M3 - Requirements and Design

1. Change History

2. Project Description

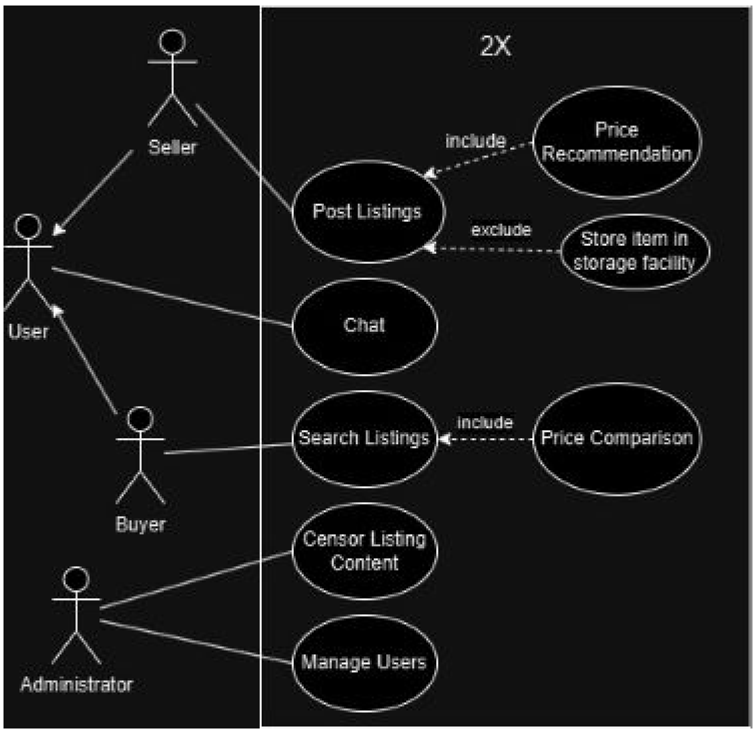
We intend to design a second-hand marketplace app for people looking to buy or sell unwanted items locally. When you need to make space, whether because you are looking to relocate or declutter, our storing service will take your items off your hands immediately. Sellers can deposit their items in nearby partner warehouses, where they are securely stored until sold. This ensures valuable items are not wasted and allows users to focus on their next steps without stress.

The app integrates Google Maps API to locate storage facilities near the seller's current position, making it easy to choose the most convenient option. Once stored, items are listed on our platform with detailed descriptions and photos. Additionally, our app offers a price recommendation and comparison feature. It analyzes our database of similar second-hand items and their past transaction prices to suggest a fair and competitive price for sellers. Furthermore, the app compares the recommended price with the market price of similar new items from other platforms, highlighting how much buyers can save by purchasing through our platform. This innovative approach not only ensures competitive pricing for sellers but also maximizes buyer satisfaction by demonstrating the cost-effectiveness of purchasing second-hand items through our app.

Buyers benefit from a personalized recommendation system and real-time chat functionality, ensuring smooth communication and a tailored shopping experience. Whether buyers prefer self-pickup from the warehouse or delivery, the app simplifies the entire process, making second-hand trading faster, more efficient, and ultimately more rewarding for all users.

3. Requirements Specification

3.1. Use-Case Diagram



3.2. Actors Description

1. **[BUYERS]**: Buyers are users looking to purchase second-hand items. They can browse listings, communicate with sellers, and choose pickup or delivery options.
2. **[SELLERS]**: Sellers are users who wish to list unwanted items for sale. They can deposit their items in partner warehouses, post product details, and manage their listings.
3. **[Administrator]**：The administrator ensures the smooth operation of the platform, including monitoring listings, managing warehouses, and handling user disputes.
4.

3.3. Functional Requirements

1. **[Register and Login]**
    - **Overview**:
        1. Google-based User Registration
        2. Google-based User Login
    - **Detailed Flow for Each Independent Scenario**:
        1. **[Google-based User Registration]**:
            - **Description**: Users register through their Google accounts. Upon successful registration, they can set preferences for personalized recommendations.
            - **Primary actor(s)**: Sellers, Buyers
            - **Main success scenario**:
                1. User opens the app and selects the "Sign in with Google" option.
                2. The system initiates Google OAuth authentication.
                3. Google verifies the user credentials and provides user data (e.g., email, name).
                4. The app creates a new account in the system or fetches an existing account based on the Google ID.
                5. The user sets preferences (e.g., categories of interest) for product recommendations.
            - **Failure scenario(s)**:
                - 1a. Google authentication fails due to network issues.
                    - 1a1. System displays an error message indicating authentication failure.
                    - 1a2. User retries the authentication process after resolving the issue.
                - 1b. Google account does not return necessary data.
                    - 1b1. System notifies the user of the incomplete data.
                    - 1b2. User retries with a valid Google account.
        2. **[Google-based User Login]**:

        - **Description**: Returning users log in using their Google accounts, and their preferences are retained for personalized recommendations.
        - **Primary actor(s)**: Sellers, Buyers
        - **Main success scenario**:
            1. User selects the "Sign in with Google" option on the login screen.
            2. The system verifies the user's Google account and fetches the corresponding system account.
            3. The app grants the user access to their dashboard with personalized product recommendations.
        - **Failure scenario(s)**:
            - 2a. Google account authentication fails due to incorrect credentials.
                - 2a1. System displays an error message indicating authentication failure.
                - 2a2. User retries with correct credentials.
            - 2b. The system cannot connect to Google's authentication service.
                - 2b1. System displays a message about Google service downtime.
                - 2b2. User is advised to try again later.

2. **[List an Item for Sale]**
    - **Overview**:
        1. Upload item details
        2. Price recommendation
    - **Detailed Flow for Each Independent Scenario**:
        1. **[User Registration]**:
            - **Description**: Sellers can upload item photos, descriptions, and set prices.
            - **Primary actor(s)**: Sellers
            - **Main success scenario**:
                1. Seller selects the "List Item" option.
                2. Seller uploads photos and fills in item details (e.g., description).
                3. The system verifies the details and accepts the listing.
            - **Failure scenario(s)**:
                - 1a. Seller uploads incomplete or invalid details.
                    - 1a1. System displays an error message highlighting missing/invalid fields.
                    - 1a2. Seller corrects the errors and resubmits the details.
                - 1b. System is down during registration.

- 1b1. User receives a message indicating temporary unavailability.
- 1b2. User is asked to try again later.

2. **[Price Recommendation]**:

   - **Description**: The system suggests a competitive price based on database analysis and comparison with new item prices on other platforms.

   - **Primary actor(s)**: Sellers

   - **Main success scenario**:

     1. Seller enters item details and clicks "Get Price Recommendation".
     2. System analyzes the database and provides a price suggestion.
     3. System also compares the price to new item prices and displays the difference.
     4. Seller accepts the recommendation or sets a custom price.

   - **Failure scenario(s)**:

     - 2a. Price recommendation fails due to missing database data.

       - 2a1. System notifies the seller about the issue.
       - 2a2. Seller can proceed without the recommendation.

     - 2b. System cannot fetch competitor prices.

       - 2b1. System displays a message about unavailability of competitor price data.
       - 2b2. Seller proceeds with the recommended price based on internal data.

3. **[Locate Storage Facilities]**

- **Overview**:

  1. Find nearby warehouses
  2. Schedule item drop-off

- **Detailed Flow for Each Independent Scenario**:

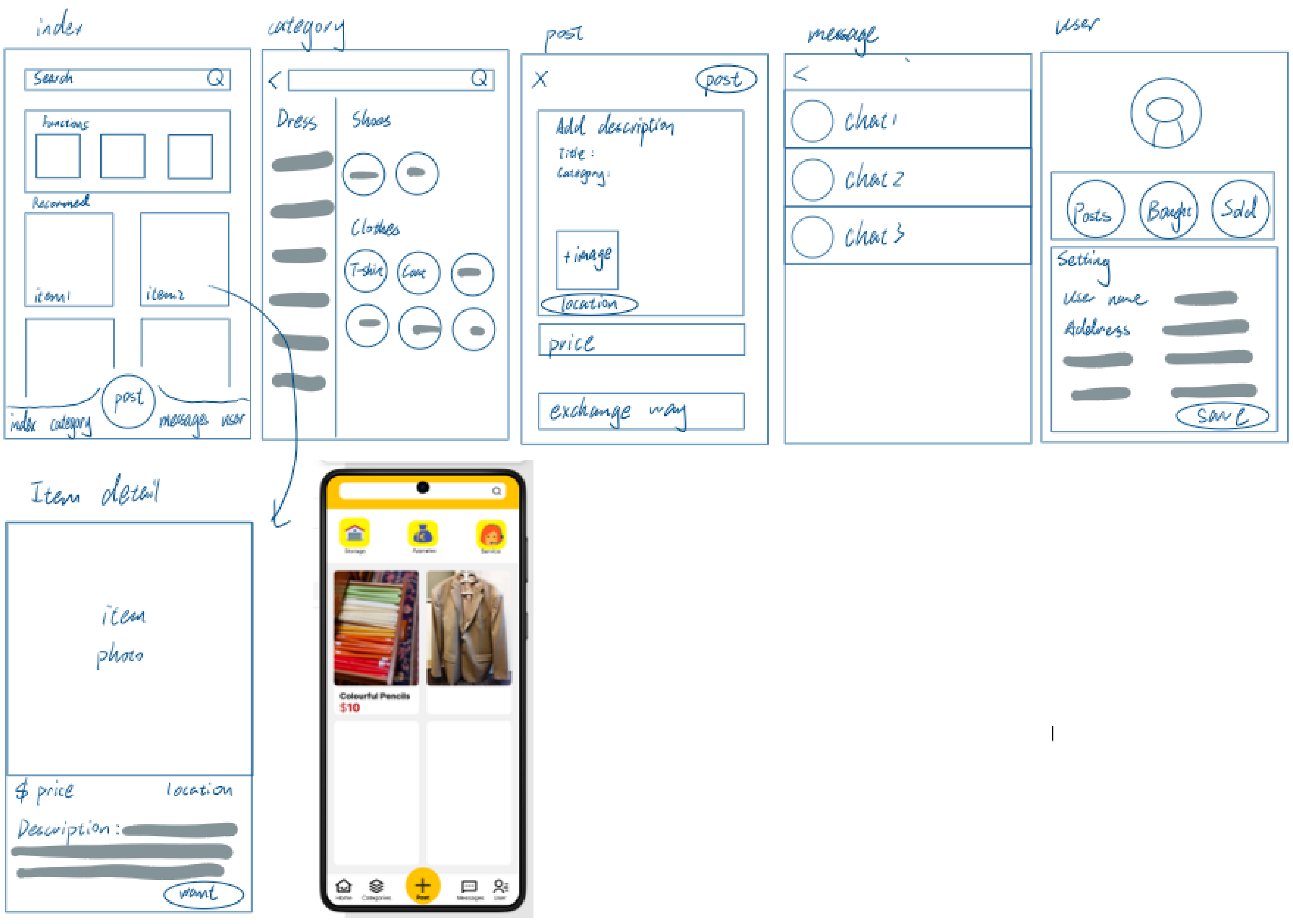
  1. **[Find Nearby Warehouses]**:

     - **Description**: Sellers locate storage facilities near their current location using the Google Maps API.
     - **Primary actor(s)**: Sellers
     - **Main success scenario**:
       1. Seller selects the "Find Storage" option.
       2. System uses the seller's location to list nearby warehouses.
       3. Seller selects a preferred facility.
     - **Failure scenario(s)**:
       - **1a.** Location permissions are denied.

        - **1a1.** System prompts the user to enable location services.
        - **1a2.** Seller enables location services and retries.
    - **1b.** No warehouses available nearby.
        - **1b1.** System displays a message stating unavailability of storage options.
        - **1b2.** Seller can retry later or contact support.

2. **[Schedule Item Drop-Off]**:
    - **Description**: Sellers schedule a time to deposit items at a selected warehouse.
    - **Primary actor(s)**: Sellers
    - **Main success scenario**:
        1. Seller selects a warehouse and chooses a convenient drop-off time.
        2. System confirms the booking and sends a confirmation message.
    - **Failure scenario(s)**:
        - **2a.** Selected time slot is unavailable.
            - **2a1.** System suggests alternative time slots.
            - **2a2.** Seller selects a new time and proceeds.
        - **2b.** System fails to confirm the booking due to server issues.
            - **2b1.** Seller receives a notification about the issue.
            - **2b2.** Seller retries later or contacts support.

3.4. Screen Mockups



3.5. Non-Functional Requirements

1. **[System Performance]**
    - **Description**: The system should support multiple users simultaneously and ensure that most pages load within 2 seconds.
    - **Justification**: Providing a smooth user experience ensures that the system remains usable even during peak times.

2. **[Data Security]**
    - **Description**: The system should safeguard users' personal information (e.g., login details, order data) against unauthorized access or breaches.
    - **Justification**: Protecting user data builds trust and ensures users feel safe while using the platform.

3. **[System Availability]**
    - **Description**: The system should minimize downtime, with no more than 1 hour of unavailability per month.
    - **Justification**: Ensuring high availability allows users to access critical functionalities like placing orders or logging in at any time.

4. Design Specification

4.1. Main Components

1. **Marketplace Service**

    - **Purpose**: Handles product listings, pricing, and search functionality.
    - **Interfaces**:
        - `POST /listings` - Creates a new product listing.
        - `GET /listings/{id}` - Retrieves details of a specific listing.
        - `PUT /listings/{id}` - Updates an existing listing.
        - `DELETE /listings/{id}` - Removes a listing from the marketplace.
        - `GET /listings/search?query={query}` - Searches for listings using keywords.

2. **Storage Management Service**

    - **Purpose**: Manages warehouse storage and assigns storage locations for stored items.
    - **Interfaces**:
        - `POST /storage/request` - Requests storage space for an item.
        - `GET /storage/status/{itemId}` - Retrieves storage status of an item.
        - `DELETE /storage/{itemId}` - Removes an item from storage after sale or withdrawal.

3. **User Service**

    - **Purpose**: Manages authentication, profiles, and permissions.
    - **Interfaces**:
        - `POST /users/register` - Creates a new user account.
        - `POST /users/login` - Authenticates a user and returns a token.
        - `GET /users/{id}` - Retrieves user profile information.
        - `PUT /users/{id}` - Updates user profile details.
        - `DELETE /users/{id}` - Deletes a user account.

4. **Recommendation Engine**
   - **Purpose**: Provides price suggestions and personalized recommendations.
   - **Interfaces**:
     - `GET /recommendations/{userId}` - Fetches personalized item recommendations.
     - `POST /price-suggestions` - Suggests a price for a new listing.
     - `GET /price-comparison/{itemId}` - Retrieves price comparisons from external sources.

5. **Chat Service**
   - **Purpose**: Manages buyer-seller chat functionality.
   - **Interfaces**:
     - `POST /chat/start` - Initiates a chat between a buyer and seller.
     - `GET /chat/{chatId}` - Retrieves chat history.
     - `POST /chat/{chatId}/message` - Sends a new message.

4.4. Frameworks

- **Cloud Provider**: AWS
- **Backend Framework**: Node.js with Express.js
- **Frontend Framework**: Native Kotlin for Android
- **Databases**: MongoDB (Atlas) for chat, MySQL (AWS RDS) for listings & user data
- **Other Tools**: Docker, Kubernetes, Redis, Firebase Auth, AWS API Gateway

4.5. Dependencies Diagram

```
graph TD;
    %% Define Components
    Frontend -->|"POST /listings
GET /listings/{id}
PUT /listings/{id}
DELETE /listings/{id}
GET /listings/search?query={query}"| MarketplaceService;
    Frontend -->|"POST /users/register
POST /users/login
GET /users/{id}
PUT /users/{id}
DELETE /users/{id}"| UserService;
    Frontend -->|"POST /chat/start
GET /chat/{chatId}
POST /chat/{chatId}/message"| ChatService;

    MarketplaceService -->|"GET /recommendations/{userId}
POST /price-suggestions
GET /price-comparison/{itemId}"| RecommendationEngine;

    MarketplaceService -->|"Store & Retrieve Listings"| MySQL;
    MarketplaceService -->|"Fetch Prices"| eBayAPI;
    MarketplaceService -->|"Fetch Prices"| AmazonAPI;

    StorageManagementService -->|"Store & Retrieve Storage Info"| MySQL;
    UserService -->|"Store & Retrieve User Data"| MySQL;
    UserService -->|"Authenticate Users"| FirebaseAuth;

    ChatService -->|"Store & Retrieve Messages"| MongoDB;

    %% Bidirectional Arrows for DB Interactions
    MySQL -->|"Used by
Marketplace, Storage, User"| MarketplaceService;
    MySQL -->|"Used by
Storage Management"| StorageManagementService;
    MySQL -->|"Used by
User Service"| UserService;
    MongoDB -->|"Used by
Chat Service"| ChatService;
```

4.6. Functional Requirements Sequence Diagram

User Registration

```
sequenceDiagram
    participant User
    participant Frontend
    participant UserService
    participant MySQL

    User->>+Frontend: Opens Registration Page
    Frontend->>+UserService: POST /users/register {email, password}
    activate UserService

    UserService->>+MySQL: Store user credentials
    activate MySQL

    alt Registration Successful
        MySQL-->>UserService: Success Acknowledgement
        UserService-->>Frontend: Registration Success
        Frontend-->>User: Display Success Message

    else Invalid Data (Weak Password / Email Exists)
        MySQL-->>UserService: Reject Request (Invalid Data)
        UserService-->>Frontend: Error Response (Invalid Data)
        Frontend-->>User: Display Error Message

    else System Failure
        UserService-->>Frontend: Error Response (Service Unavailable)
        Frontend-->>User: Display Error Message (Try Again Later)
    end

    deactivate MySQL
    deactivate UserService
```

User Login

```
sequenceDiagram
    participant User
    participant Frontend
    participant UserService
    participant MySQL

    User->>+Frontend: Opens Login Page
    Frontend->>+UserService: POST /users/login {email, password}
    activate UserService

    UserService->>+MySQL: Verify user credentials
    activate MySQL

    alt Login Successful
        MySQL-->>UserService: Credentials Valid
        UserService-->>Frontend: Login Success + Auth Token
        Frontend-->>User: Grant Access

    else Incorrect Email/Password
        MySQL-->>UserService: Authentication Failed
        UserService-->>Frontend: Error (Invalid Credentials)
        Frontend-->>User: Display Error Message

    else System Failure
        UserService-->>Frontend: Error Response (Service Unavailable)
        Frontend-->>User: Display Error Message (Try Again Later)
    end

    deactivate MySQL
    deactivate UserService
```

Listing an Item for Sale

```
sequenceDiagram
    participant Seller
    participant Frontend
    participant MarketplaceService
    participant MySQL

    Seller->>+Frontend: Opens "List Item" Page
    Frontend->>+MarketplaceService: POST /listings {title, description, price,
images}
    activate MarketplaceService

    MarketplaceService->>+MySQL: Store listing details
    activate MySQL

    alt Listing Successful
```

```
        MySQL-->>MarketplaceService: Listing Saved
        MarketplaceService-->>Frontend: Listing Confirmed
        Frontend-->>Seller: Display Success Message

    else Invalid Input (Missing Fields)
        MySQL-->>MarketplaceService: Reject Request (Invalid Data)
        MarketplaceService-->>Frontend: Error (Missing/Invalid Fields)
        Frontend-->>Seller: Prompt for Corrections

    else System Failure
        MarketplaceService-->>Frontend: Error Response (Service Unavailable)
        Frontend-->>Seller: Display Error Message (Try Again Later)
    end

    deactivate MySQL
    deactivate MarketplaceService
```

Price Recommendation

```
sequenceDiagram
    participant Seller
    participant Frontend
    participant MarketplaceService
    participant RecommendationEngine
    participant eBayAPI
    participant AmazonAPI

    Seller->>+Frontend: Clicks "Get Price Recommendation"
    Frontend->>+MarketplaceService: POST /price-suggestions {item details}
    activate MarketplaceService

    MarketplaceService->>+RecommendationEngine: Analyze Market Data
    activate RecommendationEngine

    RecommendationEngine->>+eBayAPI: Fetch similar item prices
    RecommendationEngine->>+AmazonAPI: Fetch new item prices
    eBayAPI-->>RecommendationEngine: Return Used Item Prices
    AmazonAPI-->>RecommendationEngine: Return New Item Prices

    alt Price Suggestion Available
        RecommendationEngine-->>MarketplaceService: Suggested Price
        MarketplaceService-->>Frontend: Display Recommended Price
        Frontend-->>Seller: Show Price Suggestion

    else No Price Data Available
        RecommendationEngine-->>MarketplaceService: No Recommendation Found
        MarketplaceService-->>Frontend: Error Message (No Pricing Data)
        Frontend-->>Seller: Notify About Missing Data

    else System Failure
        MarketplaceService-->>Frontend: Error Response (Service Unavailable)
        Frontend-->>Seller: Display Error Message (Try Again Later)
    end

    deactivate eBayAPI
    deactivate AmazonAPI
    deactivate RecommendationEngine
    deactivate MarketplaceService
```

Finding Nearby Storage Facility

```
sequenceDiagram
    participant Seller
    participant Frontend
    participant StorageManagementService
    participant MySQL
    participant GoogleMapsAPI

    Seller->>+Frontend: Clicks "Find Storage"
    Frontend->>+StorageManagementService: GET /storage/request {location}
    activate StorageManagementService

    StorageManagementService->>+GoogleMapsAPI: Retrieve Nearby Warehouses
    activate GoogleMapsAPI

    alt Warehouses Found
        GoogleMapsAPI-->>StorageManagementService: List of Available Warehouses
        StorageManagementService-->>Frontend: Display Warehouse Options
        Frontend-->>Seller: Show Available Storage

    else No Warehouses Available
        GoogleMapsAPI-->>StorageManagementService: No Results Found
        StorageManagementService-->>Frontend: Display Error Message
        Frontend-->>Seller: Notify Seller About Unavailability

    else System Failure
        StorageManagementService-->>Frontend: Error Response (Service Unavailable)
        Frontend-->>Seller: Display Error Message (Try Again Later)
    end

    deactivate GoogleMapsAPI
    deactivate StorageManagementService
```

Drop-off Scehduleing

```
sequenceDiagram
    participant Seller
    participant Frontend
    participant StorageManagementService
    participant MySQL

    Seller->>+Frontend: Selects Warehouse & Time
    Frontend->>+StorageManagementService: POST /storage/request {warehouseId,
time}
    activate StorageManagementService

    StorageManagementService->>+MySQL: Store Storage Request
    activate MySQL

    alt Booking Successful
        MySQL-->>StorageManagementService: Booking Confirmed
        StorageManagementService-->>Frontend: Confirmation Message
        Frontend-->>Seller: Display Success Message

    else Time Slot Unavailable
        MySQL-->>StorageManagementService: Reject Request (Slot Unavailable)
        StorageManagementService-->>Frontend: Error Message (Choose Another Time)
        Frontend-->>Seller: Prompt for New Time Slot

    else System Failure
        StorageManagementService-->>Frontend: Error Response (Service Unavailable)
        Frontend-->>Seller: Display Error Message (Try Again Later)
    end

    deactivate MySQL
    deactivate StorageManagementService
```

3.5. Non-Functional Requirements

1. **[System Performance]**
   - **Implementation**:
     - Use **caching (Redis)** to reduce database queries.
     - Optimize **database indexing and queries** for fast retrieval.
     - Deploy on **AWS with auto-scaling** to handle peak loads.

2. **[Data Security]**
   - **Implementation**:
     - Use **Firebase Authentication** for secure login and access control.
     - Encrypt **sensitive user data** (bcrypt for passwords, database encryption).

3. **[System Availability]**
   - **Implementation**:
     - Monitor system health with **AWS CloudWatch and alerts**.
     - Perform **zero-downtime deployments** using rolling updates.

4.8. Main Project Complexity Design

AI-Enhanced Price Recommendation Engine

- **Description**: The price recommendation engine analyzes historical pricing data, fetches real-time prices from external sources (eBay, Amazon), and integrates AI (ChatGPT API) to improve search accuracy by correcting user input, suggesting related products, and enhancing query relevance.
- **Why complex?**:
  - **Multi-source data processing**: Merging internal price data with external APIs.
  - **AI-driven query refinement**: Handling ambiguous product names, typos, and missing details.
  - **Computational efficiency**: Managing API rate limits, caching results, and filtering outliers.
- **Design**:
  - **Input**: Item title, description, category, condition (from user input).
  - **Output**: Suggested competitive price, AI-refined query, price breakdown.
  - **Main computational logic**:
    1. Use **ChatGPT API** to refine user input and correct errors.
    2. Fetch **historical price data** from the internal database (MySQL).
    3. Query **eBay & Amazon APIs** using the AI-enhanced search term.
    4. Filter **outliers** and compute a **weighted average price**.
    5. Return the **final price suggestion** with AI-processed insights.
  - **Pseudo-code**:

```
def recommend_price(item_details):
    refined_query = call_chatgpt_api(item_details["title"], item_details["category"])
    historical_prices = query_database(refined_query, item_details["condition"])
    ebay_prices = fetch_ebay_prices(refined_query, item_details["category"])
    amazon_prices = fetch_amazon_prices(refined_query, item_details["category"])
    all_prices = historical_prices + ebay_prices + amazon_prices
    filtered_prices = remove_outliers(all_prices)
    suggested_price = weighted_average(filtered_prices, weights={"historical": 0.5, "ebay": 0.25, "amazon": 0.25})
    return {"suggested_price": suggested_price, "refined_query": refined_query}
```

5. Contributions

- **[Tianrui Chu]**: Wrote the **Design Specification** section, including defining the system's architecture, main components, databases, external APIs, and frameworks. Designed the **dependencies diagram** to illustrate interactions between microservices and external systems. Developed detailed **functional requirement sequence diagrams** using Mermaid to visualize system workflows. Spent around 5 hours on this assignment.
- ...
- ...
- ...