Facts)**:
  - Total duplicate cards issued: 994 in 32 days.
  - Mean: 31.06 duplicate cards/day, Standard Deviation: 12.78.
  - Current waiting time: 5.03 minutes.
  - Monthly cost of re-issuance: Rs 29,820.
- **Red Hat (Feelings)**:
  - Patients are frustrated with long wait times.
  - Staff feels burdened by the repetitive task of issuing duplicate ID cards.
- **Black Hat (Caution)**:
  - Risk of patient non-compliance even after implementing reminders.

- Potential technological challenges with new systems.

- **Yellow Hat (Optimism)**:
  - Automated reminders can significantly reduce duplicate ID card issuance.
  - Improved patient satisfaction with shorter waiting times.
- **Green Hat (Creativity)**:
  - Develop a mobile app for digital ID cards.
  - Create educational campaigns to raise awareness.
  - Streamlined check-in process using secondary IDs.
- **Blue Hat (Control)**:
  - Monitor and analyze the effectiveness of implemented solutions.
  - Regular reviews and updates to the system as needed.

iii. Affinity diagram

Affinity Groups:

1. **Patient-related Causes**:
   - Forgetfulness
   - Lack of awareness
   - Not motivated to bring the card
   - No reminders
   - Emergencies
2. **Process-related Causes**:
   - Inefficient registration process
   - Same waiting times (with cards/ without cards)
3. **System-related Causes**:
   - No automated reminder system
   - Lack of digital solutions
4. **Communication-related Causes**:
   - Poor communication about ID card policies
   - Inadequate educational campaigns

iv. Fishbone diagram

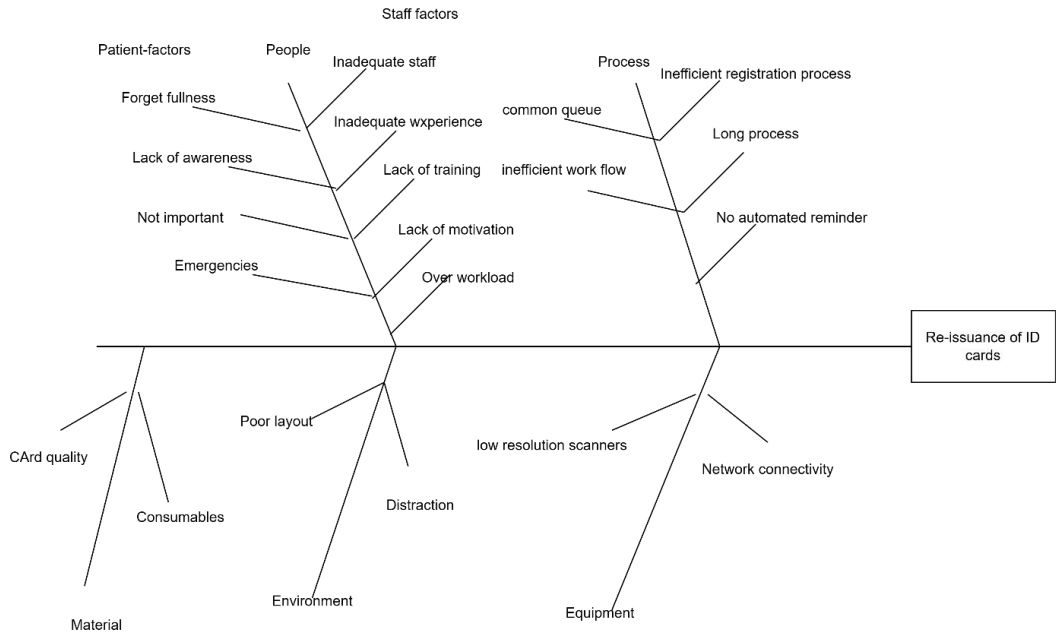

Figure 9: Fishbone analysis of the re-issuance of cards

v. 5 why technique

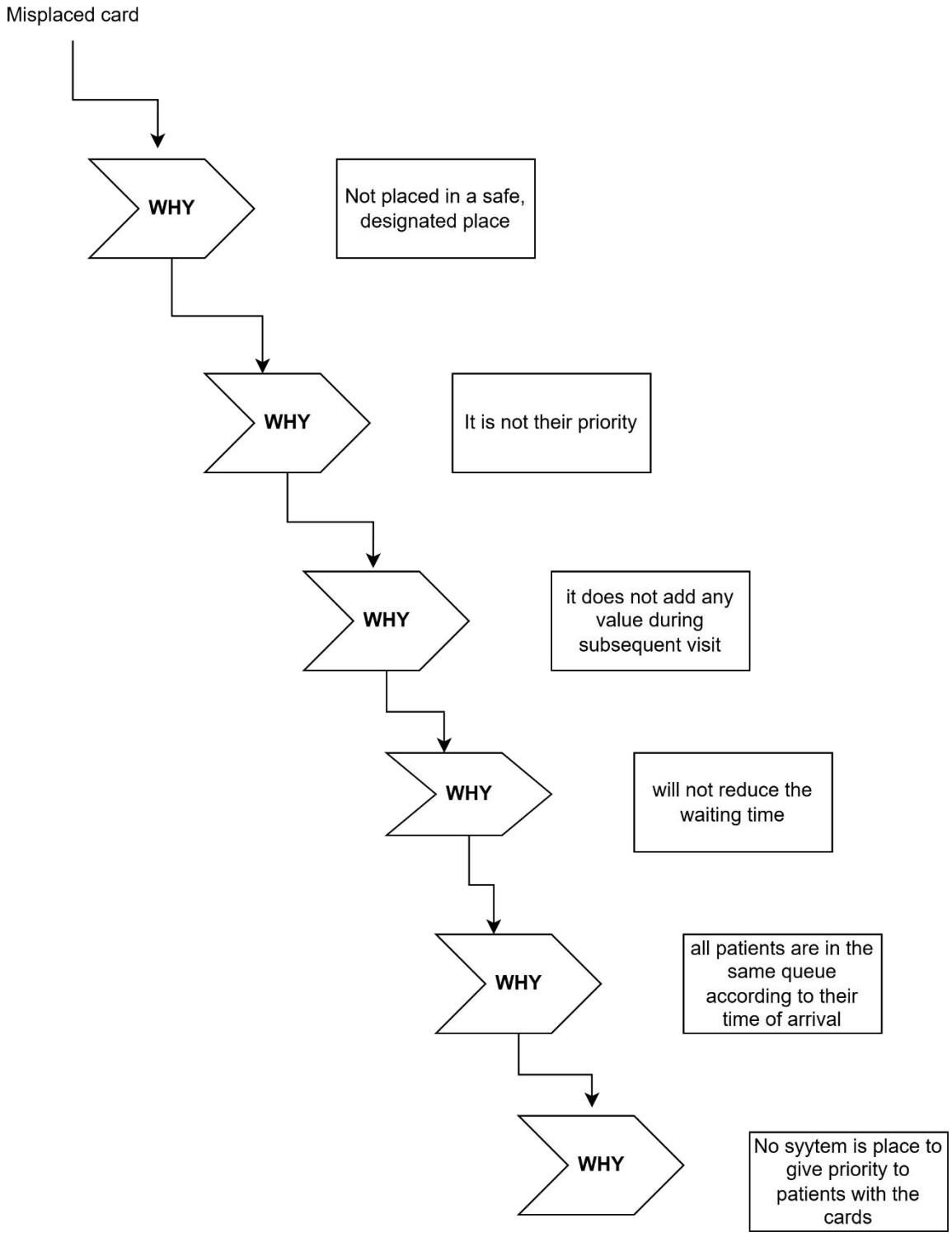

Figure 10: Five-why analysis

Improve phase

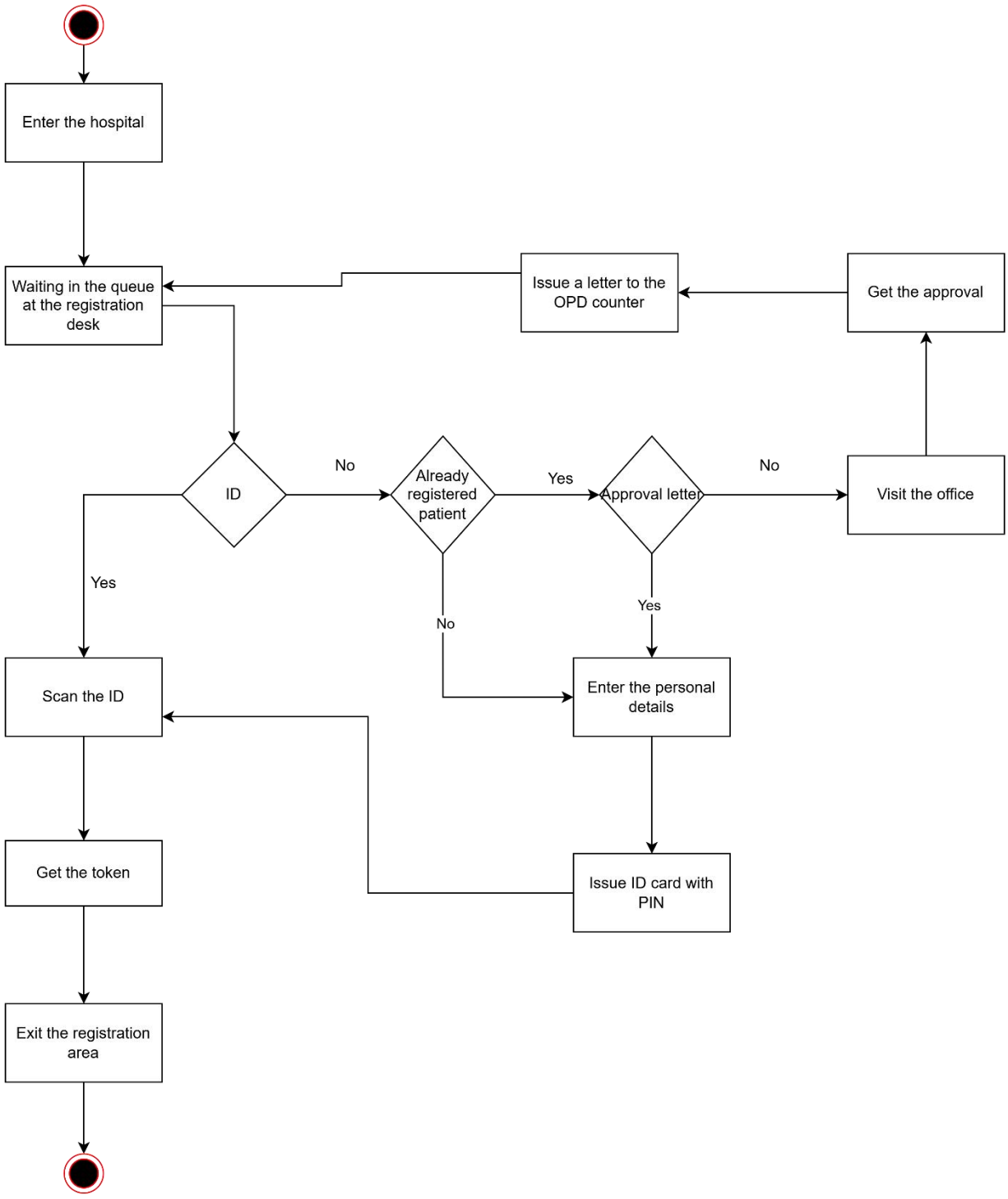

Figure 11: Process map at the OPD registration counter

Identification of Value

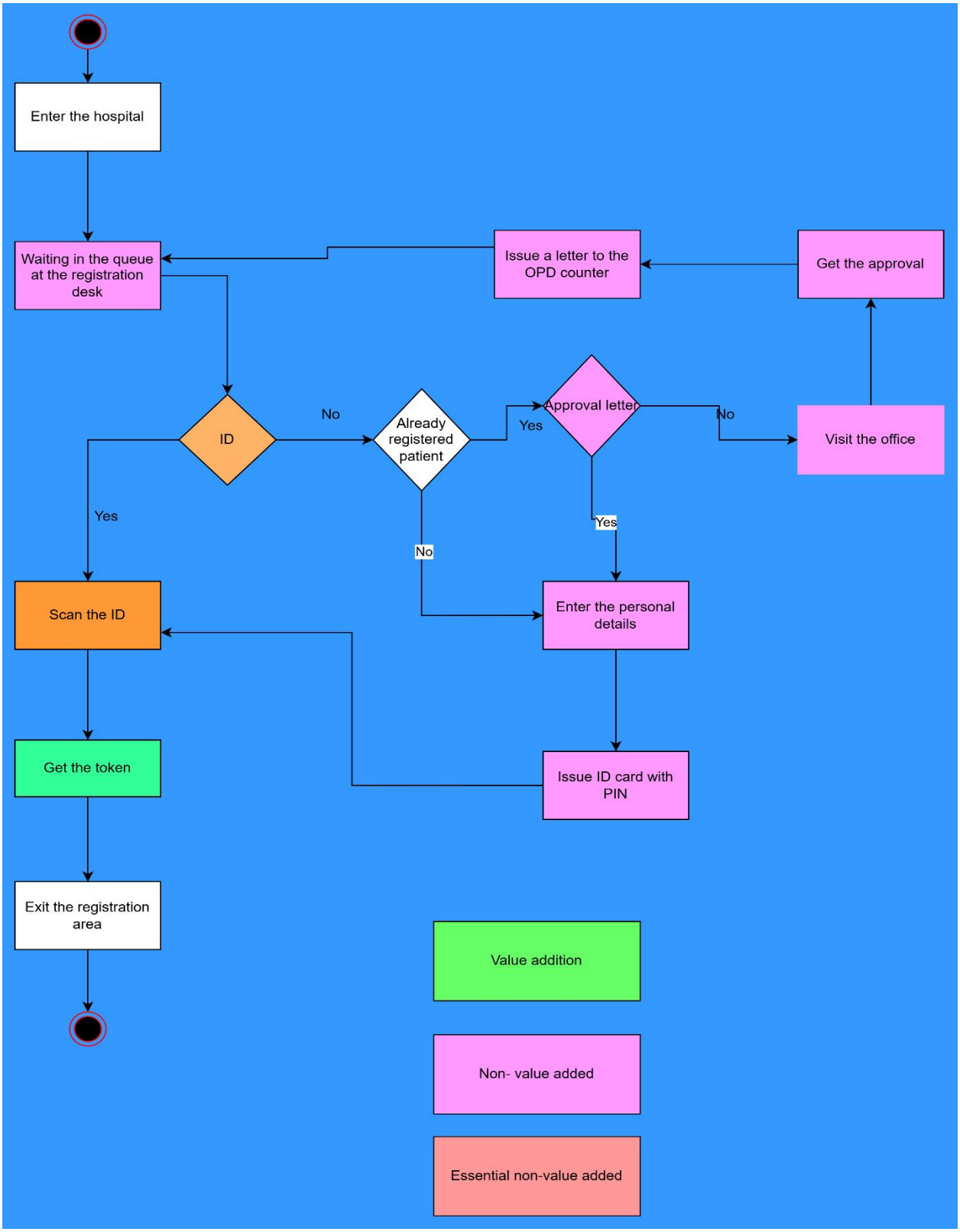

Figure 12: Value Identification

Steps for Improvement

1. **Two Separate Counters**:
    - **Counter A**: For patients who have their ID cards.
    - **Counter B**: For patients without ID cards (new or subsequent visits).

2. **Clear Instructions**:
    - Display clear instructions at the registration counters and waiting areas to guide patients through the process.
3. **Seating Facilities Adjusted**:
    - Adjust seating arrangements to facilitate smooth patient flow and reduce waiting times.
4. **High-Resolution Barcode Readers**:
    - Replace old barcode readers with high-resolution ones that can read barcodes saved on mobile phones.
5. **Patient Advice**:
    - Advise patients to take a picture of their barcodes and store them on their mobile phones.
6. **Mass Awareness Campaign**:
    - Conduct mass awareness campaigns and place multiple notices to inform patients about the new processes and the importance of bringing their ID cards.

Aspect	**Pre-improvement**	**Post-improvement**
Queue system	The single queue for all patients	Separate queues for ID-holding and new registrants.
Triage	Triage occurs at the counter	Triage occurs before counter allocation with the help of separate counters and seating facilities
Staff task allocation	Mixed tasks (ID verification & new reg., token issuing)	Dedicated staff for each counter task.
Waiting time	Average: 5.13	Average at counter A: 1.03 minutes Counter B: 3.48 minutes

Figure 13: Summary of Pre- vs. Post-Improvements in Process Mapping

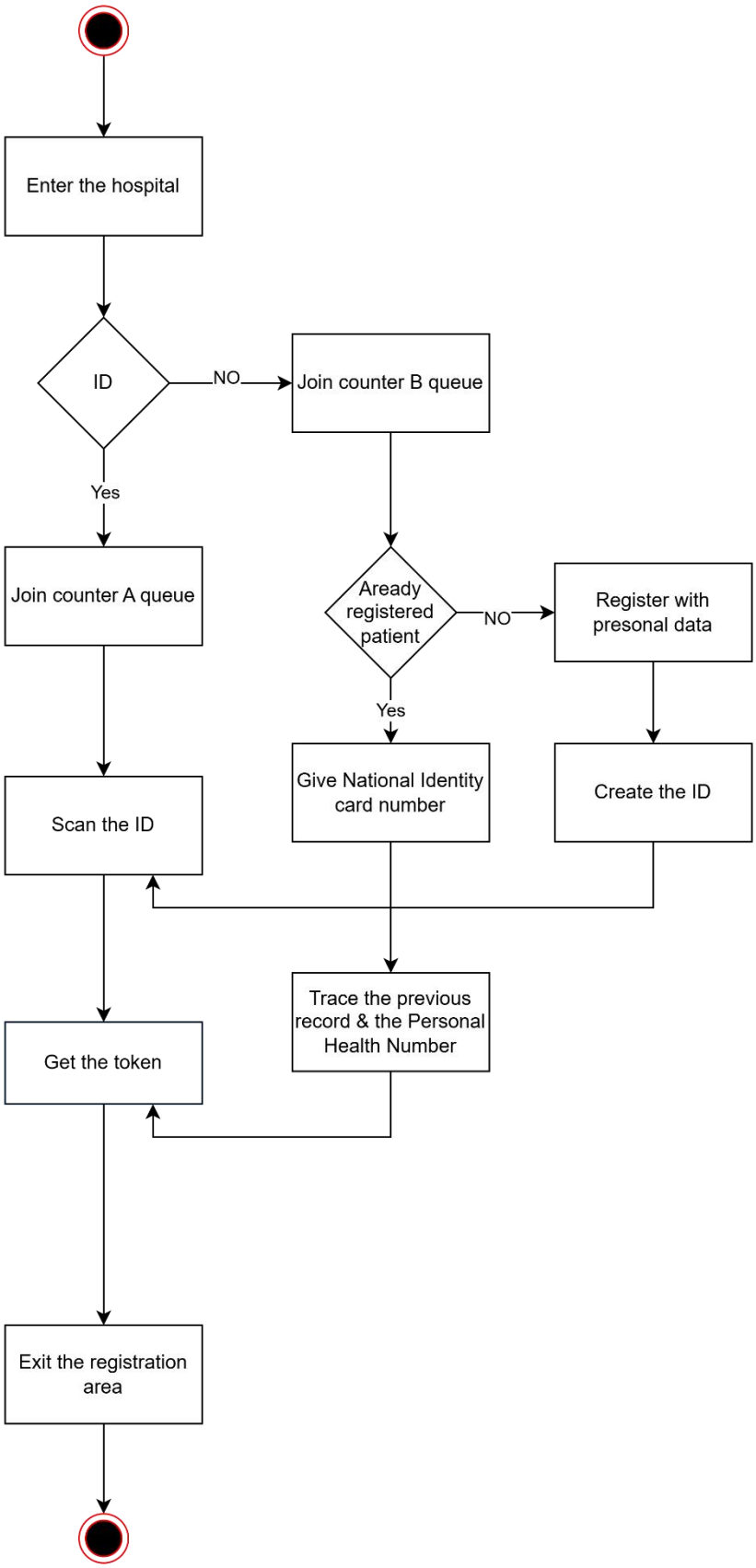

Figure 14: The re-designed process map

Control phase

Control Measure	Responsibility	Frequency	Data Collection Method	Target/ expected outcome
Monitor waiting time	OPD staff	Daily	Time tracking system	Average waiting time at counter A not more than 1 minute
Track the number of duplicate cards	Registration desk staff	Daily	Hospital record	Reduce duplicate cards by 80%
Number of patients waiting at the counter B	QMU staff	Daily	Observation	Less than 10 patients at a time
Verify barcode reader performance	IT department	weekly	Performance tests	100% barcode reading
Patient compliance	OPD staff	Monthly	Survey/ feedback	More than 95% of the patients with ID card
Awareness campaign effectiveness	QMU team/ health education team	Monthly	Patient feedback/ survey	More than 80% awareness level
Improve patient/ staff satisfaction	QMU team/ health education team	Quarterly	Survey	More than 90% satisfaction level

Figure 15: The control plan

3. Summary

Following the implementation of Lean Six Sigma methodologies in the OPD registration counter, significant improvements have been observed. Patient waiting times have been substantially reduced, by 56%. This improvement translates to a more efficient patient flow and an enhanced patient experience. Furthermore, a key driver of long wait times, the frequent re-issuance of health cards, has been effectively addressed. By implementing the two-counter system, the number of re-issued cards has decreased by 68%. This reduction has resulted in significant cost savings, estimated at Rs.17,862 per month, due to decreased material costs and improved overall process efficiency. The Lean Six Sigma approach has not only optimized the registration process but has also fostered a culture of continuous improvement within the department.

Acknowledgment

1.Dr Mahendra Seneviratne, Director, District General Hospital, Nuwara Eliya

2. Menaga Poopalan, Development Officer, District General Hospital, Nuwara Eliya

3. Tharika Gamage, Lecturer, The corporate Campus

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