Inventory Management System Through the Integration of RPA and IoT to Enhance Processes in SMEs Within Peru's Automotive Sector

Tadashi Buitron[a], Enzo Peña[b] and Pedro Castañeda[c]
Facultad de Ingeniería de Sistemas de Información, Universidad Peruana de Ciencias Aplicadas (UPC), Lima, Peru

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Abstract: This paper presents the design and implementation of an inventory management system that integrates Robotic Process Automation (RPA) and Internet of Things (IoT) technologies to enhance operational efficiency in small and medium-sized enterprises (SMEs) within Peru's automotive sector. The system addresses common challenges faced by SMEs, such as inaccurate inventories and inefficient stock management, through automated processes and real-time monitoring. By streamlining repetitive tasks and enabling continuous inventory updates, the solution reduces operating costs and improves record-keeping accuracy. Initial results show a 30% reduction in management time and a 25% decrease in operational costs, highlighting the transformative potential of RPA and IoT technologies in inventory management. The project offers a practical model that can be scaled and replicated across other sectors, contributing to the long-term competitiveness of SMEs.

1 INTRODUCTION

The rapid development and integration of Information and Communication Technologies (ICT) in business processes has led to increased efficiency and effectiveness in various industries. However, this technological advancement has also introduced new challenges, particularly in the management and security of the large amounts of data generated by these systems. These challenges are exacerbated in sectors such as retail, where data management is crucial for inventory control, customer relationship management and supply chain optimisation (Lo et al., 2024).

As businesses increasingly rely on data-driven decision making, the importance of robust and secure data management systems cannot be underestimated. Poor data management can lead to inefficiencies, security breaches and financial losses, underlining the need for effective solutions that address these issues. The implementation of advanced technologies, such as IoT and RPA, offers promising opportunities to improve data management processes, but also requires careful consideration of security and privacy issues (Farinha et al., 2023).

Several approaches have been proposed to improve data management in the retail sector. These include the use of IoT-based systems for real-time inventory tracking (Mohammadi et al., 2024), RPA-driven tools for automating repetitive tasks (Farinha et al., 2023), and blockchain technology for secure data transactions (Mahariya et al., 2023). Each of these solutions offers unique advantages, but they also present their own challenges, such as high implementation costs and the need for specialised technical expertise (Chen et al., 2022).

Despite the potential benefits, existing solutions often fail to address the specific needs of small and medium-sized enterprises (SMEs). Many SMEs lack the resources and technical knowledge to implement and maintain complex data management systems. Moreover, integrating new technologies into existing systems can be disruptive and requires careful planning and execution to avoid operational inefficiencies (Mahariya et al., 2023).

This paper proposes a novel framework that leverages IoT and RPA technologies to optimise data

[a] https://orcid.org/0009-0001-5925-7949
[b] https://orcid.org/0009-0005-9929-6626
[c] https://orcid.org/0000-0003-1865-1293

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management processes in SMEs. By focusing on scalability, affordability and ease of integration, the proposed solution aims to bridge the gap between advanced technological capabilities and the practical needs of SMEs. The framework includes a modular design that allows companies to adopt and expand the system gradually, minimising disruption and ensuring a smooth transition (Farinha et al., 2023).

In the following, a detailed overview of the proposed framework is provided, including its design, implementation and potential impact on data management practices in SMEs. The results of a case study conducted to evaluate its effectiveness are also presented. Finally, concluding remarks and suggestions for future research directions are offered (Lo et al., 2024).

2 STATE OF ART

After analysing the proposals in the market, these projects offer a comprehensive perspective on the implementation of IoT and RPA in inventory and supply chain management, aligned with the specific needs of automotive SMEs in Peru. IoT integration can improve inventory accuracy by 95% and reduce operating times by 50%, as observed in the research by Jarašūnienė et al. (2023). Furthermore, the combination of RFID and IoT, highlighted by Khan et al. (2024), demonstrates how precise asset location can optimise operational efficiency, transferring this utility to the automotive sector to track spare parts in warehouses. In parallel, Khan et al. (2023) reveal that IoT integration in supply chains not only increases operational efficiency by 25%, but also reduces operational costs by 20-30%, showing its relevance for optimising operations in this industry.

On the other hand, automation through RPA plays a key role in process efficiency. Flechsig et al. (2022) show how RPA in procurement management can save 50% in operational tasks, while Farinha et al. (2023) present a methodological framework that can automate up to 83% of critical processes. This technology is complemented by IoT-based digital platforms, such as the one proposed by Gao et al. (2023), which increases processing capacity by 320%, allowing SMEs to adopt more agile solutions. Finally, secure data management is addressed by Shin et al. (2024) through OTA protocols, ensuring integrity in data transmissions and avoiding errors in inventory systems, which strengthens the technological infrastructure of automotive companies. The combination of these solutions offers automotive SMEs a competitive advantage by enabling accurate, efficient and sustainable inventory management through IoT and RPA.

3 SYSTEM DESIGN

3.1 Architecture

The logical architecture of the developed application integrates emerging technologies such as RPA and IoT, with the objective of optimising inventory management in SMEs in the automotive sector. The solution, structured in multiple layers (Presentation, Application, Business and Data), allows automating processes, improving accuracy in inventory control and providing a platform accessible through mobile devices. Through an intuitive AppSheet interface and the implementation of automated processes with AppSheet Bots, the application is synchronised with a PostgreSQL database stored in the Google Cloud, ensuring efficient, real-time inventory management. This architecture has been designed to offer flexibility, scalability and rapid adaptation to the changing needs of the sector.

3.1.1 Presentation Layer

The presentation layer is designed to provide an intuitive and accessible user interface through AppSheet. This interface is adaptive, functioning as a Progressive Application (PWA), ensuring a consistent experience on both mobile devices and web browsers. This approach allows SMEs to manage their inventories efficiently on any platform.

3.1.2 Application Layer

The application layer integrates technologies such as process automation using AppSheet Bots, which is responsible for executing repetitive tasks, such as updating inventories. In addition, the implementation of IoT with NFC scanning facilitates real-time data capture, automatically updating the inventory database. This module also manages alerts and notifications, providing a robust system for efficient inventory management.

3.1.3 Business Layer

In the business layer, rules and workflows are implemented to manage operational processes, from goods receipt to distribution. Business rules are oriented to optimise inventory control, while an analytics dashboard allows visualising and monitoring performance, which facilitates data-driven decision making.

3.1.4 Data Layer

The data layer is supported by a PostgreSQL relational database, where all structured records of inventories, transactions and users are stored. Data synchronisation with Google Cloud ensures that the information is available in real time, providing consistency and security in the critical operations of the application.

Figure 1: System architecture.

3.2 Methodology

3.2.1 Data Set

The dataset used in this project comes from L & M DELSA SAC, an automotive parts company located in Moquegua, Peru. The data has been generated internally by the company for the management of its automotive product inventory, including detailed information on product ID, code, brand, vehicle compatibility, engine, quantity in stock and price. The dataset is non-public and has been collected through the use of NFC tags that record in real time the inputs and outputs of the products, which ensures continuous updating of the database and enables efficient inventory management.

3.2.2 Model

The proposed model for this system is composed of four main layers: Presentation, Application, Business and Data. Through the integration of RPA and IoT, much of the workflow is automated, enabling real-time inventory management without manual intervention. This approach improves accuracy and reduces processing times, optimising the operational processes of automotive SMEs.

3.2.3 Indicators

The indicators selected to measure the impact of the implementation of the inventory management system are as follows:

Table 1: Indicators for IoT and RPA Implementation at L&M DELSA SAC.

Indicator	Description	Formula / Calculation Method
Product search time	Measures the efficiency in locating products using NFC tags.	Average time before and after implementation.
Inventory accuracy	Evaluates the accuracy of inventory records.	(Products correctly recorded / Total products) × 100
Operational cost reduction	Determines the economic savings obtained by automation.	((Initial costs - Final costs) / Initial costs) × 100
Savings in man-hours	Measures the impact of automation on the elimination of manual tasks.	Manual hours before - Manual hours after
Automatically generated alerts	Monitors the efficiency of alert and notification management.	Count of alerts issued in a timely manner / Expected total

These indicators reflect the improvement in operational efficiency and cost reduction through the integration of IoT and RPA. The impact of the system will be assessed through comparative analysis between the initial and final values of each metric.

3.2.4 Interfaces

To optimise the user experience and facilitate inventory management from mobile devices and web browsers. The solution uses AppSheet, enabling a consistent and responsive experience that adapts to smartphones, tablets and computers.

The system stands out for the following features:

- Intuitive interface: Minimises the learning curve for operational staff, making it easy to locate and manage products in real time via NFC scanning.

- Control Dashboard: Provides a clear view of inventory levels, critical products and recent movements, allowing managers to make informed decisions based on up-to-date data.
- Automatic alerts: The platform issues real-time notifications on low stock levels or critical dates, improving planning and avoiding stock-outs.
- Automatic inventory updates: Each NFC tag scan instantly synchronises data with the Google Cloud database, ensuring accurate and available information in real time.

The interface is designed to optimise operational efficiency, reducing reliance on manual processes and improving inventory management visibility.

4 RESULTS

The results obtained with the implementation of IoT and RPA technologies in inventory management are presented below. These are detailed in tables reflecting the improvements achieved in efficiency, accuracy and resource savings.

Table 2: IoT Implementation Results.

Indicator	Initial Metric	Final Metric	Improvement (%)	Description
Average search time	10 minutes	3 minutes	70%	Reduction of time to find products.
Inventory accuracy	80%	95%	25%	Increased accuracy of inventory records.
Data synchroni-sation	Manual (24 hours)	Automatic	80%	Reduction of manual update time.
Savings in man-hours	20 hours/ month	5 hours/ month	75%	Elimination of repetitive manual tasks.

The results in Table 2 reflect a significant improvement through the integration of IoT technologies. The reduction in product search time is attributed to the use of NFC tags, which speed up the location of items in the warehouse. Increased inventory accuracy is due to the automatic updating of records, eliminating manual errors. In addition, real-time data synchronisation via the Google Cloud streamlines administrative tasks, allowing employees to focus on more value-added activities.

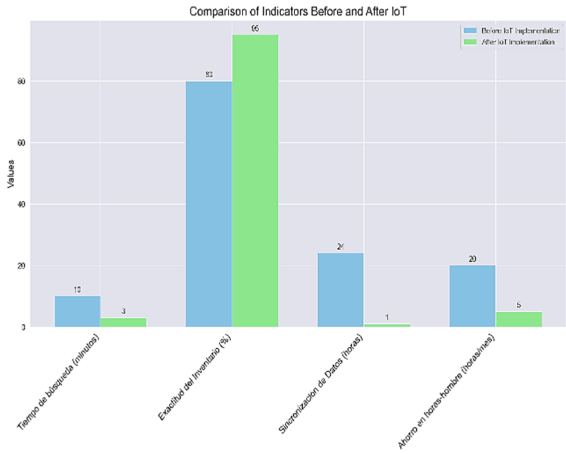

Figure 2: Comparison of Indicators Before and After IoT Implementation.

Figure 2 shows the comparison of key indicators before and after the implementation of IoT in inventory management. There is a significant reduction in search times from 10 minutes to 3 minutes. Also, inventory accuracy increased from 80% to 96%, minimising manual errors. Automatic data synchronisation has reduced the update time from 24 hours to 1 hour, enabling more efficient, real-time control.

Table 3: Results of RPA Implementation.

Indicator	Initial Metric	Final Metric	Improvement (%)	Description
Operational management time	20 hours/ month	14 hours/ month	30%	Reduction of time in administrative tasks.
Alerts and notifications	Manual	Automatic	100%	Reduced stock-outs and quick response.
Operational costs	S/5,000/ month	S/4,200/ month	16%	Savings in operating costs through automation
Savings in man-hours	30 hours/ month	10 hours/ month	66.67%	Time optimisation through automation

In Table 3, the results obtained with the implementation of RPA are mainly due to the automation of repetitive processes through AppSheet Bots. The reduction in operational time reflects the elimination of administrative tasks that previously required manual intervention. Operational cost savings are attributed to reduced man hours and increased efficiency, allowing the company to operate more profitably. In addition, automated alerts improved planning and prevented stock-outs, ensuring a continuous flow in the warehouse operation.

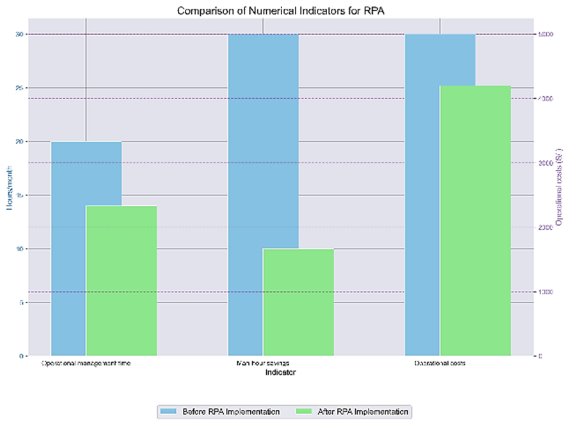

Figure 3: Comparison of Numerical Indicators for RPA Implementation.

Figure 3 highlights the impact of RPA implementation on administrative processes. Operational management time was reduced from 20 to 14 hours per month, while man-hours saved increased from 5 to 20 hours per month. Operating costs were also reduced by 16% from S/5,000 to S/4,200, reflecting the direct economic benefit of automating repetitive tasks.

5 DISCUSSION

The results obtained with the implementation of IoT and RPA at L&M DELSA SAC demonstrate a significant improvement in inventory management, particularly in the reduction of search times and process optimisation. This solution improves the investigated issue by providing a more efficient management model, replacing manual processes with automation and real-time synchronisation. The use of automatic alerts has prevented stock-outs and enabled better operational decision making, ensuring business continuity. These findings are in line with previous studies highlighting the importance of automation to increase operational efficiency in inventory management.

Compared to other approaches in the literature, the combination of IoT and RPA shows clear advantages over traditional methods based on spreadsheets or RFID inventories without real-time connectivity. However, some studies report that integration with Artificial Intelligence allows for greater personalisation and demand prediction, which was not implemented in this work. The main difference is that the presented solution is more accessible for SMEs and can be scaled up gradually without compromising operability, while more advanced technologies may require higher initial investments.

This project provides a replicable model that can be applied not only in the automotive sector, but also in other environments such as logistics and retail, where efficient inventory management is crucial. At an operational level, this solution contributes to existing knowledge by demonstrating how affordable technologies, such as IoT and RPA, can be used effectively to improve accuracy and efficiency without the need for expensive systems.

6 CONCLUSION

In summary, the integration of IoT and RPA into inventory management significantly improved operational efficiency, reducing both the time and costs associated with inventory management. Automated alerts and real-time monitoring prevented stock-outs and optimised decision making. These results highlight the relevance of automation in sectors with high product turnover and operational complexity.

This work demonstrates that the adoption of advanced technologies can make a significant difference in the competitiveness of SMEs. However, it also reveals the importance of addressing implementation challenges through a gradual approach and adequate training of staff. Going forward, it is recommended to explore the scalability of the system in other industries and to evaluate the integration of new technological tools to strengthen the functionality and security of the system, thus ensuring its long-term sustainability.

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