CentraMart: A Single-Vendor Multi-Branch E-Commerce System

Project Abstract

OVERVIEW

This project involves the design and planning of a single-vendor e-commerce platform that operates across multiple physical branches with independent inventory and fulfillment responsibilities. The platform models real-world retail systems where products are centrally managed but order fulfillment is distributed across branches based on stock availability and operational constraints.

This system focuses on correctness in inventory ownership, order lifecycle enforcement, VAT compliance, and fulfillment coordination. Orders may be fulfilled by one or more branches, and each branch operates independently within defined system rules. The project emphasizes backend domain modeling and operational workflows over UI-centric development, with the goal of understanding how real retail systems handle scale, failures, and administrative control.

PROJECT DESCRIPTION

Customers browse a centralized product catalog and place orders that trigger stock reservation and deterministic branch allocation. Prices, quantities, and VAT values are locked at order creation to preserve financial and legal correctness. Orders are internally divided into independent fulfillment units, each handled by a specific branch and progressing through its own lifecycle. An order is completed only when all fulfillments reach a terminal state.

Administrative actions are constrained by system rules to prevent unsafe operations such as retroactive price changes, unauthorized inventory manipulation, or illegal order cancellations after shipment.

KEY FEATURES

1. User Management

The platform supports secure user registration and authentication, allowing customers to manage their profiles, delivery addresses, and order history. User actions related to orders and payments are tracked to ensure traceability and prevent unauthorized modifications after order commitment.

2. Product Catalog and Variants

The system provides a centralized product catalog with clearly defined product variants (SKUs). Each variant represents a distinct sellable unit with its own attributes and images, ensuring accurate inventory tracking and fulfillment behavior across branches.

3. Branch-Level Inventory Management

Inventory is maintained at the branch level rather than globally. Stock availability, reservation, and deduction are tracked per branch to prevent overselling and ensure that fulfillment decisions reflect real physical availability. Inventory adjustments are audited to maintain operational integrity.

4. Multi-Branch Order Fulfillment

Customer orders may be fulfilled by one or more branches depending on inventory distribution. Each order is internally divided into independent fulfillment units, with each branch responsible only for its assigned items.

Fulfillment lifecycles are tracked separately while remaining linked to the parent order.

5. Order Lifecycle Enforcement

The platform enforces strict order and fulfillment state transitions. Actions such as cancellation, shipment, delivery, and returns are permitted only at valid stages, preventing illegal or inconsistent order modifications and ensuring alignment with real-world business operations.

6. Payment Processing and VAT Handling

The system supports both online payments and cash-on-delivery (COD). Prices and VAT values are calculated and locked at the time of order creation to ensure financial correctness, auditability, and compliance with tax regulations, regardless of fulfillment outcomes.

7. Administrative Control and Auditability

Administrative workflows are governed by system-defined rules that restrict unsafe actions such as retroactive price changes or unauthorized order cancellations. All critical actions, including stock adjustments and order interventions, are logged with reasons to maintain transparency and accountability.

TECHNOLOGY STACK

- Frontend: React.js
- Backend: Node.js with Express.js
- Database: MongoDB

WORKFLOW OVERVIEW

Customer Journey:

- User registers or logs in using secure authentication
- Browse products and variants from the centralized catalog
- Add selected items to the shopping cart
- Proceed to checkout and select delivery address
- Place the order and choose a payment method (online payment or COD)
- Receive order confirmation once the order is successfully created
- Track order status and individual fulfillment progress in real time
- Receive items delivered from one or more branches
- Request returns or refunds if delivery issues or product concerns arise

Branch Workflow:

- View assigned fulfillments generated from customer orders
- Verify available inventory for allocated items
- Pick and pack items assigned to the branch
- Update fulfillment status during shipping and delivery
- Handle delivery failures, returns, or damaged items
- Update inventory levels based on fulfillment outcomes

Admin Workflow:

- Add, edit, and manage products and variants in the central catalog
- Monitor and oversee branch-level inventory with audited adjustments
- Track orders and associated fulfillments across all branches
- Approve exceptional workflows such as branch reassignment or refunds.
- Enforce order lifecycle rules and resolve operational issues.
- Review audit logs for inventory changes and administrative actions.

This workflow ensures a controlled and consistent experience for **customers, branch operators, and administrators**, while maintaining inventory accuracy, order integrity, and operational accountability across a multi-branch retail system.

Security Features

- **Role-based access control (RBAC)** is implemented to clearly separate permissions for **customers, branch operators, and administrators**, ensuring that users can perform only actions appropriate to their role.
- Secure authentication mechanisms are used for user login and sensitive actions, preventing unauthorized access to customer accounts and administrative workflows.
- Order, payment, and VAT records become immutable after order creation to prevent retroactive modification of financial and legal data.
- Audit logging records all critical actions, including inventory adjustments, order state changes, and administrative interventions, providing full traceability and accountability.
- Transaction-related activities, including online payments and COD confirmations, are logged to support financial reconciliation and fraud investigation.
- Inventory changes and return-related actions are tracked with reason codes to ensure operational transparency and prevent misuse or silent stock manipulation.

Future Enhancements

Future enhancements to the platform may include smarter branch selection mechanisms that consider inventory availability, branch workload, and

delivery distance to optimize fulfillment efficiency. Additional improvements may involve more automated return and refund workflows to reduce manual intervention and improve resolution time. The system can also be extended with logistics and analytics integrations to provide better shipment tracking, inventory forecasting, and operational insights for continuous improvement.

Project Goals

1. Design a realistic single-vendor e-commerce system with branch-level inventory ownership and distributed fulfillment.
2. Ensure accurate stock reservation, order creation, and fulfillment workflows that reflect real-world operational constraints.
3. Enforce correct order and fulfillment lifecycles to maintain financial, legal, and inventory consistency.
4. Support multi-branch order fulfillment while preventing overselling and illegal state transitions.
5. Provide clear administrative workflows with audit logging and controlled permissions to avoid unsafe system actions.
6. Maintain security, traceability, and trust through role-based access control and immutable financial records.
7. Establish a strong foundation for future system extensions without compromising core correctness or design integrity.

This document presents an overview of the CentraMart single-vendor multi-branch e-commerce platform, covering its architecture, key features, security controls, and operational workflows. The platform models realistic retail operations through centralized product management, branch-level inventory ownership, and distributed order fulfillment. It supports user management, inventory and order tracking, payment and VAT handling, and controlled administrative workflows, while allowing for future system enhancements without compromising core correctness.