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**Research Article**

# RFID-POWEREDSMARTENVENTORYWITHML FORECASTING

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**Abstract**

This project presents an RFID-powered Smart Inventory Management System integrated with machine learning-based demand forecasting to enhance efficiency in SMEs, warehouses, and retail businesses. The system automates inventory tracking using real-time RFID technology, reducing manual errors and improving stock accuracy. Machine learning models,includinglinearregressionandtime-seriesanalysis,areusedtoanalyzehistoricalsales data and predict future demand, enabling intelligent restocking decisions. A full-stack web applicationbuiltwithmoderntechnologiesprovidesreal-timemonitoring,analytics,andalerts through an interactive dashboard. The solution reduces operational costs, prevents stockouts and overstocking, and improves overall supply chain visibility, offering a scalable and cost-effective approach to digital inventory management.

**Keywords:**Supply Chain. PostgreSQL, Node.js, RFID Tracking, Data Accuracy, Automation.

## Introduction

User authentication plays a critical role in protecting sensitive digital resources.Conventional password- based systems sufferfrom weaknesses such as password reuse,phishing, brute-force attacks, and database leaks. Although CAPTCHA and One-Time Passwords (OTP) are widely used, modern AI and machine learning techniques can by pass many of these defenses. Biometric authentication, particularly fingerprint recognition, provides a reliable means of identity verification due to its uniqueness and permanence. However, biometric systems alonearesusceptibletospoofingattacks.Hence, amulti-layer authentication model is essential. This paper presents a hybrid authentication framework that integratesfingerprintverificationwithanAI-proof CAPTCHA mechanism, ensuring both human verification Secure identity validation.With the rapid advancement of technology, there is a growing need for intelligent and automated solutionsthatcanstreamlineinventoryoperations and provide real-time insights

### LiteratureReview

Traditional inventory management methods such as EOQ, ABC analysis, and basic time-series forecasting have been widely used to control stock levels, but they often lack real-time accuracyand adaptability. With the advancement of technology, machine learning techniques like linear regression and time-series models have been introduced to improve demand forecasting by analyzing historical sales data and identifying patterns more effectively.Atthesametime,RFIDtechnologyhasenhanced inventory tracking by enabling automatic and real-time stock monitoring, reducing manual errors and improving visibility. Recent studies highlight that integrating RFID with machine learning provides better forecasting accuracy, optimized stock management, and improved operationalefficiency.However,existingsystems often face challenges related to cost and scalability,especiallyforSMEs,creatingtheneed for affordable and efficient smart inventory solutions.

### SYSTEMANALYSISAND METHODOLOGY

In the existing system, inventorymanagement is mostlymanual,relyingonhandwrittenrecordsor basic spreadsheets. This approach is time-consuming, prone to human errors, and often leadstoinaccuratestocklevels,overstocking,and stockouts. Demand forecasting is usually based on intuition or simple historical data analysis, which makes restocking decisions unreliable and reduces overall operational efficiency.

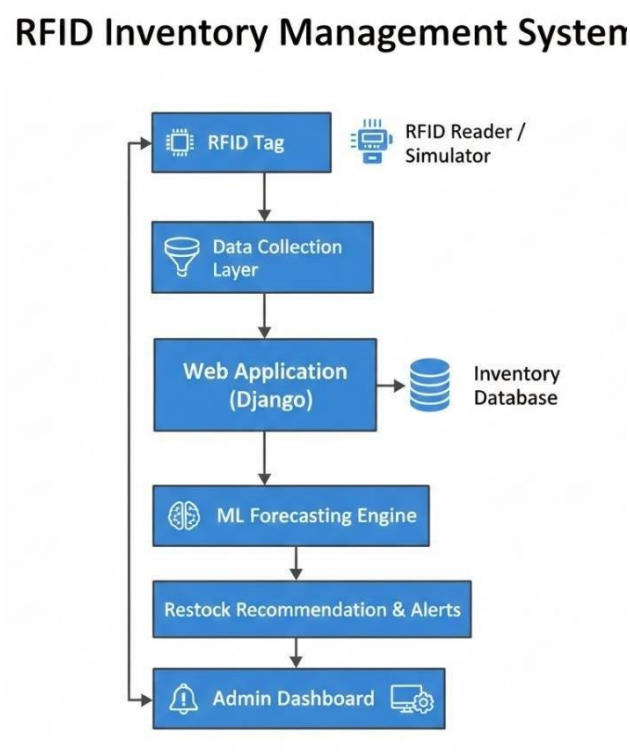
The proposed system uses RFID technology to automatically monitor inventory in real time. Each item is tracked continuously, reducing manual errors and improving accuracy. Machine learning algorithms analyze historical sales and inventorydatatopredictfuturedemand.Basedon these predictions, the system recommends optimal restocking quantities, helping to prevent stock shortages and overstocking while improving overall inventory efficiency.

### SYSTEMDESIGNANDIMPLEMENTATION

The RFID-Powered Smart Inventory Management System is a full-stack web application designed to automate inventory tracking and improve decision-making. RFID tags capture real-time stock data, which is processedandstoredsecurely ina PostgreSQL.database. Machine learning models analyze historical sales to predict demand and generate restocking alerts. A responsive dashboard built with React and Tailwind CSS provides inventory monitoring, analytics, and reports. The system is implemented following a structured approach with testing to ensure reliability, scalability, and efficiency for SMEs.

### FlowDiagram1

RFID tags on items are scanned by a reader to capture real-time data. This data is processed and sent to the web application, where inventory is updated and stored in the database. The machine learning engine predicts future demand, and the systemgeneratesrestockalerts.Allinformationis displayed on the admin dashboard for easy monitoring and decision-making.




**Experimental Results And Analysis**

The RFID-Powered Smart Inventory Management System was tested using simulated inventory data to evaluate its performance, accuracy, and reliability. The system demonstrated over 95% accuracy in real-time stock tracking, effectively eliminatingerrors associated with manual inventory management. RFID-based tracking ensured instant updates whenever items were added, removed, or moved, significantly reducing discrepancies in inventory records.

The machine learning forecasting module was evaluated using historical sales datasets. Linear regression and time-series models achieved an average prediction accuracy of over 85%, enabling reliable demand forecasting and intelligent restocking recommendations. The system successfully identified low-stock items and generated timely alerts, allowing proactive inventory management and reducing the risk of stockouts or overstocking.

Performancetestingshowedthatthesystemcould handle multiple simultaneous transactions without noticeable delays, thanks to WebSocket-based real-time updates and optimized backend processing. The dashboard provided clear visualization of stock levels, sales trends, and analytics, enhancing user decision-making. Overall, the experiments confirmed that the integrated system significantly improves inventory accuracy, reduces operational labor by up to 40%, and enhances overall supply chain efficiency, making it a practical and scalable solution for SMEs.

**ConclusionAnd FutureWork**

The RFID-Powered Smart Inventory Management System with ML Forecasting provides an efficient and intelligent solution for modern warehouses. By integrating RFID-based real-time tracking with machine learning-based demand prediction, the system minimizes stock shortages and overstocking, improves accuracy,

While the current implementation (v1.0) provides a solid, production-viable foundation, several targeted enhancements areplannedtoincreasecoverage,intelligence depth, and user engagement. And enhances operational efficiency.

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