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Automated Smart Shopping Cart

Software Systems Architecture

Group 4 - Class 3

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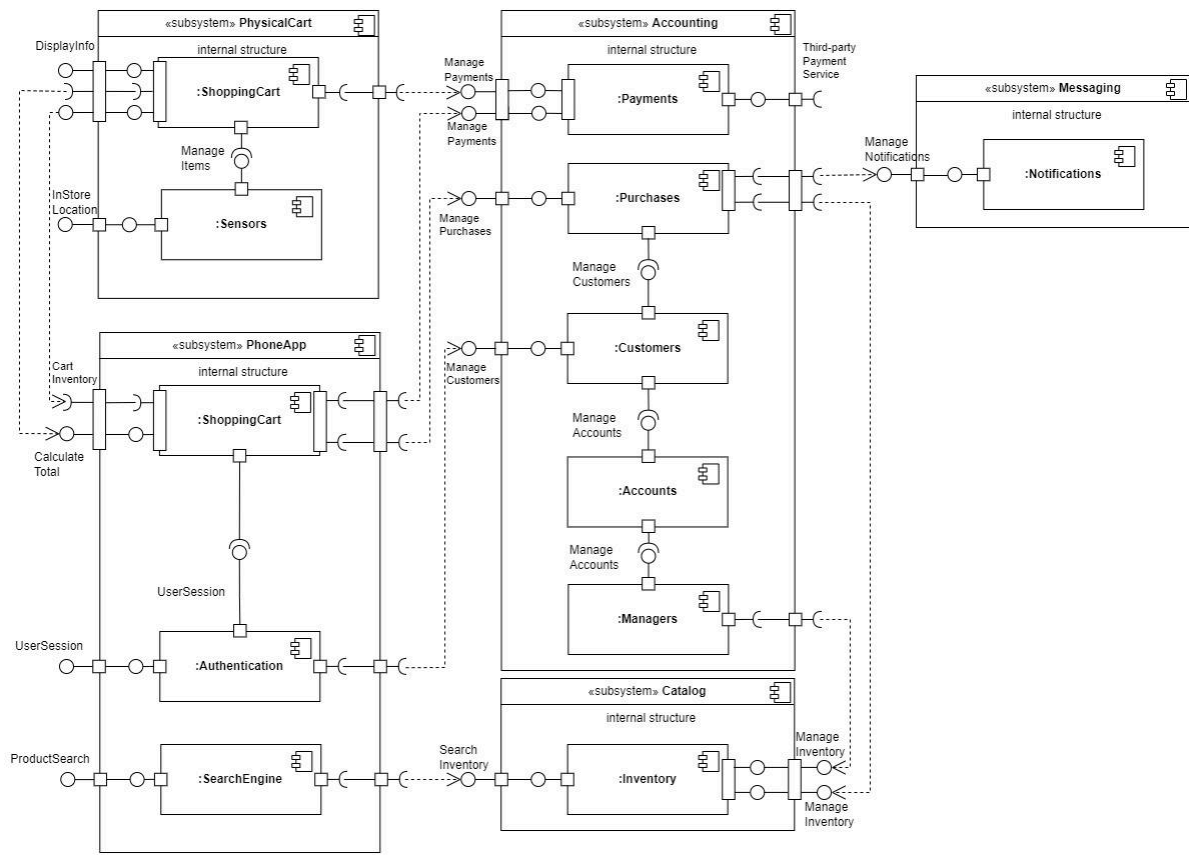# Index

Logical View

Figure 1 - Logical View

The Smart Shopping System architecture is meticulously crafted to revolutionize the shopping experience by seamlessly integrating digital and physical elements while ensuring security and convenience. The logical view (Figure 1) illustrates various subsystems ("Cart" "App", "Accounting", "Catalog" and "Messaging") that collectively orchestrate the system's operations.

The "Cart" subsystem embodies the hardware components equipped within the shopping cart, including sensors to detect added or removed items, a display unit showcasing the running total, and a slot for secure payment transactions. Additionally, communication with nearby devices is integrated into the cart to detect the nearest customer, typically identified by their smartphone with the accompanying app installed, within a specified range. This feature enables seamless linkage between the cart and the customer, facilitating personalized interactions and ensuring accurate billing and membership benefits application. The inclusion of proximity sensors enhances the system's efficiency and user experience, allowing for effortless cart association and streamlined shopping journeys. Moreover, the subsystem encompasses the exit detector mechanism, through in-store location, to ensure proper validation upon leaving the store, further enhancing security and transaction integrity.

The "App" subsystem serves as the digital counterpart, facilitating user interactions and enhancing convenience. It enables customers to view the cart's contents in real time, receive notifications, and confirm purchases securely through methods such as PIN authentication.

Additionally, it integrates features like item lookup and membership benefits, providing a comprehensive shopping experience.

The "Accounting" subsystem manages financial transactions, allowing customers to pay using their preferred methods such as credit/debit cards or digital platforms like Venmo. It ensures accurate billing and seamless integration with the store's pricing, discounts, and sales mechanisms.

The "Catalog" subsystem plays a crucial role in item management, providing access to real-time inventory data and enabling efficient item location within the store. Whether through menu selection or item name input, it empowers users to locate products swiftly, enhancing overall shopping efficiency. In addition to managing inventory, it facilitates comprehensive control over the store's pricing and catalog management.

Lastly, the "Messaging" subsystem facilitates communication between the system and users, notifying them of completed transactions, discounts, and other relevant updates. It ensures timely and relevant information delivery, enhancing customer engagement and satisfaction.

This component-driven architecture embodies innovation in retail technology, offering a harmonious blend of physical and digital elements to redefine the shopping experience. By segregating functionalities into distinct subsystems, the system promotes scalability, maintainability, and fault tolerance, laying the foundation for future enhancements and integrations with inventory management systems.

Process View

Both sequence diagrams demonstrate the core functionalities of the Automated Smart Shopping Cart system, providing insights into the interactions between various components during key user scenarios.
These diagrams help stakeholders understand the system's behavior and facilitate discussions around system design, implementation, and testing.
By visualizing the sequence of events, stakeholders can identify potential bottlenecks, edge cases, and areas for optimization, ultimately contributing to the development of a robust and user-friendly shopping experience.
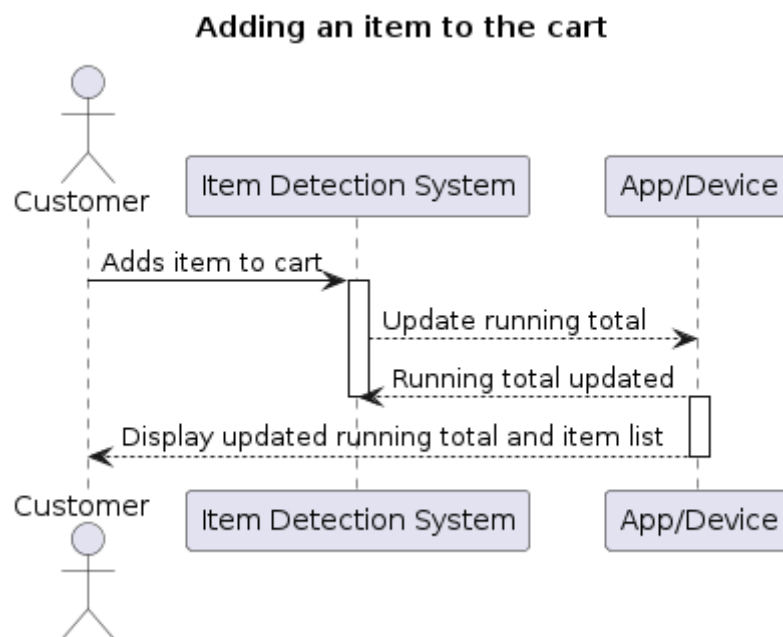
Adding an item to the cart

Figure 2.1 - Process View

Adding an item to the cart:

The sequence diagram "Adding an item to the cart" illustrates the interaction between the Customer, Item Detection System (IDS), and Cart Interface (CI) components. The sequence begins with the Customer adding an item to the cart. The Item Detection System detects this action and sends a message to the Cart Interface to update the running total and item list. Once updated, the Cart Interface sends a response back to the Customer, displaying the updated running total and item list. This sequence ensures that customers receive real-time feedback on their cart contents as they add items during their shopping experience.
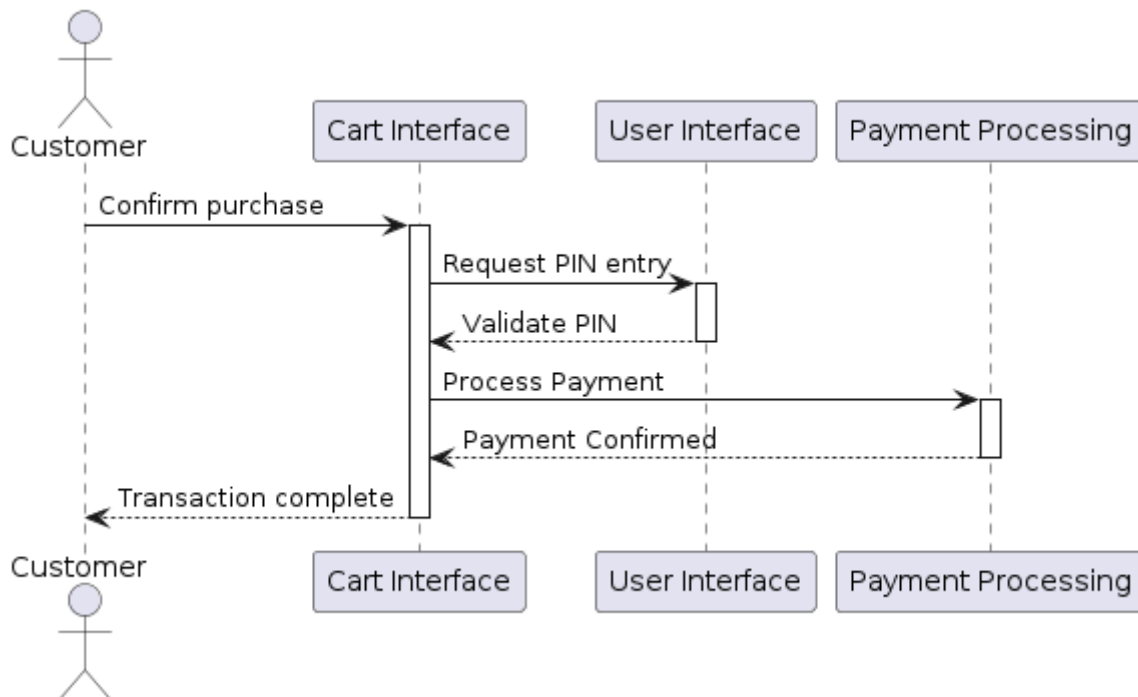
Figure 2.2 - Process View

Walking out of the store (checkout):

The sequence diagram "Walking out of the store (checkout)" depicts the checkout process within the Automated Smart Shopping Cart system. The Customer initiates the checkout by confirming the purchase through the Cart Interface. The Cart Interface then interacts with the User Interface (UI) component to request PIN entry from the Customer for authentication purposes. Upon successful validation of the PIN, the Cart Interface proceeds to Payment Processing to process the payment transaction. Once the payment is confirmed, the Cart Interface notifies the Customer of the transaction completion. This sequence ensures a seamless and secure checkout experience for customers, incorporating user authentication and payment processing functionalities.
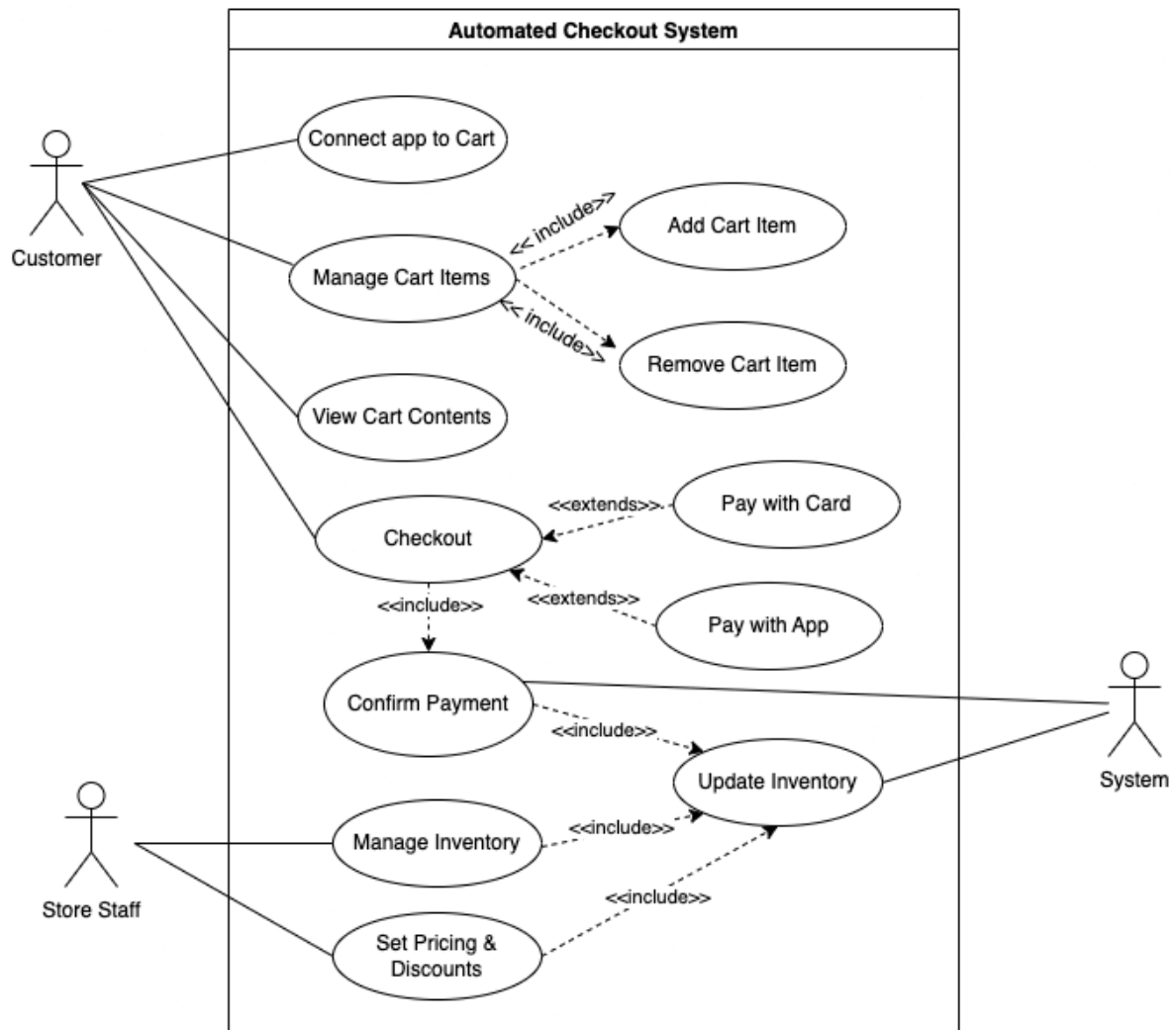
Use-Case View

Figure 3 - Use Case View

The use-case diagram on Figure 3 focuses on the interactions between Customers, Store Staff, and the System within an Automated Smart Shopping Cart environment. Here's a detailed breakdown of the functionality of the system:

Actors

- Customer: Shoppers using the Automated Smart Shopping Cart system for their purchases.
- Store Staff: Employees or managers responsible for inventory management and pricing within the store.
- System: The automated system managing inventory updates and payment confirmations.

Use Cases

Customer Interactions

- Connect App to Cart:
  - The customer initiates a connection between their mobile app and the smart shopping cart to sync their shopping session.
- Manage Cart Items:
  - The customer can add or remove items from their cart. This use case includes two sub-functions:
    - Add Cart Item: Items are added to the cart, and the cart's content list and total are updated accordingly.
    - Remove Cart Item: Items are removed from the cart, with updates reflected in the cart's content list and total.
- View Cart Contents:
  - Customers can view a list of items currently in their cart along with the total price, either on their mobile app or the cart's display.
- Checkout:
  - This is the process of finalizing the purchase, which extends to two payment methods:
    - Pay with Card: Customers can choose to pay using a debit or credit card.
    - Pay with App: Alternatively, payment can be made directly through the app. This use case includes confirming the payment.
  - Confirm Payment: A critical step where the customer confirms the payment for the items. This action triggers the "Update Inventory" use case, handled by the system to reflect the purchase in the store's inventory.

Store Staff Interactions

- Manage Inventory:
  - Store staff oversee the inventory levels, which includes updating the inventory to reflect current stock levels.
- Set Pricing & Discounts:
  - This involves adjusting prices and setting up discounts for various items, which also requires updates to the inventory to reflect these changes accurately.

System Responsibilities

- Update Inventory:
  - The system updates the inventory based on items sold, returned, or adjusted by the store staff.
- Confirm Payment:
  - The system processes payment confirmations, ensuring that transactions are completed successfully and securely.

Detailed Use Case Scenarios

- Connecting the App to the Cart (Customer):
  - Precondition: The customer has the store's mobile app installed on their smartphone.
  - The customer opens the app and selects the option to connect to a smart shopping cart.
  - The app searches for and establishes a connection with the nearest available cart through the use of an NFC tag.
  - Postcondition: The customer's app is synced with the cart, ready for a personalized shopping experience.
- Checkout and Payment Confirmation (Customer):
  - Precondition: The customer has finished shopping and is ready to checkout.
  - The customer navigates to the checkout option on the cart's display.
  - The customer chooses their preferred payment method (card or app).
  - Upon selecting "Pay with App," the customer confirms the payment amount.
  - The system processes the payment and triggers an inventory update to reflect the purchase.
  - Postcondition: The customer receives a digital receipt, and the inventory is updated accordingly.
- Inventory Management (Store Staff):
  - Precondition: Changes in stock levels due to sales, returns, or new shipments.
  - Store staff access the inventory management system to input new stock levels or adjust existing ones.
  - Any price adjustments or discounts are also entered, triggering updates in the system.
  - Postcondition: The inventory accurately reflects all items available for sale, including any price changes or discounts.

This narrative provides a comprehensive view of the Automated Smart Shopping Cart system's functionality, emphasizing the seamless integration of shopping, payment, and inventory management through user-centric and system-driven use cases.
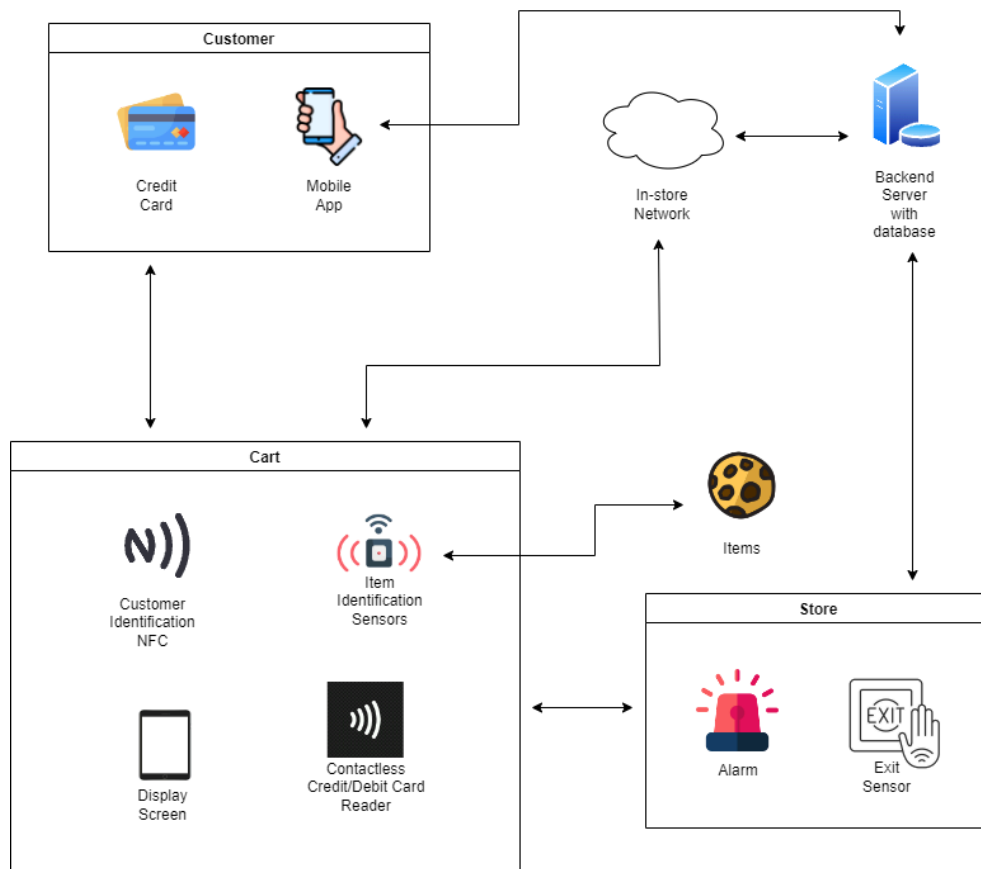
Physical View

Figure 4 - Physical View

The Automated Smart Shopping Cart System integrates customers, carts, and the store environment through smart technologies and software.

Customers use a mobile app and their credit card to interact with the system. The app connects to the smart cart for item tracking and checkout.

Each cart is equipped with NFC for customer identification, item identification sensors for product detection, a display screen for item lists and totals, and a contactless payment terminal.

The store is equipped with exit sensors to monitor cart movements and alarms for security. These components are connected through an in-store network that links carts to the store's backend server. This server manages inventory, transactions, and updates on pricing and promotions.

In summary, the system connects customers with carts and the store through a mobile app and credit card, enabling communication between carts and the store's systems via the in-store network, with all data managed by the backend server.

Quality Attributes

Security

What does it mean?
Security in the context of an Automated Smart Shopping Cart system emphasizes the protection of user data and financial transactions. This involves encryption of data transfers, secure storage of personal and payment information, and the implementation of measures to prevent unauthorized access or fraud. It also covers the physical security of the cart to prevent theft or tampering.

Acceptance Level? 9/10
Given the direct involvement of financial transactions and personal data, the system must adhere to high-security standards. While absolute security is challenging, the goal is to minimize vulnerabilities and respond swiftly to any breaches.

How important?
Security is paramount as it underpins user trust in the system. A breach could lead to financial loss, damage to the company's reputation, and legal consequences. Ensuring the confidentiality, integrity, and availability of user data is essential for the system's success and longevity.

Reliability

What does it mean?
Reliability for the Automated Smart Shopping Cart system means ensuring consistent operation without failures. This includes accurate detection and recording of items added to or removed from the cart, stable performance of the app and cart interface, and error-free payment processing. It also involves the system's ability to recover quickly from any failures or errors.

Acceptance Level? 8/10
The system must perform its intended functions under specified conditions for a designated period without failure. However, minor interruptions might be tolerable as long as they don't significantly impact the overall shopping experience or result in transaction errors.

How important?
High reliability is crucial to avoid frustration and inconvenience to users, which can directly affect the shopping experience and customer satisfaction. Frequent errors or system downtimes can deter users from using the smart cart, negatively impacting the adoption rate and the store's operational efficiency.

Usability

What does it mean?
Usability in this context refers to the ease with which customers and store staff can interact with the smart cart and its accompanying software. This includes intuitive app interfaces, straightforward cart interactions for adding or removing items, and a seamless checkout process. It also covers accessibility features to ensure the system is usable by a wide range of customers, including those with disabilities.

Acceptance Level? 9/10
The system's success heavily depends on its adoption by users, which in turn is influenced by how user-friendly and accessible it is. High usability is essential to ensure that customers prefer the automated cart over traditional shopping methods.

How important?
Usability directly impacts the shopping experience, influencing customer satisfaction, loyalty, and the system's adoption rate. A system that is difficult to use can frustrate customers, leading to negative feedback and decreased use. Ensuring a positive user experience is therefore critical for the success of the smart shopping cart system.

Performance

What does it mean?
Performance for the Automated Smart Shopping Cart system refers to its responsiveness and efficiency. This includes the speed at which the system recognizes items added or removed from the cart, updates the cart's contents and total, processes payments, and handles data synchronization between the cart, app, and backend systems.

Acceptance Level? 8/10
While users expect a high level of performance, slight delays may be tolerable in non-critical functions. However, core functionalities such as item scanning, cart updates, and payment processing must be near-instantaneous to ensure a smooth shopping experience.

How important?
Performance is key to customer satisfaction and system efficiency. Slow response times can lead to bottlenecks in the shopping process, affecting the store's throughput and potentially leading to lost sales. High performance is therefore essential to meet user expectations and maintain operational efficiency.