



**FEUP** FACULDADE DE ENGENHARIA  
UNIVERSIDADE DO PORTO

## **Arquitetura de Sistemas de Software 2023/2024**

### ***Homework #08***

#### **“Automated Smart Shopping Cart”**

Team 21

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# Introduction

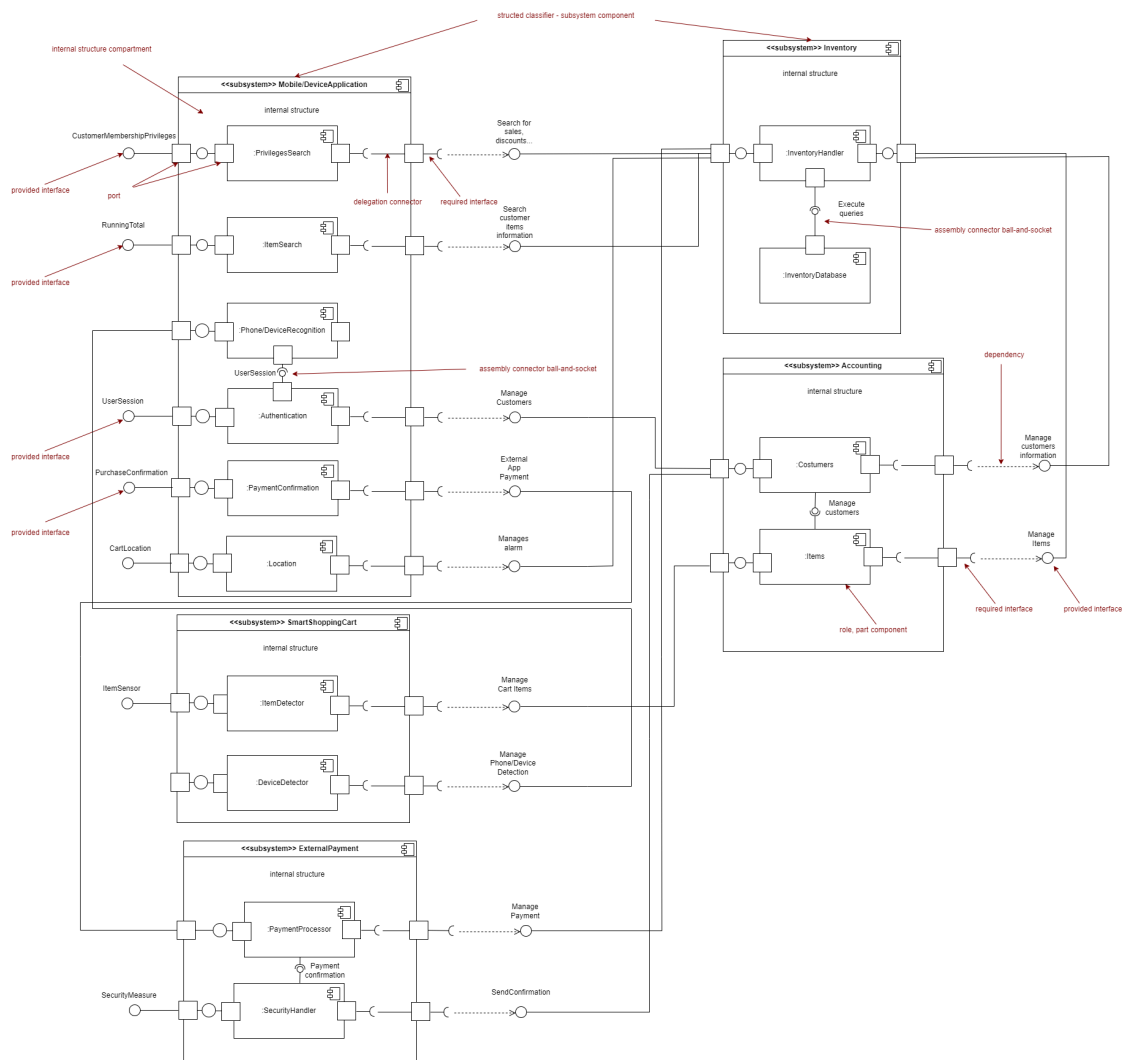
The Automated Smart Shopping Cart, which is meant to change the way we shop, is a combination of digital convenience and traditional retail. This innovative system offers personalized discounts, improves security and simplifies the checkout process in a transparent and efficient way with online means along with the physical store. Real time updates regarding the contents of your cart are promised, side to side with a revolutionary shopping experience.

This solution, that eliminates traditional checkout lines and manual scanning of products, represents a fundamental change in the retail environment. Clients can put items in their carts and immediately know the new total price, as every product is tracked real time. Even so, the robust protocol systems assure the protection of confidential information and transactions, increasing client trust in the shopping process.

This report explores structure diagrams, message sequence diagrams, main use cases and quality attributes that guide the development of the Automated Smart Shopping Cart. With its innovative technology and simple concept design, it promises to completely change the future of retail and provide clients with convenience and efficiency like they have never seen before.

## Structure Diagrams

Components and connectors diagram:



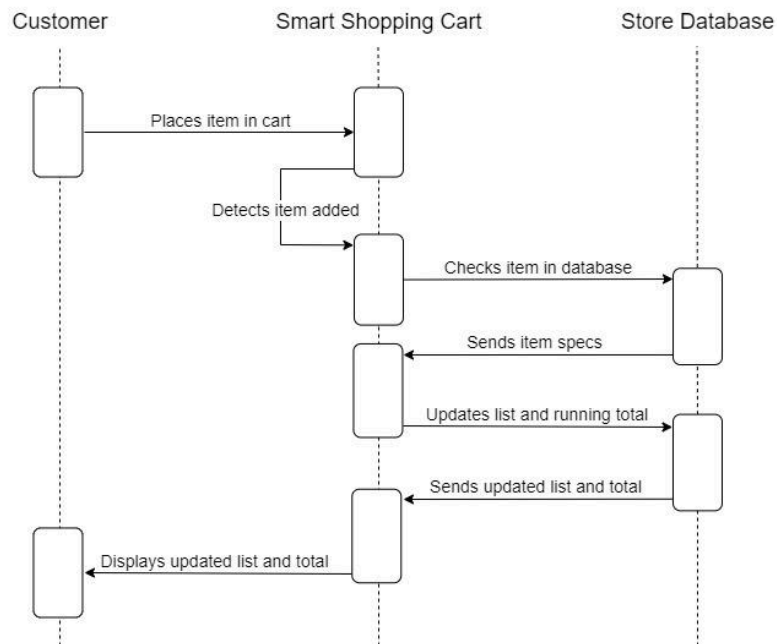
While creating the component and connectors diagram for this project, we drew inspiration from our previous homework due to the tight timeline. We divided the diagram into five subsystems, each comprising closely related components.

- Firstly, the **Inventory subsystem** handles data related to inventory, customers, and their actions. It consists of two components: the InventoryHandler and the InventoryDatabase. The InventoryHandler handles all requests for inventory and customer data by sending queries to the database. On the other hand, the InventoryDatabase is the central repository responsible for storing and organizing all information concerning both customers and inventory items.
- The **Accounting subsystem** manages customer and item information. The Customers component oversees the management of customer information stored in the database, ensuring it's accurate and up-to-date. Meanwhile, the Items component manages inventory items stored in the database and also links cart item information to the respective customers, facilitating seamless tracking and management.
- The **SmartShoppingCart subsystem** incorporates components like the ItemDetector and the DeviceDetector. The ItemDetector detects when items are added to or removed from the cart and identifies which items they are. Meanwhile, the DeviceDetector component identifies when a device is used in the cart, functioning similarly to the mobile app but as an anonymous user. It also detects when the mobile app is initiated near the cart, indicating a registered customer's presence.
- In the **ExternalPayment subsystem** there are two components. The PaymentProcessor is responsible for the payment process via credit/debit card, venmo etc. and for confirming the payment. The SecurityHandler is responsible for including a security measure for dealing with the purchase confirmation and sending a notification to the customer about that.
- Lastly, the **Mobile/DeviceApplication subsystem** comprises six components: PrivilegesSearch, ItemSearch, Phone/DeviceRecognition, Authentication, PaymentConfirmation, and Location. The PrivilegesSearch component seeks out any special offers, discounts, or perks that registered customers might have stored in the database. ItemSearch handles item inquiries, including displaying the ongoing total and the cart's item list. Phone/DeviceRecognition determines whether the user is employing the cart's device anonymously or utilizing the mobile app as a registered user, initializing a user session accordingly. Authentication confirms the user's identity, whether they're using the mobile app or anonymously associating with the cart, while also managing customer data. PaymentConfirmation logs payment details and assists in confirming payments through an external payment app. Lastly, Location tracks the user's whereabouts, obtained when they share their location using the mobile app or cart device, and oversees store alarm management, correlating it with the user's payment status in the database.

In essence, each subsystem and its components play a vital role in facilitating a seamless and efficient shopping experience, whether through inventory management, customer interaction, payment processing, or device integration.

## Sequence Diagrams

### a) Adding an item to the cart

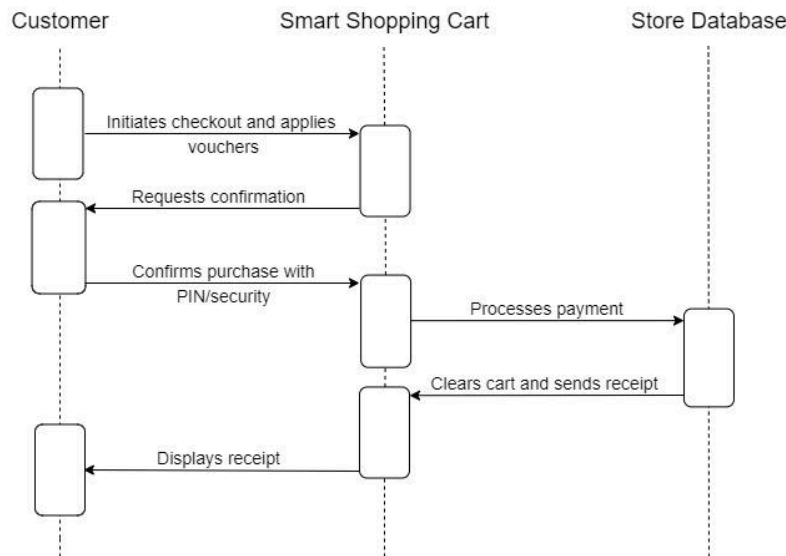


The customer starts by inserting an item in the Smart Shopping Cart. Then, this one senses that a new item was added (by a sensor / weight increment) and starts searching for this item in the Store Database.

The Store Database, after finding the added item, sends the item specs (price, quantity) to the Smart Shopping Cart, which requests back an update on the current stored list and running total.

Finally, after recalculating the new total price and list of items, the Store Database sends the updated list and total value to the Smart Shopping Cart. This info is then displayed to the customer on the cart's device or on the user app, if connected to the cart.

## b) Walking out of the store (checkout)



Firstly, the customer initiates the checkout automatically when he leaves the store (in a checkout area) providing his personal data (credit card on the cart device) and applying the vouchers he has on his mobile app, if connected to the Smart Shopping Cart.

After it, the Smart Shopping Cart requests a purchase confirmation to the customer on its device or on the user app. The customer then confirms back his purchase by inserting his safe PIN.

Once the purchase gets validated, the Smart Shopping Cart requests the Store Database to process this payment. The Store Database clears the cart that was stored in the Smart Shopping Cart and sends it a receipt which is then displayed to the customer on the cart's device or on the user app.

## Use cases

The use cases outlined below detail the fundamental interactions between users and the Automated Smart Shopping Cart system. These scenarios encapsulate the core functionalities designed to enhance the shopping experience, streamline checkout processes, and ensure seamless transactions. Each use case delineates the specific steps involved in key user interactions, providing a comprehensive understanding of the system's operation and functionality.

Through meticulous analysis and refinement, these use cases serve as the blueprint for the development and implementation of our innovative solution. By adhering to these meticulously crafted scenarios, we aim to deliver a robust and intuitive shopping experience that transcends conventional retail paradigms.

With that said, we defined six main use cases for the development of this project:

## 1. “As a user, I want to be able to add an item to the cart”

**Description:** This use case involves the process of adding an item to the shopping cart.

**Actors:** Customer, Cart Sensors, Mobile App/Cart Display.

**Flow:**

- The customer places an item in the shopping cart;
- Cart sensors detect the item and update the running total;
- The mobile app or cart display reflects the updated cart contents and total.

## 2. “As a user, I want to be able to remove an item from the cart”

**Description:** This use case involves the process of removing an item from the shopping cart.

**Actors:** Customer, Cart Sensors, Mobile App/Cart Display.

**Flow:**

- The customer decides to remove an item from the cart;
- Cart sensors detect the removal and adjust the running total accordingly;
- The mobile app or cart displays updates to reflect the revised cart contents and total.

## 3. “As a user, I want to see the cart contents and the total price”

**Description:** This use case allows the customer to view the current contents of the shopping cart and the running total.

**Actors:** Customer, Mobile App/Cart Display.

**Flow:**

- The customer accesses the mobile app or cart display;
- The app or display presents a list of items currently in the cart along with the total amount.

## 4. “As a user, I want to confirm my purchase and checkout”

**Description:** This use case involves the process of confirming the purchase and completing the checkout.

**Actors:** Customer, Mobile App/Cart Display, Store Exit Detector.

**Flow:**

- The customer approaches the store exit with the cart.
- The store exit detector prompts the customer to confirm the purchase.
- The customer confirms the purchase via the mobile app or cart display.
- If confirmation is not received, the store alarm is triggered.

## **5. “As a user, I want to be able to alternate between different payment methods”**

**Description:** This use case covers the process of completing payment using various methods besides credit/debit cards.

**Actors:** Customer, Mobile App/Cart Display, Payment Processor.

**Flow:**

- The customer selects their preferred payment method (e.g. Venmo, PayPal) during checkout;
- The payment processor processes the transaction accordingly, verifying authentication if necessary.

## **6. “As a user, I want to benefit from my membership and have some discounts or sales”**

**Description:** This use case involves managing customer memberships, discounts, and electronic coupons.

**Actors:** Customer, Mobile App/Cart Display, Store System.

**Flow:**

- The customer accesses their membership and discount information via the mobile app;
- The app applies relevant discounts and coupons to eligible items in the cart.

# Quality attributes

The success of the Automated Smart Shopping Cart system hinges upon its ability to meet the diverse needs and expectations of customers while providing a seamless and efficient shopping experience. To achieve this goal, the system is designed with a focus on several key quality attributes, each essential for ensuring the effectiveness, reliability, and usability of the solution.

In this section, we examine the quality attributes that are important to this system, and how the architecture handles each. These are considered paramount to the design and implementation of the Automated Smart Shopping Cart system. By evaluating how the architecture addresses each attribute, we gain insight into the system's capacity to deliver a superior shopping experience that transcends traditional retail paradigms. Through meticulous attention to these critical factors, we endeavor to establish a foundation for success, empowering customers with an innovative and intuitive shopping solution that redefines the retail landscape.

- **Accuracy**

The architecture ensures accurate detection of items added to and removed from the cart through robust sensor technology and reliable communication between hardware and software components. Real-time updates to the running total and cart contents guarantee accuracy throughout the shopping process.

- **Security**

Security measures are integrated into the system to protect customer data and transactions. This includes authentication mechanisms such as PIN entry for checkout confirmation, secure communication protocols between the mobile app and backend systems, and encryption of sensitive information during payment processing.

- **Reliability**

The architecture is designed to ensure the reliability of system components and operations. This involves implementing fault-tolerant mechanisms to handle unexpected errors, conducting thorough testing to identify and address potential issues, and utilizing redundant systems where necessary to minimize downtime and ensure uninterrupted service.

- **Scalability**

The architecture is scalable to accommodate varying numbers of customers and transactions, as well as future expansion. This is achieved through the use of modular and loosely coupled components that can be easily replicated or upgraded.



as demand grows. Additionally, the system is designed to efficiently utilize resources and distribute workloads to scale horizontally or vertically as needed.

- **Usability**

Usability is prioritized in the design of both hardware and software interfaces. The mobile app and cart display are designed with intuitive layouts and clear instructions to guide users through the shopping process. Additionally, feedback mechanisms such as visual cues and notifications are implemented to enhance user understanding and engagement.

## Conclusion

In conclusion, the development of the Automated Smart Shopping Cart represents a significant leap forward in the realm of retail technology, merging digital convenience with traditional shopping experiences. Throughout this report, we have explored the intricacies of the system's architecture, delved into its core functionalities through use cases, and evaluated the critical quality attributes that underpin its design.

Apart from the diagrams, the delineation of main use cases elucidated fundamental user interactions, emphasizing the system's capacity to streamline checkout processes, ensure seamless transactions, and enhance overall convenience for customers. Each use case served as a blueprint for the development and implementation of the system, guiding the design and functionality of key features.

In essence, the Automated Smart Shopping Cart system promises to revolutionize the future of retail by delivering unparalleled convenience, efficiency, and security to customers. Through its innovative technology, seamless integration, and user-centric design, the system sets a new standard for shopping experiences, empowering customers with a level of convenience and efficiency never before seen in traditional retail environments. As we look ahead, the Automated Smart Shopping Cart stands poised to redefine the retail landscape, ushering in a new era of digital convenience and personalized shopping experiences.