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# eCommerce Platform

## Project Specification

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October 1, 2025

### Comprehensive Project Specification

*A complete digital storefront solution for modern e-commerce*

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## 1 Project Overview

### 1.1 High-Level Description

The **eCommerce Platform** is a comprehensive web-based application designed to facilitate online buying and selling of products. The platform provides a complete digital storefront solution that enables businesses to showcase products, manage inventory, process payments, and fulfill orders efficiently. For customers, it offers an intuitive interface to browse products, manage shopping carts, and complete secure online purchases.

### 1.2 Goals and Objectives

#### Primary Goals

- Provide a robust, scalable, and secure environment for all aspects of online retail
- Enable product browsing, search, and purchase experiences for customers
- Streamline inventory management, order processing, and fulfillment operations
- Support marketing initiatives through promotional banners, discount codes, and content management
- Deliver business insights through comprehensive reporting and analytics

#### Key Objectives

- Support 100+ concurrent users
- Maintain PCI DSS compliance for secure payment processing
- Provide real-time inventory tracking and automatic stock level updates
- Enable multi-role access with appropriate permissions and security controls

### 1.3 Target Users and Use Cases

#### 1.3.1 Customers/End-Users (Primary Users)

##### Use Cases:

- Browse product catalogs and discover new items
- Search for specific products using keywords
- View detailed product information, images, and customer reviews
- Add items to shopping cart and proceed to checkout
- Create and manage user accounts
- Track order status and view purchase history
- Update shipping and billing information
- Write product reviews and ratings

#### 1.3.2 Store Administrators

##### Use Cases:

- Manage product catalog (add, edit, delete products)
- Update inventory levels and monitor stock

- Process customer orders and update order statuses
- Manage customer accounts and resolve issues
- Access sales reports and business analytics
- Receive and respond to low-stock alerts
- Handle returns, refunds, and customer inquiries

### 1.3.3 Content Managers

#### Use Cases:

- Create and publish landing pages for campaigns
- Update website content, images, and media
- Manage blog posts with categories and tags
- Create and schedule promotional banners
- Preview content changes in real-time before publishing
- Optimize content for user engagement and conversions

### 1.3.4 Warehouse/Fulfillment Staff

#### Use Cases:

- View new orders awaiting fulfillment
- Generate packing slips for orders
- Access product details and quantities for order preparation
- Update order status to "Shipped" and "Delivered"
- Filter and search orders by various criteria
- Receive notifications for new orders

## 2 User Stories

This section presents detailed user stories for all system stakeholders, including acceptance criteria in Gherkin format.

### 2.1 Customer User Stories

#### 2.1.1 US-1: Browse Product Catalogs

**User Story:** As a customer, I want to browse product catalogs so that I can explore available products and discover items of interest.

##### Acceptance Criteria

**AC-1**

Given the customer visits the home page or catalog section,  
When they navigate through categories or scroll the catalog,  
Then the system displays available products grouped by category.

**AC-2**

Given the catalog contains multiple pages,  
When the customer scrolls or clicks "next page",  
Then additional products are loaded and displayed.

**AC-3**

Given filters (price, brand, size) are available,  
When the customer applies them,  
Then the product list updates according to the selected filters.

#### 2.1.2 US-2: Search for Specific Items

**User Story:** As a customer, I want to search for specific items so that I can quickly find the products I need.

##### Acceptance Criteria

**AC-1**

Given the customer opens the search bar,  
When they write keywords or a product's name,  
Then the page shows products that match the names, categories, and/or descriptions.

**AC-2**

Given the customer enters a partial keyword,  
When the system processes the search,  
Then it returns products that contain the keyword in their name or description.

**AC-3**

Given no products match the search term,  
When the customer submits the query,  
Then the system displays a "No results found" message and suggests alternatives.

### 2.1.3 US-3: View Product Details

**User Story:** As a customer, I want to view product details so that I can evaluate features, prices, and specifications before deciding to buy.

#### Acceptance Criteria

**AC-1**

Given the customer clicks on a product from the catalog or search results,  
When the product page is displayed,  
Then the customer sees detailed information including name, description, price, availability, specifications, and reviews.

**AC-2**

Given the product has multiple images,  
When the customer clicks on thumbnails,  
Then the main image updates to the selected view.

**AC-3**

Given the product has size or color variants,  
When the customer selects a variant,  
Then the price and availability update accordingly.

### 2.1.4 US-4: Add Items to Shopping Cart

**User Story:** As a customer, I want to add items to my shopping cart so that I can collect products I wish to purchase in one place.

#### Acceptance Criteria

**AC-1**

Given the customer opens a product page,  
When they click to add the product to the cart,  
Then the cart stores that product along with any previous ones.

**AC-2**

Given the customer adds a product to the cart,  
When the action is successful,  
Then the cart icon updates with the new total quantity.

**AC-3**

Given the product is out of stock,  
When the customer tries to add it to the cart,  
Then the system prevents the action and shows an error message.

### 2.1.5 US-5: Proceed to Checkout

**User Story:** As a customer, I want to proceed to checkout the products in my cart so that I can complete my purchase.



**Acceptance Criteria****AC-1**

Given the customer checks the products present in the cart and their total price,  
When they proceed to the checkout,  
Then they get redirected to the payment app.

**AC-2**

Given the customer's cart is empty,  
When they try to proceed to checkout,  
Then the system prevents the action and displays a message.

**AC-3**

Given the customer is not logged in,  
When they proceed to checkout,  
Then the system prompts them to sign in or continue as a guest.

**2.1.6 US-6: Create an Account**

**User Story:** As an unregistered customer, I want to create an account so that I can access personalized features and manage my purchases.

**Acceptance Criteria****AC-1**

Given the customer receives the prompt for sign in,  
When they submit their email and password,  
Then they receive a confirmation email and get redirected to the main page.

**AC-2**

Given the email address is already registered,  
When the customer tries to create a new account,  
Then the system prevents duplication and shows an error message.

**AC-3**

Given the password does not meet security requirements,  
When the customer submits the form,  
Then the system blocks the registration and provides password guidelines.

**2.1.7 US-7: Track Orders**

**User Story:** As a registered customer, I want to track my orders so that I can stay updated on delivery status and estimated arrival times.

**Acceptance Criteria****AC-1**

Given the customer opens their order tracking page,  
When they select an active order,  
Then the system shows the delivery status, estimated arrival date, and shipping progress.

**AC-2**

Given the order has a tracking number,  
When the customer clicks on it,  
Then the system redirects them to the shipping provider's tracking page.

**2.1.8 US-8: View Past Purchases**

**User Story:** As a registered customer, I want to view past purchases so that I can review my order history.

**Acceptance Criteria****AC-1**

Given the customer visits their past purchases section in their profile,  
When they click on a specific product,  
Then the product's delivery state and order details are shown.

**AC-2**

Given the order history is long,  
When the customer applies filters (date range, product type),  
Then the list updates to show only matching purchases.

**2.1.9 US-9: Update Shipping and Billing Information**

**User Story:** As a registered customer, I want to update my shipping and billing information so that I can ensure accurate delivery and payment.

**Acceptance Criteria****AC-1**

Given the customer edits the billing and/or shipping information in their profile page,  
When they submit the changes,  
Then they receive a confirmation message via email.

**AC-2**

Given the new address is invalid or incomplete,  
When the customer submits it,  
Then the system prevents the update and shows an error message.

**2.1.10 US-10: Reset Password**

**User Story:** As a registered customer, I want to reset my password so that I can regain access to my account.

**Acceptance Criteria****AC-1**

Given a registered customer requests a password reset,  
When they submit their email address on the "Forgot Password" page,  
Then they receive a password reset link via email.

**AC-2**

Given the reset link is expired or already used,  
When the customer clicks on it,  
Then the system shows an error message and prompts them to request a new link.

**2.1.11 US-11: Write a Review**

**User Story:** As a registered customer, I want to write a review for a product so that other users can know the product's quality.

**Acceptance Criteria****AC-1**

Given the customer writes a comment in the text-box below the product's page,  
When they give it a rating,  
Then the comment is shown on that page for every customer.

**AC-2**

Given the customer submits a review,  
When the content violates community guidelines,  
Then the system flags it for moderation before publishing.

**AC-3**

Given the product has existing reviews,  
When the customer opens the product page,  
Then reviews are displayed in chronological or rating order.

**2.2 Administrator User Stories****2.2.1 US-12: Manage Product Listings**

**User Story:** As an administrator, I want to manage product listings so that I can keep the catalog updated for customers.

**Acceptance Criteria****AC-1**

Given the administrator is logged into the dashboard,  
When they add, edit, or delete a product,  
Then the system updates the catalog with the product's name, description, price, images, stock, and attributes (size, color, etc.).

**AC-2**

Given a product exists,  
When it is managed,  
Then it must contain name, description, price, images, stock, and attributes (size, color, etc.).

**2.2.2 US-13: Update Inventory Listings**

**User Story:** As a store administrator, I want to update inventory listings so that I can prevent overselling and maintain accurate stock levels.

**Acceptance Criteria****AC-1**

Given the administrator opens the inventory management section,  
When they adjust stock levels for one or more products,  
Then the updated stock is saved and reflected in the storefront and checkout availability.

**2.2.3 US-14: Process Customer Orders**

**User Story:** As a store administrator, I want to process customer orders so that I can confirm payments, prepare shipments, and keep order statuses up to date.

**Acceptance Criteria****AC-1**

Given the administrator views pending orders in the dashboard,  
When they confirm payment and update the order status,  
Then the customer is notified of the update, and the order moves into the correct stage (e.g., "Preparing shipment", "Shipped").

**2.2.4 US-15: Manage Customer Accounts**

**User Story:** As an administrator, I want to manage customer accounts so that I can resolve special cases and ensure secure usage of the platform.

**Acceptance Criteria****AC-1**

Given the administrator selects a customer account,  
When they edit customer details (name, email, addresses), reset a password, or lock/unlock/deactivate the account,  
Then the changes are applied immediately and logged for security purposes.

### 2.2.5 US-16: Access Sales Reports and Analytics

**User Story:** As a store administrator, I want to access sales reports and analytics so that I can monitor business performance.

#### Acceptance Criteria

##### AC-1

Given the administrator is in the dashboard reports section,  
When they apply filters (by date range, product category, etc.) and generate a report,  
Then the system displays metrics including revenue, best-selling products, and customer demographics.

### 2.2.6 US-17: Receive Low-Stock Alerts

**User Story:** As an administrator, I want to receive low-stock alerts so that I can replenish inventory before it runs out.

#### Acceptance Criteria

##### AC-1

Given a product's stock falls below the defined threshold,  
When the system detects this condition,  
Then an alert is displayed in the admin dashboard, and an optional email notification is sent to the administrator.

## 2.3 Content Manager User Stories

### 2.3.1 US-18: Create Landing Pages

**User Story:** As a content manager, I want to create new landing pages, so that I can launch campaigns and drive user engagement.

#### Acceptance Criteria

##### AC-1

Given a Content Manager is logged in,  
When they create a new landing page,  
Then they can define the title, description, and metadata fields.

##### AC-2

Given the landing page is published,  
When a visitor accesses it,  
Then all content and media display correctly.

### 2.3.2 US-19: Update Website Content

**User Story:** As a content manager, I want to update website content so that I can keep information accurate and relevant.

**Acceptance Criteria****AC-1**

Given a Content Manager is logged in,  
When they open an existing page,  
Then they can edit text, images, videos, or other media.

**AC-2**

Given a Content Manager is editing a page,  
When they make changes,  
Then they can see a live preview of the page updating in real time.

**AC-3**

Given the page is updated and published,  
When a visitor accesses it,  
Then all updates display correctly.

**2.3.3 US-20: Manage Blog Posts**

**User Story:** As a content manager, I want to manage blog posts, so that I can publish new content.

**Acceptance Criteria****AC-1**

Given a Content Manager is logged in,  
When they create a new blog post,  
Then they can define the title, content, and metadata fields.

**AC-2**

Given the blog post is published,  
When a visitor accesses it,  
Then all content displays correctly.

**AC-3**

Given a Content Manager is creating a blog post,  
When they assign categories and tags,  
Then these are saved and displayed correctly.

**2.3.4 US-21: Run Promotional Banners**

**User Story:** As a content manager, I want to run promotional banners, so that I can increase conversions and highlight featured offers.

### Acceptance Criteria

**AC-1**

Given a Content Manager is logged in,  
When they create a new promotional banner,  
Then they can define the title, image, description, and metadata.

**AC-2**

Given a Content Manager is creating or editing a banner,  
When they schedule start and end times,  
Then the banner is displayed according to the schedule.

**AC-3**

Given a banner is published,  
When a visitor accesses pages with banner slots,  
Then the banner displays correctly.

**AC-4**

Given a Content Manager has an existing banner,  
When they update or remove it,  
Then the changes are reflected correctly.

## 2.4 Warehouse Staff User Stories

### 2.4.1 US-22: View New Orders

**User Story:** As warehouse staff, I want to view new orders so that I can be informed about products which need to be shipped.

### Acceptance Criteria

**AC-1**

Given the warehouse staff is logged into the system,  
When they navigate to the "New Orders" section,  
Then the system displays a list of all pending orders with their order IDs, customer details, and required products.

**AC-2**

Given the list of new orders is long,  
When the warehouse staff uses filters (date, status, customer),  
Then the system narrows down the displayed orders.

**AC-3**

Given new orders arrive while the staff is viewing the list,  
When the page refreshes or notifications appear,  
Then the new orders are highlighted at the top of the list.

### 2.4.2 US-23: Generate Packing Slips

**User Story:** As warehouse staff, I want to generate packing slips so that the package contents can be verified by me and the customer.

**Acceptance Criteria****AC-1**

Given the warehouse staff selects an order from the system,  
When they choose the option to generate a packing slip,  
Then the system creates a document listing product names, quantities, and order ID, and the packing slip is available for printing or downloading.

**AC-2**

Given a packing slip is generated,  
When the order is updated later (e.g., items removed or quantities changed),  
Then the packing slip can be regenerated to reflect the new details.

**2.4.3 US-24: Update Order Status to "Shipped"**

**User Story:** As warehouse staff, I want to update order status to "shipped" so that customers can track the progress of their purchase.

**Acceptance Criteria****AC-1**

Given the warehouse staff has packed the products for a specific order,  
When they change the order status to "Shipped" in the system,  
Then the system updates the order status and notifies the customer of the shipment.

**2.4.4 US-25: Update Order Status to "Delivered"**

**User Story:** As a warehouse staff member, I want to update an order as "delivered" so that the customer, content manager, and store administrator are notified.

**Acceptance Criteria****AC-1**

Given the warehouse staff opens an order marked as "Shipped",  
When they attempt to update the status to "Delivered",  
Then the system displays a confirmation prompt, and upon confirmation, the status is updated to "Delivered", notifying customers.

**2.4.5 US-26: View Products in an Order**

**User Story:** As a warehouse staff member, I want to view the products in an order so that I know which items to prepare for delivery.

**Acceptance Criteria****AC-1**

Given the warehouse staff enters or searches for an order ID,  
When they open the order details,  
Then the system displays all products included in the order, with details such as name, quantity, and availability.



## 3 Functional Requirements

### 3.1 Customer Features

#### 3.1.1 FR-1: Product Browsing and Discovery

**Description:** Enable customers to explore and discover products through intuitive catalog navigation.

##### Requirements

- **FR-1.1:** Display products grouped by category on home page and catalog section
- **FR-1.2:** Support pagination or infinite scroll for multi-page catalogs
- **FR-1.3:** Provide dynamic filters for price range, brand, and size
- **FR-1.4:** Display product thumbnails, names, prices, and availability status
- **FR-1.5:** Support category-based product organization and navigation

#### 3.1.2 FR-2: Product Search

**Description:** Allow customers to quickly find products using keyword search.

##### Requirements

- **FR-2.1:** Search products by name, category, and description
- **FR-2.2:** Support partial keyword matching

#### 3.1.3 FR-3: Product Details

**Description:** Provide comprehensive product information to support purchase decisions.

##### Requirements

- **FR-3.1:** Display product name, description, price, availability, and specifications
- **FR-3.2:** Show multiple product images with thumbnail navigation
- **FR-3.3:** Support product variants (size, color) with dynamic pricing
- **FR-3.4:** Display customer reviews and ratings

#### 3.1.4 FR-4: Shopping Cart Management

**Description:** Enable customers to collect and manage products before purchase.

##### Requirements

- **FR-4.1:** Allow adding products to shopping cart from product pages
- **FR-4.2:** Persist cart contents across user sessions
- **FR-4.3:** Display cart icon with current item quantity
- **FR-4.4:** Allow removing items from cart
- **FR-4.5:** Display subtotal and total price calculations

#### 3.1.5 FR-5: Checkout Process

**Description:** Facilitate secure and efficient purchase completion.

**Requirements**

- **FR-5.1:** Redirect authenticated users to payment flow
- **FR-5.2:** Prompt unauthenticated users to sign in or continue as guest
- **FR-5.3:** Collect and validate shipping information
- **FR-5.4:** Calculate taxes and shipping costs automatically
- **FR-5.5:** Process payments through integrated payment gateway
- **FR-5.6:** Display order confirmation upon successful payment
- **FR-5.7:** Send confirmation email with order details

**3.1.6 FR-6: User Account Management**

**Description:** Allow customers to create and manage personal accounts.

**Requirements**

- **FR-6.1:** Enable account creation with email and password
- **FR-6.2:** Send confirmation email upon registration
- **FR-6.3:** Enforce password security requirements

**3.1.7 FR-7: Order Tracking**

**Description:** Enable customers to monitor order status and delivery progress.

**Requirements**

- **FR-7.1:** Display delivery status and estimated arrival date
- **FR-7.2:** Show shipping progress with status updates
- **FR-7.3:** Send email notifications for status changes

**3.1.8 FR-8: Order History**

**Description:** Provide access to past purchase records.

**Requirements**

- **FR-8.1:** Display complete order history in customer profile
- **FR-8.2:** Support filtering by date range and product type

**3.1.9 FR-9: Profile Management**

**Description:** Allow customers to maintain accurate account information.

**Requirements**

- **FR-9.1:** Enable editing of shipping and billing addresses
- **FR-9.2:** Allow updating personal information (name, phone, email)

**3.1.10 FR-10: Password Reset**

**Description:** Provide secure password recovery mechanism.

**Requirements**

- **FR-10.1:** Offer "Forgot Password" functionality on login page
- **FR-10.2:** Send password reset link via email
- **FR-10.3:** Enforce password requirements on reset

**3.1.11 FR-11: Product Reviews**

**Description:** Enable customers to share product experiences and ratings.

**Requirements**

- **FR-11.1:** Allow registered customers to write reviews with ratings (1-5 stars)
- **FR-11.2:** Display reviews on product pages
- **FR-11.3:** Calculate and display average product rating
- **FR-11.4:** Allow customers to edit their own reviews

**3.2 Content Manager Features****3.2.1 FR-12: Landing Page Management**

**Description:** Enable creation and management of campaign-specific landing pages.

**Requirements**

- **FR-12.1:** Allow creation of new landing pages
- **FR-12.2:** Support title, description, and metadata fields
- **FR-12.3:** Enable SEO optimization with meta tags

**3.2.2 FR-13: Website Content Management**

**Description:** Facilitate ongoing website content updates and maintenance.

**Requirements**

- **FR-13.1:** Allow editing of text, images, videos, and other media
- **FR-13.2:** Provide real-time live preview during editing
- **FR-13.3:** Enable content scheduling for future publication

**3.2.3 FR-14: Blog Post Management**

**Description:** Support content marketing through blog functionality.

**Requirements**

- **FR-14.1:** Enable creation of blog posts with title, content, and metadata
- **FR-14.2:** Support rich text editing and media embedding
- **FR-14.3:** Enable SEO optimization for blog posts

**3.2.4 FR-15: Promotional Banner Management**

**Description:** Enable targeted promotional campaigns through banner management.

**Requirements**

- **FR-15.1:** Allow creation of banners with title, image, description, metadata
- **FR-15.2:** Support scheduling with start and end times
- **FR-15.3:** Allow updating or removing existing banners
- **FR-15.4:** Support multiple banner positions (header, sidebar, footer)

### 3.3 Administrator Features

#### 3.3.1 FR-16: Product Catalog Management

**Description:** Provide product lifecycle management.

**Requirements**

- **FR-16.1:** Allow adding, editing, and deleting products
- **FR-16.2:** Require name, description, price, images, stock, and attributes
- **FR-16.3:** Enable product categorization and tagging
- **FR-16.4:** Support product variations and SKU management

#### 3.3.2 FR-17: Inventory Management

**Description:** Maintain accurate real-time inventory tracking.

**Requirements**

- **FR-17.1:** Allow adjusting stock levels for products
- **FR-17.2:** Reflect updated stock in storefront and checkout immediately
- **FR-17.3:** Automatically reduce stock when orders are placed
- **FR-17.4:** Track inventory movement history

#### 3.3.3 FR-18: Order Processing

**Description:** Streamline order management and fulfillment workflows.

**Requirements**

- **FR-18.1:** Display pending orders in dashboard
- **FR-18.2:** Notify customers of status updates
- **FR-18.3:** Support status transitions (pending → processing → shipped → delivered)
- **FR-18.4:** Enable order cancellation and refund processing
- **FR-18.5:** Provide order search and filtering capabilities

#### 3.3.4 FR-19: Customer Account Administration

**Description:** Enable administrative management of customer accounts.

**Requirements**

- **FR-19.1:** Allow editing customer details (name, email, addresses)
- **FR-19.2:** Enable password reset for customer accounts
- **FR-19.3:** Support account locking, unlocking, and deactivation

### 3.3.5 FR-20: Sales Reports and Analytics

**Description:** Provide actionable business intelligence and reporting.

#### Requirements

- **FR-20.1:** Provide reports section in dashboard
- **FR-20.2:** Support filtering by date range, category, and criteria
- **FR-20.3:** Display metrics: revenue, best-sellers, customer demographics
- **FR-20.4:** Allow report generation and export (PDF, CSV, Excel)
- **FR-20.5:** Provide visual charts and graphs

### 3.3.6 FR-21: Inventory Alerts

**Description:** Notify administrators of inventory issues.

#### Requirements

- **FR-21.1:** Monitor stock levels against defined thresholds
- **FR-21.2:** Display low-stock alerts in dashboard
- **FR-21.3:** Provide alert history and tracking

## 3.4 Warehouse Staff Features

### 3.4.1 FR-22: Order Queue Management

**Description:** Facilitate efficient order fulfillment workflows.

#### Requirements

- **FR-22.1:** Display pending orders in "New Orders" section
- **FR-22.2:** Show order IDs, customer details, and required products
- **FR-22.3:** Support filtering by date, status, and customer

### 3.4.2 FR-23: Packing Slip Generation

**Description:** Streamline package preparation and verification.

#### Requirements

- **FR-23.1:** Generate packing slips for selected orders
- **FR-23.2:** Include product names, quantities, and order ID
- **FR-23.3:** Provide printable or downloadable format
- **FR-23.4:** Allow regeneration when order details change
- **FR-23.5:** Support barcode/QR code inclusion for scanning

### 3.4.3 FR-24: Shipment Status Management

**Description:** Enable accurate order status tracking throughout fulfillment.

**Requirements**

- **FR-24.1:** Allow updating status to "Shipped"
- **FR-24.2:** Notify customers when marked as "Shipped"
- **FR-24.3:** Update status throughout system

**3.4.4 FR-25: Delivery Confirmation**

**Description:** Finalize order lifecycle with delivery confirmation.

**Requirements**

- **FR-25.1:** Display confirmation prompt for "Delivered" status
- **FR-25.2:** Update status upon confirmation
- **FR-25.3:** Notify customers, content managers, and administrators
- **FR-25.4:** Trigger post-delivery workflows (review requests, etc.)

**3.4.5 FR-26: Order Details Access**

**Description:** Provide quick access to order information for fulfillment.

**Requirements**

- **FR-26.1:** Allow searching orders by order ID
- **FR-26.2:** Display all products with name, quantity, availability
- **FR-26.3:** Show product location information (if warehouse management is implemented)

## 4 Non-Functional Requirements

### 4.1 Performance Requirements

#### 4.1.1 NFR-1: Response Time

##### Requirements

- **NFR-1.1:** Product catalog pages load within 2 seconds under normal load
- **NFR-1.2:** Search queries return results within 1 second
- **NFR-1.3:** Cart updates complete within 500 milliseconds
- **NFR-1.4:** API responses complete within 200 milliseconds
- **NFR-1.5:** Database queries execute within 100 milliseconds

### 4.2 Availability and Reliability

#### 4.2.1 NFR-2: Data Integrity

##### Requirements

- **NFR-2.1:** Ensure shopping cart data persistence without loss
- **NFR-2.2:** Maintain inventory accuracy within  $\pm 1$  unit
- **NFR-2.3:** Ensure transactional integrity for all order operations
- **NFR-2.4:** Prevent duplicate order processing

#### 4.2.2 NFR-3: Fault Tolerance

##### Requirements

- **NFR-3.1:** Gracefully handle service failures without data loss
- **NFR-3.2:** Provide meaningful error messages for user-facing failures
- **NFR-3.3:** Support automatic service restart on failure
- **NFR-3.4:** Implement retry logic with exponential backoff

### 4.3 Security Requirements

#### 4.3.1 NFR-4: Authentication and Authorization

##### Requirements

- **NFR-4.1:** Implement secure password storage
- **NFR-4.2:** Enforce password complexity
- **NFR-4.3:** Implement role-based access control (RBAC) for all user types
- **NFR-4.4:** Expire password reset links after 24 hours or first use
- **NFR-4.5:** Implement OAuth 2.0 / OpenID Connect with Keycloak

#### 4.3.2 NFR-5: Data Protection

##### Requirements

- **NFR-5.1:** Encrypt sensitive data at rest
- **NFR-5.2:** Comply with GDPR and PCI DSS requirements
- **NFR-5.3:** Implement data anonymization for analytics
- **NFR-5.4:** Support right to erasure

#### 4.3.3 NFR-6: API Security

##### Requirements

- **NFR-6.1:** Implement rate limiting
- **NFR-6.2:** Validate and sanitize all input data
- **NFR-6.3:** Implement request signing for sensitive operations

### 4.4 Usability Requirements

#### 4.4.1 NFR-7: User Interface

##### Requirements

- **NFR-7.1:** Provide intuitive navigation requiring minimal training for customers
- **NFR-7.2:** Display clear, actionable error messages with recovery suggestions
- **NFR-7.3:** Maintain consistent design patterns across all pages
- **NFR-7.4:** Implement progressive disclosure for complex forms

#### 4.4.2 NFR-8: Mobile Responsiveness

##### Requirements

- **NFR-8.1:** Provide responsive design for mobile and desktop
- **NFR-8.2:** Maintain full functionality on mobile devices
- **NFR-8.3:** Support touch gestures

### 4.5 Maintainability Requirements

#### 4.5.1 NFR-9: Monitoring and Logging

##### Requirements

- **NFR-9.1:** Log all critical operations with timestamps
- **NFR-9.2:** Monitor error rates, response times, and throughput
- **NFR-9.3:** Alert administrators of critical errors



#### 4.5.2 NFR-10: Testing

##### Requirements

- **NFR-10.1:** Maintain code coverage through automated testing
- **NFR-10.2:** Implement unit tests for business logic
- **NFR-10.3:** Implement integration tests for API endpoints
- **NFR-10.4:** Implement end-to-end tests for critical user flows
- **NFR-10.5:** Run automated tests on every code commit

## 5 Tech Stack and Architecture

### 5.1 System Architecture

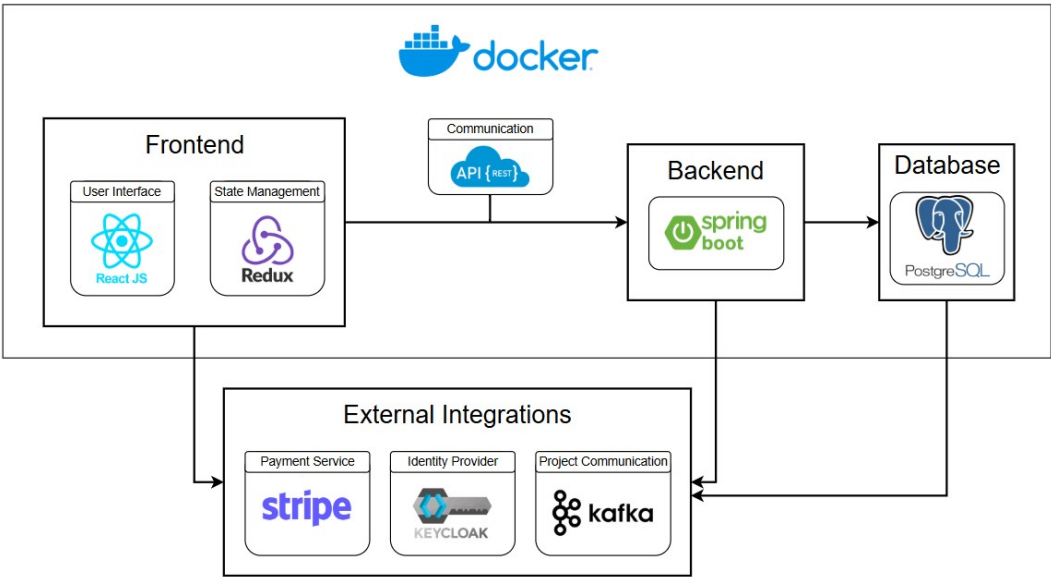


Figure 1: System Architecture Diagram

### 5.2 Technology Stack Overview

#### 5.2.1 Frontend Technologies

React Framework

**Core Technologies:**

- **State Management:** Redux Toolkit for global state
- **Routing:** React Router
- **UI Components:** Custom components with CSS modules
- **Package Manager:** npm

**React Component Structure:**

```
1 src/
2   components/           # Reusable UI components
3   features/             # Feature-based modules
4     products/
5     cart/
6     checkout/
7     auth/
8     orders/
9   store/                # Redux store configuration
10  services/              # API service layer
11  utils/                 # Utility functions
12  hooks/                 # Custom React hooks
13  assets/                # Images, fonts, styles
```

### 5.2.2 Backend Technologies

#### Spring Boot Framework

**Core Technologies:**

- **API Design:** RESTful APIs
- **Security:** Spring Security with Keycloak integration
- **Build Tool:** Maven or Gradle

**Spring Boot Project Structure:**

```
1 src/main/java/  
2     controller/      # REST controllers  
3     service/         # Business logic layer  
4     repository/      # Data access layer  
5     model/           # Domain entities  
6     dto/             # Data transfer objects  
7     config/          # Configuration classes  
8     security/        # Security configuration  
9     exception/       # Exception handling  
10    util/            # Utility classes
```

### 5.2.3 Database

#### PostgreSQL Database

**Key Features:**

- Relational database for transactional data
- Support for JSONB for flexible schema
- Full-text search capabilities
- Replication support for high availability

**Database Schema Overview:**

- **Users** – Customers, Admins, Staff
- **Products** – Catalog, Inventory, Variants
- **Orders** – Orders, Order Items, Payments
- **Content** – Pages, Blog Posts, Banners
- **Reviews** – Product Reviews, Ratings

### 5.2.4 Message Queue

#### Apache Kafka

**Use Cases:**

- Order processing events
- Inventory updates
- Email notifications
- Analytics event streaming
- Audit logging

**Kafka Topics:**

- `order.created` – New order events
- `order.updated` – Order status changes
- `inventory.updated` – Stock level changes
- `payment.processed` – Payment confirmations
- `email.notifications` – Email queue
- `user.events` – User activity tracking

**5.2.5 Authentication & Authorization****Keycloak Identity Management****Features:**

- Centralized identity management
- OAuth 2.0 / OpenID Connect
- Single Sign-On (SSO)
- Social login integration
- Multi-factor authentication
- Role and permission management

**Keycloak Configuration:**

- **Realm:** ecommerce-platform
- **Roles:** customer, warehouse-staff, content-manager, admin
- **Token lifespan:** Access token (15 min), Refresh token (30 days)

**5.2.6 Payment Processing****Stripe API****Capabilities:**

- Payment intents for secure transactions
- Webhook integration for payment events
- Support for multiple payment methods
- PCI DSS compliant tokenization

**Stripe Integration:**

- **Client-side:** Stripe.js and Stripe Elements
- **Server-side:** Stripe Java SDK
- **Webhook endpoint:** `/api/payments/webhook`

### 5.2.7 Containerization & Orchestration

#### Docker Containerization

**Features:**

- Containerized microservices
- Docker Compose for local development
- Multi-stage builds for optimization

**Container Orchestration (Production):**

- Kubernetes or Docker Swarm
- Auto-scaling policies
- Service discovery
- Load balancing

**Docker Services:**

- **frontend** – React app
- **backend** – Spring Boot API
- **database** – PostgreSQL
- **message-broker** – Kafka
- **auth-server** – Keycloak

## 6 UI/UX Requirements

### 6.1 Design Principles

The eCommerce platform should adhere to modern UI/UX design principles that prioritize user experience, accessibility, and conversion optimization.

Core Design Principles

- **Simplicity:** Clean, uncluttered interface with clear visual hierarchy
- **Consistency:** Uniform design patterns, colors, and typography throughout
- **Responsiveness:** Seamless experience across all device sizes
- **Performance:** Optimized loading times and smooth interactions

### 6.2 Mockup

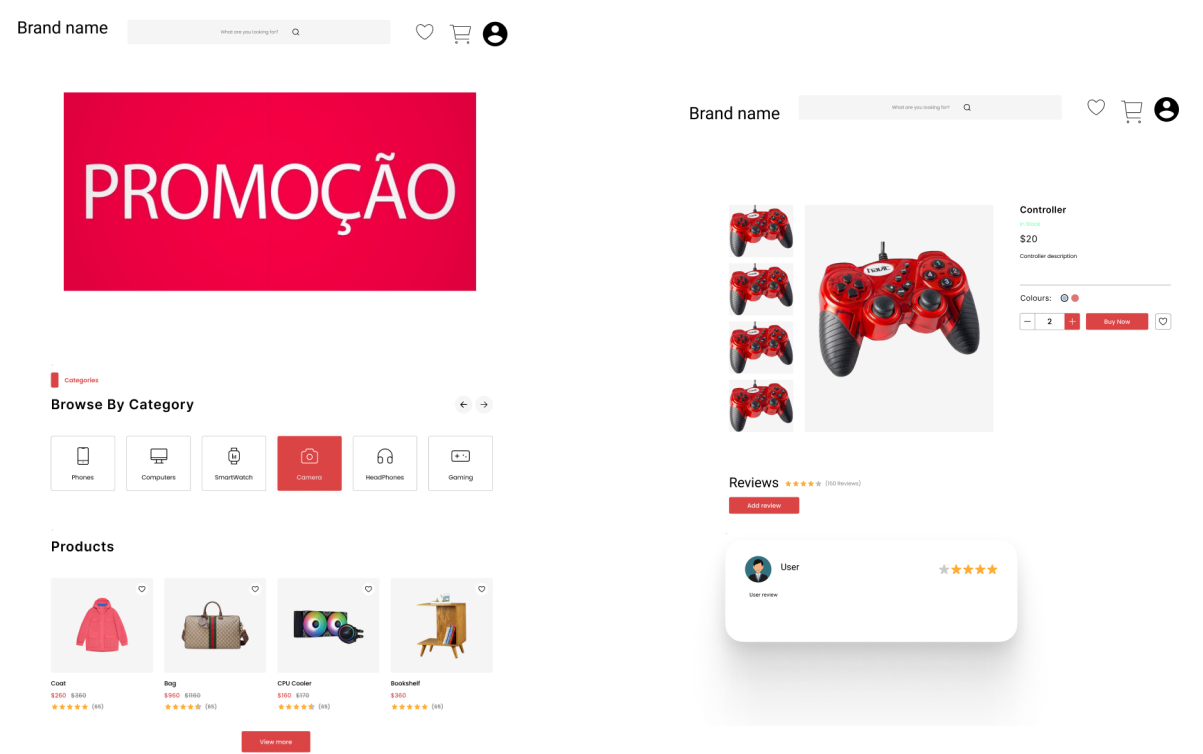


Figure 3: Product Details Page

Figure 2: Home Page

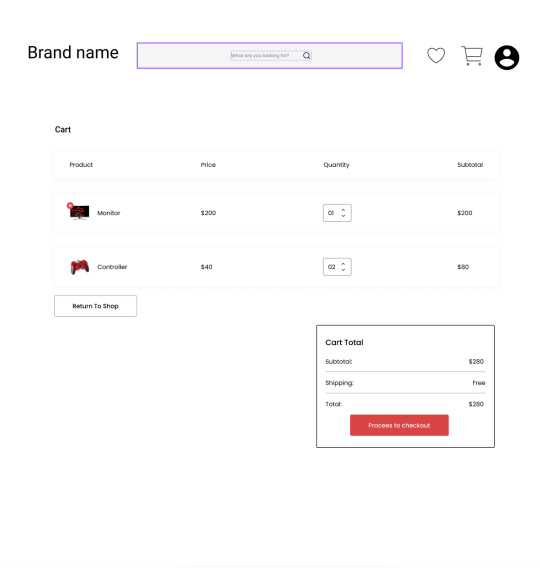


Figure 4: Cart Page

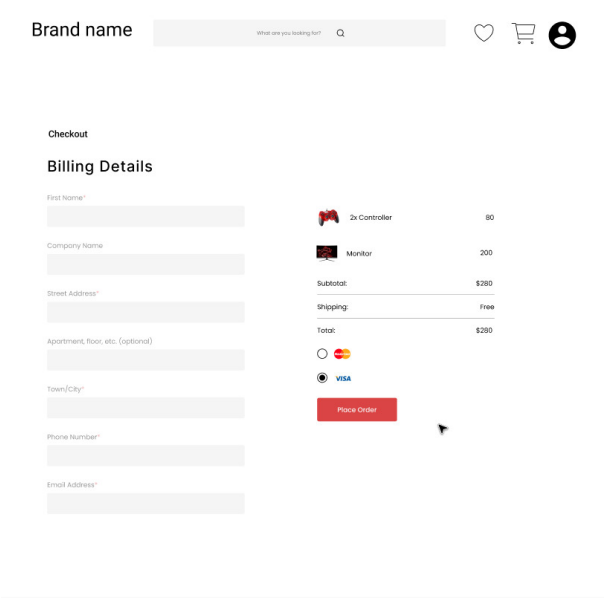


Figure 5: Billing Page

## 7 Data and Database Specifications

### 7.1 Database Architecture

The system uses PostgreSQL as the primary relational database to store all transactional and operational data.

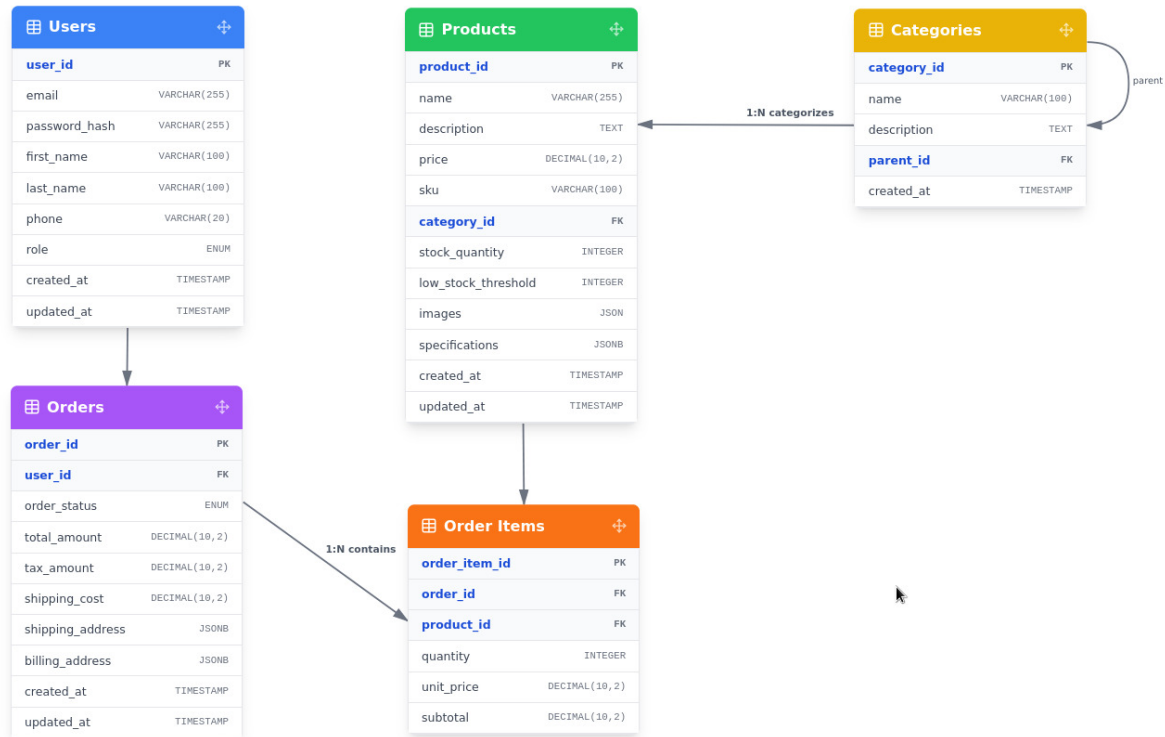


Figure 6: Database AR Diagram

### 7.2 Core Data Entities

#### 7.2.1 Users Table

Stores customer, administrator, content manager, and warehouse staff information.

**Key Fields:**

- `user_id` (Primary Key)
- `email`, `password_hash`
- `first_name`, `last_name`, `phone`
- `role` (customer, admin, content\_manager, warehouse\_staff)
- `created_at`, `updated_at`

#### 7.2.2 Products Table

Contains product catalog information.

**Key Fields:**



- product\_id (Primary Key)
- name, description, price
- sku, category\_id (Foreign Key)
- stock\_quantity, low\_stock\_threshold
- images (JSON array), specifications (JSONB)
- created\_at, updated\_at

### 7.2.3 Orders Table

Manages customer orders and their lifecycle.

**Key Fields:**

- order\_id (Primary Key)
- user\_id (Foreign Key)
- order\_status (pending, processing, shipped, delivered, cancelled)
- total\_amount, tax\_amount, shipping\_cost
- shipping\_address (JSONB), billing\_address (JSONB)
- created\_at, updated\_at