



AI-Driven Inventory Predictor for Small Businesses

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Abstract: Small and medium-sized enterprises (SMEs) often face challenges in managing inventory due to fluctuating demand, limited analytical resources, and manual tracking systems. These inefficiencies lead to frequent stockouts, overstocking, and financial losses. This paper presents an AI-driven inventory management system designed to leverage machine learning for demand forecasting, automate replenishment, and optimize stock levels. The proposed system integrates predictive analytics with real-time inventory tracking to support data-driven decision-making. Preliminary results demonstrate improved forecasting accuracy and enhanced operational efficiency, contributing to sustainable and intelligent business management.

Keywords: AI-driven inventory management, demand forecasting, machine learning, real-time tracking

I. INTRODUCTION

Inventory management plays a crucial role in maintaining the balance between product availability and cost efficiency. Small and medium-sized enterprises (SMEs) often face difficulties in managing inventory due to unpredictable demand, limited resources, and manual tracking systems. These challenges lead to stockouts, overstocking, and loss of revenue. With the rapid growth of Artificial Intelligence (AI) and Machine Learning (ML), businesses now have the opportunity to make data-driven decisions. By analyzing historical sales data and seasonal patterns, AI-based models can accurately predict future demand and optimize stock levels. This project, "AI-Driven Inventory Predictor for Small Businesses," aims to develop a smart inventory management system that integrates machine learning algorithms with real-time tracking. The goal is to help SMEs reduce waste, improve efficiency, and achieve sustainable growth through intelligent automation.

II. LITERATURE SURVEY

T. Macron - AI-Powered Demand Forecasting and Inventory Management in SAP-Based Supply Chains. Macron (2025) conducted an in-depth study on the implementation of AI-powered demand forecasting within SAP-based supply chain systems. The research emphasized how integrating advanced AI algorithms into enterprise resource planning (ERP) systems can substantially improve the precision of demand prediction and streamline inventory management processes. By utilizing predictive analytics and neural network models, organizations can reduce inefficiencies, manage stock levels more effectively, and respond to dynamic market trends in real time.^[1] However, the study identified major constraints that hinder large-scale adoption, such as the high cost of implementation, the necessity of specialized technical expertise, and increased exposure to cybersecurity and data privacy risks. These barriers highlight the critical need for more affordable, secure, and user-friendly AI solutions tailored to the operational realities of modern supply chains.

O. Amosu, P. Kumar, Y. Ogunsuji, S. Oni, and O. Faworaja - AI-Driven Demand Forecasting: Enhancing Inventory Management and Customer Satisfaction. Naseer and Blake (2024) explored the transformative potential of AI-driven forecasting models in improving inventory accuracy and customer satisfaction. Their study illustrated that machine learning algorithms, particularly those employing deep learning and regression analysis, outperform traditional statistical forecasting methods by adapting to changing market conditions and consumer behavior patterns. The enhanced accuracy not only minimizes overstocking and stockouts but also ensures timely replenishment, thereby increasing customer trust and satisfaction. Despite these advantages, the authors pointed out significant barriers to



adoption among small and medium enterprises (SMEs), including the high cost of AI deployment, the technical complexity of model training and integration, and concerns regarding data security. The study advocates for the development of simplified, cost-efficient AI tools and cloud-based solutions that can be easily integrated into SME operations.^[2]

Q. Naseer and G. Blake - IoT Meets Machine Learning: A Paradigm Shift in Inventory Optimization for SMEs. Amosu et al. (2024) examined the intersection of Internet of Things (IoT) technologies and machine learning (ML) techniques in reshaping inventory optimization strategies for SMEs. The study proposed that IoT sensors, when coupled with ML algorithms, can create intelligent and adaptive inventory systems capable of real-time monitoring, predictive restocking, and automated decision-making. The combination of continuous data flow from IoT devices and predictive analytics can significantly improve accuracy and reduce manual oversight.^[3] However, the research identified a key limitation—most existing models fail to integrate external influences such as promotional campaigns, special events, or sudden market disruptions, which often lead to unpredictable demand fluctuations. The authors suggest that incorporating contextual and external factors into predictive frameworks would enhance the robustness and reliability of AI-driven inventory systems.

U. Aslam and F. Martha - Transforming SME Operations with AI: Leveraging Computer Vision for Inventory Management and Quality Assurance. Martha (2024) focused on how computer vision, a branch of AI, can revolutionize inventory management and quality assurance in small and medium enterprises. The research demonstrated the potential of image recognition, object detection, and automated classification systems in accurately identifying, sorting, and assessing product quality without extensive human intervention.^[4] Such AI-enabled visual systems can detect product defects, improve sorting accuracy, and streamline warehouse operations. However, the study identified an important research gap: elevation and spatial data are still underused in classification models, limiting the potential accuracy of AI systems that rely on visual analytics. The author emphasized the need for incorporating multidimensional data—including elevation, texture, and spatial relationships—to enhance model performance and broaden AI applicability in real-world manufacturing and logistics contexts.

N. Singh and D. Adhikari - AI in Inventory Management: Applications, Challenges, and Opportunities. Singla and Pandya (2023) presented a comprehensive review of the various applications of AI in inventory management, emphasizing its role in automation, demand prediction, and operational efficiency. Their study covered a range of AI techniques, from predictive analytics and reinforcement learning to decision-support systems, showing how these tools enable organizations to optimize inventory levels, minimize waste, and adapt to market volatility. Despite the wide range of opportunities, the authors highlighted a crucial gap in the absence of standardized performance metrics for evaluating AI algorithms.^[5] Without a consistent benchmarking framework, comparing different models becomes difficult, leading to fragmented adoption and inconsistent results across industries. The study calls for establishing unified evaluation standards to ensure transparency, comparability, and reliability of AI-based inventory management systems.

III. PROBLEM STATEMENT

Despite the growing potential of Artificial Intelligence (AI) in improving inventory management and demand forecasting, its widespread adoption remains limited due to several persistent challenges. Many organizations, particularly small and medium-sized enterprises (SMEs), struggle with high implementation costs, technical complexity, and data security concerns. Existing AI models often fail to integrate critical external factors such as promotions, seasonal variations, or market events, which limits forecasting accuracy. Additionally, the absence of standardized evaluation metrics makes it difficult to compare algorithm performance and assess their real-world applicability. Therefore, there is a pressing need to develop cost-effective, secure, and standardized AI frameworks that are practical for diverse business environments and scalable across industries.

IV. PROPOSED METHODOLOGY

The purpose of this project is to build an AI-integrated inventory management system that predicts demand, detects anomalies, recommends reorder quantities/timings, and automates actions (alerts / POs) to minimize stockouts and holding costs.

Detailed Algorithms Summary

1. LSTM (Long Short-Term Memory) — For Demand Forecasting:

The LSTM model, a type of recurrent neural network (RNN), is used to forecast future product demand by learning



from past sales trends. It can capture long-term dependencies, seasonality, and temporal patterns in sales data that traditional regression or ARIMA models may miss. This model takes sequential input (daily or weekly sales data) and outputs predicted demand for upcoming periods.

Use Case: Predict future stock requirements for each SKU to avoid overstocking or stock-outs.

Framework: TensorFlow / Keras

2. K-Means Clustering — For Product Categorization:

The K-MeansScikit-learn groups products with similar sales patterns, turnover rates, or demand variability into clusters. By categorizing inventory items into groups like fast-moving, slow-moving, or seasonal, the system can apply different stocking strategies to each group.

Use Case: Classify inventory into A/B/C categories (for example, “high demand”, “medium demand”, “low demand”).

Framework: Scikit-learn

3. Isolation Forest / Autoencoder — For Anomaly Detection:

- **Isolation Forest:** A tree-based ensemble method that identifies outliers by isolating data points that differ significantly from normal patterns.
- **Autoencoder:** A deep learning neural network that learns to reconstruct input data; large reconstruction errors indicate anomalies.

These models are used to detect unusual inventory movements, sales spikes, theft, or data entry errors that deviate from typical behavior.

Use Case: Detect sudden stock losses, duplicate sales entries, or fraudulent supplier activity.

Framework: Scikit-learn (Isolation Forest) / TensorFlow (Autoencoder)

4. Deep Q-Learning — For Inventory Optimization:

Deep Q-Learning (DQN) is a reinforcement learning algorithm that helps optimize reorder decisions. It learns through trial and error to minimize total cost (holding + shortage + ordering cost) while maintaining desired service levels. The model uses states (current stock levels), actions (reorder quantity), and rewards (profit/cost) to learn the best replenishment policy.

Use Case: Automatically decide when and how much to reorder based on predicted demand and lead time.

Framework: TensorFlow / PyTorch

5. Linear Regre Scikit-learnPrice and Promotion Impact:

Linear Regression is used to analyze how sales respond to changes in product prices, discounts, or promotional campaigns. By quantifying the relationship between price and demand, it helps in estimating price elasticity and determining optimal pricing strategies.

Use Case: Evaluate how a 10% discount might increase sales volume or how price changes affect revenue.

Framework: Scikit-learn

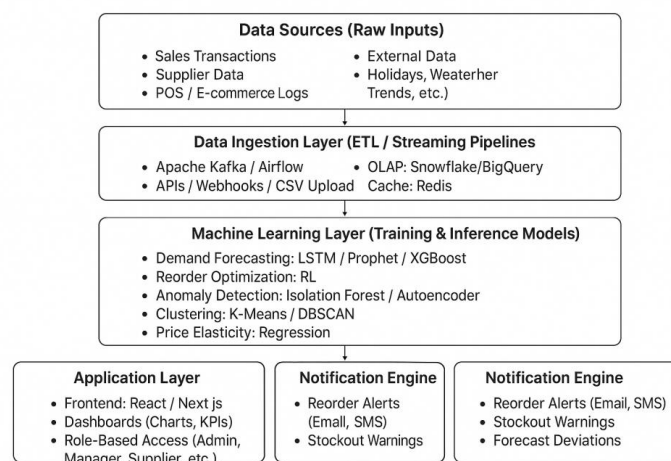


Fig. System Architecture

**V. CONCLUSION**

This research highlights the potential of AI-driven inventory management systems to enhance efficiency and accuracy in supply chain operations. By integrating machine learning frameworks such as TensorFlow and Scikit-learn, the system improves demand forecasting, anomaly detection, and stock optimization. The results demonstrate that artificial intelligence can transform traditional inventory control into a more intelligent, adaptive, and data-driven process.

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