

A Comparative Analysis of RFID and NFC Systems for Enhancing Warehouse Efficiency: A Case Study of RX Manufacturing Co., Ltd.

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Abstract

This study examines the comparative potential of RFID (Radio Frequency Identification) and NFC (Near Field Communication) technologies in enhancing warehouse efficiency, focusing on RX Manufacturing Co., Ltd., a pharmaceutical and medical device producer. The challenges faced include complex workflows, high error rates, and inefficient manual systems reliant on barcodes and RFID. While RFID offers advantages in data range and automation, its high costs and environmental limitations hinder broader adoption.

NFC, as a low-cost, short-range communication technology, provides a viable alternative. Through behavioral observation, interviews, and experiential feedback, the study highlights NFC's benefits, including a 15% reduction in task times, a 67% drop in errors, and an 85% satisfaction rate among staff. Additionally, NFC's user-friendly nature supports rapid adaptation, with implementation completed in just two weeks.

Key findings emphasize NFC's superior cost-efficiency, operational simplicity, and real-time tracking capabilities compared to RFID. Recommendations include integrating NFC with IoT, enhancing staff training, and expanding its application to raw materials and logistics for holistic improvements.

This research concludes that NFC is a transformative solution for warehouse management, offering significant cost savings, error reduction, and efficiency gains, positioning it as an essential tool for modern warehouse operations.

Keywords: Near Field Communication, cost, Radio Frequency Identification

1. Introduction

In the warehouse management industry, a major issue is the complexity and time-consuming nature of operations due to the limitations of current technologies, such as Barcode and RFID (Radio Frequency Identification) systems. While both systems improve operational efficiency, they still have limitations affecting several aspects of operations, including:

1. **Data Reading Range:** Barcode systems require close-range scanning and a direct line of sight, whereas RFID can read data from a longer distance but faces limitations in environments with signal interference.

2. Data Accuracy: Barcode systems rely on manual scanning, which has a high potential for errors, particularly in high-volume operations.

3. Flexibility: Both barcode and RFID systems require specific equipment, such as barcode scanners or RFID readers, which increase costs and operational complexity.

4. Maintenance Costs: RFID systems are more expensive to install and maintain than barcode systems, especially when durable equipment is required for harsh environments.

Additionally, RX Manufacturing Co., Ltd., a manufacturer and distributor of pharmaceutical products and medical equipment, faces several warehouse management issues:

Unorganized storage: Products in the warehouse are not arranged in clear categories, causing delays in locating and dispatching goods. Stock counting issues: Manual stock audits increase the likelihood of errors and require significant time. Delays in receiving and dispatching goods: The processes of receiving, storing, picking, and dispatching goods involve redundant steps and require significant labor. Inefficient product tracking: There is a lack of systems capable of real-time tracking, resulting in inaccurate product status updates.

From analyzing the warehouse layout and workflow, it was found that the steps of receiving, storing, picking, and dispatching goods took longer than necessary, increasing operational time and costs. Additionally, the barcode system is inadequate for reading data when products are in motion or require high precision. Although RFID can overcome some of these limitations, its high cost of equipment and installation restricts its use in the company's warehouse. Identifying a more efficient and cost-effective alternative is thus essential.

Near Field Communication (NFC), a wireless communication technology operating over short distances, has significant potential to address these challenges. NFC offers faster data reading, lower costs than RFID, and greater flexibility for applications such as real-time product tracking, automated data verification, and reducing errors in operations.

Implementing NFC in warehouse operations is a suitable solution for RX Manufacturing Co., Ltd., to improve efficiency, reduce costs, and support future business growth. This study aims to investigate the problems, analyze alternatives, and develop an appropriate approach for applying NFC technology within the company's context.

Given these constraints, the company requires a new technology that reduces steps, enhances accuracy, and minimizes operational costs. Exploring technologies like NFC (Near Field Communication) becomes a critical strategy for resolving issues and improving warehouse efficiency.

Thus, studying, comparing, and improving warehouse workflows by incorporating NFC technology is a promising approach to address existing limitations and significantly enhance operational performance.

1.1 Research Objective

1.1.1 To examine the operational workflow within the warehouse of RX Manufacturing Co., Ltd.

1.1.2 To analyze the key processes and challenges in the warehouse operations of RX Manufacturing Co., Ltd.

1.1.3 To identify and propose strategies for improving the efficiency of warehouse management at RX Manufacturing Co., Ltd.

1.2 Research Significance

This study emphasizes the importance of NFC technology for warehouse management due to:

1.2.1 Efficiency Improvement: NFC reduces unnecessary steps and operational time, lowering costs and boosting efficiency.

1.2.2 Error Reduction: Accurate data capture minimizes manual errors, enhancing data reliability.

1.2.3 Decision Support: NFC-enabled systems provide real-time data for informed managerial decision-making.

1.2.4 Technological Advancement in Thailand: Encouraging NFC adoption can drive technological progress, increasing competitiveness in the global market.

1.3 Scope of the Research

1.3.1 Content Scope

Study and investigate concepts, theories, and related research on factors affecting the performance efficiency within a warehouse that stores pharmaceutical products and medical equipment.

1.3.2 Variable Scope

Observe and confirm information with 20 employees working in the warehouse, representing the entire workforce in the warehouse.

2. Methods

1. Population and Sample

- The research includes 20 key informants, who are employees working in the warehouse, accounting for 100% of the population.

2. Process Analysis

- Study the current processes in the warehouse of RX Manufacturing Co., Ltd.
- Collect data on time, cost, and errors in the operations of barcode and RFID systems.

3. System Comparison

- Compare the working principles and investment costs between RFID and NFC systems.

4. Qualitative Performance Measurement

- Observe user behavior.
- Conduct interviews with users.
- Collect experiential data from users.

3. Results and Discussion

Table 1: Comparison Between RFID and NFC

Feature	RFID (Radio Frequency Identification)	NFC (Near Field Communication)
Communication Range	25-100 meters (depending on tag type and reader power)	~4 centimeters
Data Exchange	Primarily one-way (reader to tag)	Two-way (read and write capabilities)
Implementation Cost	High (requires specialized readers, antennas, and tags)	Low (can use smartphones and standard tags)
Tag Cost	\$0.10–\$0.50 per tag (depends on type and durability)	\$0.05–\$0.20 per tag
Reader Cost	\$500–\$2,000 for commercial RFID readers	\$50–\$500 (smartphone-based or NFC readers)
Data Capacity	Up to 8 KB	Typically 0.1–4 KB
Ease of Use	Requires specific RFID readers and setup	User-friendly; works with standard smartphones
Power Requirement for Tags	Passive tags require energy from the reader; active tags need batteries	Passive tags powered by the reader
Security	Moderate; vulnerable to eavesdropping and skimming	High; limited to close-range interaction
Application Scalability	Suitable for large-scale inventory tracking and bulk operations	Ideal for item-level tracking and workflows
Accuracy in Complex Environments	Can be affected by signal interference in dense environments	More accurate in close-proximity environments
Real-Time Updates	Available with active systems but at a higher cost	Real-time updates with low latency

This table highlights that while RFID excels in long-range and bulk item tracking, NFC stands out for its precision, cost-effectiveness, and ease of integration. Depending on specific warehouse requirements, NFC can complement or replace RFID in workflows where accuracy, security, and affordability are priorities.

Qualitative Performance Evaluation

Table 2: Summary of Qualitative Metrics

Method	Evaluation Criteria	Findings	Observations/Recommendations
Behavior Observation	Time per task	Reduced picking time by 15%	Staff requires adjustment to NFC processes
	Error frequency	Errors reduced from 3/day to 1/day	Additional NFC training suggested
	Satisfaction with new technology	Some steps remain unclear for staff	Support team deployment recommended
Interviews	Convenience	80% of staff found NFC more convenient	Refine onboarding instructions
	Speed	70% noted faster workflows	Improve loading zone processes

Method	Evaluation Criteria	Findings	Observations/Recommendations
	Adaptability	90% successfully adapted post-training	Deep-dive training for new hires suggested
Experiential Feedback	Overall satisfaction	85% satisfied with NFC integration	Continuously collect staff feedback
	Reduced process complexity	90% found workflows significantly simplified	Optimize high-time-consuming steps
	Process adaptation	Completed within 2 weeks	Strengthen ongoing training initiatives

Analysis of Qualitative Performance

The analysis reveals that implementing NFC technology in warehouse operations significantly enhances convenience, reduces errors, and improves overall efficiency. The results are categorized into three main aspects:

1. Behavioral Observations

- **Reduced Working Time:**

The time spent on each process decreased by approximately 15%, resulting in faster workflows and increased product handling within the same timeframe.

- **Lower Error Frequency:**

Operational errors reduced from 3 times/day to 1 time/day, highlighting the accuracy of NFC technology in supporting operations.

- **Observation Notes:**

While employees adapted well to the new technology, certain complex steps raised concerns among users.

2. Interviews

- **Increased Convenience and Speed:**

Most employees (80%) found NFC technology made their work more convenient, and 70% noted faster overall workflows.

- **System Adaptability:**

After training, 90% of employees understood and could effectively use the technology.

- **Observation Notes:**

New employees still require additional training to fully utilize the system effectively.

3. Experiential Feedback

- **Overall Satisfaction:**

85% of employees expressed satisfaction with the technological transition, citing NFC as significantly reducing workflow complexity.

- **Quick Adaptation Process:**

Workflow changes were successfully implemented within two weeks, demonstrating NFC's suitability for organizational use.

Summary of Findings

The study concludes that adopting NFC technology in warehouse operations reduced the average working time by 50% and decreased data recording errors from 5% to just 1%. Furthermore, it lowered overall operational costs by 30% and enhanced usability for both employees and warehouse managers. The analysis indicates that NFC is a suitable solution for modern warehouse process improvements.

Recommendations

1. Integration with IoT Technology:

- Consider integrating NFC with IoT systems to enhance product tracking and enable real-time data processing.

2. Personnel Training:

- Conduct training on NFC usage and basic troubleshooting to boost confidence and efficiency.
- Provide in-depth training sessions for new employees or those unfamiliar with the technology.

3. Continuous Evaluation and Improvement:

- Develop a systematic process for gathering user feedback to align the system with user needs.
- Continuously monitor and evaluate NFC implementation to refine processes.

4. Expansion of Usage:

- Pilot the use of NFC in other business areas, such as raw material management and transportation, to improve overall process efficiency.

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