

HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY

**SCHOOL OF INFORMATION
COMMUNICATION TECHNOLOGY**



SOICT

GRADUATION RESEARCH 1

**E-COMMERCE WEBSITE SELLING TECHNOLOGY
PRODUCTS**

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Abstract:

This report presents the design and implementation of a technology-focused e-commerce website. The project aims to develop a user-friendly platform that supports the online sales and management of technology products. By applying modern web technologies, the system is designed to be efficient, scalable, and capable of meeting current e-commerce requirements while enhancing the overall user experience.

I. Introduction

1. Context and Motivation

With the rapid advancement of technology and the growing popularity of online shopping, businesses are increasingly required to adopt modern strategies to promote and sell their products more efficiently than traditional methods. Online shopping allows customers to search for and purchase products conveniently through smartphones or other digital devices without the need to visit physical stores. As a result, e-commerce platforms have become an essential solution for both businesses and consumers in the digital era.

This trend is particularly evident in the technology product market, where customers often seek convenience, detailed product information, and quick access to a wide range of items. An e-commerce website enables users to browse, compare, and purchase various technology products with just a few clicks, making the shopping process more efficient and accessible regardless of time and location.

However, building a trusted e-commerce platform requires more than just displaying products, it demands robust security measures and reliable payment integration to protect user data and financial transactions. This project is motivated by the need to create a complete, secure, and modern e-commerce solution that addresses these challenges.

2. Project Objectives

The primary goal of this project is to design and develop a comprehensive full-stack e-commerce web application tailored for technology products. The specific objectives are as follows:

- **Full-stack System Development:** To construct a complete system architecture including a responsive Frontend (ReactJS), a robust Backend (Spring Boot), and a relational Database (PostgreSQL).
- **Adoption of Modern Technologies:** To implement the latest software standards by utilizing Java 22 and Spring Boot 3.4, ensuring the system is high-performing, scalable, and secure.
- **Real-world Payment Integration:** To solve the challenge of online transactions by integrating the VNPay Payment Gateway, allowing users to perform secure electronic payments with real-time verification (IPN).

- **Enhanced Security:** To implement a multi-layer security mechanism using Spring Security and JWT (JSON Web Token), combined with verification token via Email during registration and password recovery processes to ensure user authenticity.

3. Project Scope

The project focuses on the Business-to-Consumer (B2C) model, facilitating the entire life cycle of e-commerce transactions. The scope encompasses two main functional areas: the Storefront for customers and the Back-office for management.

- **Target Audience:**
 - **End-Users (Customers):** Individual retail customers looking to search, compare, and purchase technology devices online.
 - **Administrators & Staff (Admin/PM):** System owners and product managers responsible for managing inventory, processing orders, and overseeing user accounts.

II. System Technology Stack

1. Overall System Architecture

The system follows a decoupled Client-Server architecture, ensuring independent development and deployment of the frontend and backend components.

2. Backend Environment (Server-side)

- **Java Development Kit (JDK) 22:** The primary execution environment for the server-side application.
- **Spring Boot Framework 3.4.0:** The core framework providing managed infrastructure for the web layer, dependency injection, and data persistence.
- **Spring Security:** A framework focusing on providing both authentication and authorization to the Java application.
- **JSON Web Token (JWT):** Used for securely transmitting information between parties as a JSON object, facilitating stateless authentication.

3. Frontend Environment (Client-side)

- **ReactJS:** A JavaScript library for building user interfaces based on a component-oriented approach.

- **Axios:** A promise-based HTTP client for the browser used to interact with the Backend RESTful APIs.

4. Data Management & Storage

- **PostgreSQL:** The primary relational database management system (RDBMS) used for persistent data storage.
- **Spring Data JPA:** A part of the larger Spring family that makes it easy to easily implement JPA-based repositories.

5. Integration & Communication Services

- **VNPAY Gateway API:** The external payment interface used to process online transactions.
- **SMTP (Simple Mail Transfer Protocol):** The protocol used for automated email communication.

III. System Analysis & Design

1. Requirement Analysis

Based on the project goals, the system must support three main user roles with specific functional requirements:

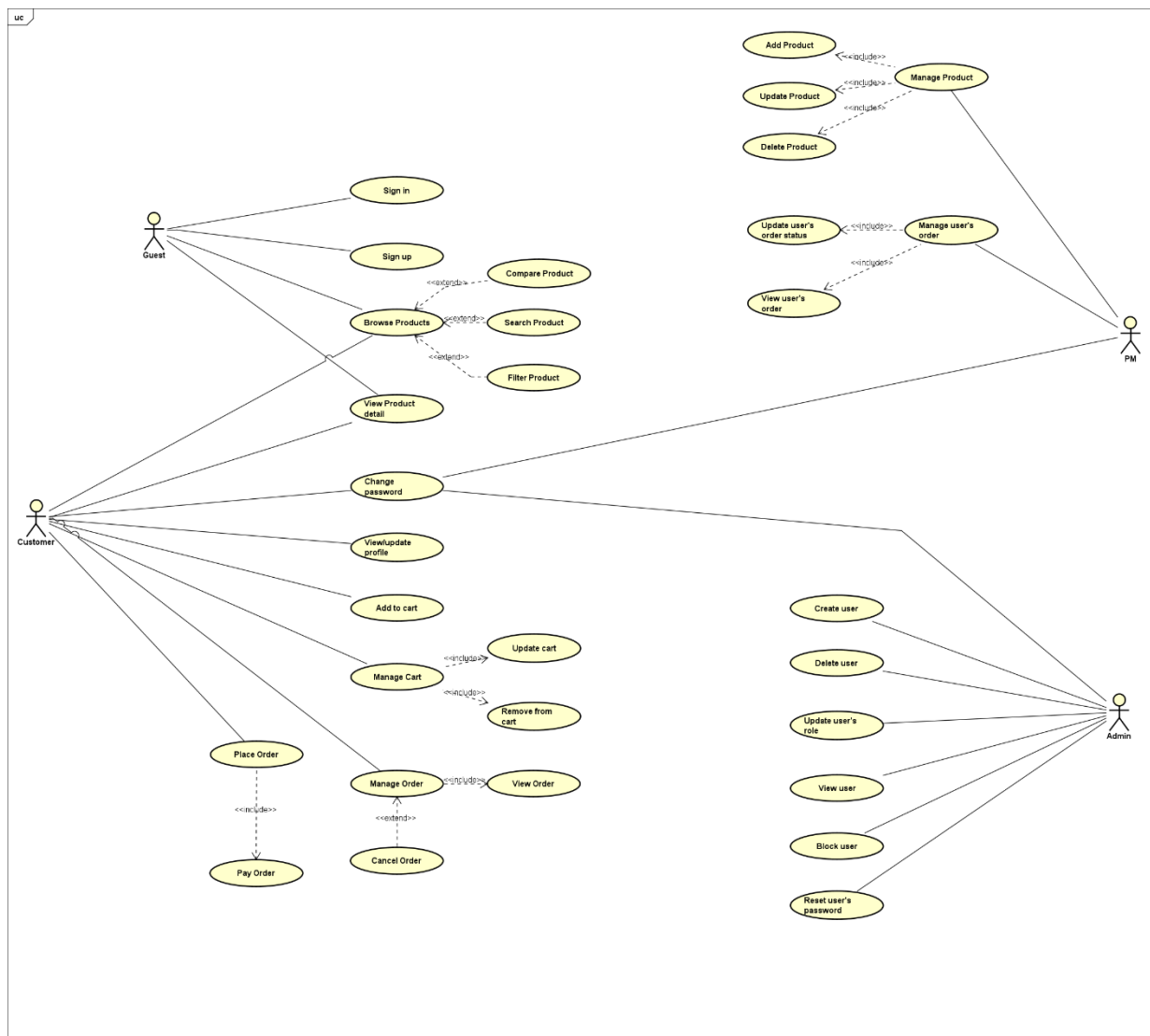
- **Customer:**
 - Browse and search for technology products by name, category, price, or filter by product components.
 - Manage personal shopping carts (Add, update quantity, remove items).
 - Secure checkout with delivery information and integrated payment via VNPAY.
 - Track order history and cancel pending orders.
 - Register with secure email-based token verification and login, change password.
- **Product Manager (PM):**
 - Manage product catalog (CRUD operations: Create, Read, Update, Delete).
 - Monitor inventory levels and update product availability.
 - Oversee all system orders and payment transactions.
- **Administrator (Admin):**
 - Manage user accounts and roles.

2. Use Case Diagram

The Use Case diagram provides a visual representation of the system's functional requirements, showing the relationships between actors and the various actions they can perform within the e-commerce platform.

The system identifies four primary actors, each with distinct responsibilities and access levels:

- **Guest:** An unauthenticated user who can browse products, search, compare, and sign up for an account.
- **Customer:** A registered user with full access to shopping features, including cart management, checkout, order tracking, and profile updates.
- **Product Manager (PM):** A staff member responsible for catalog maintenance, including adding, updating, and deleting technology products, as well as managing user orders.
- **Administrator (Admin):** The system owner with high-level privileges to manage user accounts, roles, and administrative tasks like resetting passwords or blocking users.



3. Database Design (ERD)

The system utilizes a relational database structure to ensure data integrity and efficient querying.

User & Security Management:

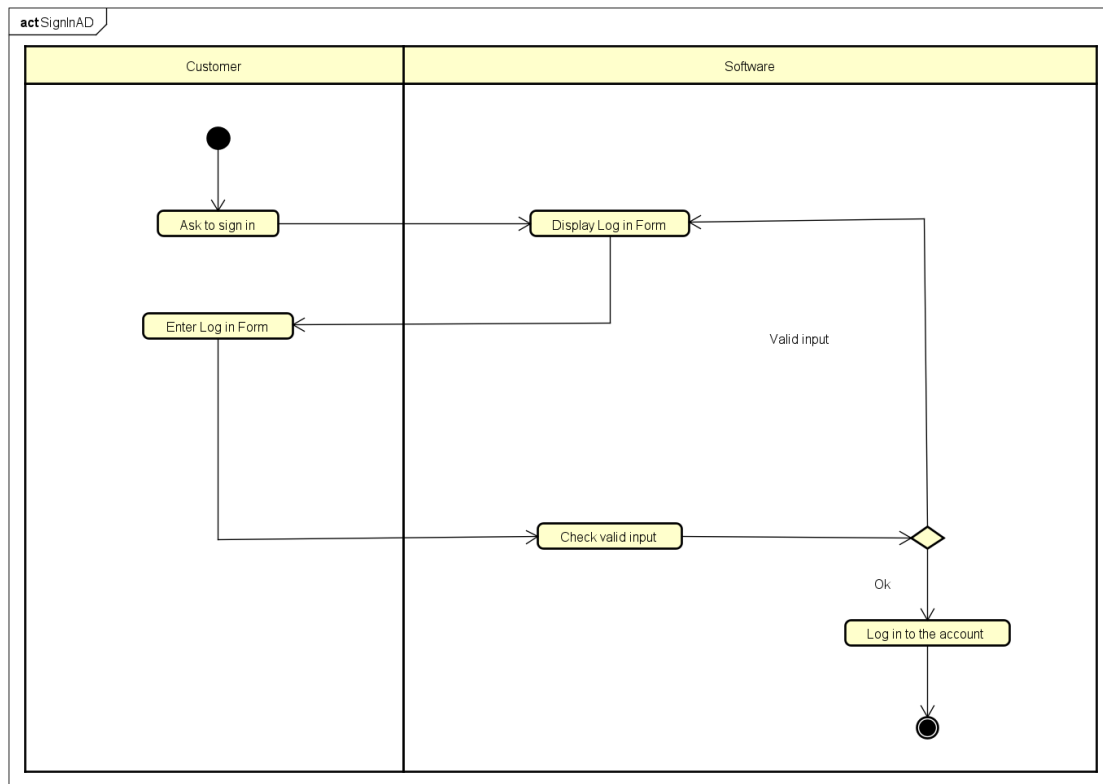
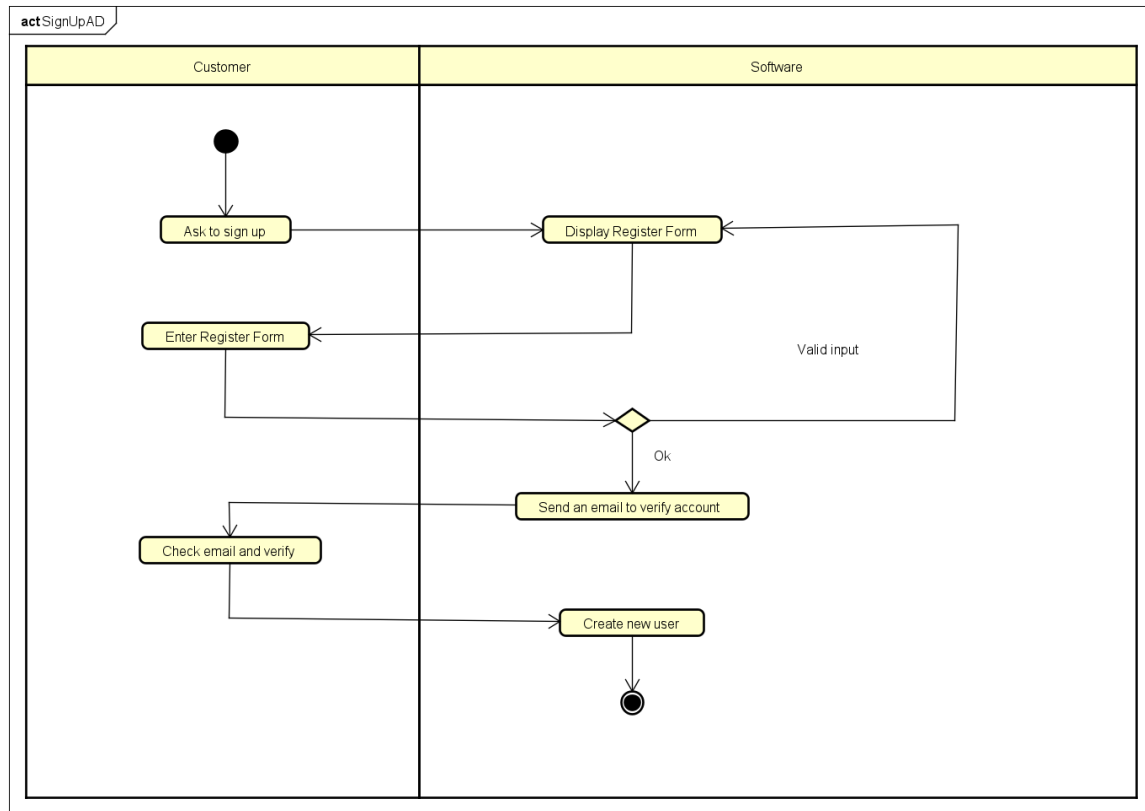
- **User:** Stores core credentials including hashed passwords, roles (Customer, PM, Admin), and the account activation status (is_active).
- **Email Verification Tokens:** A specialized table to manage Tokens for registration and password recovery, including expiryDate and isUsed flags to prevent token reuse.
- **User Profile:** Separated from the core User table to store extended personal information like address, phone, and dateOfBirth.

Product & Catalog System:

- **Product:** The central entity for inventory, including pricing, quantity in stock, and images.
- **Categories:** Organizes products into logical groups.
- **Attributes & Values (EAV Model):** This advanced design (ProductAttributes, ProductAttributeValues) allows for flexible product specifications without modifying the table schema.

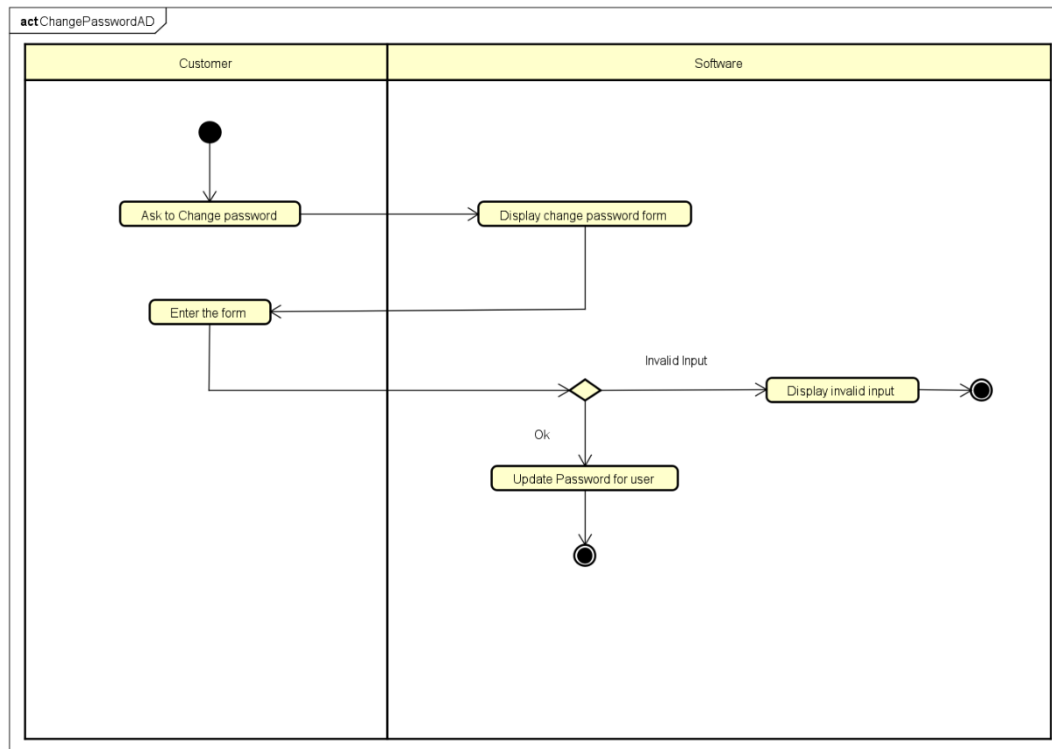
Shopping Cart & Ordering:

- **Cart & Cart Detail:** Manages items added by customers before purchase, including a flag (isSelected) to support partial checkout.
- **Order & Order Detail:** Captures a snapshot of the transaction, including shipping addresses, total price, and the status of the order.
- **Invoice:** Linked to the Order to track specific payment transactions, including transactionID from **VNPAY**, payment provider details, and raw responses for auditing purposes.



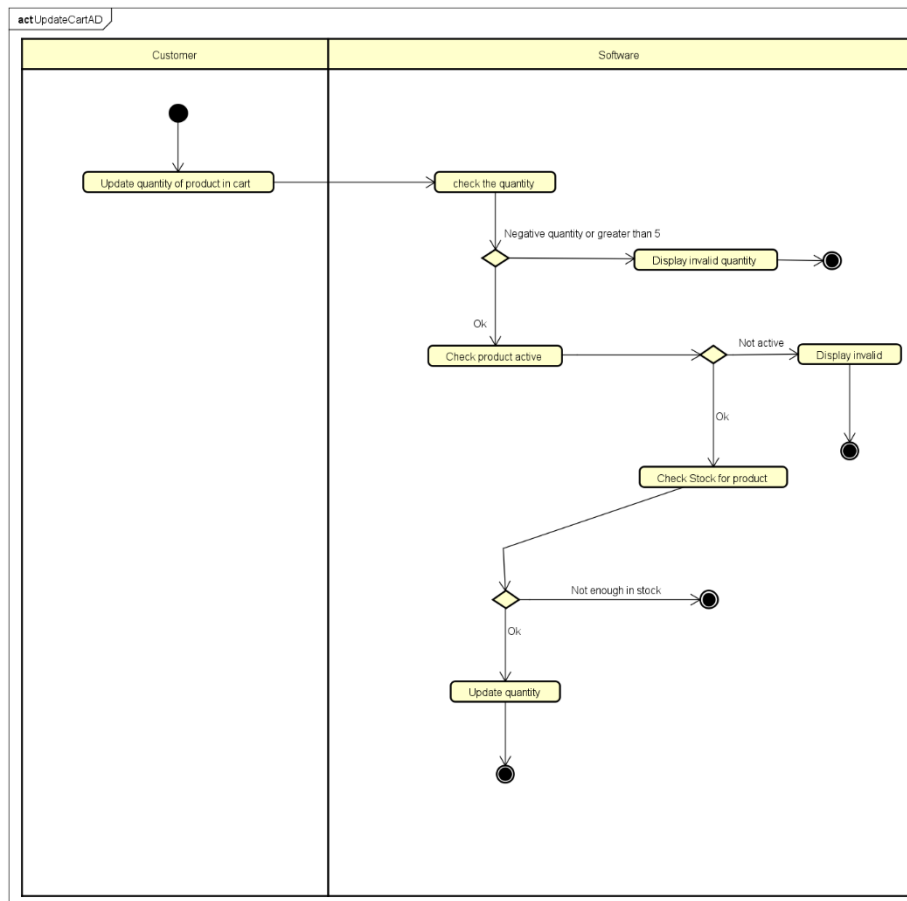
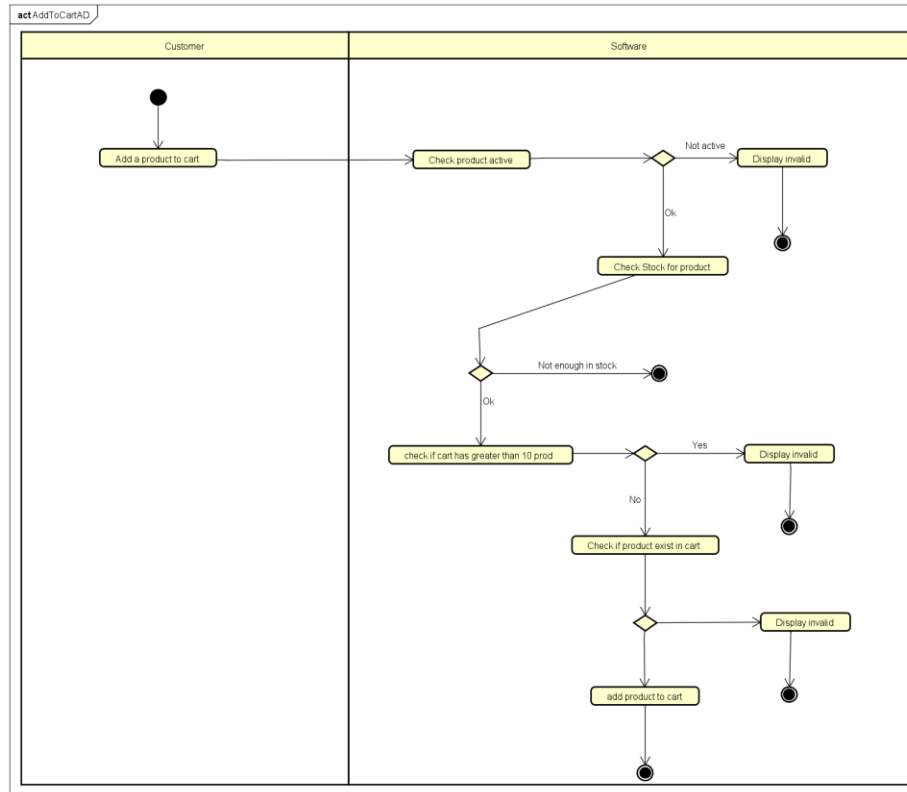
- **Account & Security (Change Password):**

The system displays a change password form and performs strict input validation. Upon successful verification of the new data, the software updates the user's password in the persistent storage.



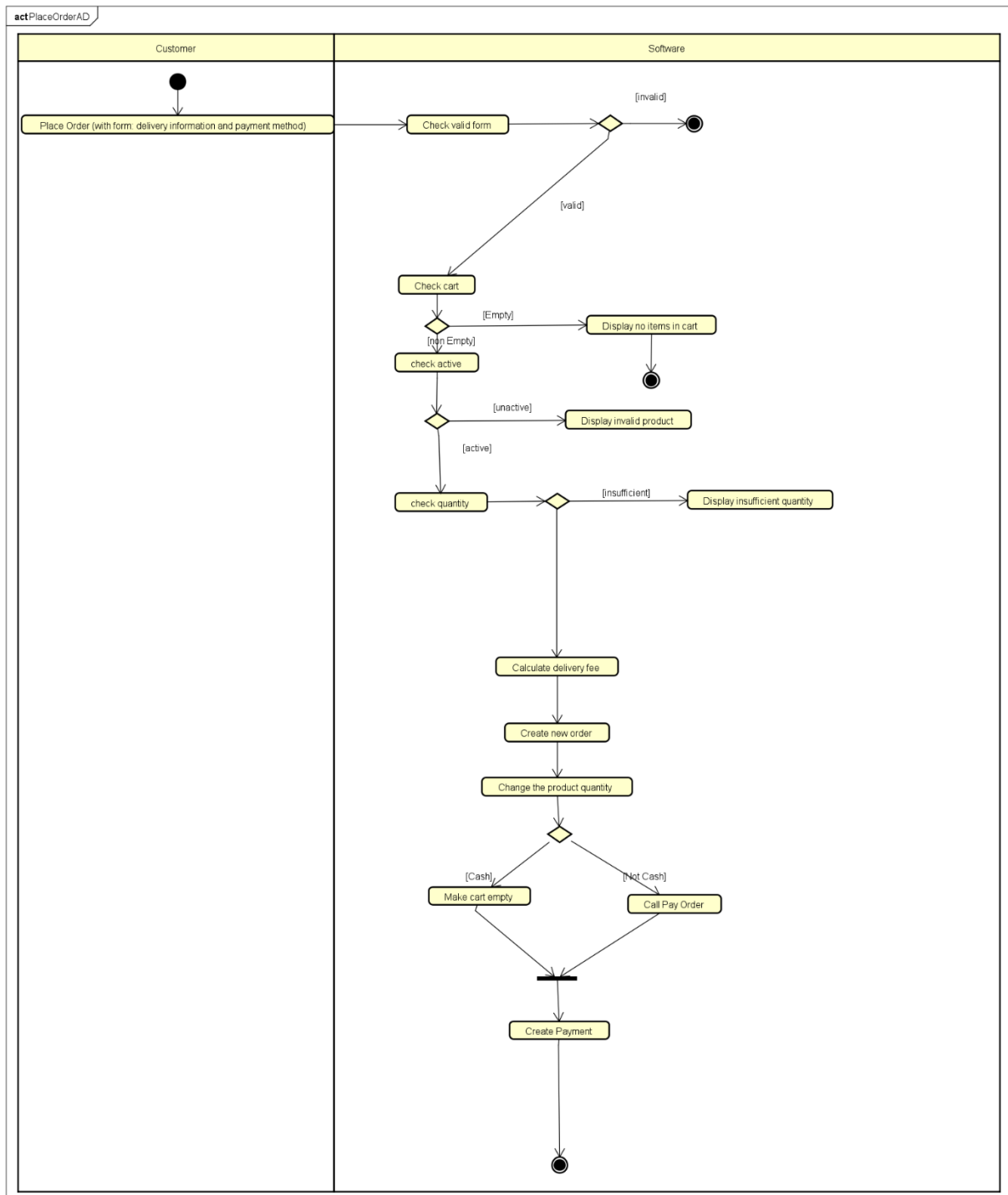
- **Shopping Cart Management (Add & Update Cart):**

- **Add to Cart:** The software performs multiple critical checks before adding a product: verifying if the product is active, checking if sufficient stock is available, and ensuring the cart does not exceed a limit of 10 products per item type.
- **Update Cart:** When a customer modifies a quantity, the system validates the request against a specific range (e.g., non-negative and not exceeding 5 units per update), checks product status, and verifies stock levels before committing the change.

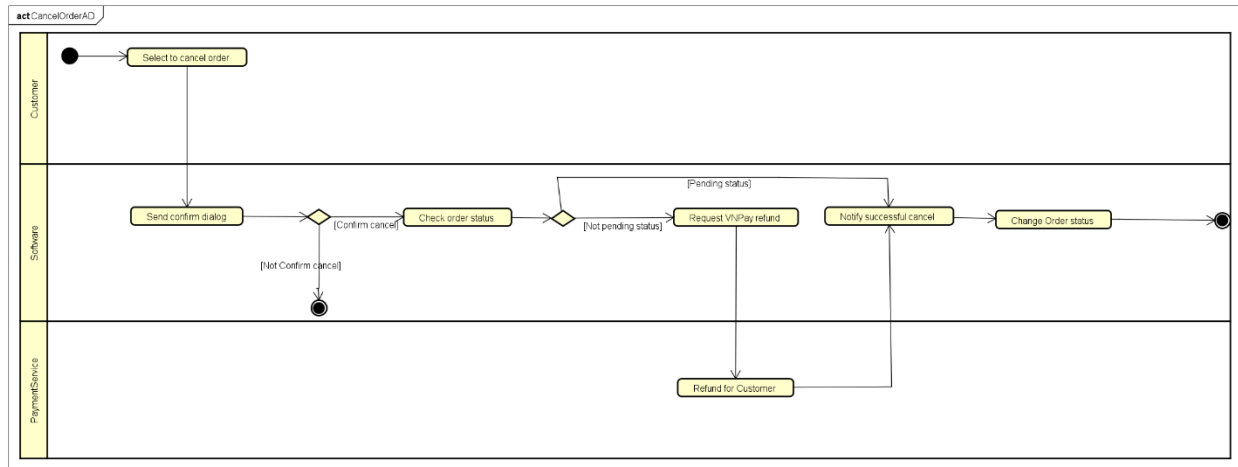


- **Order Lifecycle (Place Order & Cancel Order):**

- **Place Order:** This comprehensive flow involves validating the delivery form, checking cart contents, and verifying product availability. The system calculates delivery fees, creates orders, and updates inventory. If a non-cash payment method is selected, it triggers the "Pay Order" sub-process.



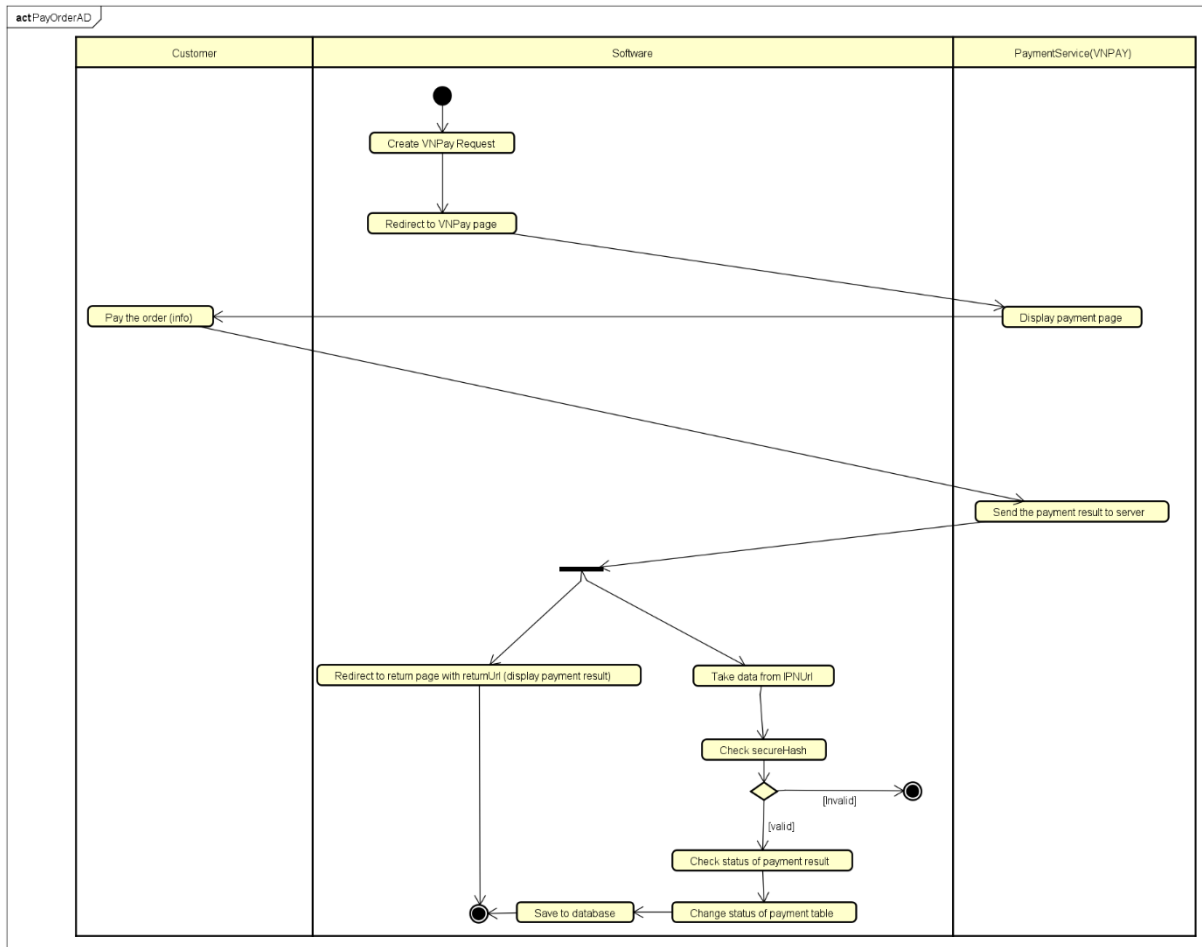
- **Cancel Order:** A customer can request to cancel an order. The software sends a confirmation dialog and checks the current order status. If the order is already paid via VNPAY, the system initiates a refund request through the PaymentService before successfully changing the order status to "Cancelled".



- **Electronic Payment (Pay Order with VNPAY):**

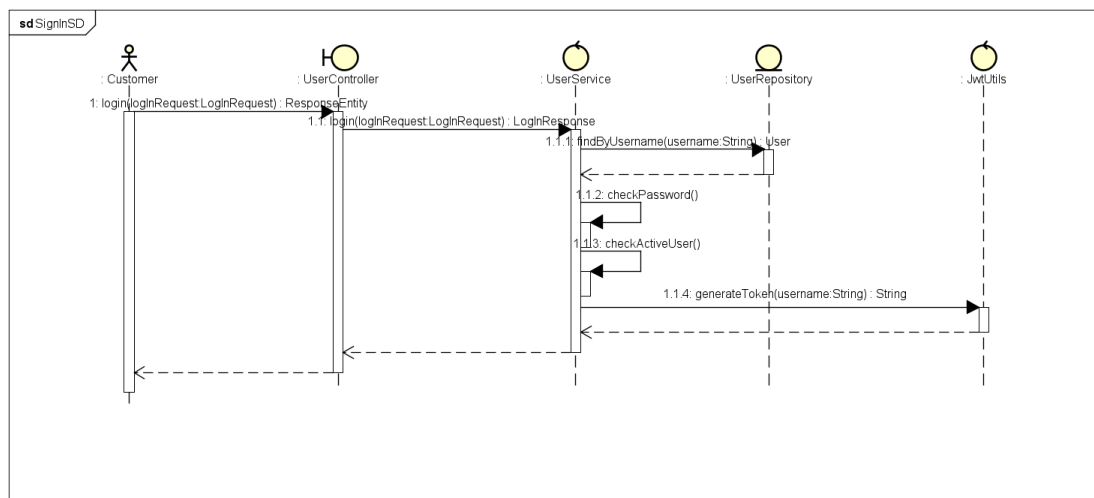
This diagram illustrates the complex interaction between the Customer, Software, and VNPAY PaymentService. After creating a request and redirecting the user to VNPAY, the system handles the response through two parallel paths:

- **User Redirect:** Returns the use
- **IPN Handling:** The software captures data from the IPN URL, performs a secureHash check for security, verifies the payment result status, and updates both the payment and database records to ensure data consistency to the website to display immediate results.

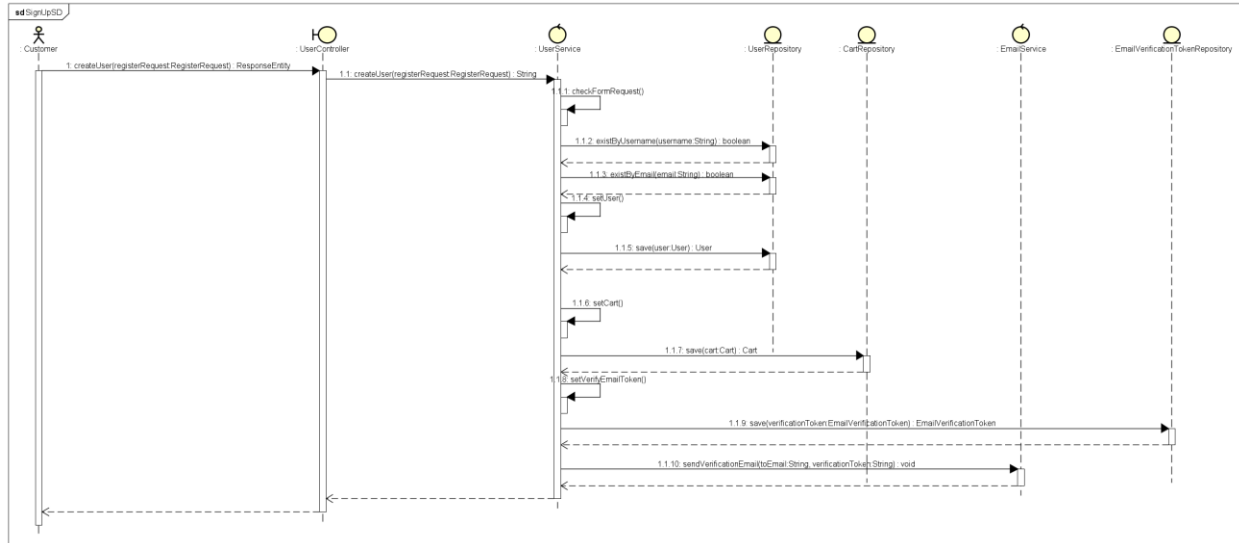


5. Sequence Diagrams

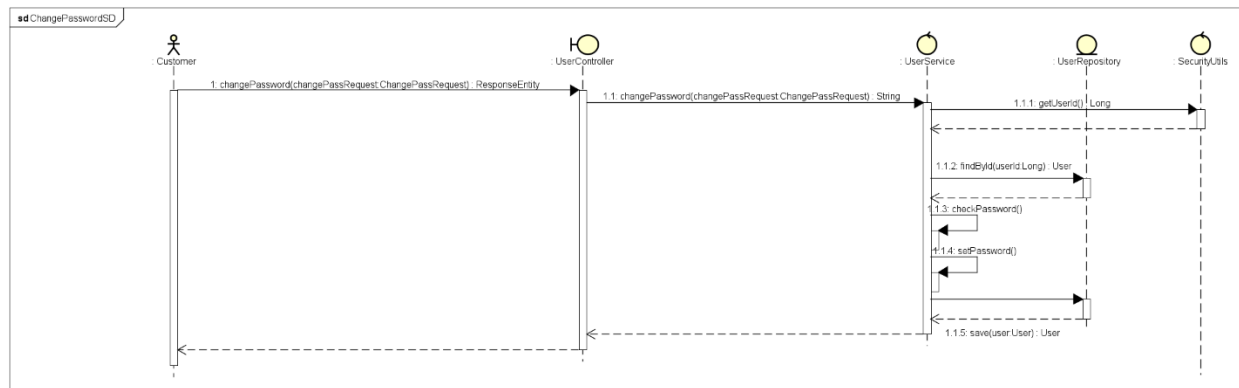
- **Sign In:** UserController → UserService → UserRepository, JwtUtils



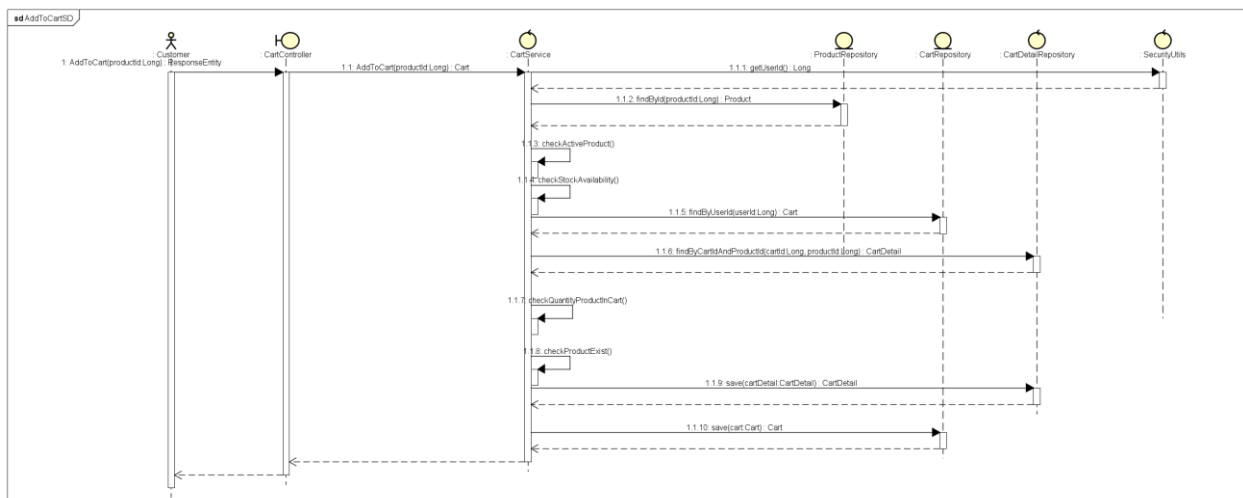
- **Sign Up:** UserController → UserService → UserRepository, CartRepository, EmailService, EmailVerificationTokenRepository.



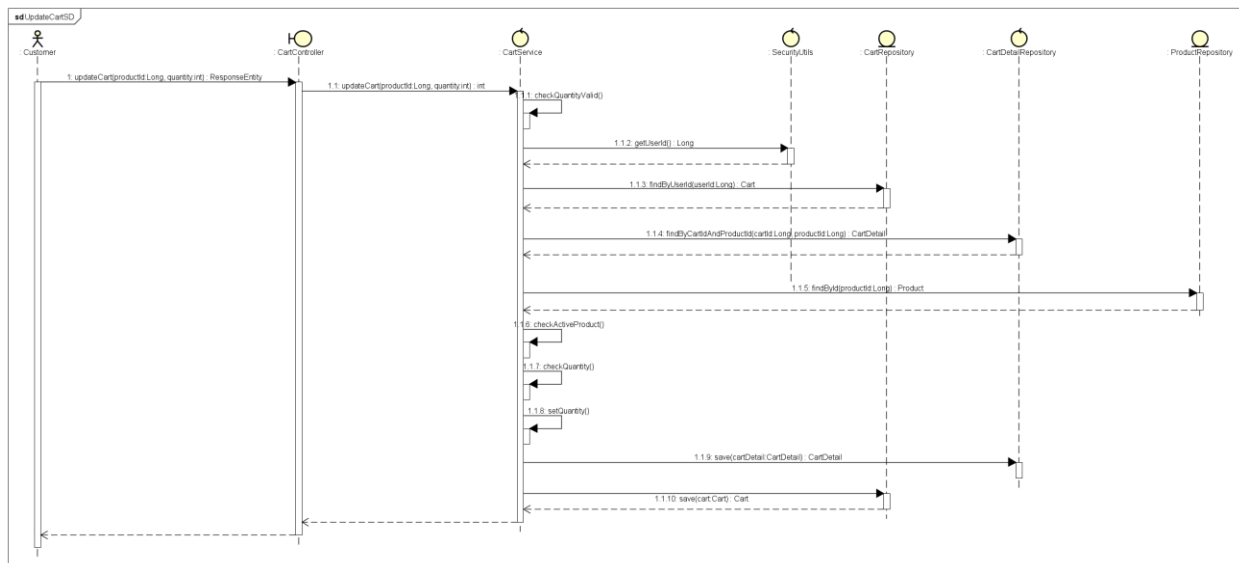
- **Change Password:** UserController → UserService → UserRepository, UserService, SecurityUtils.



- **Add to Cart:** CartController → CartService → ProductRepository, CartRepository, CartDetailRepository, SecurityUtils.



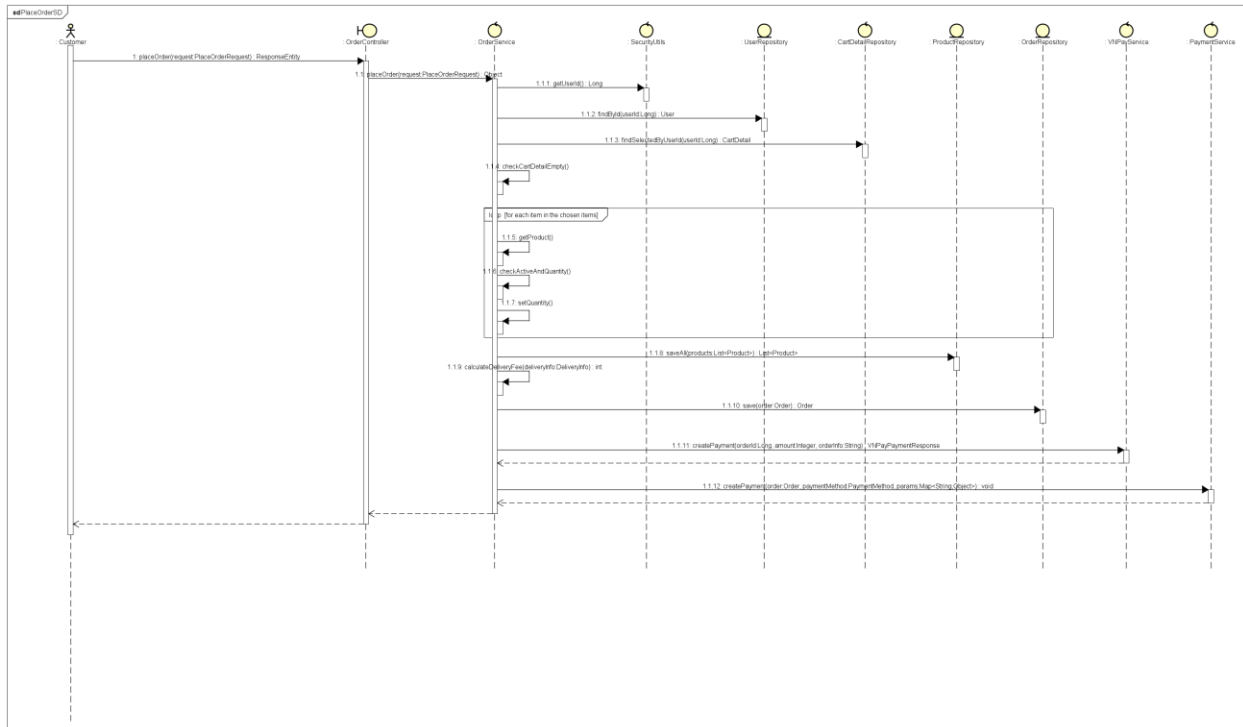
- **Update Cart:** Cart Controller → Cart Service → Security Utils, Cart Repository, Product Repository, CartDetail Repository.



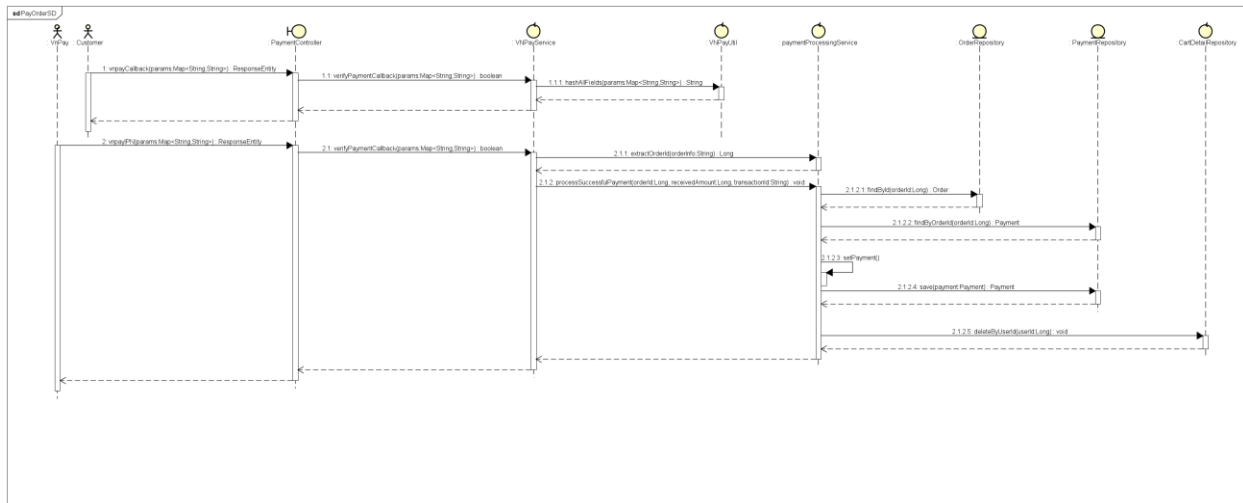
- **Order Cancel:** Order Controller → Order Service → Order Repository, Product Repository, VNPay Service, Payment Repository, Security Utils.



- **Place Order:** OrderController → OrderService → Other Service or Repository.



- **Pay Order:** PaymentController → VNPayService → paymentProcessingService → Other Service or Repository.



6. Class Diagrams

- **AuthTokenFilter.java:** Intercepts requests to validate JWTs before they reach controllers.
- **controller/:** Acts as the main entry point for REST APIs.
- **exception/:** Implements global error handling via `ExceptionHandler` and standardized `ErrorResponse` objects.
- **feature/:**
 - **cart/:** Manages the shopping cart.
 - **email/:** Manages the automated delivery of `EmailVerificationToken` via Google SMTP.
 - **jwt/:** Security utilities including `JwtUtils` (token generation/validation) and `SecurityUtils`.
 - **order/:** Manages the order lifecycle.
 - **payment/:** A complex module for transaction processing.
 - **product/:** Advanced product management.
 - **users/:** Manages user accounts.
- **Frontend Implementation Structure (ReactJS):**

The Frontend is built with React and SASS, following a component-driven architecture:

- **api/:** Abducts Axios calls, sets up the base URL and interceptors.
- **router/:** Manages client-side routing and ensures unauthenticated users cannot access restricted pages.
- **components/:** Reusable UI blocks.
- **styles/:** Global SASS management.
- **verifyemail/:** Handles the UX flow for account activation (`WaitingVerification.js` and `VerifyEmail.js`).
- **pages/:** Management all the pages to display in the web.
- **contexts:** Provides global state.
- **utils/:** Helper functions.

2. Extension Feature

- **Automated Email Verification:** Upon registration, the `EmailService` triggers a verification email. The user is redirected to a `WaitingVerification` page on the frontend until the token is verified via the `verifyemail` page logic.

- **VNPAY Payment Integration and IPN Handling:**
 - **URL Generation:** The VNPayService calculates a secure hash using HmacSHA512 to generate a redirect URL for the customer.
 - **IPN (Instant Payment Notification):** The PaymentController features a /vnpay-ipn endpoint. This allows the backend to receive payment results directly from VNPAY's server, ensuring order status is updated even if the user closes their browser during redirection. The VNpay will send the IPN to Ngrok and Ngrok will forward it to localhost.
- **Schedule to scan payment expired and verify email expired.**

V. Result

1. Home Page & Product Catalog

The Home Page acts as the main landing screen, providing users with immediate access to navigation and product discovery tools. It features a top navigation bar, and a central grid displaying available technology items.

Key Features:

- **Product Grid Display:** Showcases a comprehensive list of products with images, names, and prices.
- **Global Navigation:** A persistent top bar providing quick access.
- **Advanced Filter Sidebar:** Enables users to refine the product list by specific criteria such as Price Range, and technical specifications.
- **Search Bar:** Allows for real-time product lookup by keywords.

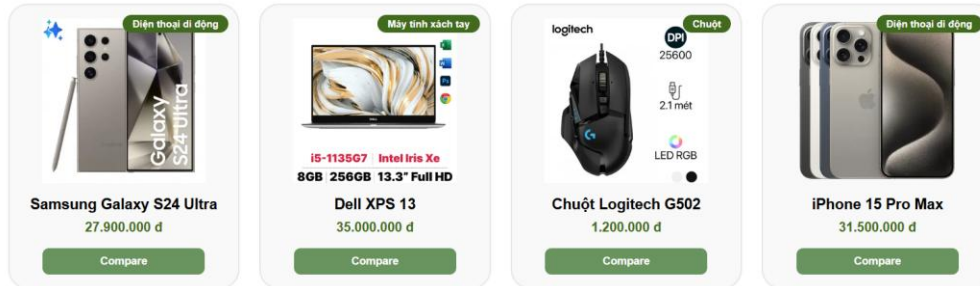
Home Page View:

Product

Search products...

Search

Category: All products



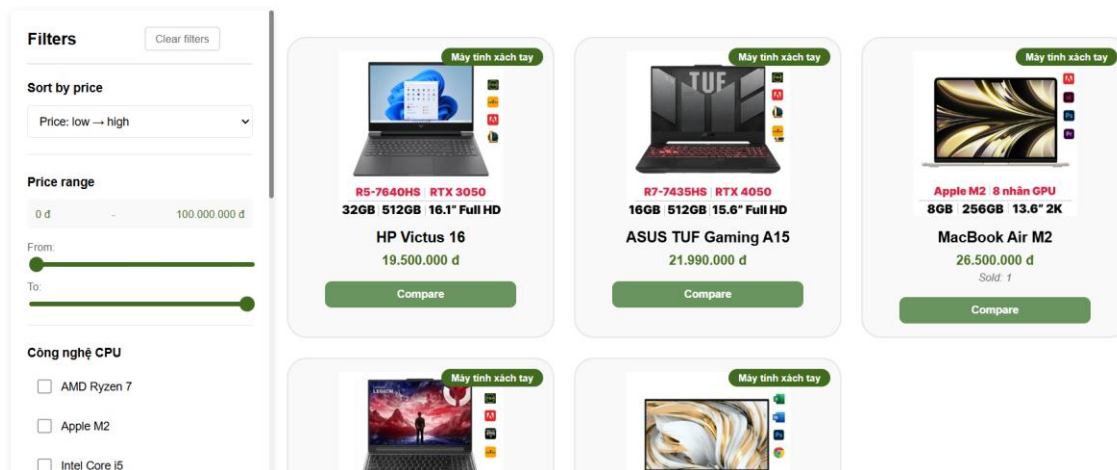
Category-Specific View:

Product

Search products...

Search

Category: Máy tính xách tay



2. Product Detail Page

This page provides a dedicated view for a single product, presenting in-depth information to assist the user's purchase decision.


Key Features:

- **Detailed Specifications:** Displays technical attributes (CPU, RAM, Color) and high-resolution images.

- **Add to Cart Action:** Allows users to select a quantity and add the item to their shopping cart.

Product Detail


← Back



ROG

cafe24

A



R5-7640HS | RTX 3050

32GB | 512GB | 16.1" Full HD

Máy tính xách tay

HP Victus 16

19.500.000 đ

✓ In Stock

Description

Cấu hình mạnh, tản nhiệt tốt

Specifications

Công nghệ CPU	Intel Core i5
Tên đầy đủ CPU	Intel Core i5-13500H
Số nhân/Số luồng	8 nhân / 16 luồng
Card đồ họa (rời)	NVIDIA RTX 4050 6GB
Dung lượng RAM	16 GB
Dung lượng SSD	512 GB
Kích thước màn hình	16.1 inch
Độ phân giải	1920 x 1080
Tần số quét	144 Hz
Trọng lượng	2.31 kg
Hệ điều hành	Windows
Dung lượng Pin	48Wh

Add to Cart

3. Shopping Cart Page

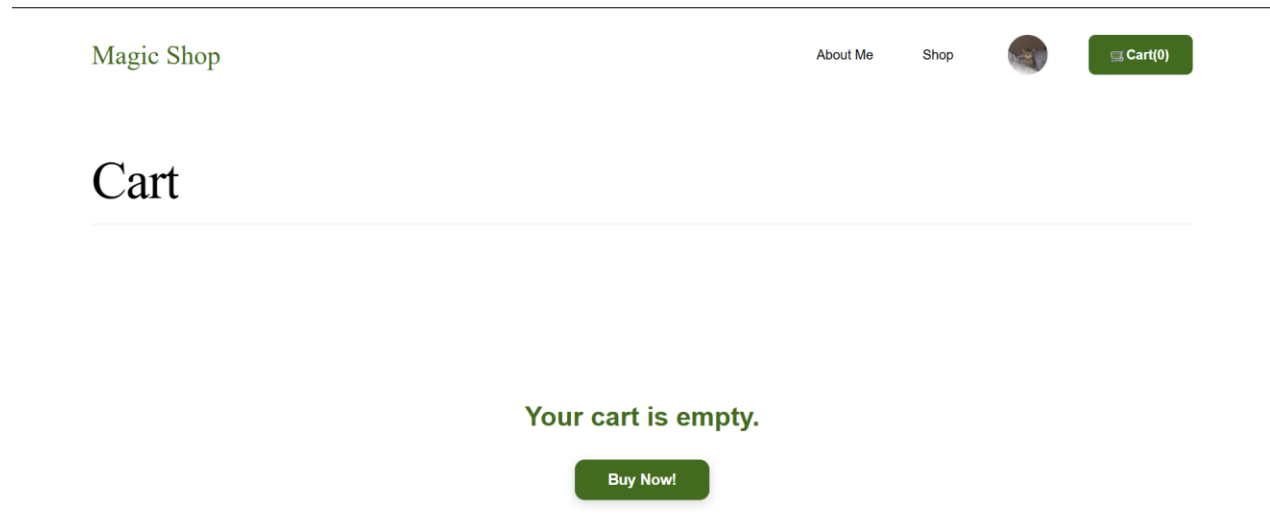
The Cart page displays a tabular summary of all items the user intends to purchase, serving as a review step before checkout.

Key Features:

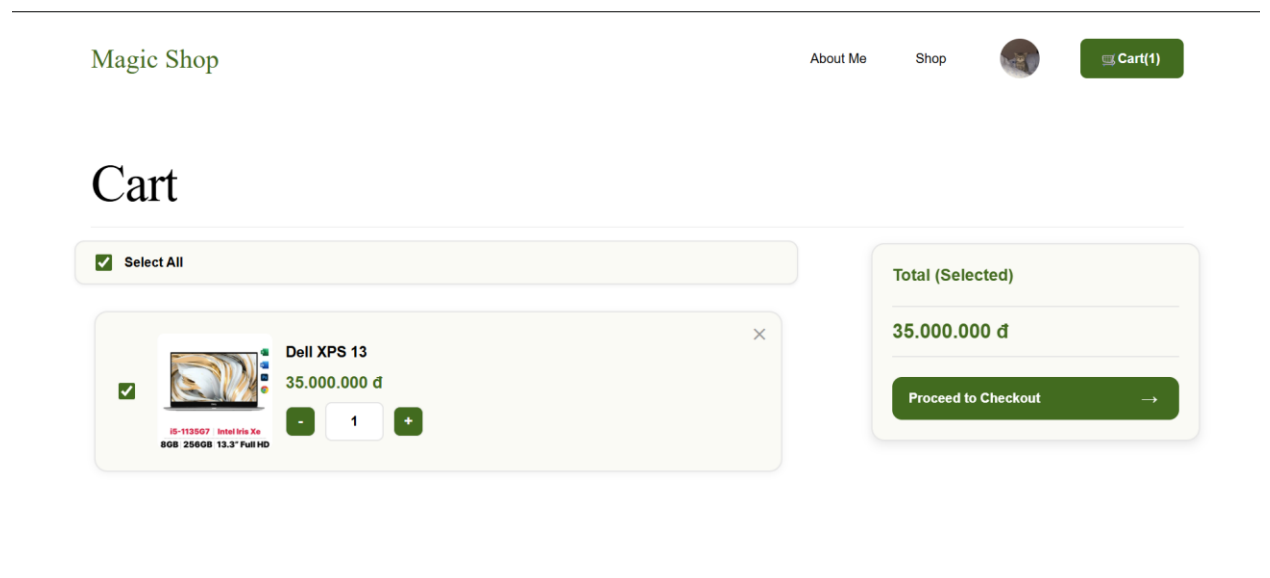
- **Item Management:** Lists selected products with options to adjust quantities or remove items.
- **Total Calculation:** Automatically updates and displays the total provisional price based on current quantities.
- **Empty State:** Shows a visual prompt to "Buy Now" if the cart has no items.

- **Select Product:** User can select the product to buy.

Empty Cart:



Cart Page:



Selected Product:

Cart

☐ Select All

☐ Samsung Galaxy S24 Ultra
27.900.000 đ
- 1 +

☒ Dell XPS 13
35.000.000 đ
IS-113567 Intel Iris Xe
8GB 256GB 13.3" Full HD
- 1 +

Total (Selected)

35.000.000 đ

Proceed to Checkout →

4. Checkout Page

The finalization screen where the user reviews their order and provides necessary fulfillment details.

Key Features:

- **Delivery Information:** Form for entering or confirming the recipient's Name, Phone Number, and Address.
- **Payment Method Selection:** Toggle options to choose between "Cash" and "Card (VNPAY)".
- **Order Summary:** A final overview of products and the total cost including shipping fees.

Place Order

Delivery Information

Full Name: *
Sang Pham


Phone: *
0912345678

Email: *
your.email@example.com

Province: *
-- Select Province --

Address: *
House number, street, ward, district...

Order Summary (1 items)

 Price: 35.000.000 đ
Quantity: 1
Subtotal: 35.000.000 đ

Subtotal: 35.000.000 đ

Delivery Fee: 30.000 đ

Total: 35.030.000 đ

Place Order

Province: *

-- Select Province --


Address: *


House number, street, ward, district...

Note:


Special instructions for delivery...

Payment: *

☒  Cash on Delivery

☐  VNPay

Order Summary (1 items)



Price: 35.000.000 đ
Quantity: 1
Subtotal: 35.000.000 đ

Subtotal:

35.000.000 đ

Delivery Fee:

30.000 đ

Total:

35.030.000 đ

Place Order

5. Login Page

The secure entry point for registered users to access their personal accounts.

Key Features:

- **Credential Entry:** Inputs for Username and Password.
- **Navigation Links:** Quick access options to register a new account or recover a lost password.
- **Error Feedback:** Visual notifications for incorrect credentials.

Login Page:

Magic Shop

About Me

Shop

Login

Cart(2)

Login

Username

Enter your username

Password

Enter your password

Submit

Don't have an account? [Sign up here](#)

Login Page invalid display:

The screenshot shows the Magic Shop website header with the logo and navigation links: About Me, Shop, Login, and a Cart(2) button. The main content area features a white login form with the title "Login" and a red error message "Invalid username or password". The form contains two input fields: "Username" with the value "a" and "Password" with a masked character. A green "Submit" button is at the bottom of the form, and a link "Don't have an account? [Sign up here](#)" is below it.

6. Register Page

The sign-up interface allows new visitors to create an account on the platform.

Key Features:

- **Information Collection:** Fields for Username, Email, and Password setup.
- **Password Confirmation:** Requires re-entering the password to prevent typing errors.
- **Submission Control:** Prevents submission if required fields are empty or invalid.
- **Verification via Email:** User need to verify email to register account.

Register Page:

The screenshot shows the Magic Shop website header with the logo and navigation links: About Me, Shop, Login, and a Cart(2) button. The main content area features a white register form with the title "Register". The form contains five input fields: "Username" (placeholder: Enter your username), "Full Name" (placeholder: Enter your full name), "Email" (placeholder: Enter your email), "Phone" (placeholder: Enter your phone number), and "Password" (placeholder: Enter your password).

register

Username
Enter your username

Full Name
Enter your full name

Email
Enter your email

Phone
Enter your phone number

Password
Enter your password

Confirm Password
Confirm your password

Register

Register Page Invalid display:

Register

Username
ttiffX

Full Name
Sang Phạm

Email
sangpham1224@gmail.com

Phone
033434343
Invalid phone number

Password

Password must be at least 8 characters

Confirm Password

Passwords do not match

Register

Verification Email Notice:

Xác Thực Email

Một email xác thực đã được gửi đến sangpham1224@gmail.com
Vui lòng kiểm tra hộp thư của bạn và nhấp vào liên kết xác thực để kích hoạt tài khoản.

1
Kiểm tra email
Mở hộp thư của bạn

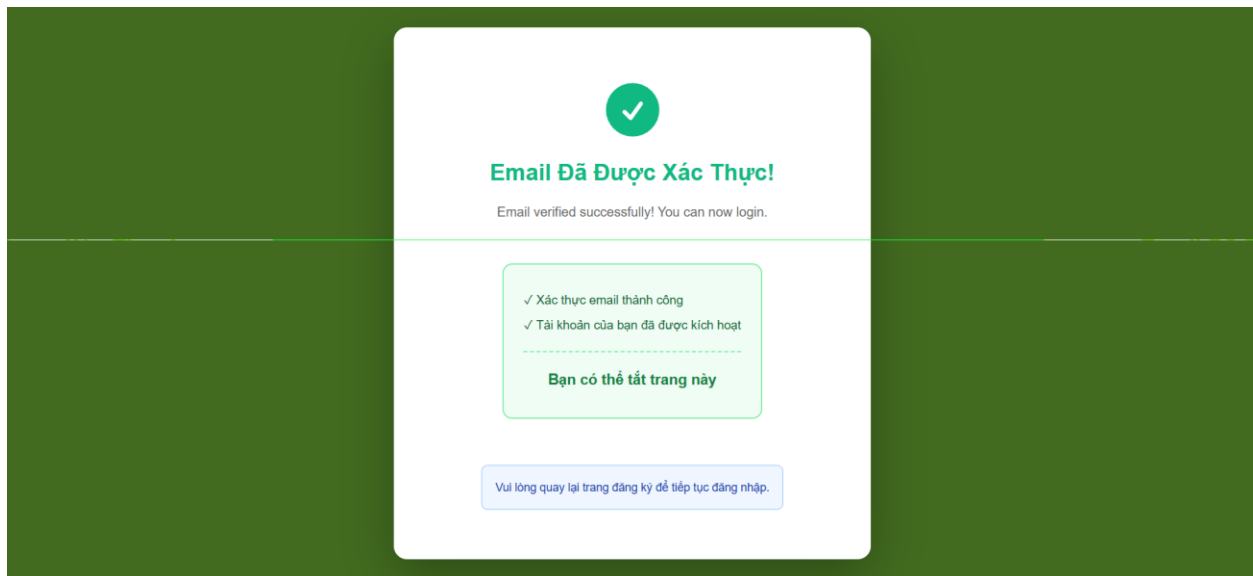
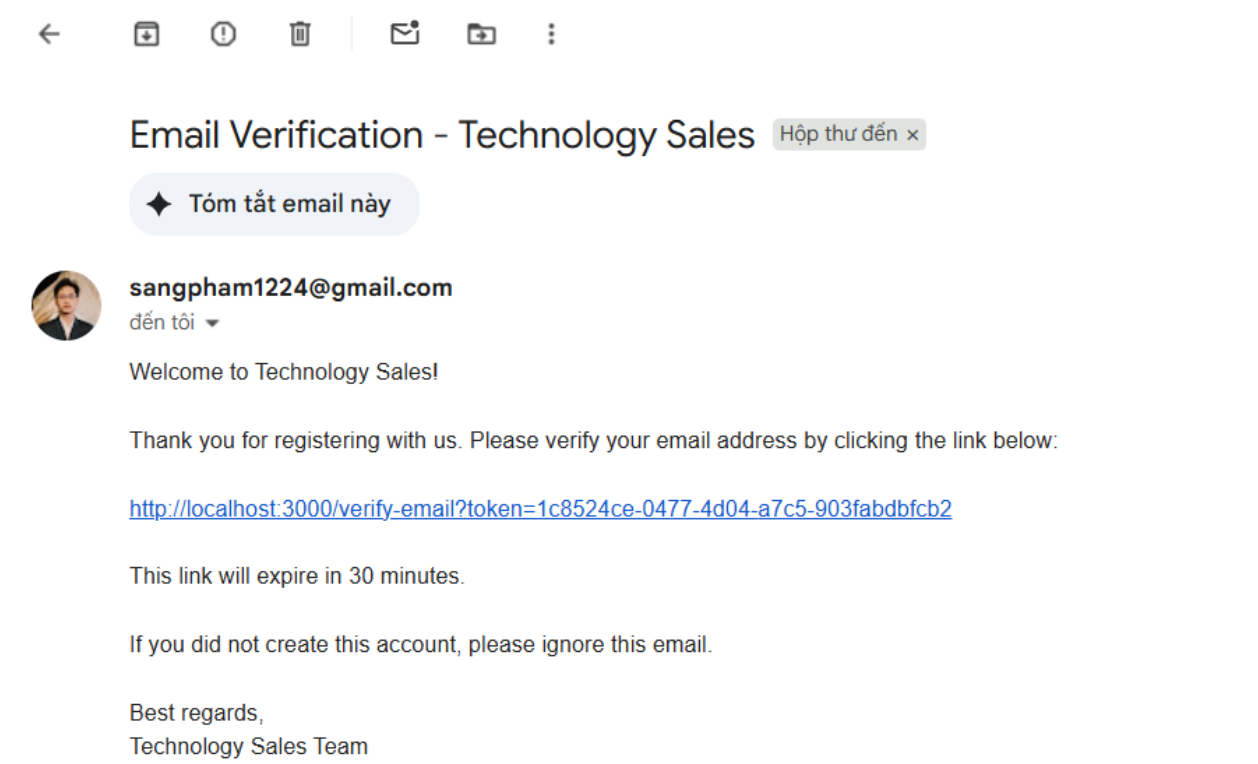
2
Click vào link
Nhấp vào liên kết xác thực

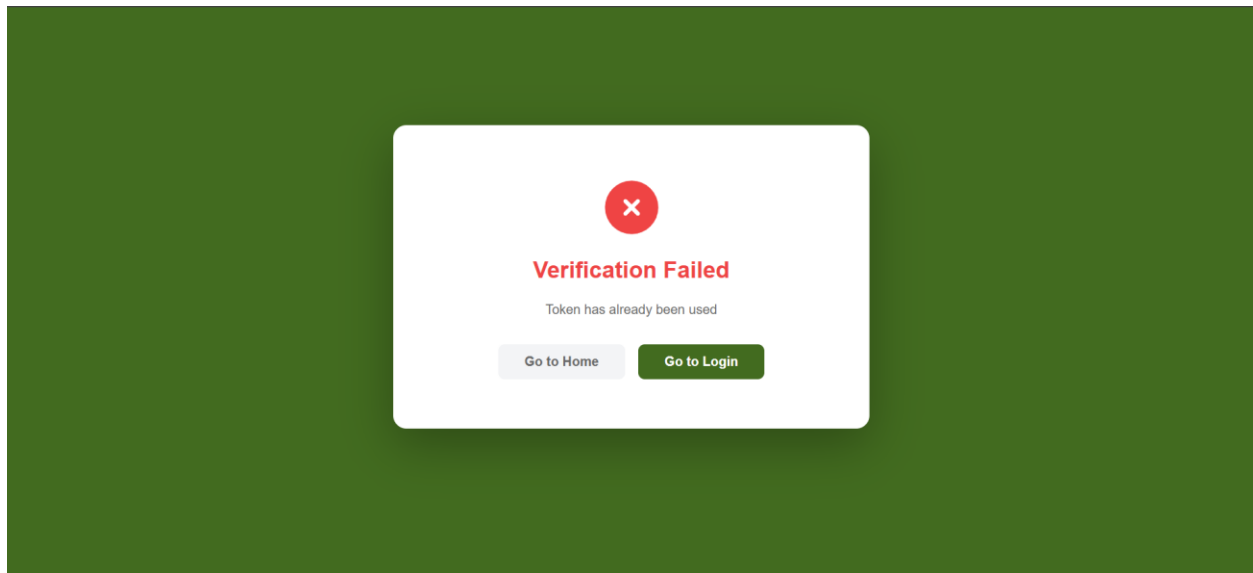
3
Hoàn tất
Quay lại để đăng nhập

Đã xác thực? Đăng nhập ngay

Sau khi xác thực email, bạn có thể đăng nhập vào hệ thống

Verification Email:





7. Order History Page

A dashboard allowing customers to track and review their past purchase activities.

Key Features:

- **Order List:** Displays a chronological list of orders with Date, Order ID, Total Price, Order Status, Payment Status and action buttons.
- **Status Filter:** Filter by status of orders.
- **View Details:** Interaction to open a modal viewing specific items within an order.
- **Cancel Order:** Cancel order with refund.

Order History

All OrdersPendingPreparingShippingDeliveredCancelledRejected

Order #1
21:24 29/01/2026

Order Status: PENDINGPayment Status: PENDING

Customer: Sang Pham

Phone: 0334343434

Email: tranthib@example.com

Address: Sevin Office 609 Trương Định, Bình Thuận

Delivery Fee: 30.000 đ

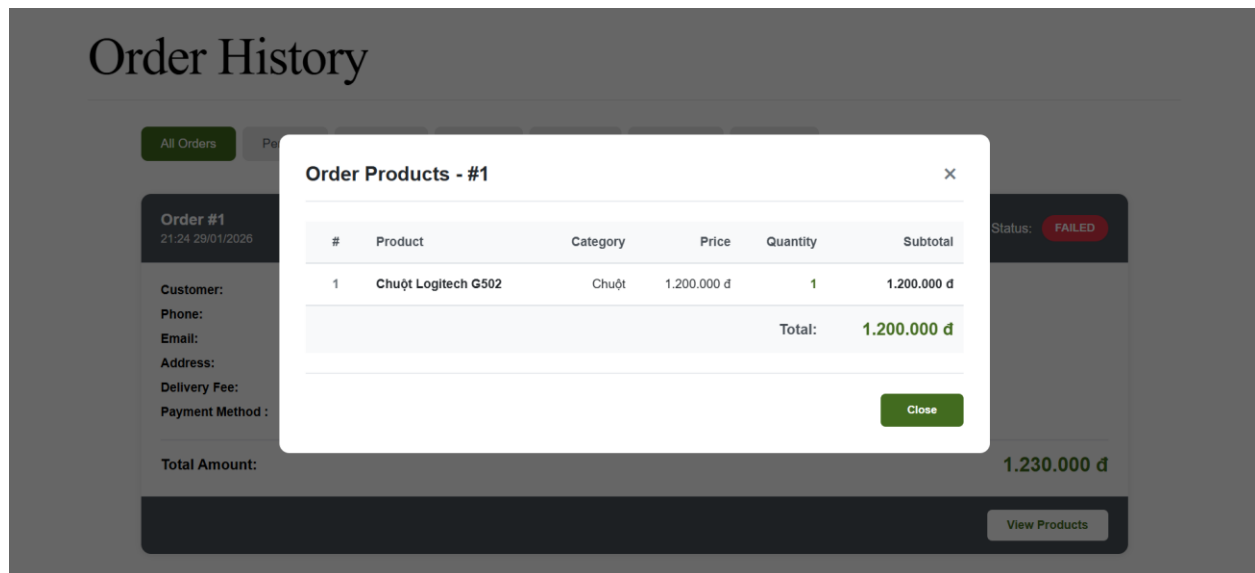
Payment Method : CASH

Total Amount:

1.230.000 đ

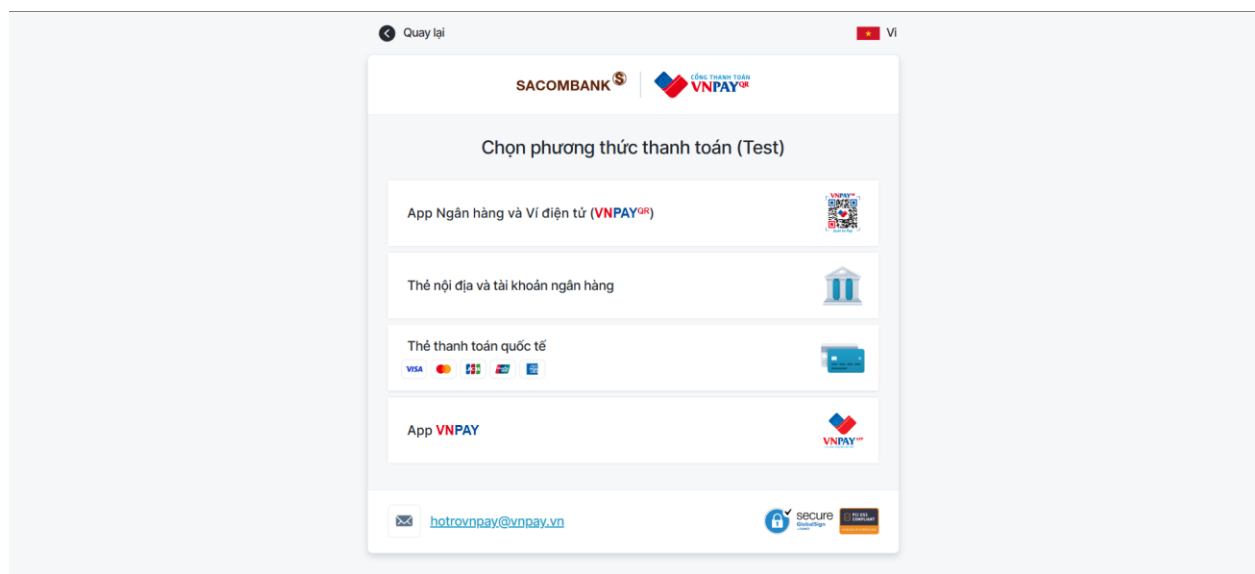
View Products

Cancel Order



8. VNPAY Gateway (Sandbox)

The external secure interface where electronic payment transactions take place.



SACOMBANK

CÔNG NGỆ THƯƠNG MẠI
VNPay

Giao dịch hết hạn sau 00 : 14

Thông tin đơn hàng (Test)

Số tiền thanh toán

19.530.000VND

Giá trị đơn hàng

19.530.000VND

Phí giao dịch

0VND

Mã đơn hàng

01935336

Nhà cung cấp

<https://vnshop.vn/>

Xác thực OTP

Nhập mã OTP

NCB

OTP đã được gửi về số điện thoại đăng ký. Quý khách vui lòng nhập OTP để tiếp tục thực hiện giao dịch.

HủyThanh toán

hovtrovnpay@vnpay.vn

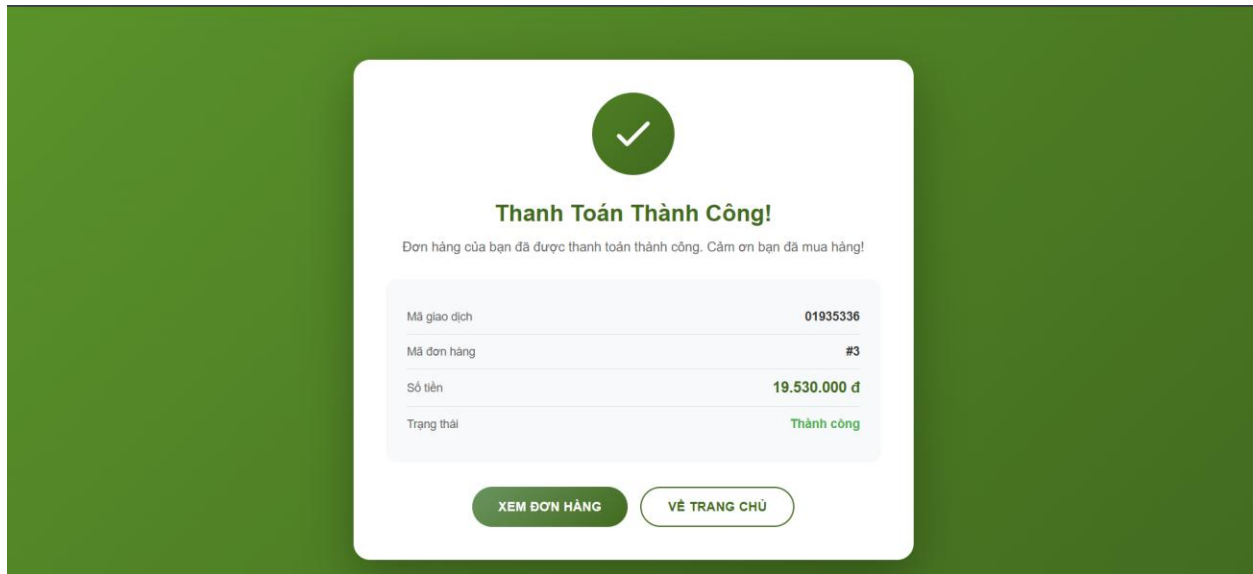
Secure

Payment

Secure

Payment

A screenshot of a payment failure modal. At the top center is a red circle with a white 'X'. Below it, the text 'Thanh Toán Thất Bại!' is displayed in bold red font. Underneath, a smaller line of text reads 'Giao dịch thất bại. Vui lòng thử lại sau.' Below this is a light gray rectangular box containing a table. The table has two rows: the first row has 'Trạng thái' on the left and 'Thất bại' on the right; the second row has 'Mã lỗi' on the left and '15' on the right. At the bottom of the modal are two green buttons with white text: 'THỬ LẠI' and 'VỀ TRANG CHỦ'.



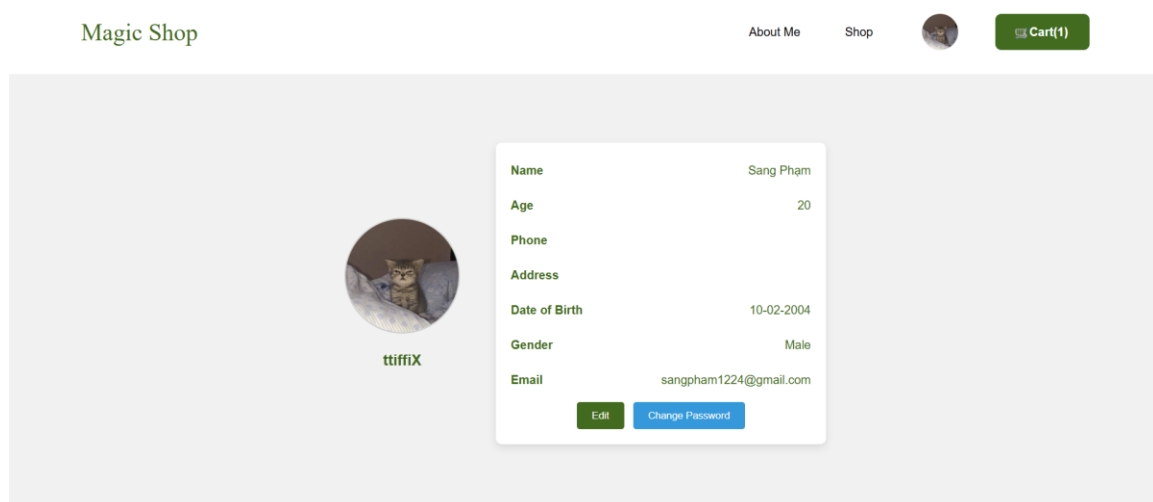
9. User Profile Page

A personal management screen where users can view and update their account information.

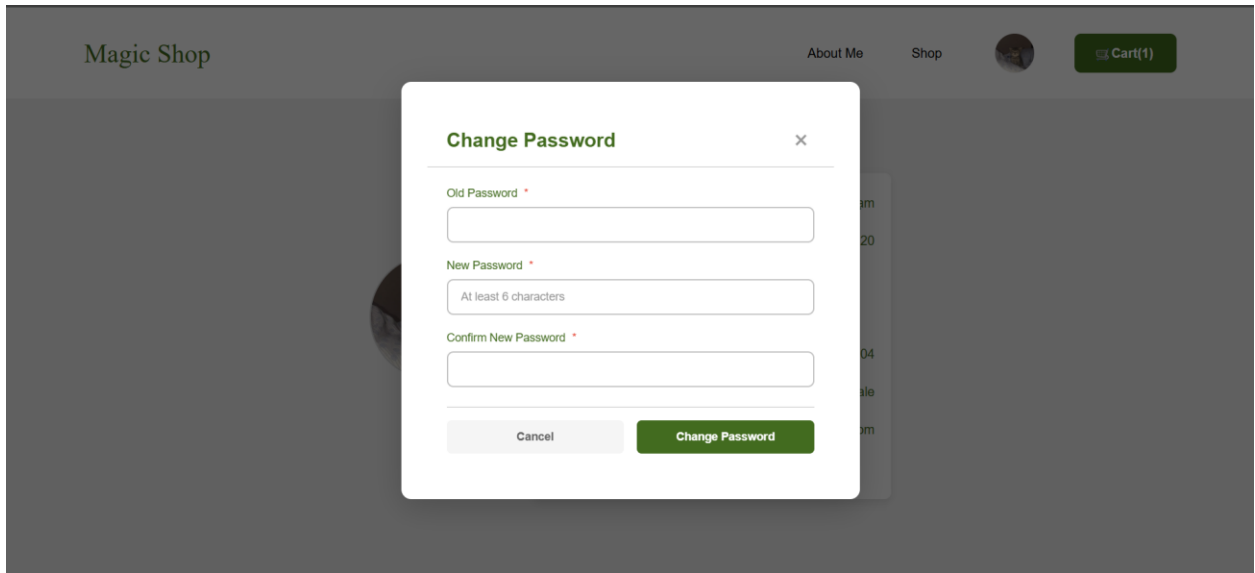
Key Features:

- **Profile Information:** Displays editable fields for Name, Phone, Address, and Date of Birth.
- **Security Settings:** Option to open a "Change Password" modal to update login credentials.
- **Read-Only Fields:** Displays the Username and Email as fixed identifiers.

User Profile Page:



Change Password Modal:



VI. Discursion

1. Limitations and Missing Features

While the core e-commerce engine is functional, several sophisticated features remain in the development backlog to be addressed in future iterations.

- **Customer Experience Gaps:**

- **Automated Refund Integration:** Although the payment flow via VNPAY is successful, the automated refund mechanism for cancelled orders has not been fully realized. Currently, transactions require manual intervention for reversals.
- **Profile Data Synchronization:** The User Profile interface is active. However, a complete bi-directional data bind between the frontend forms and the backend persistence layer is still being finalized.
- **Credential Recovery:** The "Forgot Password" workflow, involving temporary password generation and secure email dispatch, is designed but has not yet been integrated into the live production environment.

- **Administrative & Management Modules:**

- **Administrative Governance:** The dedicated interface for **Admin** users to manage system configurations, user roles, and security audits is currently under development.

- **Product & Inventory Management:** The **Product Manager (PM)** dashboard, intended for catalog maintenance and inventory tracking, remains to be implemented to provide a complete end-to-end business solution.

2. Experiment Gains

The project served as a rigorous practical experiment in full-stack engineering, yielding significant professional and technical growth:

- **Advanced Architecture Mastery:** Gained hands-on experience in implementing a **Feature-based Packaging** architecture in Spring Boot, significantly improving code modularity compared to traditional layered approaches.
- **Third-party Integration Proficiency:** Successfully navigated the complexities of financial integration by implementing **VNPAY**, including secure hash algorithms and the mission-critical **IPN (Instant Payment Notification)** mechanism to ensure data consistency.
- **Security & Authentication Flow:** Developed a deep understanding of stateless security using **JWT (JSON Web Tokens)** and multi-step verification via **Google SMTP**, enhancing the system's defensive posture.
- **Dynamic Data Modeling:** Mastered the **Entity-Attribute-Value (EAV)** model to support diverse technical specifications for technology products without requiring frequent database schema migrations.

VII. Conclusion

The development of the Technology Sales Website represents a successful transition from theoretical system design to a functional, full-stack application.

The project successfully achieved its primary objective: building a high-performance e-commerce platform that handles real-time product discovery, secure cart management, and electronic payments. By utilizing Java 22 and Spring Boot 3.4, the system benefits from the latest advancements in backend performance and security. The frontend, powered by ReactJS, provides a dynamic and intuitive user experience that meets modern web standards.

Despite the identified limitations in the administrative modules and advanced customer features, the core infrastructure is robust and scalable. The lessons learned regarding IPN handling, EAV modeling, and Stateless Security provide a solid foundation for future professional development.

In conclusion, the product is not merely a shopping tool but a comprehensive technical experiment that demonstrates the power of integrating modern frameworks with secure third-party financial services to solve real-world e-commerce challenges.