Supermarket Management System

The **Advanced Supermarket Management System** simulates real-world operations of a supermarket, incorporating dynamic inventory and customer management. The project effectively utilizes **linked lists**, **queues**, **stacks**, and **binary search trees** to handle a variety of functionalities, making it a robust, feature-rich application. With modules for inventory management, customer cart operations, order processing, and analytics, the system ensures efficient and user-friendly operations for both administrators and customers.

Features

1. **Inventory Management**
   - **Purpose**: Enable administrators to manage product inventory dynamically.
   - **Core Functionality**:
     - **Add, Update, and Remove Products**: Manage products using a linked list for dynamic memory allocation and traversal.
     - **Categorize Products**: Organize products in a **Binary Search Tree (BST)**, enabling fast searches and hierarchical browsing.
     - **Search Products**: Find products by name or category using the BST.
     - **Generate Inventory Reports**: Display products sorted by name or category. Provide low-stock alerts using a **priority queue** for items with stock below a threshold.
2. **Customer Shopping Cart**
   - **Purpose**: Provide a dynamic and intuitive shopping experience for customers.
   - **Core Functionality**:
     - **Add Items to Cart**: Use a linked list to store cart items dynamically.
     - **Undo Last Operation**: Implement undo functionality with a stack, allowing customers to revert their last action (e.g., adding or removing an item).
     - **Update Quantities**: Adjust the quantity of an existing item in the cart.
     - **Cart Summary**: Calculate the total price dynamically, including applicable taxes.
3. **Checkout and Order Management**
   - **Purpose**: Simplify customer checkout and streamline order processing.
   - **Core Functionality**:
     - **Checkout**: Generate an itemized bill with taxes and discounts.
     - **Place Orders**: Add completed customer orders to the order queue for admin processing.
     - **Order Fulfillment**: Admin processes orders in a **First-In-First-Out (FIFO)** manner using a queue.
     - **Track Pending Orders**: Display all pending orders, showing estimated processing times.

4. **Analytics and Reporting**
   - o **Purpose**: Provide insights into supermarket operations and customer behavior.
   - o **Core Functionality**:
     - ▪ **Sales Reports**: Generate reports showing the most popular products and categories.
     - ▪ **Customer Behavior**: Track customer spending patterns and generate loyalty insights.
     - ▪ **Inventory Alerts**: Highlight products that are low in stock using a priority queue.
     - ▪ **System Logs**: Maintain a stack of system operations (e.g., inventory updates, order processing) for audit and debugging.
5. **Promotions and Discounts**
   - o **Purpose**: Attract customers with dynamic pricing and promotions.
   - o **Core Functionality**:
     - ▪ **Dynamic Pricing**: Adjust product prices based on demand using a priority queue.
     - ▪ **Seasonal Discounts**: Apply discounts to products in specific categories, stored in the BST.
     - ▪ **Promotional Codes**: Allow customers to enter promotional codes during checkout for additional savings.
6. **Loyalty Program**
   - o **Purpose**: Encourage repeat customers with rewards and exclusive benefits.
   - o **Core Functionality**:
     - ▪ **Customer Profiles**: Store customer profiles in a linked list or hash table.
     - ▪ **Reward Points**: Track reward points based on purchase history.
     - ▪ **Exclusive Offers**: Provide loyalty members with exclusive discounts or early access to promotions.

Bonus:

Advanced Search and Categorization
   - o **Purpose**: Enhance product discoverability with efficient search and organization.
   - o **Core Functionality**:
     - ▪ **Fast Search**: Use a **trie** data structure for faster autocomplete functionality when searching for product names.
     - ▪ **Hierarchical Categorization**: Organize categories as a tree, allowing users to navigate products by parent-child relationships.

Workflow

Admin Workflow

- Log in using an admin password.

- Manage inventory by adding, updating, or deleting products.
- Process orders from the customer order queue.
- View sales and inventory analytics.
- Apply dynamic pricing or promotions to products.

Customer Workflow

- Browse products by category or search by name.
- Add items to the cart and review the cart contents.
- Adjust quantities or undo the last action.
- Proceed to checkout and place the order.
- Receive a detailed bill with itemized costs and discounts applied.

Data Structures and Their Roles

1. **Linked List**:
   - **Inventory and Cart Management**: Dynamically add, remove, and traverse products or cart items.
2. **Queue**:
   - **Order Processing**: Manage customer orders in a FIFO manner.
   - **Customer Service**: Handle customer queries in real time.
3. **Stack**:
   - **Undo Functionality**: Revert the last operation for both admin and customers.
   - **System Logs**: Track system operations for debugging and audits.
4. **Binary Search Tree (BST)**:
   - **Product Categorization**: Organize and retrieve products by name or category efficiently.
5. **Priority Queue**:
   - **Dynamic Pricing**: Adjust prices based on demand or stock levels.
   - **Inventory Alerts**: Highlight low-stock products.

Collaboration and Teamwork

Module Assignments:

- **Inventory and Categorization**: Manage inventory using linked lists and BST.
- **Cart and Checkout**: Develop cart operations with linked lists and integrate stack-based undo functionality.
- **Order and Customer Service**: Implement queue-based order and customer service management.

- **Analytics and Promotions**: Build sales reports, loyalty programs, and dynamic pricing using priority queues.