AI-Powered Clothing App for Personalized Outfit Recommendation

By

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A project report submitted to the
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Faculty of Computing and Information Technology
Tunku Abdul Rahman University of Management and Technology
Kuala Lumpur

Declaration

The project submitted herewith is a result of my own efforts in totality and in every aspect of the project works. All information that has been obtained from other sources had been fully acknowledged. I understand that any plagiarism, cheating or collusion or any sorts constitutes a breach of TAR University rules and regulations and would be subjected to disciplinary actions.

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ID: 24WMR16773

Abstract

This project presents the development of an AI-powered clothing mobile application designed to provide personalized outfit recommendations based on a user's height, weight, gender, and preferred fashion style. The project addresses the common challenge faced by online shoppers who struggle to select clothing that fits their personal style and body measurements, often resulting in dissatisfaction and product returns. By integrating machine learning-based recommendation logic with a mobile user interface, the system aims to enhance user confidence during the shopping process and improve product discovery.

The scope of the project includes the construction of a Flutter-based mobile application, a backend service for AI processing, and a structured database storing product, user, and recommendation data. Core features include user authentication, product browsing, cart management, wishlist, order simulation, and AI-generated outfit recommendations tailored to individual user profiles.

The system employs a rule-based filtering model combined with similarity scoring to compute personalized recommendations. Firebase Authentication, real-time database storage, and REST API communication were used throughout development. Testing involved functional validation of user flows, UI/UX testing, and evaluation of the AI recommendation accuracy using predefined scenarios.

The results show that the developed application successfully provides relevant outfit suggestions and delivers smooth user interaction. While the AI model is lightweight and suitable for prototype use, future improvements may include implementing a deeper learning model and expanding the dataset for better personalization. Overall, the project demonstrates the feasibility of integrating AI-driven recommendations into a mobile shopping application and provides a solid foundation for future enhancements.

Acknowledgement

I would like to express my sincere gratitude to my supervisor, Ms. Siti Nadiah Binti Nain, for her guidance, support, and constructive feedback throughout the duration of this project. Her encouragement and expertise have been invaluable in shaping the direction and quality of this work. I would also like to thank the lecturers and moderators who provided academic insights and support along the way. My heartfelt appreciation goes to my family and friends for their continuous motivation, understanding, and patience during the development of this project. Their support has been instrumental to the successful completion of this work.

Chapter 1: Introduction

1.1 Project Objectives

The primary goal of this project is to design and develop a mobile fashion e-commerce application that addresses the limitations of existing platforms by integrating artificial intelligence (AI) for personalized outfit recommendations. Traditional e-commerce applications such as those offered by H&M, Uniqlo, Zara, and Padini provide product browsing, cart management, and user accounts but lack a strong emphasis on personalization tailored to individual users.

To bridge this gap, the objectives of the project are as follows:

1. **Develop a comprehensive mobile application for online clothing retail** that includes standard e-commerce functionalities such as product browsing by category, cart and wishlist management, and secure authentication. This ensures that the system can meet basic user expectations while serving as a functional shopping platform.

2. **Implement an AI-powered recommendation engine** that uses users' body profile information (e.g., height and weight) and preferred fashion styles (e.g., Japanese, Korean, European) to suggest appropriate outfits. Unlike generic recommendation engines that rely on purchase history or collaborative filtering, this engine aims to generate personalized and practical recommendations aligned with user needs.

3. **Enhance customer engagement through value-added features** such as wishlist creation, product reviews, ratings, and user profile customization. These features allow customers to interact more actively with the platform, improving trust and satisfaction.

4. **Improve user experience by reducing time spent searching for appropriate items** and minimizing frustration from purchasing clothes that do not fit or suit their style. By doing so, the project also addresses the problem of high cart abandonment rates common in online fashion e-commerce.

5. **Contribute to inclusivity and cultural diversity in online shopping**, as the system will cater to different body types and provide style recommendations influenced by multiple cultural fashion trends.

These objectives form the foundation of the project, ensuring that the final system not only replicates standard e-commerce features but also innovates by leveraging AI-driven personalization.

1.2 Project Background

The fashion and apparel industry represents one of the largest and fastest-growing segments of global e-commerce. In Southeast Asia, the market is expected to generate USD 53.45 billion in revenue by 2025, supported by an annual growth rate of 3.6% (Statista, 2023). This trend is largely driven by the region's mobile-first consumer behavior, with 89% of internet users accessing the web primarily via smartphones (MarketResearchSEA, 2023). Moreover, 94% of urban internet users in the region engage in e-commerce, indicating strong adoption of digital shopping (Daxue Consulting, 2022).

Despite this promising growth, online fashion shopping remains fraught with challenges. One of the most significant problems is the lack of personalization. Shoppers often find it difficult to identify items that fit both their

physical measurements and personal style preferences. Unlike in physical stores, customers cannot try on clothes before purchase, which often leads to mismatched sizing, dissatisfaction, and high product return rates. This inefficiency contributes to cart abandonment, with research showing that 82% of users abandon their shopping carts due to poor user experience (VWO, 2023).

Existing mobile applications developed by global fashion retailers primarily focus on replicating the in-store browsing experience, offering users a catalog of products, filtering options, and basic recommendations such as “customers who bought this also bought…” While these features provide some convenience, they fail to address the deeper needs of consumers who desire personalized suggestions that consider body type, style preferences, and cultural influences.

This project therefore seeks to fill this gap by creating an application that not only incorporates the standard e-commerce functions but also integrates an AI recommendation system. By analyzing both quantitative (body profile) and qualitative (stylistic preference) inputs, the system aims to provide users with more accurate and meaningful outfit suggestions.

1.3 Advantages and Contributions

1.3.1 Advantages for Consumers

The most immediate advantage of the proposed system is an improved user experience. Consumers will benefit from:

- **Personalized recommendations** that are based on both physical measurements and fashion preferences, ensuring that suggested outfits are more relevant and practical.
- **Time-saving features**, as users can quickly discover suitable products without having to browse through an extensive catalog.
- **Increased confidence in purchasing**, reducing the likelihood of returns and dissatisfaction.
- **Engagement features** such as ratings, comments, and wishlists that foster a sense of interaction similar to social commerce platforms.

1.3.2 Contributions to the Industry

From a business perspective, the application demonstrates how artificial intelligence can be practically applied to improve personalization in the fashion retail industry. This project contributes to the industry by:

- **Reducing cart abandonment rates** by offering better-targeted product suggestions.
- **Encouraging inclusivity** in fashion retail by catering to a wider variety of body types and cultural styles.
- **Supporting trend adaptation**, as the AI model can be updated with new datasets to reflect seasonal and cultural fashion changes.

1.3.3 Contributions to Research

The academic contribution of this project lies in exploring how AI can be applied in fashion e-commerce through a dual-input recommendation approach. While most recommendation systems rely solely on collaborative filtering or purchase history, this project integrates physical body data with style-specific datasets. This approach opens

new avenues for research into more holistic recommendation engines that blend technical efficiency with cultural and stylistic adaptability.

1.4 Project Plan

The project will be developed in stages to ensure structured progress and proper evaluation:

- **Phase 1: Core Services (July – September 2025)**
    - Conduct background study and finalize system requirements.
    - Implement essential app features such as product browsing, account management, shopping cart, and simulated checkout.
    - Develop and integrate the AI-powered recommendation engine for personalized outfit suggestions.
- **Phase 2: Extended Services (October – December 2025)**
    - Add wishlist functionality, ratings, and comments.
    - Build user profile management features (edit details, view history).
    - Optionally design and implement an admin panel for product management.
- **Phase 3: Testing and System Preview (January – March 2026)**
    - Create detailed test plans and test cases.
    - Conduct functional, usability, and performance testing.
    - Present a prototype for review and refine based on feedback.
- **Phase 4: Finalization and Documentation (March – April 2026)**
    - Complete integration of all features.
    - Finalize report submission and system documentation.

This phased approach ensures that the project is completed on time while allowing room for testing, feedback, and improvements.

1.5 Project Team and Organization

This project is undertaken by:

- **Student Researcher:** Sia Jin Sheng (RSD2S3 G6)
- **Supervisor:** Ms. Siti Nadiah Binti Nain

As this is an individual project, the student researcher is responsible for all aspects, including system design, development, testing, and documentation. The supervisor's role is to provide academic guidance, monitor progress, and evaluate deliverables at each milestone.

The project organization follows a simple structure:

- **Student:** Responsible for technical implementation, research, and reporting.
- **Supervisor:** Provides oversight, ensures project relevance, and assesses quality.

This lean structure ensures efficient communication and accountability throughout the project lifecycle.

1.6 Chapter Summary and Evaluation

This chapter introduced the project by highlighting its objectives, background, advantages, contributions, plan, and organization. The project addresses a pressing gap in the online fashion retail industry, where personalization remains limited despite technological advances. By integrating AI with e-commerce, the project seeks to create a platform that not only meets basic consumer needs but also enhances inclusivity and personalization.

The evaluation of this chapter indicates that the proposed system:

- Aligns with industry growth trends in Southeast Asia.
- Offers clear consumer, industrial, and academic contributions.
- Has a feasible implementation plan with defined phases and milestones.

The foundation established in this chapter provides the basis for the following sections. **Chapter 2 will present a detailed literature review, examining existing works on AI in e-commerce, recommendation systems, and fashion retail applications.**

Chapter 2: Literature Review

2.1 Introduction

This chapter reviews existing studies, technologies, and related systems relevant to the development of an AI-powered clothing e-commerce application. It focuses on fashion recommender systems, machine learning techniques, AI-based personalization, and e-commerce design practices. The aim is to establish the theoretical and practical foundation for the proposed system.

2.2 Related Studies on Fashion Recommendation Systems

Fashion recommender systems (FRS) use machine learning algorithms to suggest clothing items based on user preferences, purchase history, or visual similarity. According to Liu et al. (2023), hybrid recommender systems that combine user-based and content-based filtering show improved accuracy in fashion-related recommendations.

Existing research also explores the integration of **body measurement data** into fashion recommendations. For instance, Park and Yoo (2022) demonstrated that user height and weight can significantly enhance the relevance of outfit suggestions compared to purely visual-based models. However, few applications combine **physical measurements with stylistic preferences** such as cultural fashion styles (e.g., Japanese or Korean aesthetics).

2.3 Artificial Intelligence and Machine Learning in Fashion

AI and machine learning play a major role in enabling personalization in fashion retail. Deep learning techniques such as Convolutional Neural Networks (CNNs) are often applied to clothing image recognition, while Natural Language Processing (NLP) models are used for product description matching.

The proposed system will utilize a **pre-trained recommendation model** that can interpret numeric (height, weight) and categorical (style preference) data to recommend suitable outfits. Using a pre-trained model reduces training time and ensures feasibility within the FYP duration.

Algorithm	Application in Fashion	Relevance to Project
Collaborative Filtering	Recommends based on similar users	Low—does not use personal data
Content-Based Filtering	Matches items by attributes (e.g., color, type)	Medium—suitable for style tags
Hybrid Model	Combines both user and item data	High—used in this project
Deep Neural Networks	Learns complex relationships between user and item	High—enhances personalization

2.4 E-Commerce Application Features and Design

E-commerce applications such as H&M, Uniqlo, and Zara offer essential features including product browsing, wishlists, carts, and user authentication. However, their recommendation systems are often limited to category-based filters or trending products.

Research by Chiu and Wong (2021) found that **AI-driven personalization increases customer engagement by 35%** in e-commerce environments. Thus, incorporating AI recommendations, ratings, and feedback mechanisms is key to enhancing user experience and loyalty.

Core e-commerce design considerations include:

- **Usability:** Simple, clean interfaces that support efficient browsing.
- **Security:** Safe authentication and data protection measures.
- **Responsiveness:** Mobile-first design ensuring cross-platform compatibility.

2.5 Related Systems Comparison

System	Features	AI Recommendation	Personalization	Limitation
H&M App	E-commerce browsing, cart, wishlist	No	Limited to filters	No personalization based on body data
Uniqlo App	Product listing, store locator, membership	No	Based on purchase history	No AI recommendation
Zalora	Product browsing, recommendation by brand	Basic collaborative filtering	Moderate	Does not consider style or body profile
Proposed System	AI recommendation, product feedback, style-based suggestion	Yes	High	Will be developed

The proposed system differs from competitors by integrating user body profile and style preferences into AI-driven outfit recommendations.

2.6 Summary and Evaluation

This chapter reviewed the current literature and systems relevant to fashion recommendation applications. Studies indicate that AI and machine learning significantly improve personalization in fashion e-commerce. However, current market applications lack integration between body measurement data and cultural fashion preferences.

The proposed system fills this research and commercial gap by combining both dimensions, offering a hybrid recommendation model that improves inclusivity and personalization. This literature foundation supports the project's innovation and technical feasibility.

2.7 Reference

- Chiu, T., & Wong, L. (2021). *AI Personalization in E-Commerce: User Engagement and Purchase Intentions.* Journal of Retail Technology, 14(3), 45–56.

- Liu, J., Zhang, M., & Li, S. (2023). *A Hybrid Fashion Recommendation System Using Visual and Attribute Data.* IEEE Transactions on Consumer Electronics.

- Park, Y., & Yoo, J. (2022). *Body-Aware Fashion Recommendations: Integrating Anthropometric Data in AI Models.* Computers in Industry, 139, 103–121.

Chapter 3: Methodology And Requirements Analysis

3.1 Introduction

This chapter outlines the methodology used in developing the proposed mobile clothing e-commerce application with AI-based outfit recommendations. It also discusses the requirements gathering process, requirement analysis (including diagrams), and the identification of functional and non-functional requirements. The aim is to ensure that the development process is systematic, practical, and aligned with the project objectives.

3.2 Methodology

3.2.1 Selected Development Model: Agile Development

The **Agile development model** was chosen due to its flexibility and suitability for projects that involve iterative improvements and evolving requirements. Since this project involves both AI integration and UI/UX optimization, Agile enables incremental progress through sprints, allowing feedback and adaptation at each stage.

Key Agile Phases:

1. **Planning:** Define objectives, scope, and features.
2. **Design:** Create system architecture and UI/UX mockups.
3. **Development:** Implement core modules such as authentication, product management, and AI recommendation.
4. **Testing:** Conduct functional and usability testing in each sprint.
5. **Review:** Collect supervisor and user feedback for improvement.
6. **Deployment:** Prepare the final, tested prototype for demonstration.

3.2.2 Advantages of Agile for This Project

- Allows continuous integration of AI and UI features.
- Supports dynamic adjustments based on supervisor feedback.
- Reduces project risks by ensuring deliverables at each sprint.
- Encourages collaboration and iterative testing.

3.3 Requirements Gathering Techniques

The requirements for the proposed system were collected through a combination of **primary** and **secondary** data collection methods.

Method	Description	Expected Outcome
Observation	Review of existing fashion e-commerce apps (H&M, Uniqlo, Zara, Zalora)	Identify common features and user interface standards
Online Surveys	Gather potential user preferences on AI outfit recommendations and privacy concerns	Understand user expectations and acceptance of AI features
Literature Review	Analyze existing research on recommender systems and e-commerce design	Identify technological gaps and feasible AI approaches
Consultation with Supervisor	Discuss scope, limitations, and risk management	Validate feasibility within the FYP timeframe

3.4 Requirements Analysis

The requirements analysis focuses on defining system components, data flow, and interactions between users and the system.

3.4.1 Use Case Diagram

Main Actors:

- **User:** Browse products, receive recommendations, rate/comment, manage profile.
- **Admin:** Manage product listings and monitor user activities.

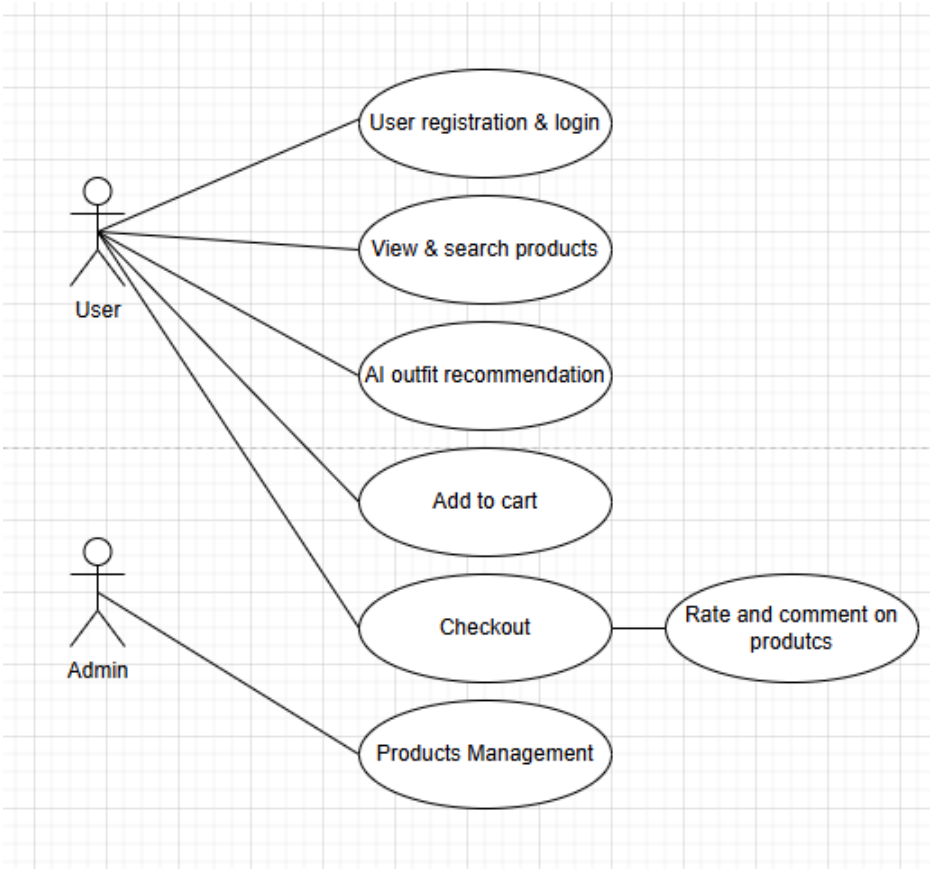
Use Cases:

- User registration/login
- View and search products
- AI outfit recommendation
- Add to cart/wishlist
- Rate and comment on products
- Checkout
- Manage user profile
- Admin product management

3.4.2 Data Flow Diagram (DFD) – Level 0

Process Overview:

1. **User inputs** personal details and style preferences.
2. **System retrieves** relevant product data from the database.
3. **AI model processes** inputs and generates outfit recommendations.
4. **User views** recommended products and may add them to cart or wishlist.
5. **System stores** user ratings and feedback for iterative improvement.



3.5 Functional and Non-Functional Requirements

3.5.1 Functional Requirements

ID	Description
FR1	Users can register and log in securely.
FR2	Users can browse clothing products by gender, category, and style.

FR3	AI models recommend outfits based on height, weight, and style preference.
FR4	Users can add items to cart or wishlist.
FR5	Users can rate and comment on purchased or viewed items.
FR6	Admin can manage product listings and review user activity.
FR7	The system stores user data securely and retrieves it efficiently.
FR8	The user can perform a payment during checkout to confirm an order.

3.5.2 Non-Functional Requirements

ID	Description
NFR1	**Performance:** The system must return recommendations within 3 seconds.
NFR2	**Security:** User authentication and data must be protected via encryption.
NFR3	**Usability:** Interface must be simple, responsive, and mobile-friendly.
NFR4	**Scalability:** The system should accommodate future dataset expansion.
NFR5	**Maintainability:** Code should be modular to allow future upgrades.
NFR6	**Reliability:** The app must maintain uptime of at least 95% during testing.

3.6 Chapter Summary and Evaluation

This chapter presented the development methodology, requirements gathering methods, and system analysis for the proposed project. The **Agile model** was selected for its adaptability, enabling iterative development of AI and e-commerce features.

By clearly defining both functional and non-functional requirements, this chapter ensures that the project objectives are measurable, feasible, and technically grounded.

The methodology demonstrates structured planning and technical realism, increasing the project's feasibility and reliability within the FYP timeframe.

CHAPTER 4 – SYSTEM DESIGN

4.1 System Overview / Workflow Design

This section provides a high-level overview of how the clothing e-commerce application with AI outfit recommendation operates from input to output.

4.1.1 System Workflow Steps

The system workflow defines all major interactions a user performs within the mobile fashion e-commerce application, including the integrated AI-based outfit recommendation module. The workflow ensures a consistent, user-centered process from application launch to order tracking and profile management.

The complete workflow steps are outlined as follows:

1. **Application Launch**
    - The user opens the application on a mobile device.
    - The system initializes and loads the Home Screen.

2. **Home Screen Interaction**
    - The user is presented with key options including browsing categories, searching products, accessing AI recommendations, and managing the user profile.

3. **AI Recommendation Module (Optional Path)**
    - The user selects the AI Recommendation feature.
    - The system prompts the user to input height, weight, and preferred fashion style (e.g., Japanese, Korean, European).
    - The AI Recommendation Engine processes the inputs.
    - The system retrieves recommended outfits based on user attributes and style preferences.
    - The recommended product list is displayed to the user.
    - The user may click on any recommended item to open the Product Page.

4. **Browsing Categories**
    - The user selects a category such as Men, Women, Kids, or Accessories.
    - The system retrieves relevant product listings from the database.
    - Product items are displayed according to the selected category.

5. **Searching Products**
    - The user enters keywords into the search bar.
    - The system retrieves matching products based on search criteria.

6. **Viewing Product Details**
    - The user selects a product from search results, category lists, or AI recommendations.
    - The system displays product details including description, size availability, images, and reviews.

- The user may add the item to the Cart or Wishlist.

7. **Adding Items to Wishlist or Cart**
   - The user adds desired items to the Wishlist for future reference.
   - Alternatively, the user may add items directly to the Cart for purchase.
   - The system updates the corresponding list and confirms the action.

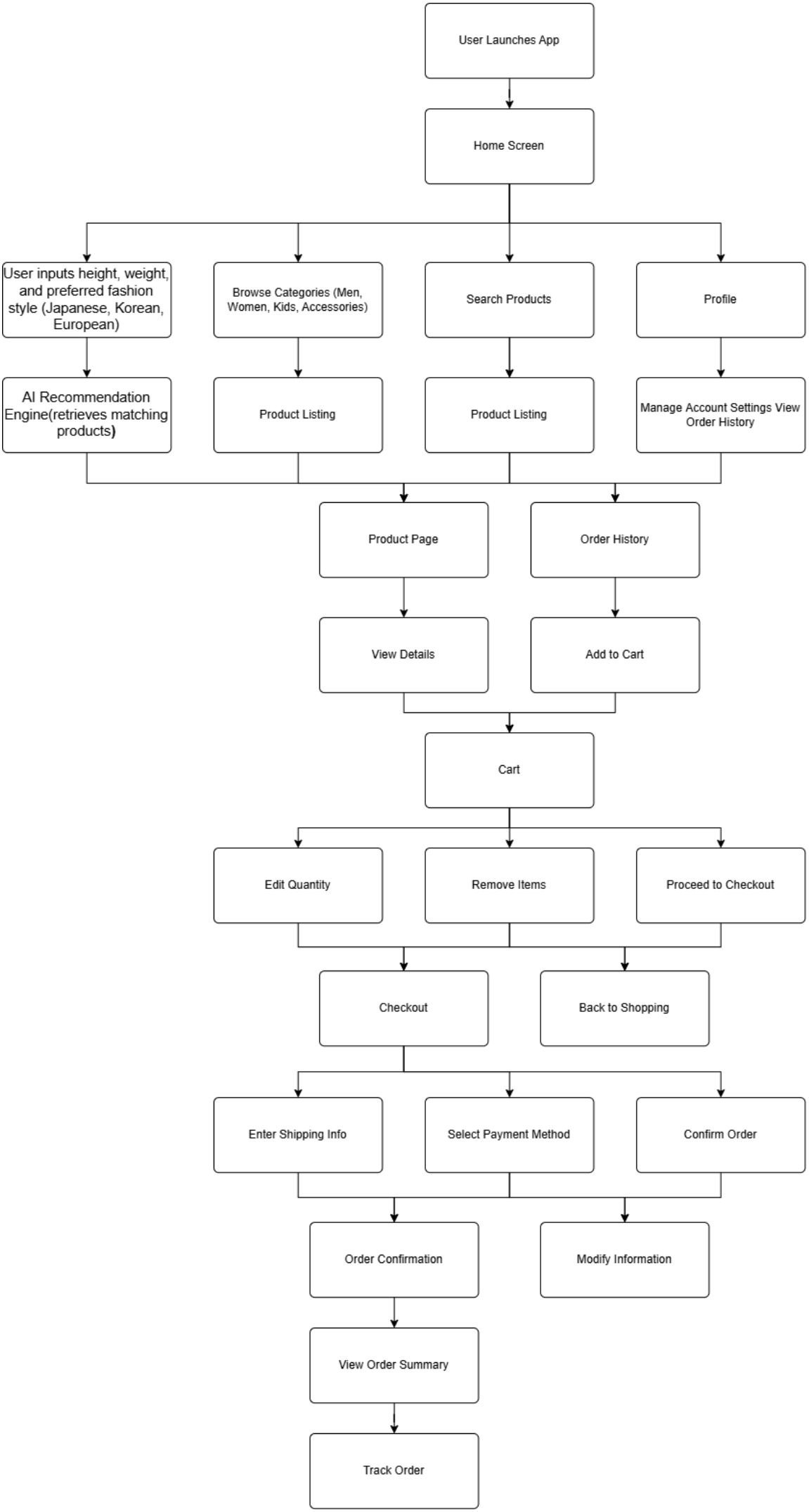
8. **Cart Management**
   - The user navigates to the Cart to review selected items.
   - The user may update quantities, remove items, or continue shopping.
   - When ready, the user proceeds to Checkout.

9. **Checkout Process**
   - The user enters shipping information including name, address, and contact number.
   - The user selects a preferred payment method (e.g., card, online banking, e-wallet).
   - The system prepares the order for confirmation.

10. **Order Confirmation**
    - A summary of the order is displayed, including product details, total cost, delivery information, and payment method.
    - The user confirms the order.
    - The system records the order and displays the Order Confirmation page.

11. **Order Summary & Tracking**
    - The system generates a detailed Order Summary.
    - The user may monitor delivery progress through the Track Order feature.

12. **User Profile Management**
    - The user accesses the Profile page from the Home Screen.
    - Functions include viewing order history, updating personal information, and managing account settings.
    - Changes are saved in the database.


User Launches App
Home Screen
User inputs height, weight, and preferred fashion style (Japanese, Korean, European)
Browse Categories (Men, Women, Kids, Accessories)
Search Products
Profile
AI Recommendation Engine(retrieves matching products)
Product Listing
Product Listing
Manage Account Settings View Order History
Product Page
Order History
View Details
Add to Cart
Cart
Edit Quantity
Remove Items
Proceed to Checkout
Checkout
Back to Shopping
Enter Shipping Info
Select Payment Method
Confirm Order
Order Confirmation
Modify Information
View Order Summary
Track Order

4.1.2 Workflow Diagram (Description)

The workflow diagram visually represents the system's operational sequence, including the integration of the AI Recommendation Engine. The diagram begins with the Application Launch and flows into the Home Screen, which acts as the central navigation hub for all major user operations.

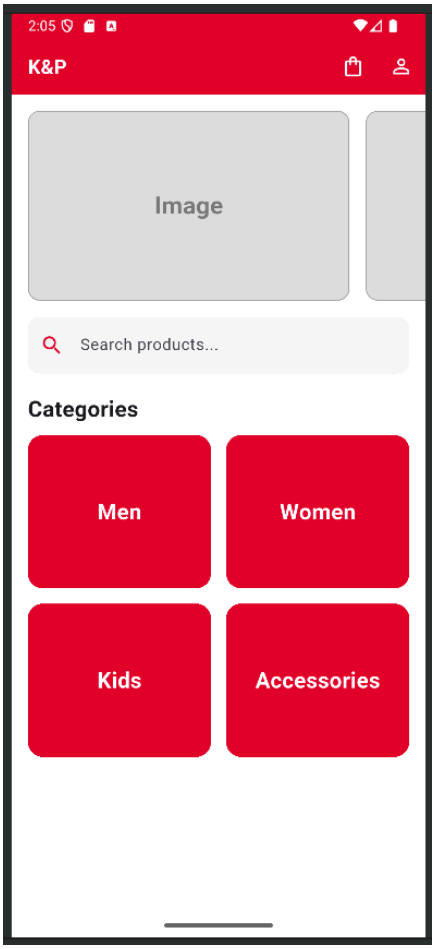
To the right of the main flow, an additional branch illustrates the AI Recommendation Path. When the user selects the AI Recommendation feature, the system prompts for height, weight, and preferred style (Japanese, Korean, European). These inputs flow into the AI Recommendation Engine, where the model analyzes attributes and retrieves suitable outfit suggestions. The recommended product list is then displayed, and the flow converges seamlessly back into the standard Product Page sequence.

The core browsing flow includes category selection, product searching, viewing product details, and adding items to Wishlist or Cart. This leads to Cart Management and eventually transitions to the Checkout process, which comprises entering shipping details, choosing a payment method, and confirming the order. The diagram then concludes with Order Summary, Order Tracking, and Profile Management.

Overall, the diagram clearly demonstrates the interaction between standard e-commerce functions and the AI-driven personalization feature. The AI path is intentionally placed adjacent to the Browsing Categories block to indicate that users may choose either manual exploration or AI-assisted recommendations, both ultimately leading to the Product Page.

4.2 User Interface (UI) / System Interaction Design

4.2.1 UI Wireframe Description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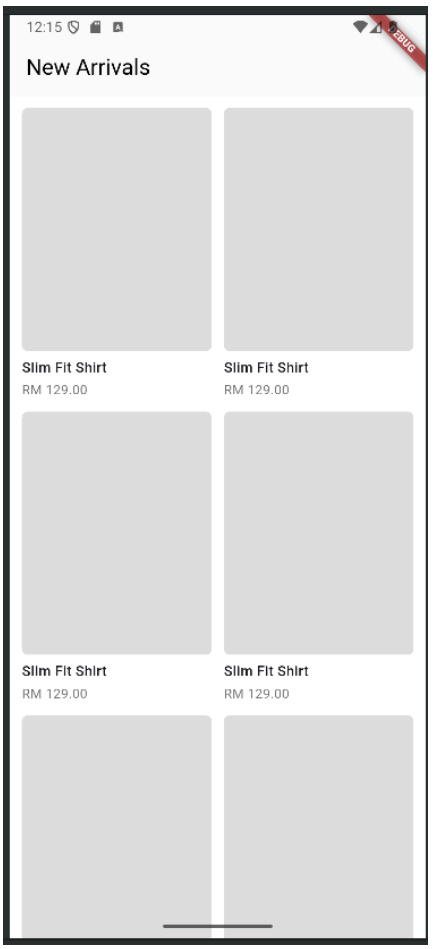
K&P
Image
Search products...
Categories
Men
Women
Kids
Accessories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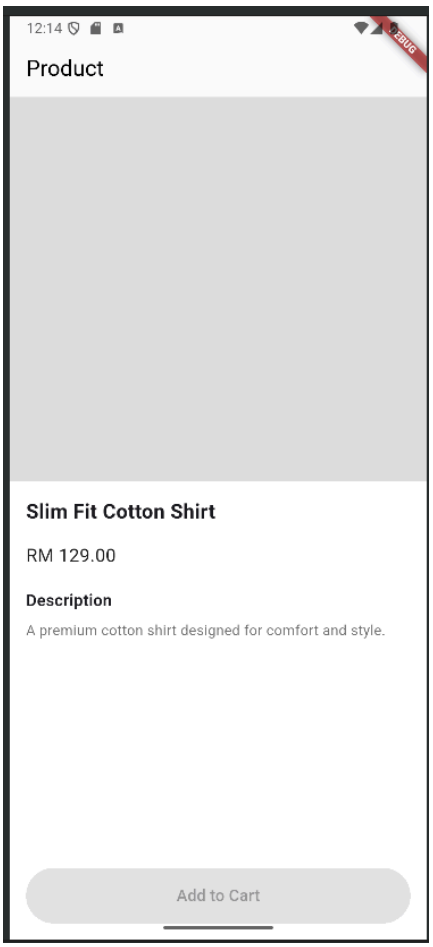
Slim Fit Shirt
RM 129.00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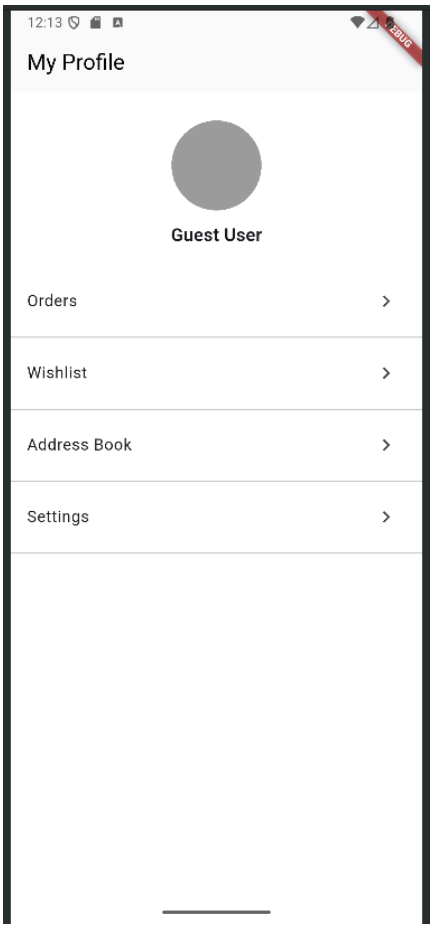
Product
Slim Fit Cotton Shirt
RM 129.00
Description
A premium cotton shirt designed for comfort and style.
Add to Cart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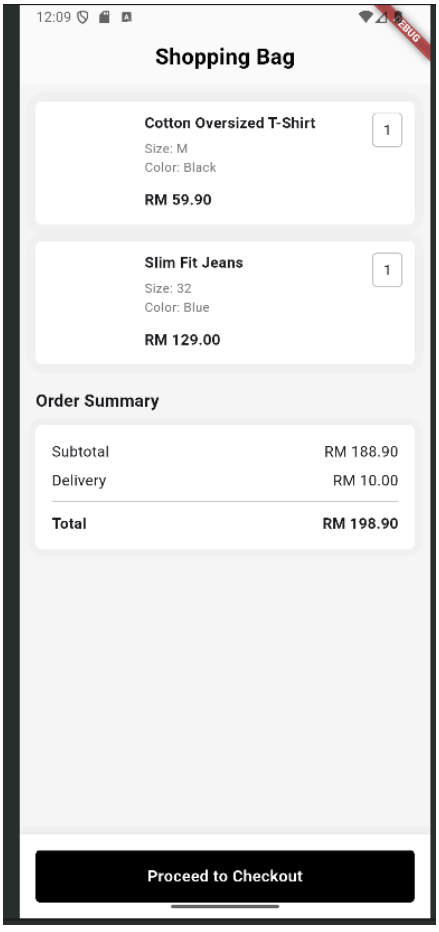
My Profile
Guest User
Orders
Wishlist
Address Book
Settings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Total
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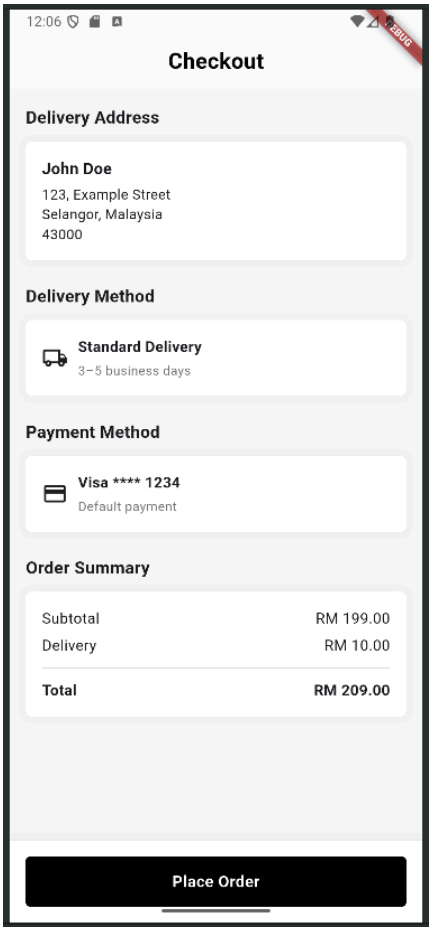
Proceed to Checkout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Delivery Method
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Total
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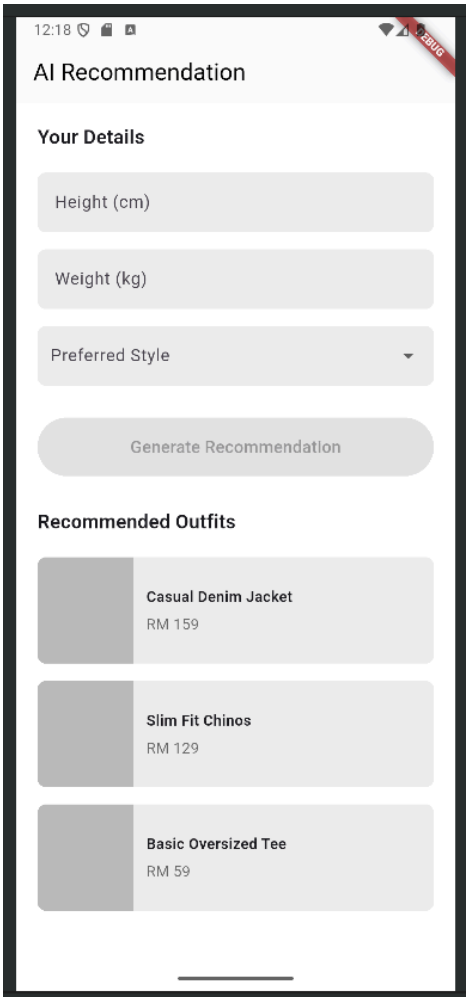
Place Order



Home Screen

- Shows main shopping categories such as **Men**, **Women**, and **Unisex**.
- Provides quick access to **Recommended for You** and **Trending** sections.

Login & Registration Screen

- Allows users to enter **email** and **password**.
- Designed for future integration with **Firebase/Flutter authentication**.

Product List Screen

- Displays products filtered by **gender**, **style**, or **category**.
- Each product card includes **View Details** and **Add to Cart** options.

Product Details Screen

- Shows a large product image, price, and description.
- Displays user ratings and comments.
- Includes **Add to Cart** and **Add to Wishlist** buttons.

AI Recommendation Screen

- Contains input fields for **height**, **weight**, and **preferred style**.
- A **Generate Recommendation** button produces a list of suggested outfits.

Cart & Checkout Screen

- Displays all selected items.
- Includes a **Simulated Payment** option that confirms an order.

User Profile Screen

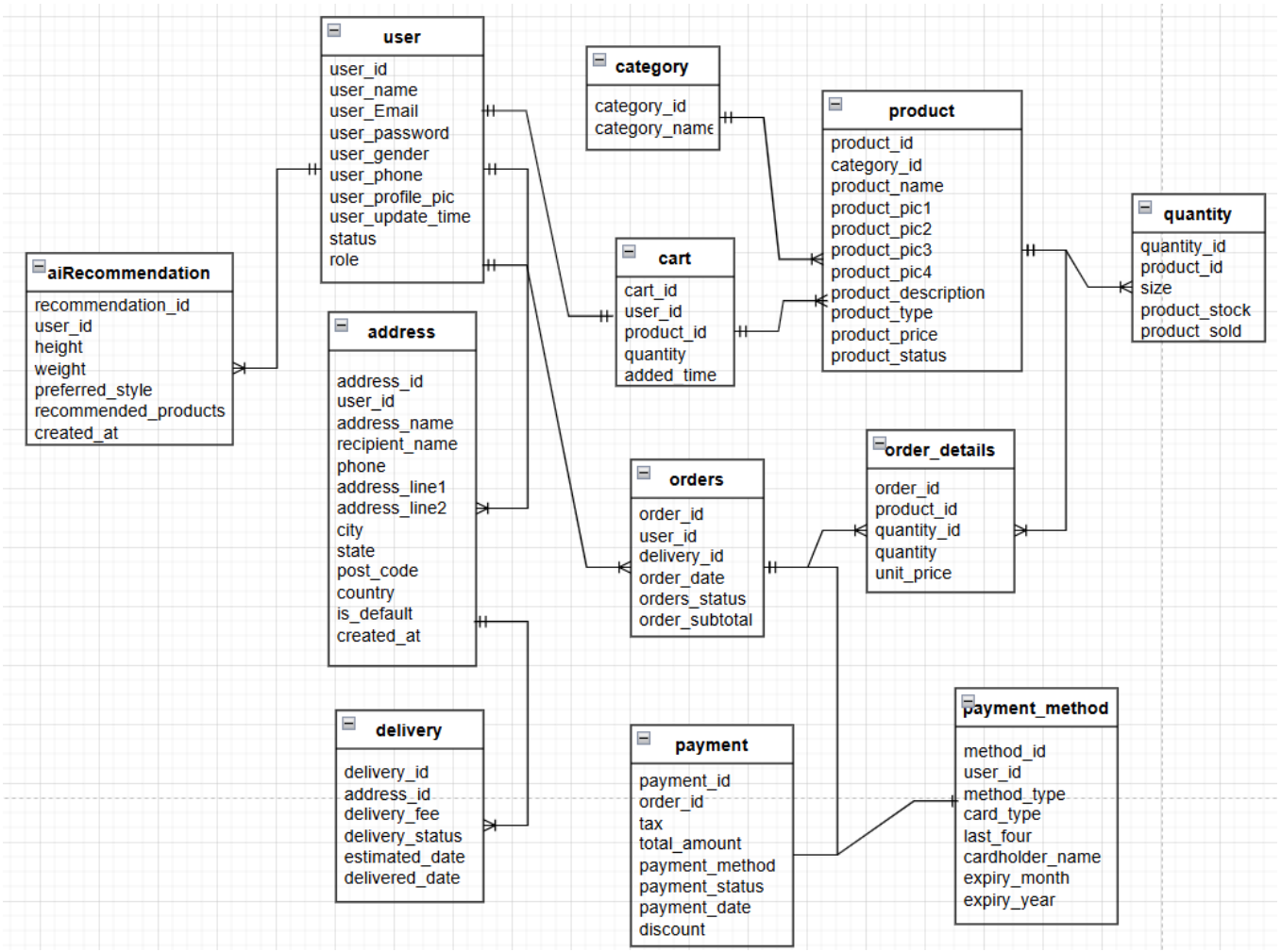
- Allows users to edit their profile.
- Provides access to **order history** and **wishlist**.

4.3 Data Design

4.3.1 Entity Relationship Diagram (ERD)

Your ERD includes these entities:

Entity	Key Attributes
User	**user_id**, user_name, user_email, user_password, user_gender, user_phone, user_profile_pic, user_update_time, status, role
Category	**category_id**, category_name
Product	**product_id**, category_id, product_name, product_pic1, product_pic2, product_pic3, product_pic4, product_description, product_type, product_price, product_status
Quantity	**quantity_id**, product_id, size, product_stock, product_sold
Cart	**cart_id**, user_id, product_id, quantity, added_time
Orders	**order_id**, user_id, delivery_id, order_date, orders_status, order_subtotal
Order_Details	**order_id**, product_id, quantity_id, quantity, unit_price
Address	**address_id**, user_id, address_name, recipient_name, phone, address_line1, address_line2, city, state, post_code, country, is_default, created_at
Delivery	**delivery_id**, address_id, delivery_fee, delivery_status, estimated_date, delivered_date
Payment	**payment_id**, order_id, user_id, tax, total_amount, payment_method, payment_status, payment_date, discount
Payment_Method	**method_id**, user_id, method_type, card_type, last_four, cardholder_name, expiry_month, expiry_year
ai_Recommendation	**recommendation_id**, user_id, height, weight, preferred_style, recommended_products, created_at



4.3.2 Class Diagram

Class	Attributes	Methods
User	user_id, user_name, user_email, user_password, height, weight, style_preference, gender, phone, profile_pic	login(), updateProfile(), viewRecommendations()
Product	product_id, product_name, category_id, description, product_type, price, status, images[], stock	getDetails(), getStock()
Category	category_id, category_name	listProducts()
Quantity (ProductVariant)	quantity_id, product_id, size, stock, sold	updateStock()
Cart	cart_id, user_id	addItem(), removeItem(), clearCart(), getTotal()

Orders	order_id, user_id, delivery_id, subtotal, order_date, status	placeOrder(), cancelOrder()
OrderDetails	order_id, product_id, quantity_id, quantity, unit_price	calculateSubtotal()
Address	address_id, user_id, name, phone, full_address, is_default	setDefault(), updateAddress()
Delivery	delivery_id, address_id, fee, status, estimated_date, delivered_date	updateStatus()
Payment	payment_id, order_id, user_id, payment_method, payment_date, total_amount	processPayment()
PaymentMethod	method_id, user_id, method_type, card_type, last_four, expiry_month, expiry_year	validate(), remove()
AIRecommendation	recommendation_id, user_id, height, weight, preferred_style, recommended_products	generateRecommendation(), getRecommendedProducts()

4.3.3 Database Schema

Table: User

Field	Type	Description
user_id	varchar	Primary key
user_name	varchar	User’s full name
user_email	varchar	Email address
user_password	varchar	Hashed password
user_gender	enum	Male / Female / Other
user_phone	varchar	Contact number
user_profile_pic	varchar	Profile picture URL
user_update_time	timestamp	Last updated time

status	enum	Active / Inactive
role	varchar	User role (e.g., customer/admin)

Table: Category

Field	Type	Description
category_id	varchar	Primary key
category_name	varchar	Clothing category

Table: Product

Field	Type	Description
product_id	varchar	Primary key
category_id	varchar	Foreign key → Category
product_name	varchar	Product name
product_pic1	varchar	Image URL 1
product_pic2	varchar	Image URL 2
product_pic3	varchar	Image URL 3
product_pic4	varchar	Image URL 4
product_description	varchar	Description
product_type	enum	Type (e.g., shirt/pants)
product_price	decimal	Product price
product_status	enum	Active / Inactive

Table: Quantity (Product Variant)

Field	Type	Description
quantity_id	int	Primary key
product_id	varchar	Foreign key → Product
size	enum	S / M / L / XL
product_stock	int	Available stock
product_sold	int	Total sold

Table: Cart

Field	Type	Description
cart_id	varchar	Primary key
user_id	varchar	Foreign key → User
product_id	varchar	Foreign key → Product
quantity	int	Quantity added
added_time	timestamp	Added date/time

Table: Orders

Field	Type	Description
order_id	varchar	Primary key
user_id	varchar	Foreign key → User
delivery_id	varchar	Foreign key → Delivery
order_date	datetime	Order date
orders_status	enum	Pending / Shipped / Delivered
order_subtotal	decimal	Final subtotal

Table: Order_Details

Field	Type	Description
order_id	varchar	Foreign key → Orders
product_id	varchar	Foreign key → Product
quantity_id	int	Foreign key → Quantity
quantity	int	Item quantity
unit_price	decimal	Price per item

Table: Address

Field	Type	Description
address_id	varchar	Primary key

user_id	varchar	Foreign key → User
address_name	varchar	Label (Home/Work)
recipient_name	varchar	Receiver name
phone	varchar	Recipient phone
address_line1	varchar	Address line 1
address_line2	varchar	Address line 2
city	varchar	City
state	varchar	State
post_code	varchar	Postal code
country	varchar	Country
is_default	tinyint	1 = Default address
created_at	timestamp	Creation date

Table: Delivery

Field	Type	Description
delivery_id	varchar	Primary key
address_id	varchar	Foreign key → Address
delivery_fee	decimal	Shipping cost
delivery_status	enum	Pending / In Transit / Delivered
estimated_date	date	Expected delivery date
delivered_date	date	Actual delivery date

Table: Payment

Field	Type	Description
payment_id	varchar	Primary key
order_id	varchar	Foreign key → Orders

user_id	varchar	Foreign key → User
tax	decimal	GST / VAT
total_amount	decimal	Final total after tax
payment_method	varchar	Payment type (card/cash/etc.)
payment_status	enum	Paid / Failed
payment_date	datetime	Payment timestamp
discount	decimal	Applied discount

Table: Payment_Method

Field	Type	Description
method_id	varchar	Primary key
user_id	varchar	Foreign key → User
method_type	enum	Card / FPX / E-wallet
card_type	varchar	Visa / Master / Etc
last_four	varchar	Last 4 digits
cardholder_name	varchar	Card holder
expiry_month	int	Expiry MM
expiry_year	int	Expiry YYYY

Table: AIRecommendation

Field	Type	Description
recommendation_id	int	Primary key
user_id	varchar	Foreign key → User
height	float	User height
weight	float	User weight
preferred_style	varchar	Japanese/Korean/European
recommended_products	JSON	AI selected product IDs

created_at	timestamp	Recommendation date

4.4 Software Architecture Design

4.4.1 Layers

1. **Presentation Layer (Flutter Mobile App)**

This layer is built using **Flutter** and serves as the user interface of the system.

Key responsibilities:

- Display UI components (product cards, recommendations, cart screen)
- Send/receive data through REST API
- Manage app state (e.g., Provider, Bloc, GetX)
- Handle user interactions such as:
    - Logging in
    - Browsing clothing items
    - Adding to cart
    - Viewing recommendations
    - Simulating orders

Flutter ensures cross-platform performance on both **Android and iOS**.

2. **Application Layer (Backend API)**

The backend handles all the system logic and AI operations.

Key responsibilities:

- **Authentication** (login, JWT token, sessions)
- **Product management** (search, filtering, stock updates)
- **Cart and wishlist logic**
- **Order simulation and payment simulation**
- **AI Recommendation Engine**:
    - Dataset preprocessing
    - User style + body measurement analysis
    - ML model inference
    - Generating recommended product list
    - Storing results in AIRecommendation table

The backend returns JSON data to Flutter through REST APIs.

3. **Data Layer**

Responsible for long-term data storage.

- **SQL database** (MySQL/PostgreSQL) containing:
    - User
    - Product

- Cart
- AIRecommendation
- Order (Simulated)
- Delivery
- Payment

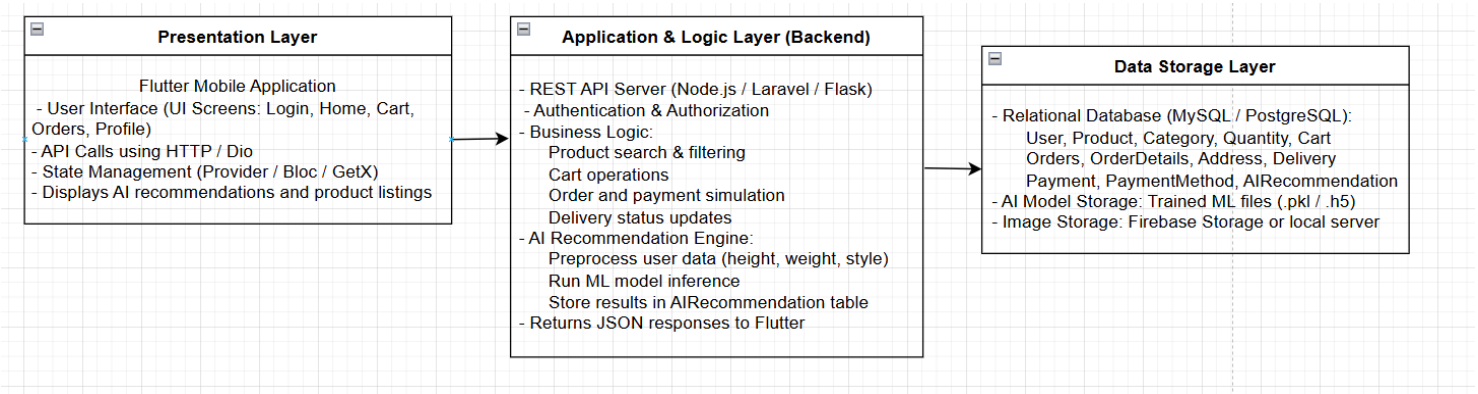
- **AI model storage**

  Saved files like .pkl or .h5 for machine learning models.

- **Image storage**

  Could be Firebase Storage or your own backend server.

4.4.2 Architecture Diagram



4.5 Process Design

4.5.1 Login Validation Process

1. The user enters their **email** and **password** in the Flutter application.

2. The app sends the credentials to **Firebase Authentication** for validation.

3. Firebase performs the following checks:
   a. Whether the email exists
   b. Whether the password matches
   c. Whether the account is active/verified

4. If the credentials are **valid**, Firebase returns a success response and the user is logged in.

5. If the credentials are **invalid**, Firebase returns an error message (e.g., “Incorrect email or password”).

6. The Flutter app displays the corresponding success or error notification.

4.5.2 AI Recommendation Process

1. The user inputs body measurement and style information:
    a. **Height**
    b. **Weight**
    c. **Preferred clothing style**
2. The Flutter app sends the data to the **AI Model API**.
3. The backend API preprocesses the data and:
    a. Filters products based on selected style
    b. Applies the ML recommendation model
    c. Calculates **compatibility scores** for each product
4. The AI engine generates a list of recommended products.
5. The backend stores the results in the AIRecommendation table.
6. The API sends the recommended product list back to the Flutter app.
7. The app displays the recommendations to the user in the UI.

4.5.3 Simulated Payment Process

1. The user reviews items added to the shopping cart.
2. The user taps **"Proceed to Payment"**.
3. The system performs a **simulated payment operation**:
    a. The user reviews items added to the shopping cart.
    b. The user taps **"Proceed to Payment"**.
    c. The system performs a **simulated payment operation**:
4. The system sets the payment status to '**successful'** and links the order to a mock payment entry.
5. The Flutter app displays the confirmation screen:
    a. "Order Successful"
    b. Order ID
    c. Summary of purchased items

4.6 Algorithm / Model Design

The AI component of the system generates personalized clothing recommendations based on user body measurements, style preferences, and product attributes. The solution uses a **Hybrid Recommendation Algorithm**, combining **Content-Based Filtering** with a **Lightweight Machine Learning Model**.

4.6.1 Algorithm Overview and Justification

Design Element	Description
Algorithm Name	Hybrid Recommendation Algorithm (Content-Based Filtering + ML Scoring)

Justification	Content-based filtering provides accurate matches based on style, while the ML model improves personalization by learning hidden patterns such as user size compatibility and product popularity. This hybrid approach overcomes cold-start issues and works well with small to medium datasets.
Primary Goal	Recommend products that best match the user's height, weight, gender, and preferred fashion style.

4.6.2 Model Input Features

User Features

- Height
- Weight
- Gender
- Style preference (e.g., Japanese, Korean, European)

Product Features

- Category (Men/Women/Unisex)
- Style
- Type of clothing
- Available sizes
- Price
- Popularity score (based on sales)

4.6.3 Model Architecture

Model Layers

Layer	**Description**
Input Layer	Encoded user features + encoded product features
Hidden Layer 1	32 neurons, ReLU activation
Hidden Layer 2	16 neurons, ReLU activation
Output Layer	1 neuron, Sigmoid activation → outputs compatibility probability (0–1)

4.6.4 Activation & Loss Functions

Component	**Description**
Activation (Hidden Layers)	ReLU — chosen for fast training and stability

Activation (Output Layer)	Sigmoid — used for binary-like compatibility scoring
Loss Function	Binary Cross-Entropy, suitable for probability predictions
Optimizer	Adam optimizer for efficient training

4.6.5 Compatibility Scoring Formula

Before feeding data into the ML model, the algorithm calculates a baseline **compatibility score**:

Score=w1(StyleMatch)+w2(SizeFit)+w3(Popularity)Score = w_1(StyleMatch) + w_2(SizeFit) + w_3(Popularity)Score=w1(StyleMatch)+w2(SizeFit)+w3(Popularity)

Where:

- StyleMatch = 1 if matches, else between 0–0.5
- SizeFit = estimated fit from BMI & product sizing
- Popularity = normalized sales count

Weights:

- w1 = 0.5
- w2 = 0.3
- w3 = 0.2

4.6.6 Final Prediction Equation

The final recommendation score combines both algorithms:

FinalScore=0.6(CompatibilityScore)+0.4(MLProbability)FinalScore = 0.6(CompatibilityScore) + 0.4(MLProbability)FinalScore=0.6(CompatibilityScore)+0.4(MLProbability)

Where:

- CompatibilityScore = rule-based score
- MLProbability = neural network output (0–1)

4.7 Security Design

Security Measures Implemented

Area	Design Approach

Authentication	Firebase Authentication (email/password login)
Password Storage	Secure encrypted hashing handled by Firebase (SHA-256 / salted hashing)
Data Privacy	Only minimal data collected; height/weight optional; no sensitive or personally identifiable data stored in AI datasets
Secure Communication	All API requests and data transfers use HTTPS
Database Access Control	Role-based access control (Admin vs User) to restrict product and order management operations
Session Handling	Token-based authentication (Firebase tokens) with automatic expiration
AI Training Data Ethics	User IDs anonymized; no raw personal data used for model training
Local Storage Security	Sensitive values (tokens) stored using secure Flutter storage mechanisms
Input Validation	API validates all inputs to prevent SQL injection and malformed requests

4.8 Chapter Summary and Evaluation

This chapter outlined the system's design in detail, covering the architectural structure, algorithms, data flow, class and database design, and security mechanisms. A layered architecture using Flutter, a backend API, and a database was defined to ensure scalability and maintainability. The AI recommendation engine design, including model inputs, architecture, and algorithm logic, was also presented to demonstrate how personalized recommendations are generated.

The security design further ensures that user data, authentication processes, and AI datasets are handled responsibly and safely throughout the system.

In conclusion, the proposed system architecture, workflow diagrams, database schema, and algorithm design show that the solution is technically feasible and ready for implementation. The next chapter will focus on developing the system based on this design and conducting functional and performance testing to validate the implementation.

GENERAL FORMATTING, LANGUAGE, AND ACADEMIC WRITING FEEDBACK