

Stock Management and Live Inventory Monitoring System: Design, Development, and Role-Based Access Control

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Abstract—This paper presents the design and implementation of a web-based Stock Management and Live Inventory Monitoring System developed as a final year engineering project. The system addresses the operational inefficiencies of manual warehouse management by providing a digital, real-time solution with a structured three-tier role hierarchy: Superadmin, Admin, and Standard User. Key functionalities include live stock tracking, automated low-stock alerts, QR code integration, Excel-based bulk upload, audit logging, and role-based access control (RBAC). The system employs a split-pane dashboard interface designed for usability in industrial environments. Evaluation of the system demonstrates significant improvement in inventory accuracy, operational accountability, and procurement responsiveness compared to traditional methods. This paper details the system architecture, module design, security protocols, and user experience considerations, contributing to the domain of enterprise inventory management systems.

Index Terms—Inventory management, role-based access control, live monitoring, QR code, warehouse management system, web application, audit trail, stock dashboard.

I. INTRODUCTION

Inventory management is a fundamental pillar of supply chain operations in manufacturing, warehousing, retail, and industrial sectors. Inefficient tracking of stock leads to financial losses, operational downtime, procurement delays, and poor resource allocation. Traditional manual systems relying on spreadsheets or paper-based records are error-prone, lack real-time visibility, and do not provide accountability for stock movements [1].

The rapid advancement of web technologies has created an opportunity to replace legacy inventory processes with intelligent digital platforms. This project, titled the "Stock Management and Live

Inventory Monitoring System," was developed as a final year engineering project to address these challenges through a feature-rich, role-stratified web application.

The proposed system provides a centralized portal that enables organizations to monitor stock levels in real time, receive automated low-stock alerts via email, perform bulk data uploads through Excel integration, and maintain a comprehensive audit log of all system activities. The interface is designed for use in industrial environments, balancing simplicity for warehouse operators with advanced controls for administrators.

This paper is organized as follows: Section II reviews related literature. Section III describes the system architecture. Section IV details the individual modules and features. Section V discusses security design. Section VI presents role comparison and access control. Section VII evaluates the system. Section VIII concludes the paper with future directions.

II. LITERATURE REVIEW

Several studies have examined the effectiveness of digital inventory management systems across various industries. Muller (2019) emphasized that real-time inventory tracking reduces stock discrepancy rates by up to 35% compared to periodic manual audits [2]. The integration of barcode and QR code technology in warehouse management systems (WMS) has been widely studied, with Faber et al. (2020) demonstrating that QR-based item identification reduces retrieval time by approximately 40% [3].

Role-based access control (RBAC) in enterprise software has been explored extensively by Ferraiolo and Kuhn (1992) and later formalized in the NIST RBAC model (2001) [4]. The application of RBAC in inventory systems ensures that sensitive financial and administrative data is accessible only to authorized personnel, reducing the risk of data tampering and unauthorized stock movement [5].

Bulk data import capabilities using Excel formats have been adopted in enterprise resource planning (ERP) systems such as SAP and Oracle, allowing businesses to manage large datasets efficiently. Studies by Monk and Wagner (2013) highlight the importance of structured data templates in minimizing upload errors during mass inventory updates [6].

Automated email alert systems for inventory thresholds have been shown to reduce procurement response time significantly. A study by Khader et al. (2021) found that automated stock alert mechanisms decreased the average time to reorder by 60% compared to manual monitoring approaches [7].

Despite existing commercial solutions, many small to medium-scale industries require custom-built, cost-effective systems tailored to their operational structures. This project contributes to that gap by providing an open, modular, and extensible inventory management platform.

III. SYSTEM ARCHITECTURE

The system is built on a three-layer client-server architecture consisting of a frontend presentation

layer, a backend application layer, and a database persistence layer. The frontend is developed using modern web technologies and employs a split-pane layout strategy for the login interface, separating illustrative context from functional input components.

A. Frontend Design

The user interface follows a minimalist design philosophy with functional form over decorative complexity. The login portal uses ghost-text placeholders, a split-pane layout with industry-relevant visual cues (forklifts, gears, industrial containers), and an orange call-to-action button chosen for its psychological associations with energy and industrial environments. Color choices — soft grays and whites — minimize eye strain for operators working in varying warehouse lighting conditions.

The dashboard employs card-style KPI tiles for at-a-glance metrics, a donut chart for proportional stock health visualization, and a detailed tabular ledger for granular item tracking. The interface is designed to be mobile-responsive, supporting tablet and handheld scanner-based access for supervisors on the warehouse floor.

B. Backend and Database

The backend application manages all business logic including authentication, role verification, inventory calculations, alert triggering, and audit logging. The database stores user credentials, item records (including item codes, names, locations, machine assignments, minimum and maximum thresholds, current stock, unit price, and criticality flags), transaction histories, and system logs with microsecond-precision timestamps.

The system implements an additive stock calculation logic: when stock is added to an existing item, the new total is computed as the sum of previous quantity and added quantity. When stock is issued, the quantity is decremented and checked against the minimum threshold to trigger low-stock alerts.

IV. SYSTEM MODULES AND FEATURES

A. Authentication Module

The authentication module implements a character-sensitive (case-sensitive) credential validation system. This design choice increases password entropy significantly — for an 8-character password, enforcing case sensitivity increases the combinatorial space from millions to billions, substantially increasing resistance to brute-force attacks.

The module incorporates account lockout logic after 3–5 failed attempts, Multi-Factor Authentication (MFA) readiness for new terminal logins, encrypted session initiation upon successful authentication, and credential masking in input fields. Sessions are terminated upon logout or inactivity timeout, with shorter timeout periods enforced for Admin and Superadmin roles due to elevated privileges.

B. Main Stock Dashboard

The main dashboard provides Admin and Superadmin users with a comprehensive view of warehouse inventory. It displays high-level KPI metrics including total unique items, count of low-stock items, and total stock value in Indian Rupees (₹). A donut chart provides a visual health indicator comparing normal stock to low-stock proportions.

The tabular ledger provides item-level detail including item code, item name, location, machine assignment, minimum and maximum thresholds, current quantity, unit price, total value, criticality status, QR code access, and last updated timestamp. The financial columns (price, total value) are visible exclusively to Admin and Superadmin roles.

C. Add Stock Module

The Add Stock module provides a data entry form for registering new inventory items. The form captures the following fields:

- Item Code — Alphanumeric SKU with character-sensitive validation
- Item Name — Descriptive product label
- Location — Physical shelf, bin, or aisle designation
- Machine — Equipment assignment for machine-specific tracking
- Minimum and Maximum Quantity — Safety threshold boundaries
- Current Stock — Initial unit count
- Unit Price — Financial value for total stock calculation
- Criticality Flag — Yes/No toggle for mission-critical parts

The Save button commits data to the live database, while the Back button discards changes and returns to the dashboard.

D. Issue Stock Module

The Issue Stock module records stock removal transactions. It uses a smart search field for item code lookup and auto-populates the issuing user field based on the active session, ensuring automatic audit attribution. A mandatory comment field requires the user to document the reason for issuance (e.g., routine machine maintenance, departmental transfer). The submission button is colored red to visually signal a reductive database action.

A real-time suggestion dropdown validates item codes against the database and displays available stock quantities to prevent over-issuing beyond physical availability.

E. Add Quantity (Existing Item) Module

This streamlined module allows rapid replenishment of already-registered items. By selecting from an existing item list, item code integrity is preserved automatically, preventing duplicate entries. The system validates that the quantity field is non-empty before processing, and the new total is calculated and reflected on the dashboard instantly, including automatic clearance of Low Stock alerts if the new quantity exceeds the minimum threshold.

F. Bulk Upload Module

The Bulk Upload module enables mass data import through a structured Excel (.xlsx) template. Admins first download the official sample template, populate it offline with item data, and upload the completed file. The system parses each row and maps it to the database schema. The required columns are:

Column Header	Description
item_code	Unique alphanumeric identifier (case-sensitive)
item_name	Product or part description
location	Physical warehouse zone or shelf
machine	Assigned equipment or department
min_qty	Minimum safety stock threshold
max_qty	Maximum stock capacity
current_stock	Initial unit count
price	Unit cost in INR
critical	Mission-critical flag (YES/NO)

This feature is particularly valuable for initial warehouse setup and annual inventory audits, allowing thousands of records to be synchronized in a single operation.

G. Export Module

The Export module generates a comprehensive Excel file (stock_master.xlsx) containing the full inventory ledger including financial valuations, operational data, threshold configurations, and QR associations. Export access is restricted exclusively to Admin and Superadmin roles. Each export operation is recorded in the audit log to maintain data governance accountability.

H. System Logs Module

The System Logs module serves as the primary accountability and forensic tool for Superadmin users. Each log entry records a microsecond-precision timestamp, the acting user, the action category (e.g., LOGIN, ADD_ITEM, ISSUE, EMAIL_SKIPPED), and contextual details such as item codes and quantity deltas. The module includes a search interface for filtering by user, action type, or item code, enabling targeted audits and incident investigation.

I. Email Recipients Module

The Email Recipients configuration screen, accessible exclusively to Superadmin users, manages the distribution list for automated low-stock alert notifications. When an item's quantity falls below

its minimum threshold, the system generates an alert and dispatches it to all registered recipients. The module supports adding, verifying, and deleting recipient email addresses, and displays recipient status (Active or Unsubscribed).

V. SECURITY DESIGN

The system incorporates multiple layers of security appropriate for an enterprise inventory management context:

- **Character-Sensitive Authentication:** Enforced case sensitivity for all credential fields, increasing password entropy and resistance to automated attacks.
- **Account Lockout Policy:** After 3–5 consecutive failed login attempts, the account is temporarily frozen, requiring administrative reset to prevent brute-force exploitation.
- **Role-Based Access Control (RBAC):** Permissions are granted based on user role, ensuring that sensitive financial data, administrative controls, and audit logs are inaccessible to unauthorized roles.
- **Encrypted Session Initiation:** All post-authentication data transmission is encrypted to protect live inventory data in transit.
- **Audit Trail:** Every system action is timestamped and attributed to a specific user account, creating a non-repudiable digital paper trail for compliance and forensic purposes.
- **Session Timeout:** Inactivity-based session termination is enforced, with stricter timeouts applied to elevated privilege roles.
- **Zero-Space Accuracy:** The system does not auto-trim credential fields, requiring exact input to prevent accidental authentication with padded strings.
- **Export Restriction:** The data export feature is restricted to privileged roles, preventing unauthorized movement of sensitive inventory data.

VI. ROLE-BASED ACCESS CONTROL

The system implements a three-tier role hierarchy designed to separate system governance, operational management, and observational monitoring. Table I provides a comprehensive comparison of permissions across the three roles.

TABLE I. Role Permission Matrix

Feature / Permission	Superadmin	Admin	Standard User
System Access Level	Full (all settings)	Operational	View-Only
Inventory Actions	Add, Edit, Issue, Delete	Add, Increase, Issue	View Only
User Management	Create, Edit, Delete	No Access	No Access
System Logs	Full Access	Own actions only	No Access

Email Configuration	Full Control	No Access	No Access
Bulk Upload	Yes	Yes	No
Export	Yes	Yes	Yes (limited)
Financial Data View	Yes (full)	Yes (full)	No
QR Code Management	Yes	Limited	View Only
Session Timeout	Short (high security)	Medium	Standard

VII. RESULTS AND EVALUATION

The system was deployed and tested in a simulated warehouse environment with multiple user roles. The following key outcomes were observed:

A. Inventory Accuracy

The real-time synchronization between stock transactions (additions and issuances) and the dashboard eliminated the discrepancy lag inherent in periodic manual audits. Low-stock alerts were triggered automatically and consistently when item quantities fell below defined minimum thresholds.

B. Operational Accountability

The audit log module successfully recorded all system events with microsecond precision. Testing confirmed that every stock movement — including additions, issuances, and login events — was accurately attributed to the responsible user, providing a reliable forensic trail.

C. User Experience

The tab-key navigation design and auto-focus on input fields enabled warehouse staff to complete login and stock issuance operations without mouse interaction, improving throughput in fast-paced environments. The mobile-responsive card layout was tested on tablet devices and validated for warehouse floor use.

D. Bulk Upload Efficiency

The Excel bulk upload module was tested with datasets of 50, 100, and 500 item records. All uploads completed successfully with proper schema validation, preventing malformed entries from corrupting the database. Character-sensitivity warnings were displayed for mismatched item codes, preventing unintended duplicate creation.

E. Alert System

The email alert system was tested by issuing stock below minimum thresholds. Upon configuration

of recipient addresses, notifications were dispatched correctly. The EMAIL_SKIPPED log entry was correctly generated when no recipients were registered, demonstrating robust system logging even for non-critical failures.

VIII. CONCLUSION

This paper presented the design, architecture, and implementation of a Stock Management and Live Inventory Monitoring System developed as a final year engineering project. The system addresses critical limitations of manual inventory management through real-time monitoring, automated alerting, structured role-based access control, comprehensive audit logging, and Excel-integrated bulk operations.

The three-tier role hierarchy (Superadmin, Admin, Standard User) ensures that system capabilities are appropriately delegated based on operational responsibility, protecting sensitive financial and administrative data while empowering warehouse staff with the observational tools they need. The security architecture — incorporating character-sensitive authentication, account lockout, encrypted sessions, and inactivity timeouts — provides enterprise-grade protection suitable for industrial deployment.

Future work may include integration with barcode scanners and RFID hardware for physical stock validation, implementation of predictive restocking algorithms using machine learning, expansion of the mobile interface for full native app deployment, and integration with ERP systems such as SAP or Oracle for end-to-end supply chain visibility.

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