Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA
Published: February 18, 2025

DOI: 10.46254/AN15.20250069

Integrating Robotic Process Automation in Healthcare: Challenges and Opportunities

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Abstract

Robotic Process Automation (RPA) is software-based robotics which automates and offloads unnecessary processes performed by human workers. RPA was introduced by Hospital X primarily to support the operations team in making informed decisions about procurement as well as to notify vendors to bill for the consumed items. Before the implementation, the process was straightforward but tedious. After implementation, the process was considerably shortened. Instead of manually tracking and informing individual vendors, staff could simply submit a report to the RPA bot. However, inefficiencies remained in the procurement process. In this paper, we identify the operational inefficiencies that arise from RPA implementation using lean six sigma methodology. We map the current and to-be process and brainstormed for improvements. Finally, we compare the advantages and disadvantages of manual processes versus RPA to determine which one is more superior and analyzed the time savings from implementing RPA. RPA essentially automates some of the most mundane and repetitive computer-based tasks and processes in the workplace. It promises to boost efficiency by taking over tasks that were previously handled by humans. This paper contributes to the extant literature on RPA implementation and how lean six sigma and DMAIC methodology helped Hospital X to transition from manual to automated process and improve its procurement process.

Keywords
Robotic Process Automation, Lean Six Sigma, Healthcare, Procurement, Process Improvement.

1. Introduction

1.1 Background

Hospital X plays a vital role in Singapore's healthcare system, striving to revolutionize healthcare delivery by offering seamless, one-stop care. This approach reduces the need for patients to transfer between facilities or consult multiple specialists. As part of its commitment to operational excellence, the 300+ bed hospital adopted Robotic Process Automation (RPA) to enhance procurement efficiency. RPA refers to software-based robotics designed to automate repetitive tasks to reduce human errors, improve efficiency, and ensure compliance with workplace regulations and standards. Its primary function at the organization is to support the operations team in making informed decisions, while its secondary function is to notify vendors to bill the hospital for items consumed.

The adoption of RPA coincided with the opening of a major new operating theatre specializing in complex surgeries, including total knee and cervical disc replacements. This addition significantly increased staff workload. To address this challenge and drive process improvement, Hospital X identified innovative automation as the key to maintaining operational excellence. Before implementing RPA, the procurement process was labor-intensive but straightforward. Staff manually tracked the utilization of items using Excel, monitored Purchase Order (PO) balances, and acted when PO utilization exceeded 65% - either by topping up contracts or raising new POs. Staff then emailed vendors to request billing for consumed items.

With RPA in place, the process became more efficient. Instead of manual tracking and vendor notifications, staff now submit a report to the RPA bot, which analyzes the data based on dates of operation, patient case numbers, item codes and unit prices. The bot assigns items to the appropriate POs, sends automated emails to vendors, and provides an updated database to the procurement department the following day. Despite these improvements, inefficiencies remained in the procurement process. This study aims to evaluate whether the implementation of the RPA bot truly enhanced operational efficiency at Hospital X and to propose enhancements for further improvement.

1.2 Objectives

This study seeks to achieve the following objectives:

- Objective 1: Assess the performance of the RPA bot. Determine whether the workload has been successfully lightened as anticipated since its implementation. This involves identifying new inefficiencies that have emerged with the use of RPA.

- Objective 2: Propose system improvements. Explore potential enhancements to address the challenges encountered during the use of RPA.

- Objective 3: Compare RPA with the manual process. Analyze the advantages and limitations of both processes to determine which approach is more effective for procurement operations.

2. Literature Review

2.1 Advantages of RPA Implementation

Casey (2020) highlighted that Robotic Process Automation (RPA) automates repetitive computer-based tasks, significantly boosting efficiency and reducing human errors. For data-intensive processes, RPA is particularly effective as it operates based on pre-defined rules and delivers consistent outputs. According to Casey (2020), the four fundamental principles of RPA are:

- The process must be rule-based.
- It must be repeated at standardized intervals or be triggered by pre-defined events.
- It must have defined inputs and outputs.
- It must involve a substantial volume of tasks.

Both Casey (2020) and Huang et al. (2024) agreed that RPA alleviates monotonous workloads, enabling employees to focus on value-added activities. Huang et al. (2024) further linked this to Lean Management's "Waste of Talent", emphasizing how RPA empowers employees by eliminating underutilization of skills and knowledge.

2.2 Challenges of RPA Implementation

Eulerich et al. (2022) cautioned that RPA, while beneficial, is not a panacea. It addresses symptoms rather than root causes, necessitating human oversight for optimal performance. Key challenges associated with RPA include:

- Security and control vulnerabilities
- A tendency to be used as a temporary fix without addressing core system issues
- Misunderstood or underestimated implementation costs
- Complex governance requirements
- Risk of losing process knowledge due to automation erasing manual steps.

For example, in manual processes, a clear trail of actions provides transparency, while RPA systems may obscure certain steps, creating knowledge gaps. If key personnel leave, successors may struggle without clear documentation. Eulerich et al. (2022) emphasized the importance of balanced governance and collaborative efforts to mitigate these challenges.

2.3 Applications of RPA

Casey (2020) noted that RPA gained significant traction in the finance industry by 2020, automating tasks such as data processing, collection, and correction. This allows skilled employees to focus on analytical and strategic work.

RPA's utility extends to returns processing, where it simplifies rule-based repetitive steps, offering a cost-effective alternative to manual labor. Other applications include customer service, HR, sales, marketing, and legal services, where automation ensures consistency and efficiency. This aligns with the paper's aim to compare RPA with manual processes. While RPA is not flawless, its potential for continuous improvement makes it a promising solution.

2.4 RPA and Process Improvement

Huang et al. (2024) applied the Lean Six Sigma DMAIC (Define, Measure, Analyze, Improvement and Control) framework together with RPA to enhance Taiwan's National Health Insurance (NHI) medical expense claims process. The study found that process duration was reduced by 380 minutes (from 1220 minutes to 840 minutes), including a 340-minute decrease in non-value-added tasks. RPA was introduced in the Improve phase to counter inefficiencies, demonstrating its value as a process improvement tool.

2.5 Utilization of RPA in Procurement

Dilmegani and Alp (2024) identified 12 key use cases of RPA in procurement: namely, input identification, contract management, purchase request and purchase order submission, category management, purchase request approval, automated re-ordering, inventory management, three-way matching, automated payments, supplier onboarding, price negotiation, and digitized records. These use cases showcase RPA's potential to streamline operations, reduce manual errors, and enhance compliance.

While the application of RPA in procurement is well-documented, its integration at Hospital X remains limited. Incorporating these practices could address inefficiencies and optimize workflows.

2.6 Data Management and RPA

Radke et al. (2020) advocate combining RPA with master data management to ensure accurate reporting, eliminate redundancies, and improve decision-making. RPA can automate database updates, reducing human errors and ensuring audit trails. At Hospital X, the manual maintenance of the item master database has led to errors, as mismatched codes or prices require human intervention to resolve. Exploring RPA for database updates could alleviate these challenges.

Currently, Hospital X and two other public hospitals utilize the Epic electronic health records system for end-to-end patient data. However, RPA remains disconnected from Epic to protect sensitive patient information. Establishing a secure integration between the systems could enhance automation and data accuracy while maintaining compliance.

3. Methodology

This study adopts the case study approach, focusing on Hospital X, and employs the DMAIC framework (Define, Measure, Analyze, Improve, Control) to evaluate the effectiveness of RPA implementation. As highlighted by Saunders et al. (2023), case study research is particularly suited for addressing "how" and "why" questions, making it a valuable method for exploring process improvements driven by RPA.

Key steps of the DMAIC methodology are (Monday 2022):

- Define Phase: The main objective of the Define phase is to establish clear project goals and a structured approach to achieve the desired outcomes. This phase begins with creating a project charter to outline objectives, scope, deliverables, and roles. In addition, the Voice of the Customer (VoC) methodology is used to capture feedback and translate it into actionable insights that enhance customer satisfaction. Understanding customer experience and expectations ensures process improvements and stakeholder needs are aligned.

- Measure Phase: The Measure phase focuses on understanding the current state of processes and identifying opportunities for improvement. This involves collecting baseline data to enable a before-and-after comparison of process performance. Tools such as process mapping are employed to visualize workflows, identify inefficiencies, and establish metrics for performance evaluation.

- Analyze Phase: In the Analyze phase, the main objective is to determine the root causes of identified inefficiencies using the data collected. A key tool in this phase is the 5 Why's analysis, which systematically uncovers the underlying issues contributing to process inefficiencies. This phase provides the foundation for informed decision-making by isolating critical problem areas.

- Improve Phase: The Improve phase aims to address the root causes identified in the Analyze phase by implementing targeted solutions. This involves designing and executing an implementation plan to enhance process performance. By eliminating inefficiencies, the organization can achieve measurable improvements. This phase emphasizes collaboration and innovation to develop practical solutions that align with project objectives.

- Control Phase: The Control phase ensures that the improvements achieved in the previous phases are sustained over time. This phase validates whether the project objectives established during the Define phase have been met and incorporates measures to maintain the improvements. A training plan is a key tool used in this phase to ensure that staff are equipped to uphold the enhanced processes. Continuous monitoring, motivation, and commitment are essential for preventing regression and fostering long-term success.

By leveraging the DMAIC framework, this methodology provides a structured and iterative approach to evaluate and improve RPA implementation at Hospital X. It combines qualitative and quantitative tools to address challenges, optimize processes, and ensure sustained benefits.

4. Results and Discussion

4.1 Define

Figure 1 shows the project charter for the RPA enhancement project that serves as a concise overview of the project objectives and provides a clear timeline for achieving them. The key requirements align closely with opportunities for RPA improvement, while the expected benefits reflect the desired outcomes of successful enhancements.

Project Charter	
Date: 14/10/2024	
General Project Information	
Project Name:	RPA Enhancement Project
Project Manager:	"Kate"
Start Date:	1/3/2024
Expected Completion Date:	28/2/2025
Project Details	
Project Description:	To improve the current RPA system
Key Requirements:	1. RPA bot must provide update based on usage balance, not PO balance 2. RPA system must be regularly maintained 3. RPA bot must be able to capture the right PO used 4. Epic must reflect the correct and complete information when exported
Expected Benefits:	1. For informed decision-making 2. To avoid downtime 3. To streamline process 4. To reduce additional human intervention
Expected Milestones:	1. 01/08/2024 - Done 2. 01/08/2024 - Done 3. 06/01/2024 4. 28/02/2024
Project Team:	Project Manager: "Kate" Team Member: Jalene Development Team: Tech Company "S" Subject Matter Expert(s): "John"
Stakeholders:	1. Support Operations Team 2. Procurement Team 3. Nursing Team 4. Other hospitals in the same cluster

Figure 1. Project charter for the RPA enhancement project

To better manage user experiences and expectations of RPA, gathering and reviewing feedback is critical. The Voice of the Customer (VoC) methodology offers a more detailed perspective than the project charter. While the project charter reflects key requirements, the VoC includes a feedback section to provide actionable insights that can guide improvements. In addition, the VoC has a priority section to help identify and address the most critical areas for improvement. Table 1 (column 1) captures the VoC qualitative feedback of the RPA enhancement project obtained from brainstorming and formal discussion sessions with the hospital's support operations and procurement team as well as feedback from other hospitals in the same cluster.

Table 1. Voice of the Customer for the RPA enhancement project

VoC Goal	To Enhance the Functions of the RPA System
Stakeholders	Hospital X's Support Operations Team, Procurement Team, Nursing Team and other hospitals in the same cluster

Feedback	Request	Solution (Feasibility is to be confirmed by Tech Company "S")	Priority
1. The RPA bot notifies users based on PO balance, which is incorrect. The difference between a PO balance and a usage balance is that the PO balance changes after Hospital X pays vendors, whereas the usage balance is the actual reflection of the utilisation of items after a successful RPA report submission. Thus, users should prioritise the usage balance to ensure sufficient PO funds to support future cases.	1. The RPA bot must provide updates based on usage balance, not PO balance	1. Change the logic of the RPA bot	High
2. The RPA performance is unstable. - Unintended database changes (eg. DD/MM/YYYY to MM/DD/YYYY) Resulted in an unsuccessful RPA report submission. - Incorrect rejection of vendor invoices, despite correct submissions from users and vendors Resulted time wasted in investigations.	2. The RPA system must be regularly maintained	2. Schedule a monthly check on the system	Medium to high
3. The RPA bot was unable to capture the right PO used. Currently, the RPA bot identifies the PO used based on the latest contract start date, but that may not necessarily be the case for each consumption of the item. To prevent omission, new POs are added to the database promptly. However, this leads to additional human interventions necessitated by excessive modification of the database. Which, is not ideal.	3. The RPA bot must be able to capture the right PO used	3. Change the logic of the RPA bot Instead of reading the data based on the latest contract start date, read it based on the contract period. In cases of overlapping contract durations between 2 or more POs, the RPA bot should choose the earliest PO with sufficient PO balance.	High
4. Unable to export correct and complete information from Epic. - The Epic database is not as up-to-date as the RPA database, thus, causing discrepancies. As such, there is a surge in the usage of "one-time consumables". Given that they are in a free-text format (item code, description and unit price), it encourages human errors. - The nursing team is unaware of the extensive backend data cleanup needed. As such, manual review and correction is essential for successful submission. Thus, compromising the automation benefits of RPA.	4. Epic must reflect the correct and complete information when exported	4. Update the Epic database and engage all stakeholders to be proactive in this improvement program	Medium to high

4.2 Measure

Figure 2 shows the process map of the manual procurement process. The process is straightforward but time-intensive, particularly when emailing vendors to prompt invoice submissions. These tasks consume time that could otherwise be allocated to high value-added activities prioritized by the organization.

In contrast, Figure 3 depicts the process flow after deploying RPA. While automation streamlines email functionality and saves time, the system lacks robust logical reasoning. To begin with, the RPA solution was not designed as a build-to-order product but rather as an off-the-shelf solution requiring continual improvisation to address inefficiencies. Ideally, the RPA implementation should relieve users from routine vendor communication and provide accurate procurement insights. However, the current system's limitations need ongoing enhancements.

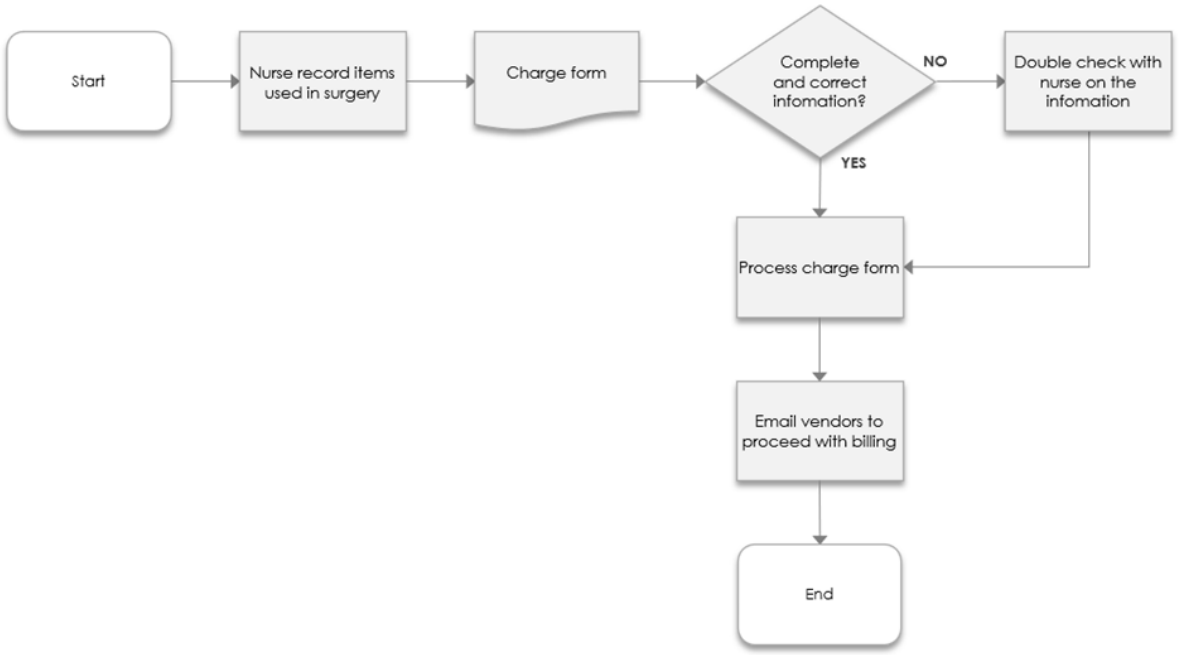

Figure 2. Process map of manual process

Table 2 summarizes a comparison of manual processes and RPA, highlighting their advantages and disadvantages. The total implementation cost was approximately SGD26,000, with recurring annual operational costs averaging SGD7,000. To justify these investments, areas of RPA enhancement were explored, leading to recommendations based on extensive VoC insights and brainstorming sessions.

Table 2. Advantages and disadvantages of manual process and RPA

	Advantages	**Disadvantages**
Manual Process	• Straightforward, e.g. simple Excel updates on utilization and direct reconciliation with vendors	• Time-consuming
RPA After Deployment (Before Enhancement)	• Timesaving (where applicable)	• Complex system, e.g. report submission, update and modification of database and error list submission • Costly

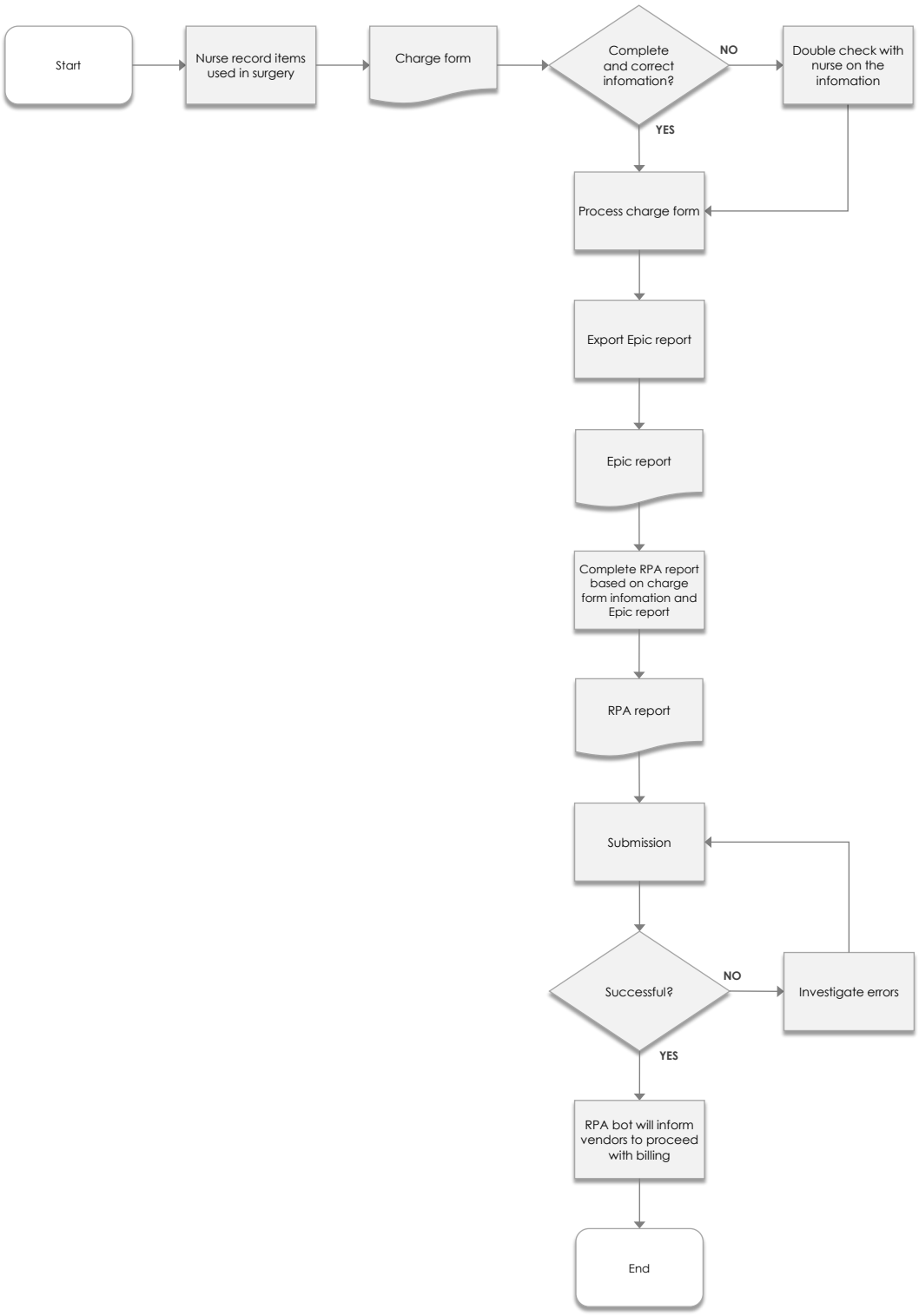

Figure 3. Process map of RPA after deployment (before enhancement)

4.3 Analyze

The 5 Why's Analysis was conducted to investigate the reasons hindering the effectiveness of the RPA deployment. Table 3 summarizes the findings from the analysis. Two main factors were identified:

- System's inability to accommodate changes outside specified timeframes
- Non-conformance in managing the Epic electronic health records system updates.

Table 3. The 5 Why's analysis of RPA deployment

Problem	RPA's performance falls below expectation	
Aspect	System	Human
1. Why?	Requires more time and effort to handle	
2. Why?	Investigation of cases is mandatory once engaged • Who/what resulted in the error?	
3. Why?	Creates unpremeditated workload	
4. Why?	Investigation can be completed on the same day, but unable to reconcile the error immediately	Extensive backend rectifications are needed - Epic needs to be amended to ensure the capturing of correct information - Error list - Resubmission
5. Why?	Reconciliation of error can only be made within the time window of 10 am to 2 pm the following day.	Inaccurate and/or incomplete information captured in Epic
Root cause	Fixed deadline	Act of data entry does not conform to standard

4.4 Improve

To address the identified issues, a detection-based poka-yoke methodology was employed, recognizing the team's limited experience with the initial system. Challenges in the pre-enhanced RPA performance included weak logical reasoning and instability, which necessitated frequent enhancement meetings and rework. On the user side, inefficiencies arose from time spent on charge form checking and case investigations. Recognizing the immutable nature of reconciliation timeframes, the focus shifted to addressing system and user performance challenges.

Referring to Table 1, the VoC 'Feedback' from Table 1 (column 1) is translated to 'Request' (column 2), 'Solution' (column 3) and 'Priority' (column 4).

Addressing system challenge #1:

- Request: The RPA bot must provide updates based on usage balance, not PO balance.
- Solution: Change the logic of the RPA bot.
- Priority: High

Addressing system challenge #2:

- Request: The RPA system must be regularly maintained.
- Solution: Schedule a monthly check on the system.
- Priority: Medium to High

Addressing system challenge #3:

- Request: The RPA must be able to capture the right PO used.
- Solution: Change the logic of the RPA bot.
- Priority: High

Addressing human challenge #1:

- Request: Epic must reflect the correct and complete information when exported.
- Solution: Update the Epic database; engage all stakeholders to be proactive in this improvement programme.
- Priority: Medium to High

4.5 Control

The RPA enhancement project is ongoing, with Hospital X emphasizing system monitoring and execution stability. The hospital is collaborating with its system partner, Tech Company "S," for immediate support in addressing inefficiencies. As part of the improvement program, the hospital is focusing on addressing challenges related to updating records in Epic, particularly for the nursing team.

Initial efforts involve assessing current difficulties and implementing a training plan to improve data input skills. The potential for significant time savings with RPA can depend on the extent that users are properly trained. Consequently, the Control phase emphasizes the implementation of a training plan, with its impact regularly assessed to ensure sustained performance improvements.

5. Conclusions and Recommendations

5.1 Conclusions

This study aimed to evaluate the post-implementation efficiency of Robotic Process Automation (RPA), identify areas for improvement, and compare the performance of manual processes with RPA.

- Objective 1 sought to assess whether the RPA system effectively streamlined processes and reduced workload. The findings revealed that the current RPA implementation fell short of expectations, failing to achieve significant workload alleviation.

- Objective 2 focused on identifying solutions to overcome the challenges and limitations observed post-RPA deployment. To achieve the desired outcomes, the study explored opportunities for enhancing the RPA system and proposed a training plan tailored to address the specific needs of the nursing team.

- Objective 3 compared the strengths and weaknesses of the manual process and RPA. Surprisingly, the manual process proved more effective in its current state, as the RPA system failed to deliver the anticipated workload reductions. Unlike artificial intelligence, RPA lacks adaptive learning capabilities. Its rigidity, while limiting in some aspects, also ensures it processes data according to predefined standards - a characteristic that can be advantageous with appropriate enhancements.

5.2 Recommendations

To improve the current system, key recommendations include:

- Modifying the RPA system to provide informed procurement decisions based on usage balance and accurate purchase order identification.

- Ensuring continuous system operability to avoid delays in procurement decision-making and invoice processing timelines. Proactive maintenance by Tech Company "S" is critical to preventing unplanned downtime.

- One major limitation of RPA is that it requires human initiation in certain steps due to security constraints. Excessive human intervention, however, has hindered the system's ability to achieve its full potential. Eliminating unnecessary user involvement is essential for maximizing efficiency. To address this, it is crucial to ensure the information in charge forms is accurate, complete, and consistent with data in Epic. Once a successful match is established between charge forms and Epic, the RPA system can generate and submit reports autonomously.

- A verification layer within the Hospital X database can safeguard data accuracy, eliminating the need for manual checks, modifications, and reconciliations. This improvement will enhance process efficiency, reduce workload stress, and ensure the RPA system fulfills its intended purpose.

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