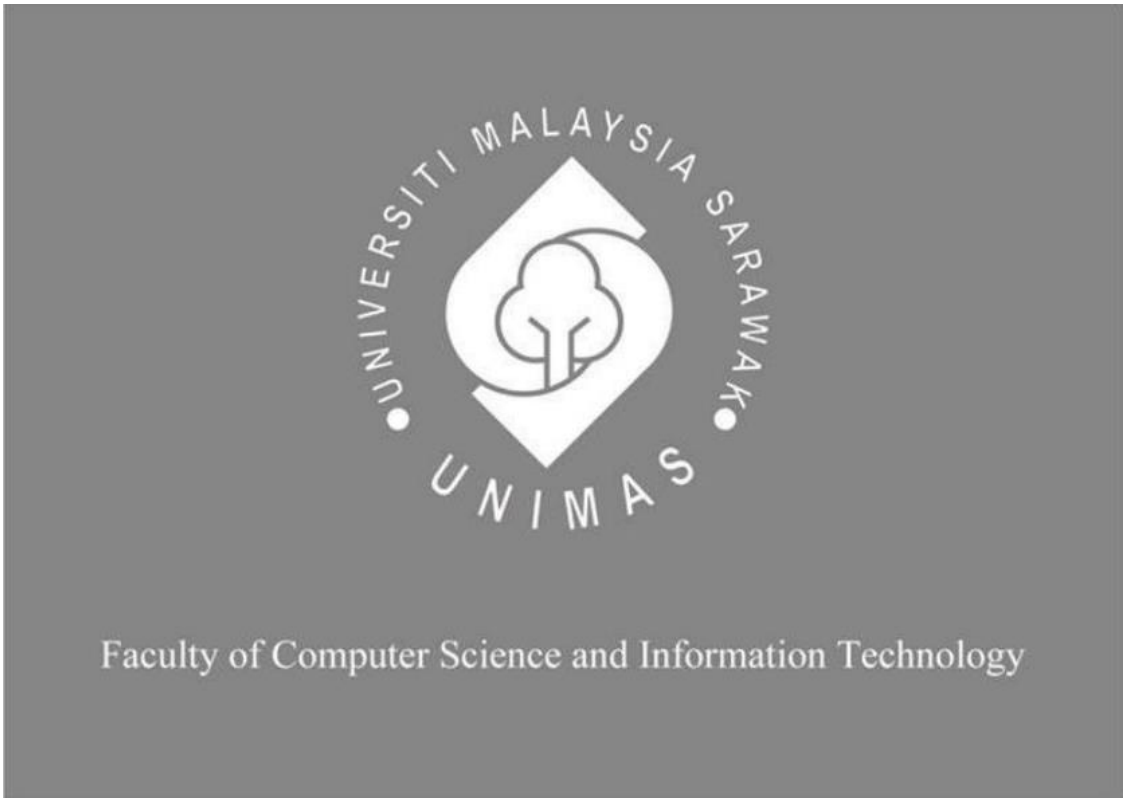

BEAUTYBOT: AI-BASED SKINCARE PRODUCT ANALYZER AND RECOMMENDER

Siti Nur Azizah Binti Zamadil

Bachelor of Software Engineering with Honours

2025

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SITI NUR AZIZAH BINTI ZAMADIL

78537

This project is submitted in partial fulfilment of

requirements for the degree of

Bachelor of Software Engineering with Honours

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UNIVERSITI MALAYSIA SARAWAK

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Ijazah Sarjana Muda Kejuruteraan Perisian dengan Kepujian

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ABSTRACT

The skincare industry has witnessed rapid growth, driven by increased consumer awareness and technological advancements. However, the overwhelming variety of skincare products and the complexity of ingredient formulations often leave consumers uncertain about the best choices for their unique skin needs. This project, titled "BeautyBot: AI-Based Skincare Product Analyzer and Recommender," aims to address this issue by developing a personalized skincare recommendation system. BeautyBot leverages artificial intelligence and machine learning to analyse user data collected through an interactive questionnaire and provide tailored skincare routines and product suggestions. The system features a comprehensive product database, dynamic adaptability to changing user preferences, and a user-friendly interface. By offering personalized, science-backed recommendations, BeautyBot seeks to enhance user satisfaction, reduce trial-and-error in product selection, and improve overall skincare outcomes. This report details the requirements, design, development, and potential impact of BeautyBot as an innovative solution in the skincare industry.

ABSTRAK

Industri penjagaan kulit telah menyaksikan pertumbuhan pesat, didorong oleh peningkatan kesedaran pengguna dan kemajuan teknologi. Namun, pelbagai produk penjagaan kulit yang terlalu banyak dan kerumitan formulasi bahan sering membuat pengguna keliru tentang pilihan terbaik untuk keperluan kulit mereka. Projek ini, bertajuk "BeautyBot: AI-Based Skincare Product Analyzer and Recommender," bertujuan untuk menangani isu ini dengan membangunkan sistem cadangan penjagaan kulit yang diperibadikan. BeautyBot menggunakan kecerdasan buatan dan pembelajaran mesin untuk menganalisis data pengguna yang dikumpulkan melalui soal selidik interaktif dan menyediakan rutin penjagaan kulit serta cadangan produk yang disesuaikan. Sistem ini dilengkapi dengan pangkalan data produk yang komprehensif, keupayaan untuk menyesuaikan diri dengan perubahan keutamaan pengguna, dan antara muka mesra pengguna. Dengan menawarkan cadangan yang diperibadikan dan berasaskan sains, BeautyBot bertujuan untuk meningkatkan kepuasan pengguna, mengurangkan cubaan dan kesilapan dalam pemilihan produk, serta memperbaiki hasil penjagaan kulit secara keseluruhan. Laporan ini merangkumi keperluan, reka bentuk, pembangunan, dan potensi impak BeautyBot sebagai penyelesaian inovatif dalam industri penjagaan kulit.

CHAPTER 1: INTRODUCTION

1.1 Introduction

The skincare industry has seen rapid growth in recent years, driven by the rise of social media, e-commerce platforms, beauty influencers, and greater consumer awareness of personal care. As skincare routines become more detailed, consumers are spending more on various products, from cleansers and toners to serums and moisturizers, all in the hopes of achieving healthier, glowing skin. This trend is not just about looking good, it's about feeling good, with people choosing products tailored to their individual skincare needs. As a result, the skincare market has expanded, offering a wide range of options for self-care and beauty.

However, the huge variety of products has created a challenge for consumers (B et al., 2024). Many people feel confused and unsure about which products truly suit their skin. Factors like skin type, specific issues (such as acne, aging, or dryness), and sensitivity to certain ingredients make choosing skincare products difficult and time-consuming. Without expert guidance, many people rely on trial and error, which can lead to disappointing results, skin irritation, or wasted money. This shows a clear need in the market for personalized, science-based skincare advice to help people make better choices for their unique skin.

BeautyBot is an AI-based tool designed to solve this problem by offering a customized skincare experience. Using artificial intelligence and machine learning, BeautyBot looks at a large database of skincare products, analysing their ingredients to create recommendations tailored to each user. Users will create a profile with details like their skin type, main concerns, and preferences. Based on this information, BeautyBot will suggest suitable products and even provide a morning and evening routine to help users get the best results from their skincare. By

making product selection easier and providing step-by-step guidance, BeautyBot aims to make skincare simpler, more effective, and enjoyable.

Unlike general product reviews or one-size-fits-all recommendations, BeautyBot's AI approach allows it to keep learning from user feedback, improving its suggestions over time. It considers not just the user's profile but also how ingredients interact, offering insights into how specific products will work for everyone's skin. This level of personalization is rare in the skincare market, where advice is often too general. BeautyBot fills this gap by providing data driven, personalized advice that helps users make better choices, avoid trial and error, and achieve improved skincare results.

The demand for personalized skincare solutions is growing fast, as more people look for products and routines that suit their unique needs and preferences (Kania et al., 2024). BeautyBot is in a great position to meet this trend, combining advanced technology with a user-friendly design to transform the skincare experience. As an AI-based tool, BeautyBot has the potential to become a trusted skincare assistant, helping users navigate a complex market and achieve their skincare goals with confidence.

1.2 Problem Statement

With thousands of skincare products on the market, selecting the right product for one's specific needs can be overwhelming (Miryabbelli et al., 2024). Many consumers also struggle to understand how different ingredients work and which products are suitable for their unique skin profiles. This can lead to ineffective skincare routines and sometimes adverse reactions. Many existing skincare apps and online tools provide users with insights into product ingredients, potential allergens, and general product recommendations. However, they often lack the level of personalized detail that users need to select products suited specifically to their

unique skin profiles, such as skin type, specific concerns (like acne or aging), and individual sensitivities to certain ingredients.

Moreover, while some skincare apps provide basic ingredient analysis, they often overlook the complex interactions between various ingredients and how these may impact different skin types. This lack of detailed, personalized guidance pushes many consumers into a frustrating cycle of trial and error, which can lead to skin irritation, disappointing results, or wasted money on ineffective products. This highlights a significant gap in the market for a personalized solution that tailors recommendations, provides structured routines, and adapts based on user feedback.

While skincare apps have grown in popularity, they face notable challenges that limit their effectiveness. Many apps use outdated databases, leading to recommendations that do not reflect new products or reformulated versions of existing ones. Additionally, these platforms often provide generalized advice rather than addressing users' unique skincare concerns, offering limited flexibility in adapting recommendations to evolving skin conditions. Some apps lack transparency about ingredient safety and efficacy, leaving users uncertain about the scientific reliability of the suggestions. Furthermore, the absence of advanced machine learning techniques prevents these apps from learning and improving based on user preferences and feedback. These issues emphasize the need for a more innovative, dynamic solution to address these gaps in the existing skincare applications.

1.3 Scope

- User Profile and Preferences: Users can create a profile and provide details about their skin type, specific concerns, and preferences. Users will complete a questionnaire designed to assess their skin type (oily, dry, combination or sensitive).

- AI-Based Recommendation Engine: The AI model will generate personalized product suggestions by evaluating the user's profile against a database of skincare products.
- Personalized Skincare Routines: The system will generate tailored skincare routines that outline specific products and application techniques for morning and evening routines, helping users adhere to a structured skincare plan.

1.4 Aims and Objectives

- To develop an AI-powered skincare product analyser that evaluates product ingredients and recommends personalized options based on user skin data (type, concerns, and preferences) collected through an easy-to-complete questionnaire.
- To develop a system that generates personalized morning and evening skincare routines based on the user's skin type and concerns, recommending specific products and techniques.
- To offer a comparative analysis tool where users can compare recommended products side-by-side in terms of ingredients, suitability, and price.

1.5 Brief Methodology

The development of BeautyBot will follow the Agile methodology, which allows for flexibility and continuous improvement throughout the project. Agile is structured around iterative cycles known as Sprints, allowing development, test and refine the application in manageable stages (Laoyan, 2024). Key stages of the Agile process for this project are as follows:

Planning Phase

The Agile process begins with planning, which involves gathering requirements and understanding user needs for BeautyBot. This phase includes conducting research on common skincare concerns and analysing existing skincare recommendations applications. User surveys help collect insights on preferences and skin conditions to define the key functionalities of BeautyBot. The main project goals are established, focusing on developing an AI-driven skincare product analyser and recommender. Based on the gathered requirements, user stories are created, and a prioritized backlog of tasks is formed, ensuring an organized workflow for development.

Design Phase

In the design phase, an initial layout and structure for the BeautyBot are created, including user interfaces and any necessary visual elements. The UI/UX design is developed using Figma, ensuring a clean and user-friendly experiences for users searching for personalized skincare recommendations. The application architecture is planned, detailing the flow of data between user inputs, AI analysis and product recommendations. The design is intended to be flexible, allowing for adjustments based on feedback received in each iteration.

Development Phase

The development of BeautyBot follows an incremental approach, where features are built and tested in short sprints. The first sprint focuses on setting up user authentication and database integration for skincare products and user profiles. Subsequent sprints implement the AI-driven recommendation system, allowing users to receive product suggestions based on their skin type and concerns. The filtering and sorting features are also developed to enhance user experience. Each sprint includes code reviews, debugging, and refinements to ensure functionality and performance optimization.

Testing Phase

Testing is conducted alongside development to ensure early detection of issues. Unit testing is performed to validate individual components, such as AI model predictions and UI responsiveness. User Acceptance Testing (UAT) allows selected users to interact with BeautyBot and provide feedback on the accuracy of product recommendations and ease of use. Performance testing ensures that the system can handle multiple user requests efficiently. Identified bugs and usability concerns are addressed in subsequent iterations to enhance the overall stability of the application.

Deployment Phase

Once the core functionalities are successfully tested, BeautyBot is deployed in a controlled environment. The application is hosted on a web server, integrating all necessary components, including AI algorithms and a secure database. Security measures are implemented to protect user data, ensuring compliance with privacy regulations. The deployment phase allows for further validation before the official launch, ensuring a smooth user experience.

Review Phase

In the review phase, user engagement data and feedback are collected to analyse BeautyBot's performance. Metrics such as user interaction rates, recommendation accuracy, and system responsiveness are evaluated. Based on user feedback, necessary adjustments are planned, including refining the AI recommendation logic and enhancing the filtering options. Continuous monitoring helps identify any post-deployment issues, which are promptly addressed to improve functionality.

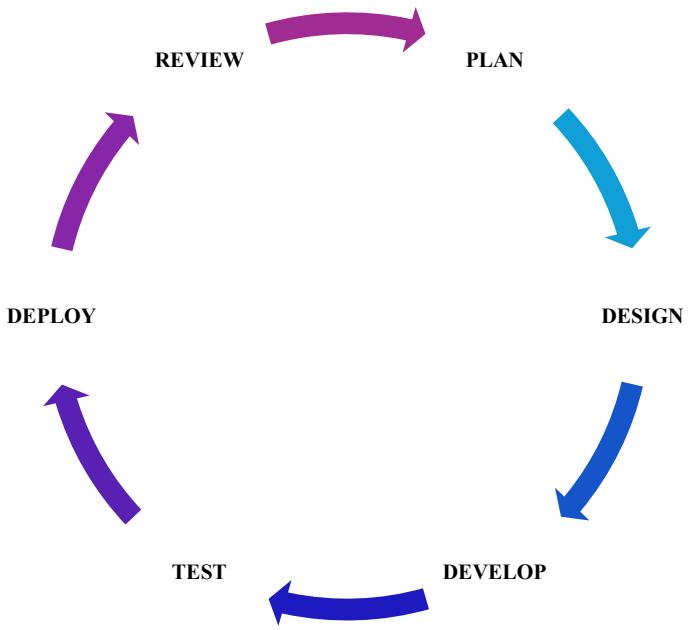

Figure 1.1: Agile Methodology

1.6 Significance of Project

This project will contribute to the growing field of personalized skincare by using AI to address individual skin needs, potentially reducing adverse reactions from unsuitable products. It will also simplify the product selection process, providing users with easy-to-follow routines that enhance skincare effectiveness. The insights gained from user feedback can help improve recommendation accuracy and expand the understanding of ingredient interactions for diverse skin types.

1.7 Project Schedule

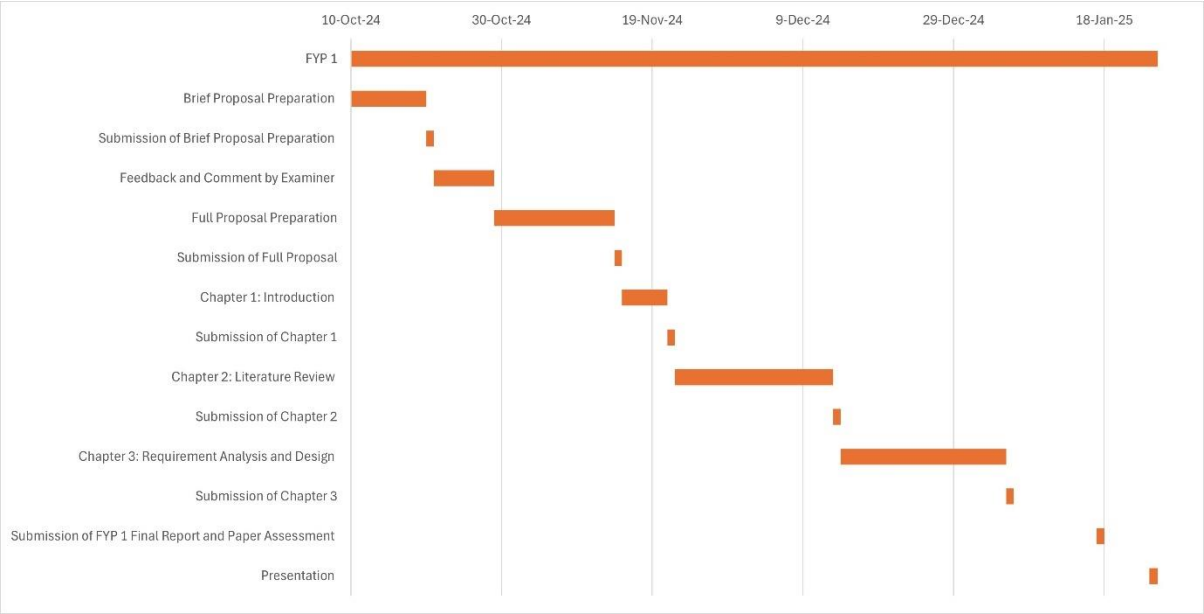

Figure 1.2: Gantt Chart for FYP 1

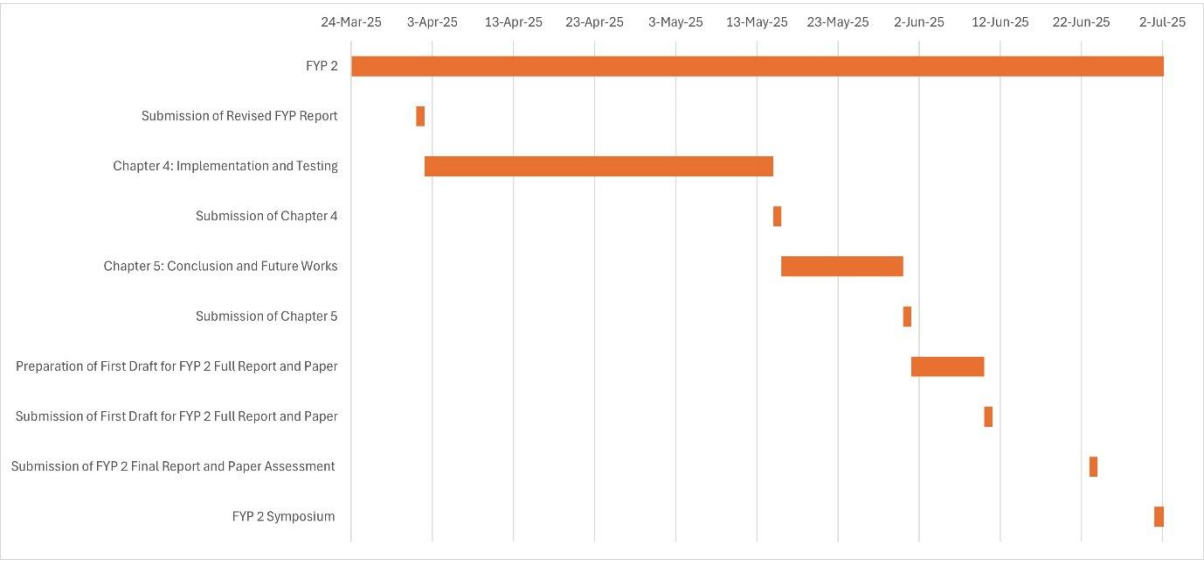

Figure 1.3: Gantt Chart for FYP 2

1.8 Expected Outcome

By the end of this project, the expected outcomes include:

- A web-based application that delivers personalized skincare product recommendations based on detailed analysis of product ingredients and provides a structured approach to skincare with personalized routines.
- An AI model that can assess ingredient suitability and predict user preferences based on user skin data and product ingredient data.
- A user-friendly comparison tool that helps users make informed choices when selecting skincare products.

1.9 Project Outline

Chapter 1: Introduction

Chapter 1 highlights the introduction and objectives of the project goals. This chapter includes the project background, problem statement, aims and objectives, project scope, brief methodology, project significance, project schedule, and the expected outcomes. The problem statement explains the challenges faced by consumers in choosing suitable skincare products and the limitations of current skincare apps. The aims and objectives clarify how the proposed system addresses these issues through personalized skincare recommendations and routines. The chapter also outlines the methodology for developing the system and discusses the significance of bridging the gaps in current skincare technologies.

Chapter 2: Literature Review

Chapter 2 provides a review of existing systems, including current skincare apps and other related technologies. The chapter analyses the strengths and weaknesses of these systems, focusing on ingredient analysis, product recommendations, and personalization. It also

explores the application of AI and machine learning in similar areas to establish the research gap and justify the need for the proposed solution.

Chapter 3: Requirement Analysis and Design

Chapter 3 discusses the development process and methodologies used to achieve the project objectives. This chapter describes the system architecture, data collection process for users' skin types and concerns, and the integration of machine learning techniques for personalized recommendations. It also elaborates on the tools, technologies, and frameworks employed and presents a timeline for the project's execution.

Chapter 4: Implementation and Testing

Chapter 4 details the implementation phase, including the step-by-step development of the AI-based skincare recommender system. It covers the integration of functionalities such as product ingredient analysis, recommendation algorithms, and personalized skincare routines. This chapter also includes testing results, such as system accuracy, user feedback, and overall performance, to evaluate the effectiveness of the system.

Chapter 5: Conclusion and Future Work

Chapter 5 summarizes the findings and outcomes of the project. It highlights the contributions of the AI-based skincare recommender system in addressing the limitations of current skincare apps. This chapter also acknowledges the project's limitations and proposes future enhancements, such as real-time skin condition analysis and expanding the product database for broader applicability.

1.10 Summary

In this chapter, a brief overview of the project was presented, outlining the problem statement, project aims, and objectives. The chapter also discussed the significance of the project, which

aims to address the challenges in selecting personalized skincare products and improving existing skincare apps. The methodology for the project was identified, focusing on an AI-based approach to offer personalized recommendations. The project timeline was also defined, which spans several months to ensure the achievement of the project's objectives. The chapter sets the stage for the next phase of the project, where the methodology will be explored in detail.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The skincare industry has witnessed significant advancements in digital solutions aimed at assisting consumers in navigating the world of skincare products and routines. As skincare needs vary greatly among individuals, many platforms and applications have emerged to provide personalized recommendations, ingredients analysis, and product insights. These solutions aim to address the growing need for personalized skincare advice in a market filled with many product choices and complicated ingredient lists.

This chapter reviews three (3) existing skincare platforms that relate to the proposed project. The background and functionalities of each system will be compared with BeautyBot to evaluate how well they address user needs. Additionally, this chapter outlines the key features of BeautyBot and highlights its advantages over existing solutions. The comparison focuses on identifying gaps in current systems and how BeautyBot aims to provide a more personalized and effective skincare experience.

The three platforms selected for comparison are:

i. Love From Yours

ii. Proven Skincare

iii. Skin Type Solutions

2.2 Reviewed on Existing Systems

2.2.1 Love From Yours

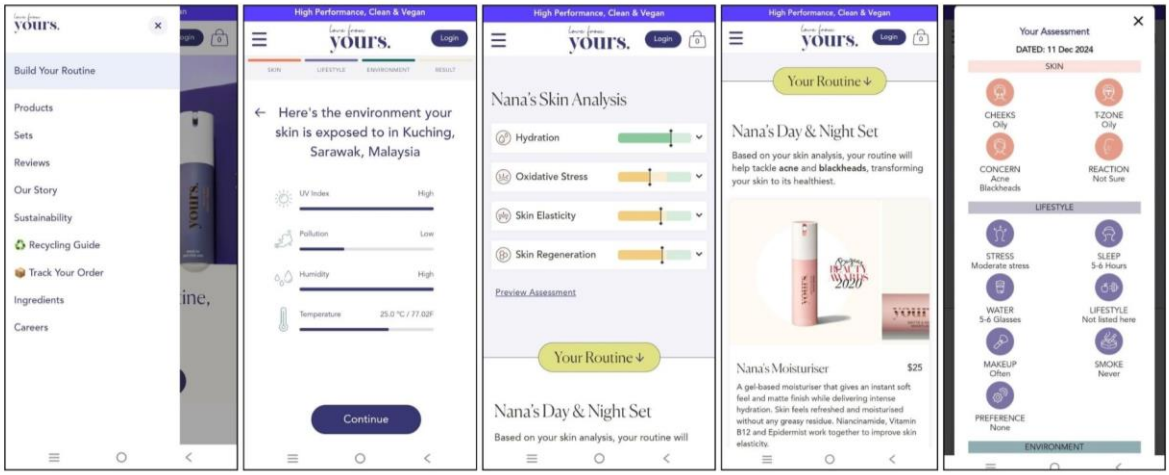

Figure 2.4: Love From Yours Website Interfaces

Love From Yours is a Switzerland-based skincare platform founded with the mission of simplifying skincare for individuals worldwide. The system originated as a response to the growing complexity of skincare routines and the overwhelming variety of products available in the market. The platform is tailored to cater to individuals who prefer natural, science-backed, and sustainable approach to skincare (*Yours® Official Site - Personalized Skincare | Skin Analysis*, 2024).

The main purpose of Love From Yours is to provide personalized skincare solutions that are easy to understand and use. It seeks to eliminate the confusion associated with choosing skincare products by offering recommendations tailored to each user's specific skin type, environment, and lifestyle habits.

Love From Yours employs a web-based questionnaire where users answer questions about their skin type, daily habits, and environmental factors, such as climate and pollution levels in their location. According to Vinutha et al. (2024), questionnaire-based approaches are effective for

extracting detailed user data without relying on complex imaging technology. The platform's AI processes this data to suggest customized skincare products. The recommendations are crafted with sustainability in mind, using vegan, cruelty-free ingredients that cater to modern consumer values. The platform adopts a clean and minimalistic design, ensuring a smooth user experience. Users can access their personalized skincare recommendations and purchase products directly through the platform. The system prioritizes accessibility and inclusivity by avoiding the need for advanced tools like image recognition, making it widely accessible to users worldwide.

While Love From Yours provides an excellent starting point for skincare personalization, its reliance on user-provided data might result in less accurate recommendations compared to systems using advanced skin analysis technologies. Additionally, it does not provide real-time skin condition assessments.

2.2.2 Proven Skincare

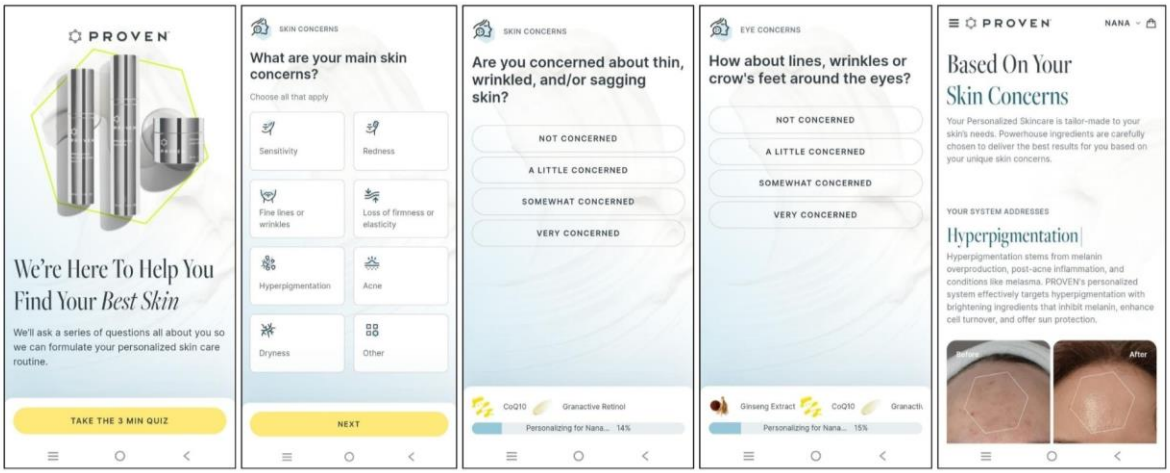

Figure 2.5: Proven Skincare Website Interfaces

Proven Skincare is a United States-based platform launched by Ming Zhao and Amy Yuan. It uses machine learning algorithms to predict user needs and recommend tailored products.

According to Vatiwutipong et al. (2023), systems like Proven Skincare rely on pre-trained models for decision-making based on structured inputs, enabling a robust recommendation process. Proven Skincare's ability to provide evidence-backed recommendations stems from integrating multiple data sources.

The goal of Proven Skincare is to simplify and optimize skincare routines by delivering products customized for each user's unique skin profile. The system aims to bring scientific rigor to skincare personalization, leveraging large-scale data to create effective formulations. Its functionality begins with a comprehensive questionnaire that collects detailed information about the user's skin type, concerns (such as acne, sensitivity, or aging), lifestyle habits, and environmental factors like climate and pollution levels. This data is then processed by Proven's proprietary The Skin Genome Project, a robust database that analyses over 20,000 ingredients, 100,000 products, 20 million customer reviews, and thousands of scientific studies. Using machine learning, the system matches the user's profile with the best ingredient combinations and formulations to produce custom skincare products, including cleansers, moisturizers and serums. Each product is created specifically for the user, addressing individual needs and preferences (Proven skincare, 2024).

A unique aspect of Proven's functionality is its iterative feedback loop. Users can provide reviews and input about their product performance, which allows the AI to refine and improve future recommendations. This ensures the products adapt over time to evolving skin conditions or preferences. Additionally, Proven integrates external environmental and lifestyle factors into its analysis, making its recommendations practical and effective for real-world application. The platform also emphasizes ingredient transparency, offering detailed insights into the components of its products and their benefits. However, Proven Skincare is limited to its custom formulations, which may not appeal to users looking to incorporate products from other brands.

Proven Skincare's website has a simple and clean design, giving it a professional look that matches its focus on science and research. The system integrates a direct-to-consumer model, allowing users to order their personalized products online. Its design emphasizes trustworthiness by showcasing its science-driven approach and extensive data utilization.

2.2.3 Skin Type Solutions

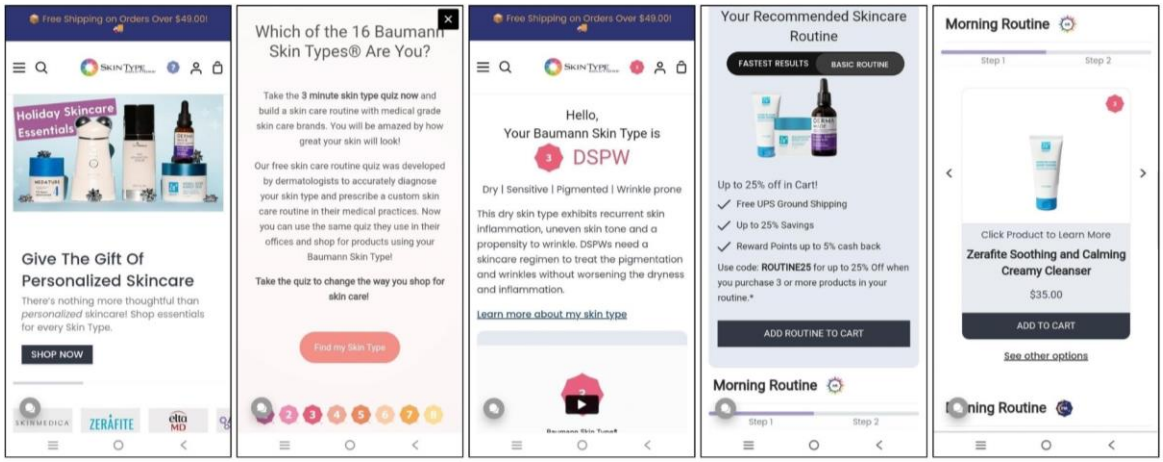

Figure 2.6: Skin Type Solutions Interfaces

Skin Type Solutions (STS), founded by dermatologist Dr. Leslie Baumann, is a personalized skincare platform designed to address individual skin needs using a scientifically validated system. The platform is based on the Baumann Skin Typing System, which classifies users into 16 unique skin types (Baumann, 2008). This classification goes beyond traditional skin categories (such as oily, dry, or sensitive) by considering additional factors like pigmentation, inflammation, and propensity for wrinkles. This detailed approach aims to provide a more accurate and personalized skincare solution for each user, making it an essential tool in modern skincare personalization (Skin Type Solutions, 2024).

The core functionality of Skin Type Solutions begins with a comprehensive skin type quiz, scientifically validated to accurately determine a user's skin profile. The quiz assesses multiple

skin characteristics, including hydration levels, sensitivity, pigmentation, and the risk of developing wrinkles. This data is then used to recommend a tailored skincare regimen that aligns with the user's unique skin type and concerns. The system's strength lies in its ability to diagnose precise skin barriers, ensuring users receive recommendations that address both immediate needs and long-term skin health.

One of the most significant features of the Skin Type Solutions platform is its customized product recommendations. After determining the skin type, the system suggests products that are specifically suited to the user's skin needs. The platform evaluates over 40,000 skincare routines, ensuring that only dermatologist-approved, effective products are recommended. The system also emphasizes product layering and ingredient compatibility to optimize results. This unique product selection process relies on the expertise of medical professionals and dermatologists to ensure high efficacy (Skin Type Solutions, 2024).

Additionally, Skin Type Solutions emphasizes continuous user feedback and periodic retakes of the skin quiz. As skin conditions can change over time due to factors like age, environmental exposure, or lifestyle, the system encourages users to retake the quiz every three months to adjust their skincare routine accordingly. This adaptive approach ensures that users' skincare regimens evolve to meet their changing needs.

However, one limitation of the Skin Type Solutions system is its focus on a select group of products, often from high-end, dermatologist-approved brands. While this ensures high-quality recommendations, it may limit accessibility for users seeking budget-friendly or more mainstream skincare options. Despite this, the system's science-backed, personalized approach sets it apart from other skincare platforms and establishes it as a leader in the field of skincare personalization.

2.3 Comparison on Existing Systems and the Proposed System

Table 2.1: Comparison Between Existing Systems and Proposed System

Systems / Features	Love From Yours	Proven Skincare	Skin Type Solutions	Proposed System
Personalized Recommendations	Yes	Yes	Yes	Yes
Data Collection Method	Questionnaire	Questionnaire	Questionnaire	Questionnaire
AI Integration	Basic (Static AI)	Advanced (Machine Learning)	Minimal (Rule-Based Logic)	Advanced (Machine Learning)
Adaptability to Skin Changes	No	No	No	Yes
Product Recommendations	Limited	Moderate	Moderate	Extensive
Platform	Web	Web	Web	Web

Table 2.1 above shows the comparison between the existing systems with the proposed system based on the functionalities. When comparing the systems Love From Yours, Proven Skincare, Skin Type Solutions, and the proposed system, BeautyBot, several critical differences and similarities emerge regarding their features, strengths, and limitations. These distinctions highlight how BeautyBot addresses existing gaps in the current skincare personalization platforms.

All four systems provide personalized skincare recommendations and include tailored day and evening routines, designed to optimize skincare effectiveness throughout the day. However, the methods and depth of personalization vary significantly across these systems. Love From Yours, Proven Skincare, and Skin Type Solutions all rely on questionnaires as their primary data collection method. While effective in gathering initial data, these systems offer static recommendations that do not adapt to changes in the user's skin over time. For example, Love From Yours focuses on providing clean and sustainable product recommendations but lacks dynamic updates, making it less responsive to evolving skin needs. Proven Skincare, on the other hand, uses machine learning through its Skin Genome Project to provide scientifically rigorous and customized products. However, it remains confined to proprietary formulations, which limits user choice. Skin Type Solutions offers dermatologist-reviewed recommendations based on its 16 Baumann Skin Types, providing tailored day and night routines. Yet, it relies heavily on rule-based logic and does not include iterative learning capabilities, meaning it cannot adapt dynamically to user feedback or changes in skin conditions. In contrast, BeautyBot overcomes these limitations by integrating advanced machine learning, enabling the system to adjust its recommendations in real time as user feedback and conditions evolve. This dynamic adaptability ensures that BeautyBot's suggestions remain relevant and accurate, regardless of changes in the user's skin.

Another key distinction lies in the adaptability of these systems to changes in skin conditions. Love From Yours, Proven Skincare, and Skin Type Solutions offer static routines that do not automatically adjust over time. To receive updated recommendations, users must retake the questionnaire, which can be inconvenient and less efficient. In contrast, BeautyBot offers dynamic adaptability, continuously refining its recommendations based on updated user profiles and feedback. This real-time personalization sets BeautyBot apart, making it more user-centric and responsive to evolving needs.

Furthermore, product recommendations also vary significantly across these systems. Love From Yours prioritizes clean and sustainable products but offers a limited selection. Proven Skincare restricts its recommendations to proprietary formulations, while Skin Type Solutions emphasizes dermatologist approved. While these approaches ensure high-quality recommendations, they may not accommodate users seeking a diverse range of products at different price points. BeautyBot addresses this gap by offering an extensive product database that includes options from multiple brands, providing users with greater flexibility and choice tailored to their preferences and budgets.

In conclusion, while Love From Yours, Proven Skincare, and Skin Type Solutions each have their strengths, such as sustainability, scientific rigor, and dermatological expertise, they also exhibit significant limitations, including static recommendations, limited adaptability, and constrained product ranges. BeautyBot addresses these shortcomings by combining advanced AI, dynamic adaptability, and a diverse product database, positioning itself as a comprehensive and innovative solution in personalized skincare. This unique combination of features not only bridges the gaps in existing systems but also sets a new standard for user-centric skincare personalization.

2.4 Summary

In this chapter, three existing skincare systems were reviewed and compared with the proposed system, BeautyBot. It explores how each system provides personalized skincare recommendations, focusing on their methods of data collection, AI integration, and product recommendations. All systems offer personalized day and evening skincare routines through questionnaires, but they differ in the depth of AI integration and adaptability. Love From Yours uses basic AI with static recommendations, while Proven Skincare employs advanced machine learning. Skin Type Solutions relies on rule-based logic for its dermatologist-approved recommendations. In contrast, BeautyBot incorporates dynamic machine learning, allowing it to adapt recommendations over time based on user feedback and changing skin conditions. The chapter concludes that while the existing systems offer valuable features, BeautyBot addresses their limitations by offering more flexibility, adaptability, and a wider product range, positioning it as an innovative and user-focused solution in personalized skincare.

CHAPTER 3: REQUIREMENT ANALYSIS AND DESIGN

3.1 Introduction

This chapter discusses the requirements, methodologies and design of BeautyBot, an AI-powered skincare recommendation system. It explores the needs of users, the software and technical requirements, and the methodology for developing the system. By addressing gaps in existing skincare platforms, BeautyBot focuses on providing adaptive, personalized recommendations through advanced AI and a diverse product database. The chapter also details the system architecture and design, ensuring the platform meets user expectations and delivers an innovative, efficient, and user-friendly solution.

3.2 Project Methodology

The development of BeautyBot follows the Agile methodology, which is a highly flexible and iterative approach suitable for projects with evolving requirements. Agile focuses on breaking down tasks into smaller, manageable chunks known as sprints. This allows for continuous feedback, quick improvements, and regular adaptations based on real-world user interactions.

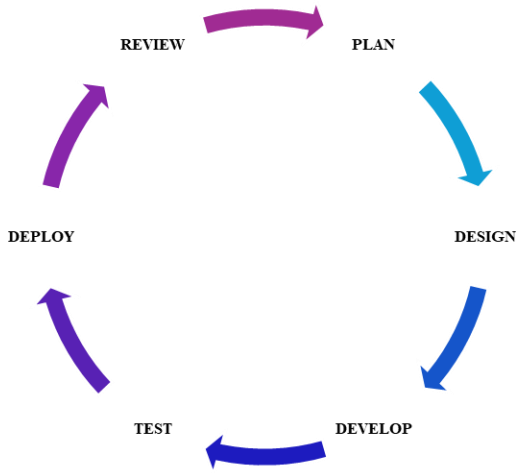

Figure 3.7: Agile Development Model

The stages of Agile implementation for BeautyBot are as follows:

Planning Phase

The planning phase begins with planning, which involves gathering requirements and understanding user needs for BeautyBot. This phase includes conducting research on common skincare concerns and analysing existing skincare recommendations applications. User surveys help collect insights on preferences and skin conditions to define the key functionalities of BeautyBot. The main project goals are established, focusing on developing an AI-driven skincare product analyser and recommender. Based on the gathered requirements, user stories are created, and a prioritized backlog of tasks is formed, ensuring an organized workflow for development.

Design Phase

In the design phase, the system's architecture and user interfaces are designed to maximize usability and optimize the user experience in selecting skincare products. The design process includes the creation of wireframes and prototypes, developed using Figma, to ensure that the navigation is intuitive and that users can easily input their skin concerns and preferences. The application architecture is planned, detailing the flow of data between user inputs, AI analysis and product recommendations. The design is intended to be flexible, allowing for adjustments based on feedback received in each iteration.

Development Phase

The development of BeautyBot follows an incremental approach, where features are built and tested in short sprints. The first sprint focuses on setting up user authentication and integrating the database for skincare products and user profiles using Django for backend development and MySQL for database management. In the following sprints, the AI-driven recommendation system is built using Python and PyTorch, which help process user data and implement machine

learning models for personalized skincare recommendations. The system uses a Hybrid Recommendation approach that combines Content-Based Filtering (CBF) and Collaborative Filtering (CF). For frontend development, HTML, CSS, and JavaScript are used to structure, style, and add interactivity to the pages. React is employed to build dynamic, component-based user interfaces, enhancing the experience with features like questionnaires and profile management. The user interface design is guided by wireframes and prototypes created in Figma, ensuring an intuitive layout for users. Each sprint includes code reviews, debugging, and refinements to ensure functionality and performance optimization.

Testing Phase

Testing is conducted alongside development to ensure early detection of issues. Unit testing is performed to validate individual components, such as AI model predictions and UI responsiveness. User Acceptance Testing (UAT) allows selected users to interact with BeautyBot and provide feedback on the accuracy of product recommendations and ease of use. Performance testing ensures that the system can handle multiple user requests efficiently. Identified bugs and usability concerns are addressed in subsequent iterations to enhance the overall stability of the application.

Deployment Phase

After successful testing, features are deployed incrementally. The application is hosted on a web server, integrating all necessary components, including AI algorithms and a secure database. Security measures are implemented to protect user data, ensuring compliance with privacy regulations. The deployment phase allows for further validation before the official launch, ensuring a smooth user experience.

Review Phase

In the review phase, user engagement data and feedback are collected to analyse BeautyBot's performance. Metrics such as user interaction rates, recommendation accuracy, and system responsiveness are evaluated. Based on user feedback, necessary adjustments are planned, including refining the AI recommendation logic and enhancing the filtering options. Continuous monitoring helps identify any post-deployment issues, which are promptly addressed to improve functionality.

3.3 Requirement Analysis

3.3.1 Identify the User

To ensure that BeautyBot meets the needs of its target audience, a Google Form survey was conducted with 53 respondents. The survey was aimed to gather data on user demographics, skincare habits, challenges faced in selecting skincare products, and preferences for web features. The insights gained from this survey were used to define system requirements and guide the development process. Below is a detailed explanation of the findings:

Section 1: Demographics

This section aimed to understand the basic profile of participants, focusing on their age, gender, and skin type. The data collected provides valuable insights into the target audience for BeautyBot.

Age Distribution

The survey revealed that the majority of respondents fall into the 18–24 age group (77.4%), reflecting the primary audience for the system. A smaller proportion, 17%, were under 18, indicating that the system could also appeal to younger users. The remaining participants, 5.6%, were above 25, showing some interest from an older demographic. This age distribution

highlights that BeautyBot's audience primarily consists of young adults actively engaged in skincare routines.

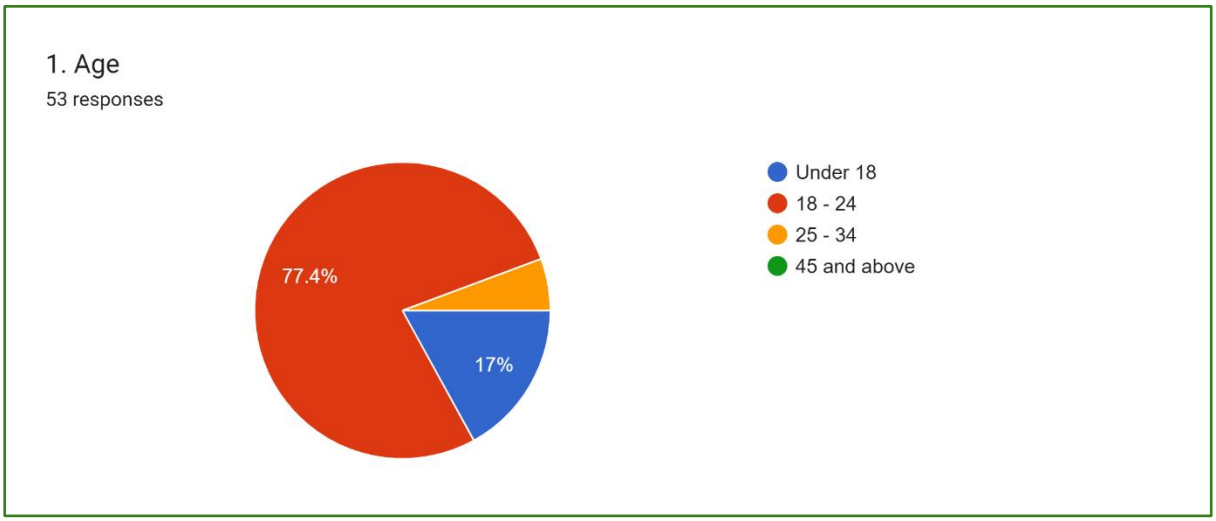

Figure 3.8: Age Distribution

Gender Distribution

In terms of gender, the data shows that the majority of respondents identified as female (81.1%), while 18.9% identified as male. This significant difference underscores the dominance of female users in the skincare market but also suggests the potential to cater to male users who are increasingly interested in personalized skincare solutions.

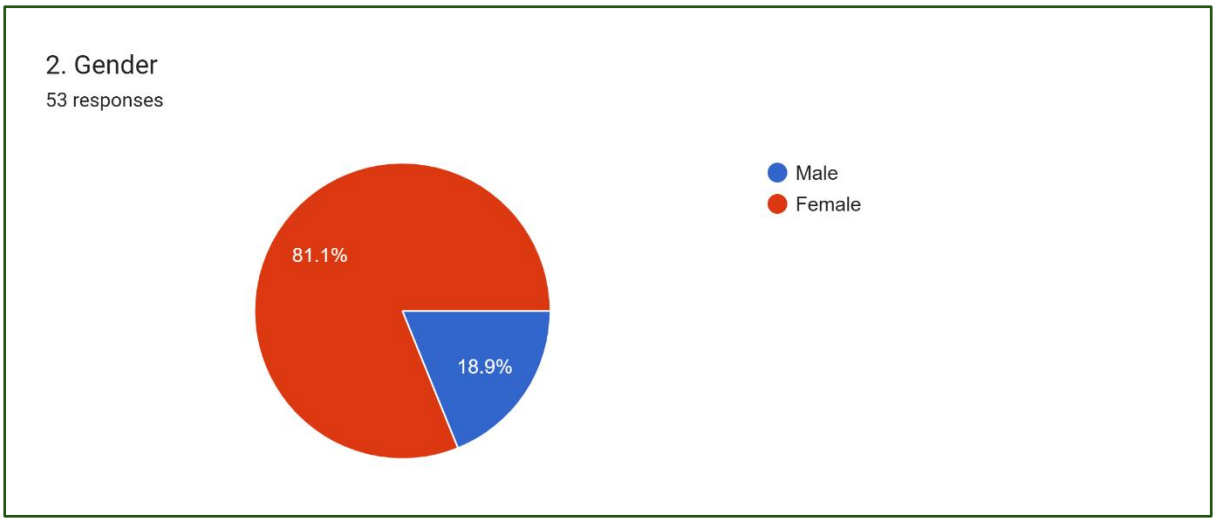

Figure 3.3: Gender Distribution

Skin Type

When asked about their skin type, a significant portion of respondents reported having combination skin (45.3%), indicating a need for versatile skincare routines that cater to both oily and dry areas. The next most common responses were oily skin (20.8%) and normal skin (20.8%), followed by sensitive skin (9.4%). A small percentage, 3.8%, reported having dry skin, indicating less representation from users with this skin type. This distribution shows that BeautyBot must focus on accommodating combination and oily skin types while also addressing the needs of other skin categories to ensure inclusivity.

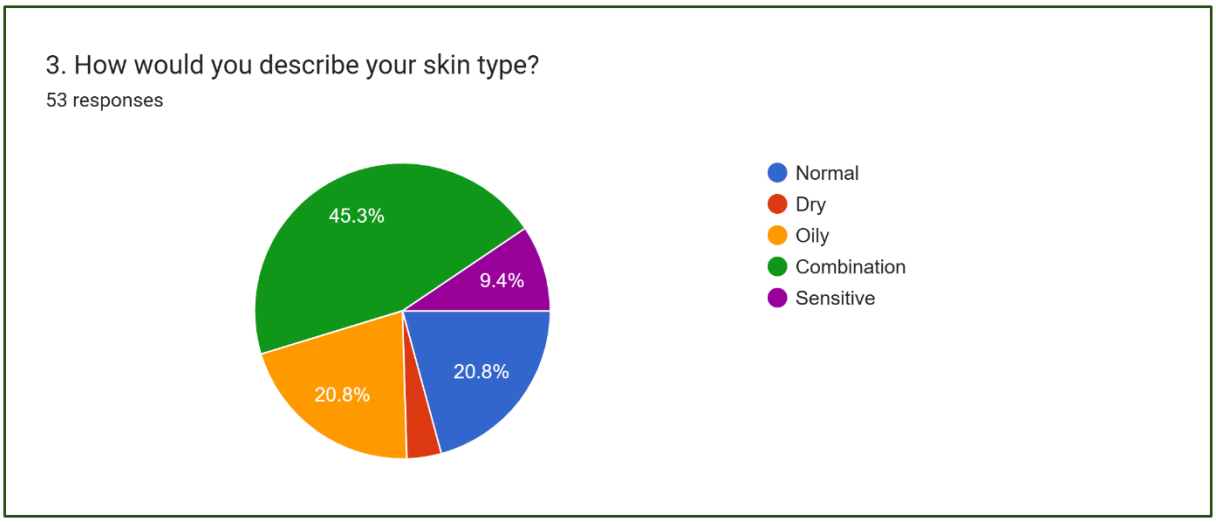

Figure 3.9: Skin Type

Section 2: Skincare Habits

This section explored the participants' skincare routines, the products they regularly use, and their sources of skincare advice. The findings provide insights into current habits and highlight areas where BeautyBot can enhance user experience through personalized recommendations.

Routine Frequency

The survey revealed that the majority of respondents, 66%, follow a skincare routine twice daily, in the morning and evening. This indicates a strong commitment to maintaining skin health. Another 20.8% practice skincare occasionally, while 11.3% engage in routines once a day. A small percentage, 1.9%, reported not following any routine. This data highlights that most users are consistent with their skincare practices, making them likely to benefit from a system like BeautyBot that optimizes their routines.

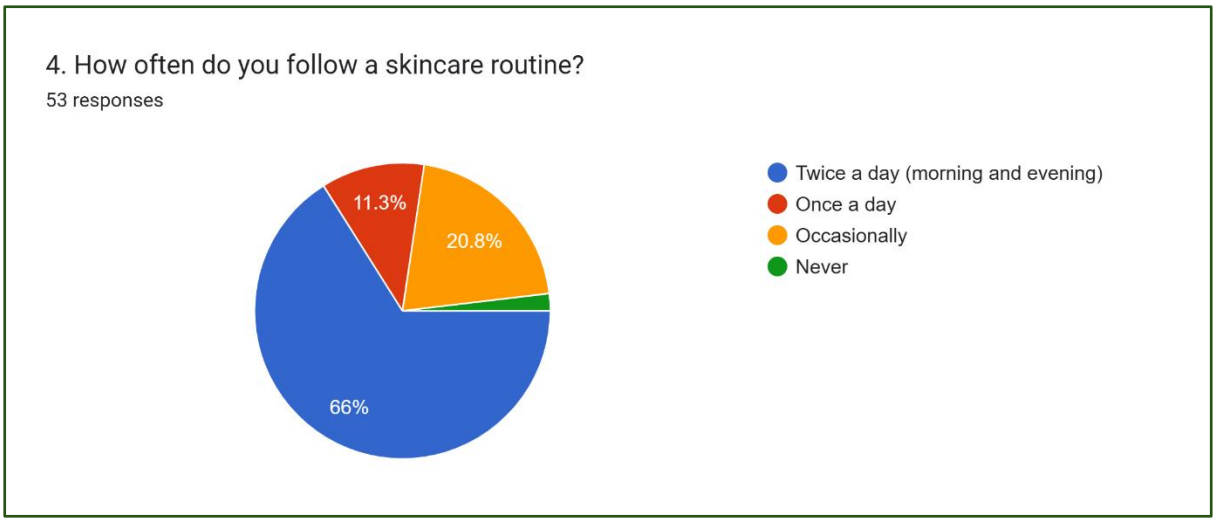

Figure 3.10: Routine Frequency

Commonly Used Products

Participants were asked about the types of products they regularly use in their skincare routines. The most frequently mentioned were:

- Cleanser (83%),
- Sunscreen (77.4%),
- Moisturizer (58.5%),
- Toner (41.5%)
- Serums (30.2%)
- Exfoliants (17%)

This shows a strong preference for basic skincare essentials, with many users also incorporating specialized products like serums into their routines. These insights underscore the importance of BeautyBot recommending products across all categories to meet user needs comprehensively.

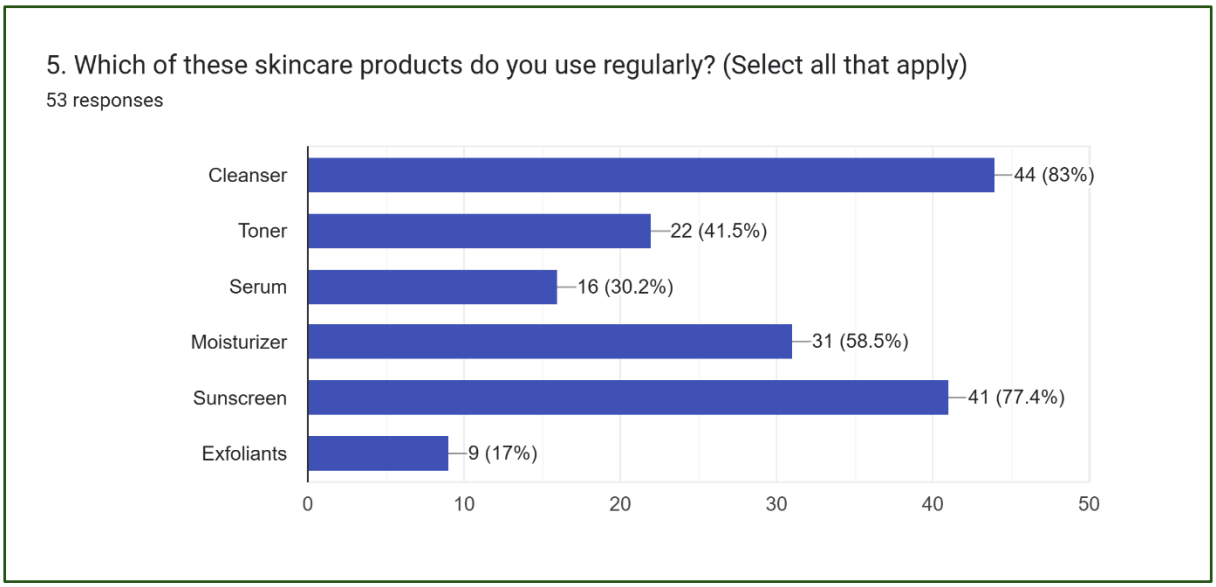

Figure 3.11: Commonly Used Products

Sources of Advice

When asked if they consult apps, websites, or dermatologists for skincare advice, 52.8% of respondents said they do not seek external advice. However, 47.2% indicated they use resources. This highlights the potential for BeautyBot to fill this gap by providing trusted, science-backed recommendations, especially for those who may not have access to professional advice.

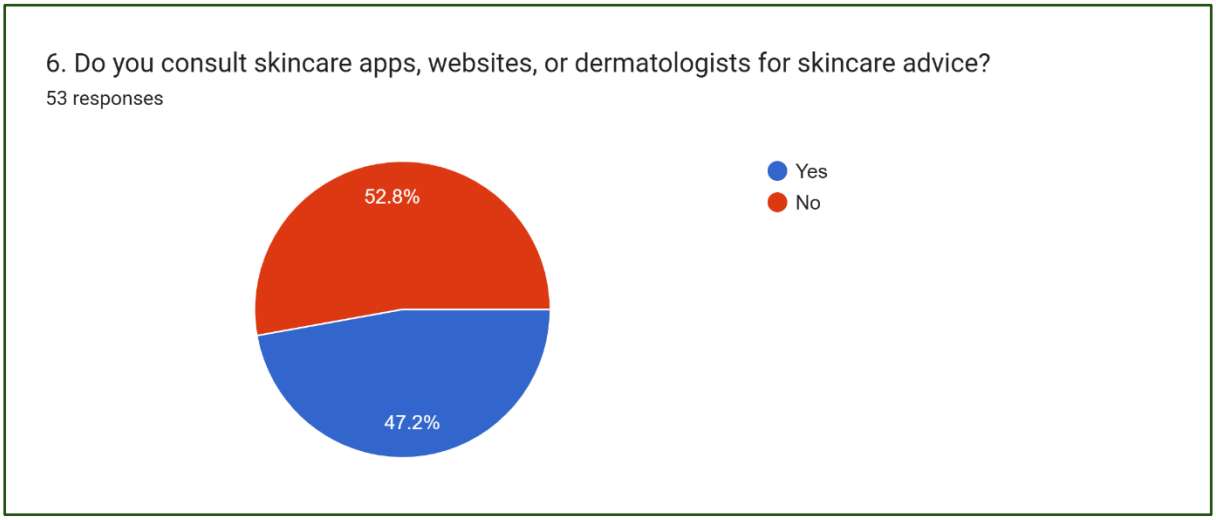

Figure 3.12: Source of Advice

Factors Influencing Skincare Product Choices

When participants were asked what factors, most influence their choice of skincare products, the following were identified as the key determinants:

- Reviews and Recommendations: 84.9% of respondents cited product reviews and recommendations as the most influential factor in their decision-making process. This highlights the importance of trusted advice from peers, influencers, and online reviews in shaping purchasing decisions.
- Ingredients: 60.4% of participants emphasized the ingredients in skincare products. Many respondents are looking for products with specific ingredients that cater to their skin type and concerns, such as natural or dermatologist-recommended ingredients.
- Price: 62.3% of respondents considered the price of products as a significant factor in their choices. While product effectiveness remains important, affordability plays a key role for many users when selecting skincare solutions.
- Brand Reputation: 45.3% of participants preferred products from well-established brands, suggesting that brand trust and credibility are influential factors when it comes to skincare purchases.
- Dermatologist's Advice: 34% of respondents rely on dermatologist recommendations, indicating that professional advice is also a trusted source for choosing skincare products.

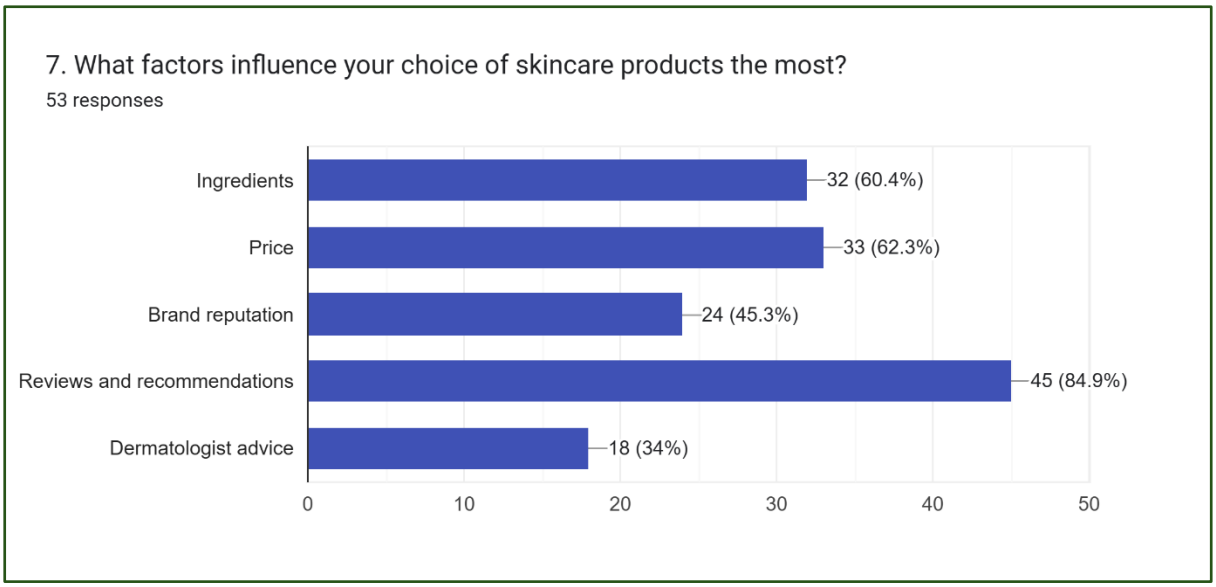

Figure 3.13: Factors Influencing Skincare Product Choices

Section 3: Challenges

This section highlights the key challenges respondents face when selecting skincare products, experiencing negative effects, and maintaining their skincare routines. Understanding these challenges is vital for BeautyBot to offer effective and relevant solutions.

Challenges in Selecting Skincare Products

Respondents were asked about the challenges they face when selecting skincare products, and the following factors emerged as the most significant:

- Not Knowing What Suits Their Skin Type: 77.4% of respondents stated that they have difficulty knowing which products are suitable for their skin type. This highlights the importance of personalized recommendations based on skin type to ensure users make informed choices.

- Products Are Too Expensive: 62.3% of participants cited the high cost of skincare products as a major barrier. Many users find it difficult to balance product quality with affordability, pointing to a need for price-sensitive recommendations.
- Too Many Product Options: 52.8% of respondents felt overwhelmed by the abundance of skincare products available. The vast number of options can lead to decision fatigue, emphasizing the need for a tool that narrows down choices to suit individual needs.
- Lack of Reliable Recommendations: 32.1% of respondents noted that they struggle with unreliable skincare product recommendations. This suggests a demand for expert-backed, trustworthy recommendations to guide users in selecting the right products for their skin.

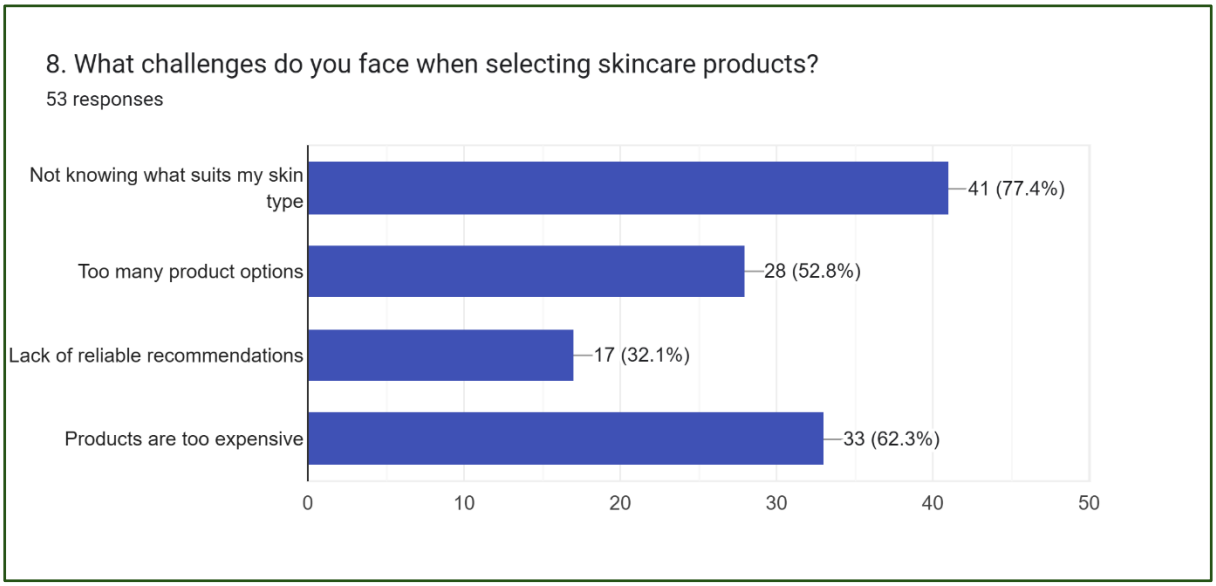

Figure 3.14: Challenges in Selecting Skincare Products

Experience with Negative Effects

When asked if they had experienced negative effects, such as irritation, from using skincare products, 60.4% of respondents reported having adverse reactions. This highlights the need for

BeautyBot to focus on recommending products that are suitable for users' specific skin types and sensitivities.

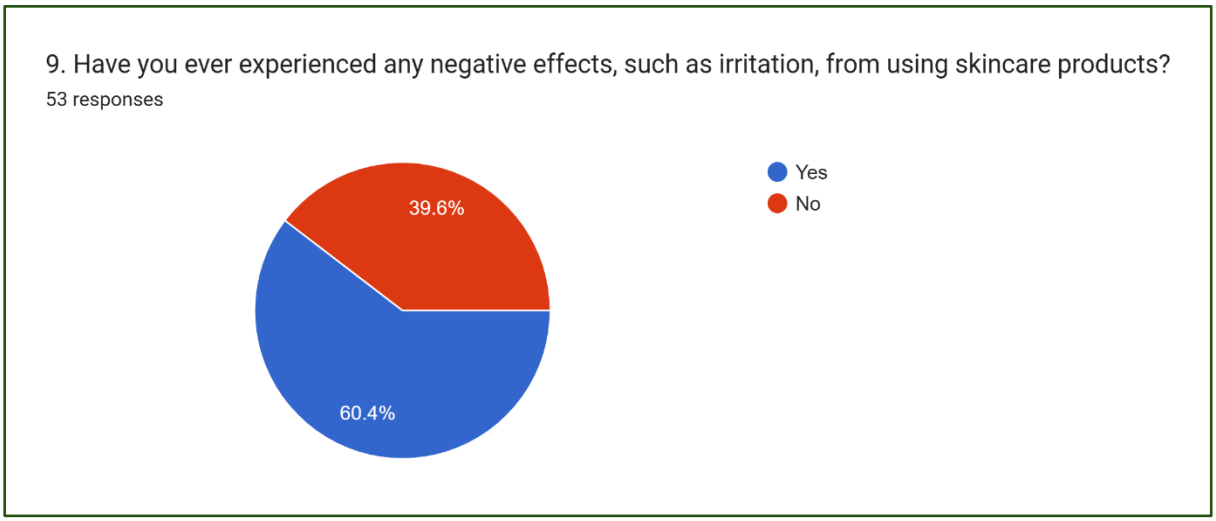

Figure 3.15: Experience with Negative Effects

Struggles with Maintaining a Skincare Routines

Respondents were also asked about how often they struggle with tracking or maintaining their skincare routine. The responses were as follows:

- Sometimes: 58.5% of respondents indicated that they sometimes struggle with maintaining their skincare routine. This suggests that many users may need occasional reminders or guidance to stay consistent.
- Frequently: 30.2% of participants reported struggling frequently with maintaining their skincare routine. This highlights a larger group of users who may benefit from regular prompts and tracking features.
- Never: 7.5% of respondents said they never struggle with maintaining their routine, suggesting that they are consistent with their skincare practices.

- Rarely: 3.8% indicated that they rarely struggle with their routine, which shows that most participants face at least occasional difficulties.

This data suggests that BeautyBot could help users who struggle with routine consistency by incorporating features like personalized skincare routine suggestions.

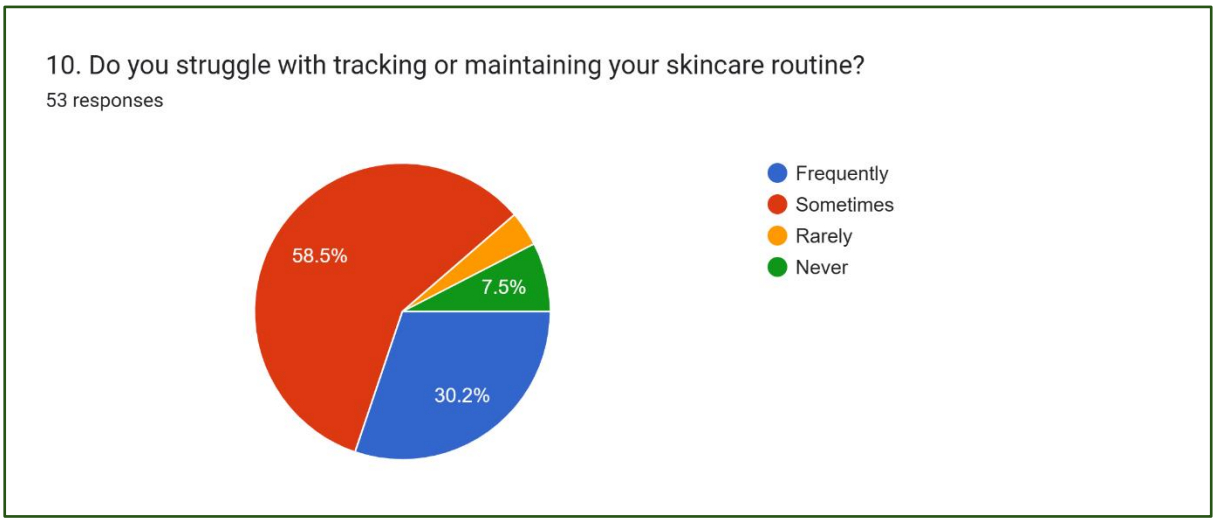

Figure 3.16: Struggles with Maintaining a Skincare Routines

Section 4: Desired Features

This section explores the features respondents would find most helpful in a skincare website and their preferences for personalized skincare recommendations. These insights will guide the development of BeautyBot's features, ensuring it aligns with user expectations and delivers value.

Use of Personalized Skincare Apps

When asked if they have used any personalized skincare apps or websites, the majority of respondents reported that they have not used such platforms. This indicates that there is a potential market for introducing personalized skincare solutions like BeautyBot, as many users are not yet engaged with these types of apps or websites.

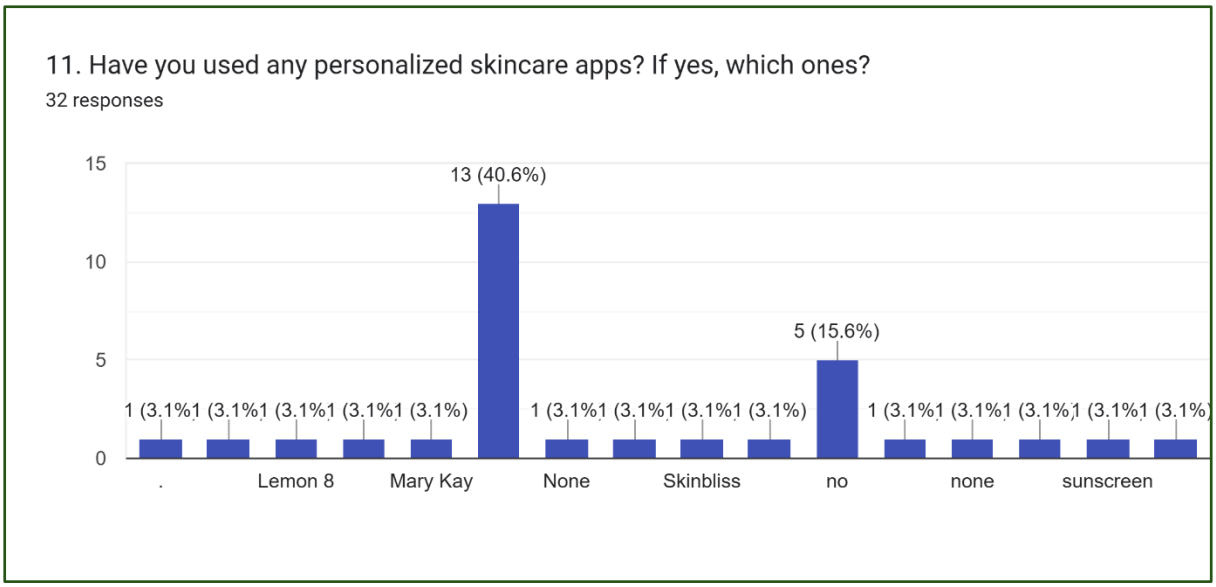

Figure 3.17: Use of Personalized Skincare Apps

Most Helpful Features in a Skincare App/Website

When asked about the most helpful features they would find in a skincare app/website, respondents highlighted the following as the most important:

- Personalized Product Recommendations (70%)
- Day and Evening Skincare Routines (58%)
- Skin Condition Tracking and Updates (72%)
- Price Comparison for Products (50%)
- Regular Updates Based on Skin Changes (58%)
- Reviews and Ratings of Products (60%)

These features demonstrate the key functionalities users are looking for, including personalized product recommendations, skincare routines, skin conditions tracking, price comparison, regular updates, and user-generated reviews and ratings of products.

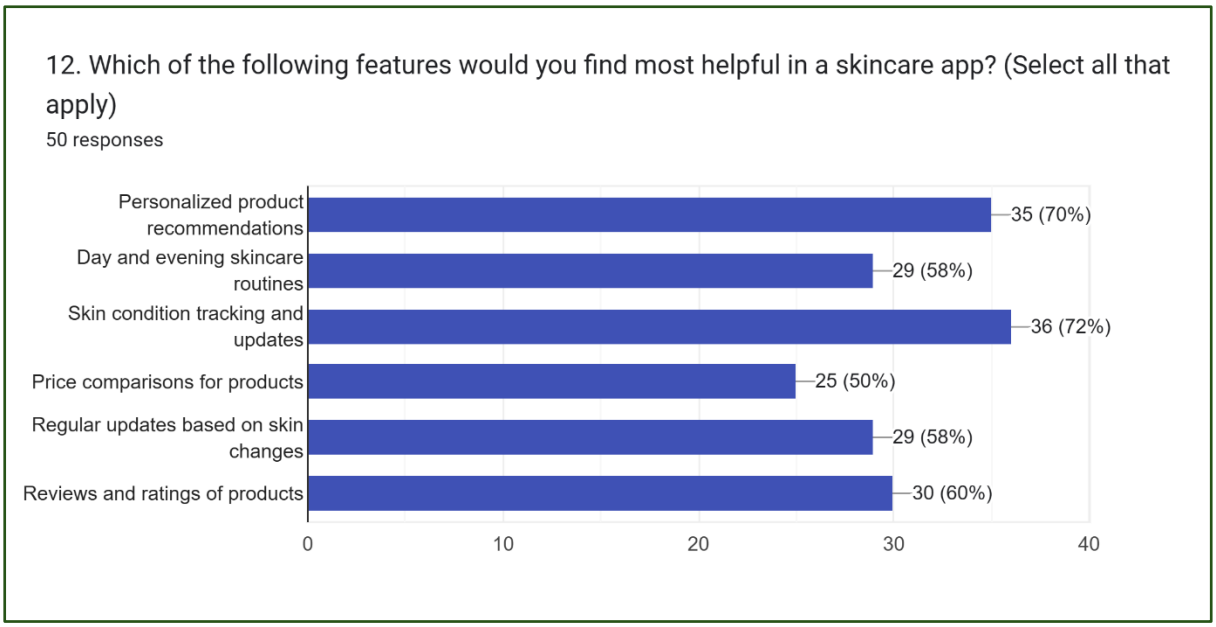

Figure 3.18: Most Helpful Features in a Skincare App/Website

Brand Preferences for Product Recommendations

Respondents were asked whether they would prefer a skincare app to recommend products from multiple brands or from a specific brand only. The results were:

- Multiple Brands: 70% of respondents preferred receiving recommendations from multiple brands, suggesting that users value variety and the freedom to choose from a wide range of products.
- Specific Brand: 30% of respondents preferred receiving recommendations from a specific brand, indicating that some users are loyal to particular brands or want to focus on trusted options.

This indicates that BeautyBot should offer a broad selection of brands to cater to the preferences of most users while still allowing for brand-specific recommendations where needed.

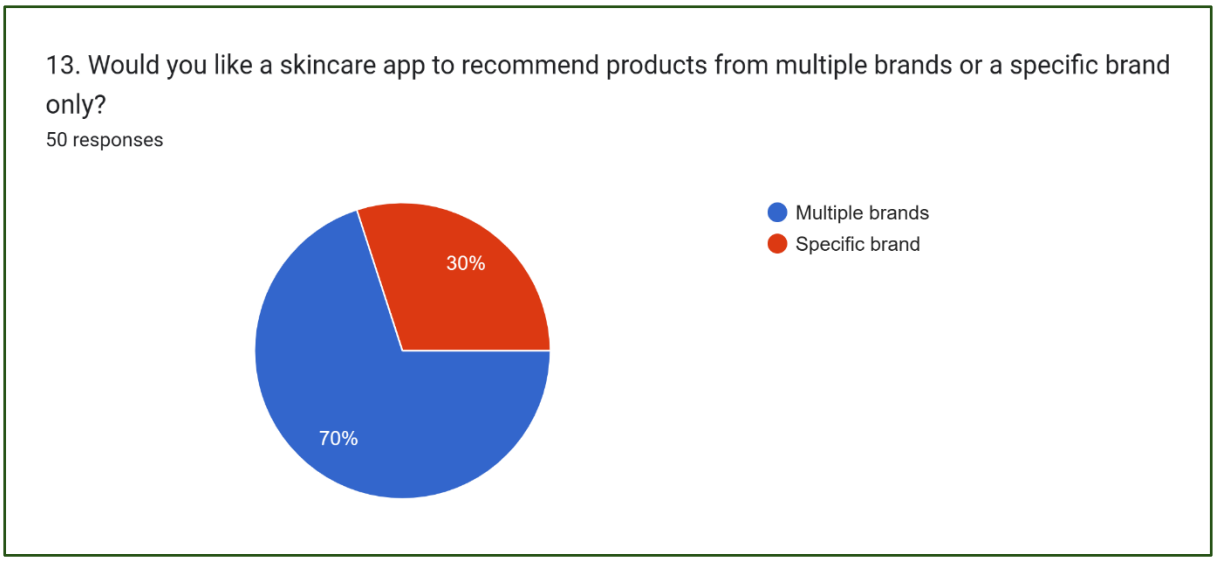

Figure 3.19: Brand Preferences for Product Recommendations

Frequency of Updating Skin Profile

Respondents were asked how often they would be willing to update their skin profile in the app/website, such as inputting new skin data. The responses were as follows:

This data suggests that BeautyBot should allow users to update their skin profile at their own pace while encouraging frequent updates through reminders or notifications.

- **When Needed**: 52% of respondents indicated they would update their skin profile only when necessary, such as when experiencing significant changes in their skin.
- **Monthly**: 24% of participants would update their profile on a monthly basis, suggesting that they prefer periodic updates to keep their information relevant.
- **Weekly**: 12% of respondents would be willing to update their skin profile weekly, showing a preference for more frequent tracking.
- **Rarely**: 12% of users indicated that they would update their profile rarely, possibly due to limited engagement with ongoing skin changes.

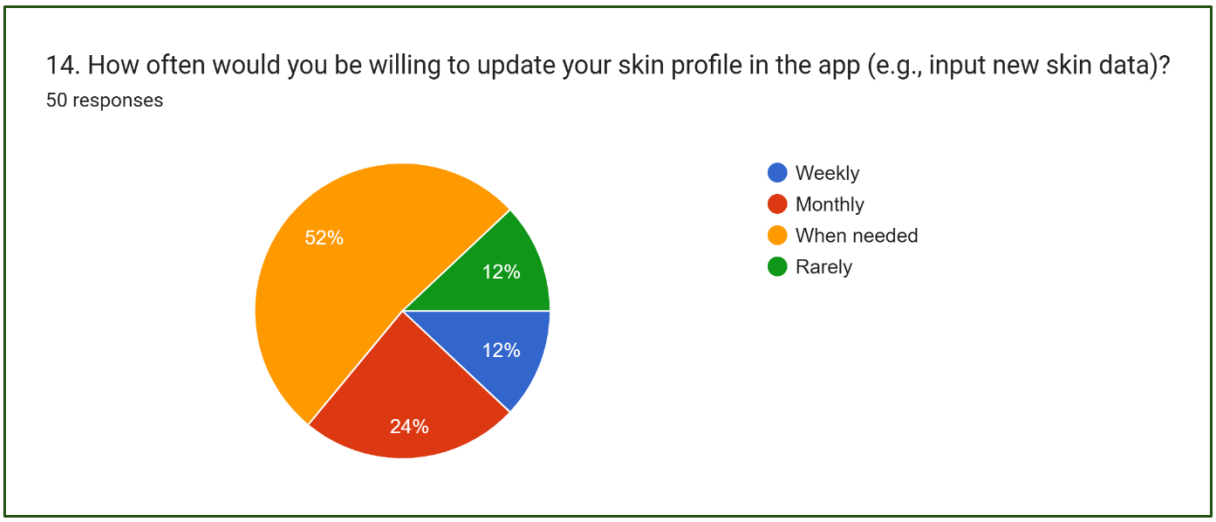

Figure 3.20: Frequency of Updating Skin Profile

Section 5: Feedback

This section gathers additional user feedback on their budget for skincare products, providing insights into what price range is most suitable for the target audience of BeautyBot.

Budget for Skincare Products

When asked about their monthly budget for skincare products, the distribution was as follows:

- Under RM50: 35.8% of respondents reported spending less than RM50 per month on skincare products.
- RM50–RM100: 39.6% indicated they typically spend between RM50 and RM100 each month.
- RM100–RM200: 22.6% of participants have a monthly budget ranging from RM100 to RM200.
- Above RM200: Only 1.9% of respondents spend more than RM200 per month on skincare products.

This data highlights that the majority of respondents have a moderate budget for skincare, with most spending between RM50 and RM100 monthly, which should be considered when recommending products on BeautyBot.

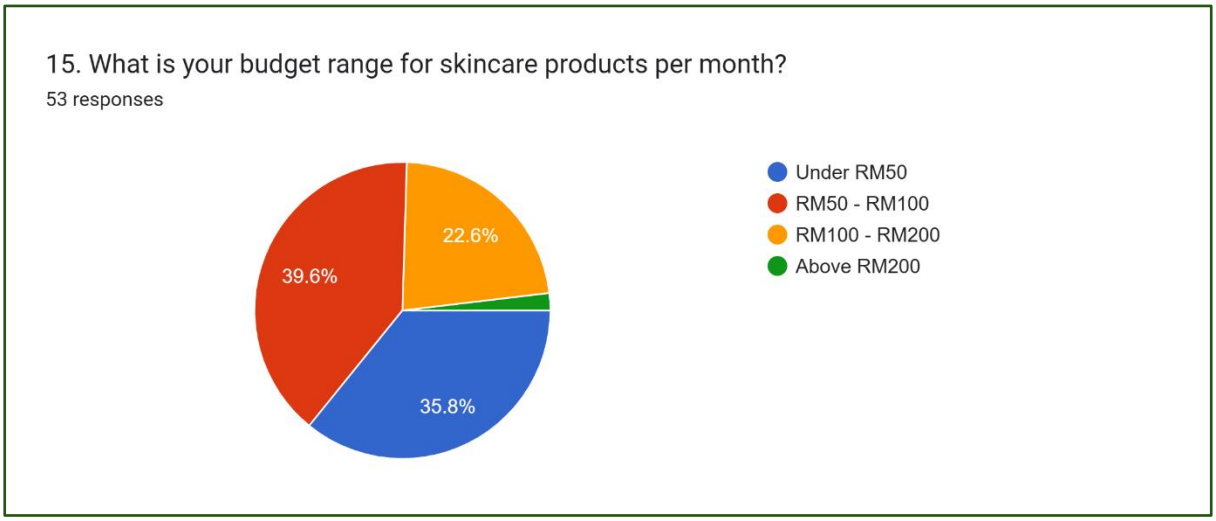

Figure 3.21: Budget for Skincare Products

3.3.2 Functional Requirements

The core features of BeautyBot include:

- User Profile and Preferences: The system must collect comprehensive user information via a questionnaire about skin type, concerns and preferences.
- AI-Based Recommendation Engine: The system uses AI to recommend suitable products, utilizing a dynamic and adaptable algorithm based on the user's profile.
- Personalized Skincare Routines: Based on the collected data, BeautyBot generates customized skincare routines for morning and evening, adjusted according to the user's skin profile.

3.3.3 Non-Functional Requirements:

- Usability: The user interface should be intuitive and easy to navigate, ensuring a seamless experience for all users.
- Performance: Fast processing times are required, particularly for generating AI-based recommendations in real-time.
- Scalability: The system should be able to accommodate a growing user base and an expanding product database over time.
- Security: Robust data security measures, including encryption and secure data storage, must be implemented to protect user privacy.
- Accessibility: The platform should adhere to accessibility standards, ensuring that users with disabilities can also benefit from its features.

3.3.4 User Requirements

The user requirements for BeautyBot were derived from insights gathered through a comprehensive survey of 53 participants, emphasizing the features and functionalities users expect to effectively address their skincare needs. By incorporating these expectations, BeautyBot is designed to provide a highly user-focused and personalized solution. The proposed system identifies two primary user groups: the end-users, who utilize the system for personalized skincare recommendations, and the administrators, responsible for managing and maintaining the platform.

Details of the requirements are discussed as follows:

(i) User

- Users should receive tailored skincare recommendations based on their skin type, concerns, and preferences.
- Users should have access to structured skincare routines for both morning and evening, with clear instructions for product application.
- Users should complete a step-by-step questionnaire to input details about their skin type, concerns, preferences, and budget.
- Users should be able to compare products by ingredients and user ratings to make informed decisions.
- Users should have the ability to create and update their skin profiles, including retaking the questionnaire or modifying their preferences.
- Users should be able to rate products and provide feedback to improve the system's future recommendations.
- Users should be able to register and log in securely.

(ii) Administrator

- Administrators should have the ability to add, update, or remove products from the database.
- Administrators should have access to user feedback for analysis and system improvement.

3.3.5 Software Requirements

These software requirements are essential for the successful development of BeautyBot, ensuring a seamless integration of backend and frontend components, efficient data handling, and personalized AI-powered recommendations. Each tool and framework have been selected to optimize the development process, enhance user experience, and ensure the system's scalability and security.

Table 3.2: Software Requirements

Software	Purpose	Descriptions
Python	Programming Language	Used for backend development, implementing AI models, and processing user data.
Django	Backend Framework	Django is a Python framework that helps build web applications quickly and securely. It provides built-in features like user login, database management and an admin panel.
MySQL	Database	MySQL is used for storing user profiles, product information and other data. It is a

		widely used, open-source relational database management system that uses SQL.
PyTorch	AI/ML Frameworks	Used for building, training, and deploying machine learning models, specifically for generating personalized product recommendations based on user data.
HTML/CSS/JavaScript	Frontend Development	HTML structures the page, CSS styles the page, and JavaScript adds interactivity and dynamic functionality to the system.
React	Frontend Framework	React is a JavaScript library used to build dynamic, component-based user interfaces. It's particularly useful for building interactive elements like questionnaires, recommendations, and profile management.
Figma	UI/UX Design	Used for designing wireframes, prototypes and high-fidelity user interfaces to guide frontend development.
GitHub	Version Control	GitHub stores repositories online for collaboration and version history.

3.4 System Design and General Architecture

3.4.1 Use Case Diagrams

The use case diagram depicts a high-level overview of the relationship between use case (actions), systems and actors (external users and admin of the system). Figure 3.16 shows the use case diagram of the proposed system.

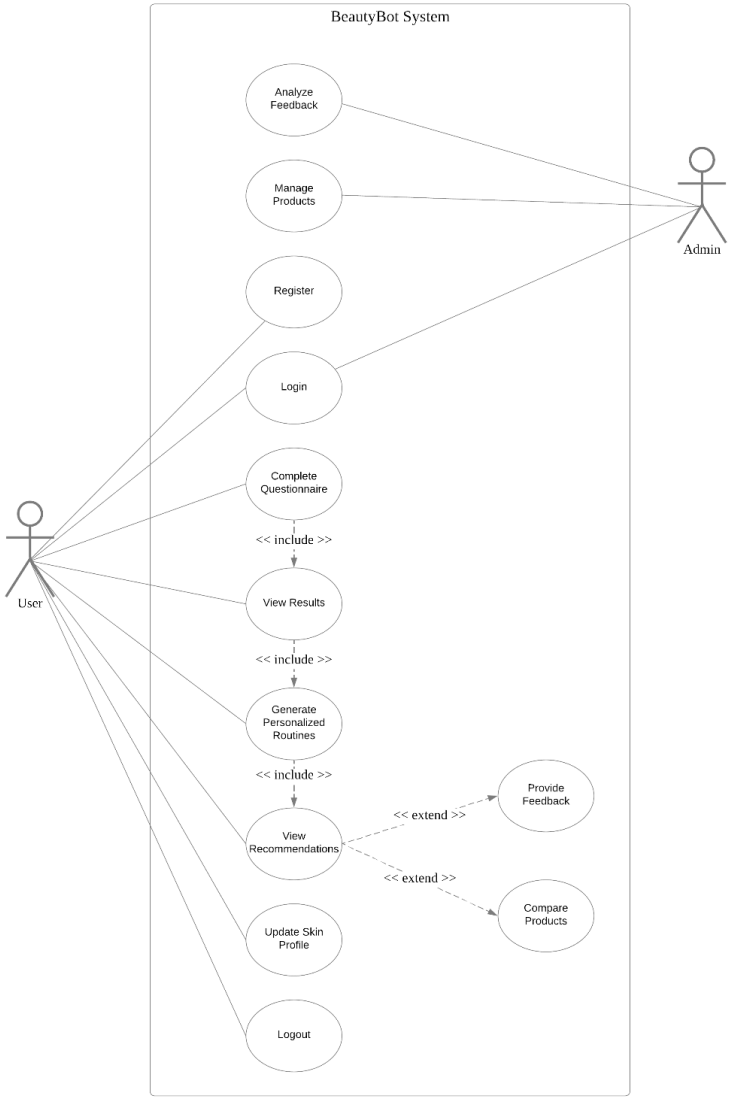

Figure 3.22: Use Case Diagram

Use Case Description

The BeautyBot system is designed to provide personalized skincare recommendations and routines through a set of interconnected use cases. These use cases represent the core functionalities and optional features that enhance the user experience, ensuring adaptability, ease of use, and efficiency. Below are the detailed descriptions of each use case:

Table 3.3: Use Case Description for Register

Use Case:	Register
Brief Description:	The user registers an account to access the system.
Actor(s):	User
Pre-condition(s):	The user does not have an account in the system.
Post-condition(s):	The user account is successfully created.
Main Flow:	1. The user navigates to the registration page. 2. The user enters the required details. 3. The user clicks the “Register” button. 4. The system validates the information and creates the account. 5. The system notifies the user of successful registration.
Alternative Flow:	N/A
Exception Flow:	E1. The entered email is already registered. E2. The information provided is invalid or incomplete.

Table 3.4: Use Case Description for Login

Use Case:	Login
Brief Description:	The user login into the system.
Actor(s):	User, Admin
Pre-condition(s):	The user has registered an account in the system.
Post-condition(s):	The user successfully login into the system.
Main Flow:	1. The user clicks into the login page. 2. The user enters login information. 3. The user clicks on “Login” button. 4. The user successfully login into the system. 5. The system redirects to homepage.
Alternative Flow:	N/A
Exception Flow:	E1. The user cancels the login process. E2. The login information is incomplete.

Table 3.5: Use Case Description for Complete Questionnaire

Use Case:	Complete Questionnaire
Brief Description:	The user fills out a skincare-related questionnaire to help the system generate personalized recommendations.
Actor(s):	User
Pre-condition(s):	The user is logged in.
Post-condition(s):	The questionnaire responses are successfully saved.
Main Flow:	1. The user navigates to the questionnaire page. 2. The system displays the questionnaire.

	3. The user answers all the questions. 4. The user submits the completed questionnaire. 5. The system confirms that the responses are saved.
Alternative Flow:	N/A
Exception Flow:	E1. A technical issue prevents the response from being saved.

Table 3.6: Use Case Description for Generate Personalized Routines

Use Case:	Generate Personalized Routines
Brief Description:	The system generates skincare routines based on the user's questionnaire responses.
Actor(s):	System
Pre-condition(s):	The user has completed the questionnaire.
Post-condition(s):	The personalized routines are displayed to the user.
Main Flow:	1. The system analyses the questionnaire responses. 2. The system generates personalized routines. 3. The system displays the routines to the user.
Alternative Flow:	N/A
Exception Flow:	E1. The system fails to analyse the responses due to missing data.

Table 3.7: Use Case Description for View Recommendations

Use Case:	View Recommendations
Brief Description:	The user views personalized skincare product recommendations.

Actor(s):	User
Pre-condition(s):	The system has generated recommendations.
Post-condition(s):	The user views the recommendations.
Main Flow:	1. The user navigates to the recommendations page. 2. The system displays the personalized product recommendations.
Alternative Flow:	N/A
Exception Flow:	E1. The recommendations are not available due to a system error.

Table 3.8: Use Case Description for Update Skin Profile

Use Case:	Update Skin Profile
Brief Description:	The user updates their skin profile details.
Actor(s):	User
Pre-condition(s):	The user is logged in.
Post-condition(s):	The user's skin profile details are updated in the system.
Main Flow:	1. The user navigates to their skin profile page. 2. The user edits their skin profile information. 3. The user clicks on "Save" button. 4. The system updates the user's profile.
Alternative Flow:	N/A
Exception Flow:	E1. The updated information is invalid.

Table 3.9: Use Case Description for Logout

Use Case:	Logout
Brief Description:	The user logs out of the system.
Actor(s):	User
Pre-condition(s):	The user is logged in.
Post-condition(s):	The user is logged out, and the session is terminated.
Main Flow:	1. The user clicks the “Logout: button. 2. The system ends the user’s session.
Alternative Flow:	N/A
Exception Flow:	N/A

Table 3.10: Use Case Description for Provide Feedback

Use Case:	Provide Feedback
Brief Description:	The user provides feedback on their experience or the recommended products.
Actor(s):	User
Pre-condition(s):	The user is logged in.
Post-condition(s):	The feedback is successfully submitted and saved.
Main Flow:	1. The user navigates to the feedback page. 2. The user enters feedback. 3. The user submits the feedback. 4. The system confirms receipt of the feedback.
Alternative Flow:	N/A
Exception Flow:	E1. The feedback submission fails due to a system error.

Table 3.11: Use Case Description for Compare Products

Use Case:	Compare Products
Brief Description:	The user compares the features of different skincare products.
Actor(s):	User
Pre-condition(s):	The user is logged in.
Post-condition(s):	The product comparison is displayed.
Main Flow:	1. The user selects products for comparison. 2. The system displays a side-by-side comparison of the products.
Alternative Flow:	N/A
Exception Flow:	N/A

Table 3.12: Use Case Description for Manage Products

Use Case:	Manage Products
Brief Description:	The administrator adds, updates, or removes products in the system.
Actor(s):	Administrator
Pre-condition(s):	The administrator is logged in.
Post-condition(s):	The product database is updated.
Main Flow:	1. The administrator navigates to the product management page. 2. The administrator selects an action (add, update, or remove). 3. The system performs the action and updates the database.

Alternative Flow:	N/A
Exception Flow:	E1. The action fails due to system errors or invalid inputs.

Table 3.13: Use Case Description for Analyze Feedback

Use Case:	Analyse Feedback
Brief Description:	The administrator reviews user feedback for system improvement.
Actor(s):	Administrator
Pre-condition(s):	Feedback data is available in the system.
Post-condition(s):	Feedback insights are generated and reviewed.
Main Flow:	1. The administrator navigates to the feedback analysis page. 2. The system displays the feedback data. 3. The administrator reviews the feedback.
Alternative Flow:	N/A
Exception Flow:	E1. Feedback data is unavailable due to system errors.

3.4.2 Data Flow Diagram (DFD)

A Data Flow Diagram (DFD) is a visual tool that shows how data moves through a system. It highlights the flow of information between external entities, processes, data stores, and outputs. The Level 0 DFD gives a broad overview of the system, while the Level 1 DFD provides a more detailed look at the system's processes and how data is handled. In Chapter 3, which focuses on the system design of BeautyBot, the DFD is important because it helps explain how the system works. It shows how data is collected from the user, processed by the AI, stored, and used to generate personalized skincare recommendations. The DFD makes it easier for both technical and non-technical readers to understand the system's structure and data flow. The DFD also helps identify potential problems or areas for improvement by showing how data moves between different parts of the system. It is an essential part of the project documentation, as it provides a clear, simple way to communicate the system design to others. By using a DFD, it's easier to ensure the system works as intended and meets the project's goals.

Level 0 Data Flow Diagram (DFD)

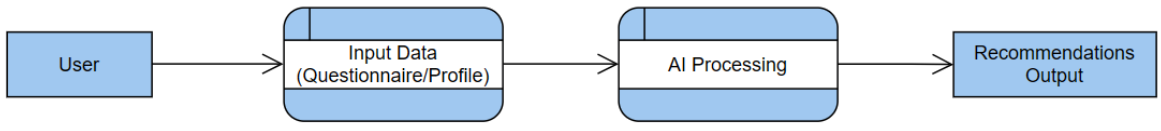

Figure 3.23: Level 0 DFD

The Level 0 Data Flow Diagram (DFD) offers a high-level overview of the BeautyBot system, illustrating its key components and their interactions. In this diagram, the User is the primary

external entity, interacting with the system by providing personal information such as skin type, concerns, and product preferences. This data is crucial for the system to generate personalized skincare recommendations.

Once the user inputs their information, it flows into the Input Data process, where it is captured, validated, and structured for further analysis. This ensures that the data is properly prepared for the next phase, AI Processing, which serves as the core function of the system. Here, advanced artificial intelligence algorithms analyse the user's profile, factoring in skin type, preferences, and product characteristics to generate tailored product recommendations. The system also considers product ingredients, compatibility, and user feedback, ensuring that the recommendations are both relevant and effective.

The result of the AI analysis is a Recommendations Output that includes personalized skincare routines and product suggestions. This output, which is presented through an intuitive user interface, provides detailed information about recommended products, including their names, descriptions, and usage instructions. By simplifying the user's journey from entering their data to receiving customized suggestions, the Level 0 DFD highlights how BeautyBot utilizes AI to offer an efficient and user-centric skincare solution.

Level 1 Data Flow Diagram (DFD)

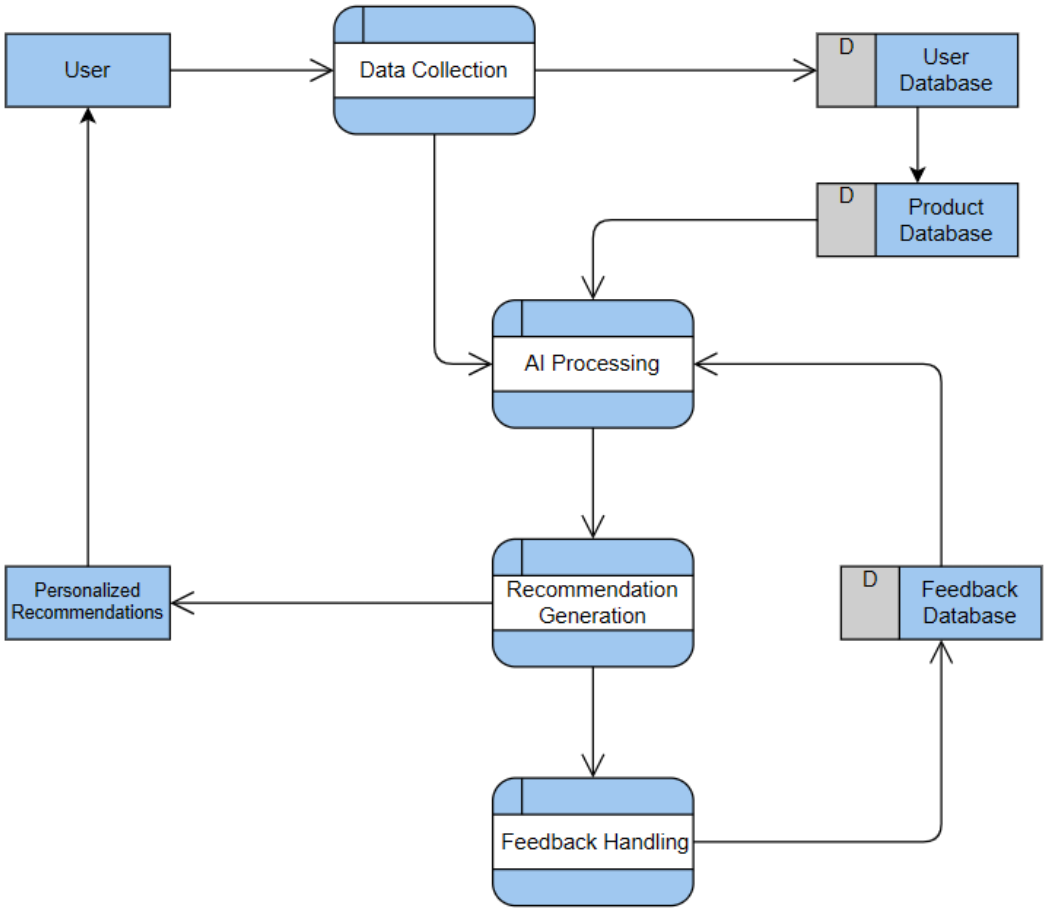

Figure 3.24: Level 1 DFD

The Level 1 Data Flow Diagram (DFD) provides a more detailed look at the internal processes of BeautyBot, showing how data is handled, processed, and utilized to generate personalized recommendations. This diagram breaks down the core system components and their functions, focusing on the flow of data from input collection to output generation.

1. User: The process begins with the User, who provides key information through a detailed questionnaire or profile update. This input includes skin type, concerns, age, preferences, and any relevant feedback on previous skincare products. The data

collected is essential for the system to understand the unique needs and preferences of each user.

2. Data Collection: The Data Collection process captures and organizes the user's input, ensuring the information is validated and structured. This step prepares the data for subsequent analysis, ensuring that the AI can make accurate recommendations based on the user's profile. The data is stored in the User Database for easy access during future interactions.
3. User Database: The User Database stores all user-related information, including their skin profile, preferences, and feedback. It acts as a repository, continually updating as users provide new information or feedback. The AI system retrieves data from this database to create personalized recommendations, ensuring the suggestions are tailored to everyone.
4. AI Processing: The AI Processing module is the core of BeautyBot, where the system's intelligence comes into play. Using advanced algorithms, the AI analyses the user's profile stored in the User Database, as well as the available product data from the Product Database. It assesses factors such as skin type, preferences, product ingredients, and past feedback to generate optimal product recommendations and skincare routines for each user.
5. Product Database: The Product Database contains a comprehensive list of skincare products, including detailed information about ingredients, uses, and benefits. The AI uses this database to compare the user's preferences with the available products, ensuring that each recommendation aligns with the user's needs and requirements.
6. Recommendation Generation: After the AI processing is complete, the system generates the final Recommendations Output. This output includes personalized skincare routines and product suggestions that are tailored to the user's profile. Each

recommendation is accompanied by detailed information, such as product names, descriptions, and usage instructions, ensuring that the user can easily follow the suggested skincare routine.

7. Feedback Handling: Once the user receives their recommendations, they may provide feedback on the suggested products or routines. The Feedback Handling process captures this input and stores it in the Feedback Database. The feedback is then used to refine the AI's algorithms, improving the accuracy and relevance of future recommendations.

3.4.3 Activity Diagram

The activity diagram for the BeautyBot system illustrates the workflows for both users and administrators. Each workflow consists of specific steps, decision points, and actions that guide the interaction with the system. Below is a detailed step-by-step explanation:

User Interaction Flow

Step 1: The user interacts with the system by accessing the BeautyBot platform.

Step 2: If the user is new, they must register for an account by providing the required information.

Step 3: After registration, or if the user already has an account, they proceed to log in.

Step 4: Once logged in, the user completes a questionnaire to provide details about their skin type, concerns, and goals.

Step 5: The system processes the questionnaire data and generates a personalized skincare routine.

Step 6: The user can view recommendations for skincare products, compare products based on features and suitability and provide feedback on the recommendations.

Step 7: The user can update their skin profile to reflect changes in personal information or preferences.

Step 8: When finished, the user logs out, ending their session.

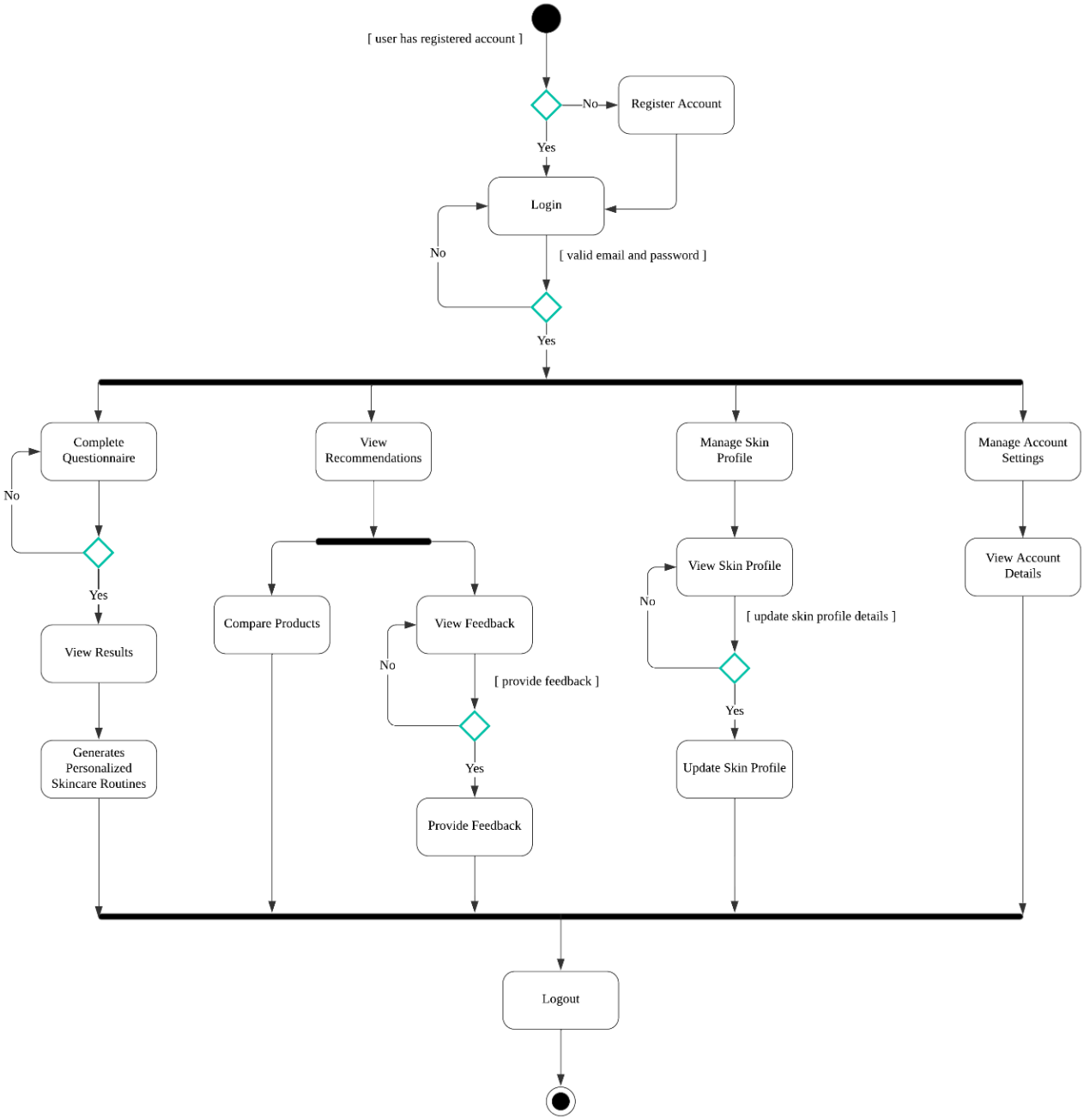

Figure 3.25: Activity Diagram for User

Admin Interaction Flow

Step 1: The process begins when the admin logs into the system.

Step 2: After logging in, the admin can manage users, manage products and review feedback.

Step 3: The admin logs out upon completing their tasks.

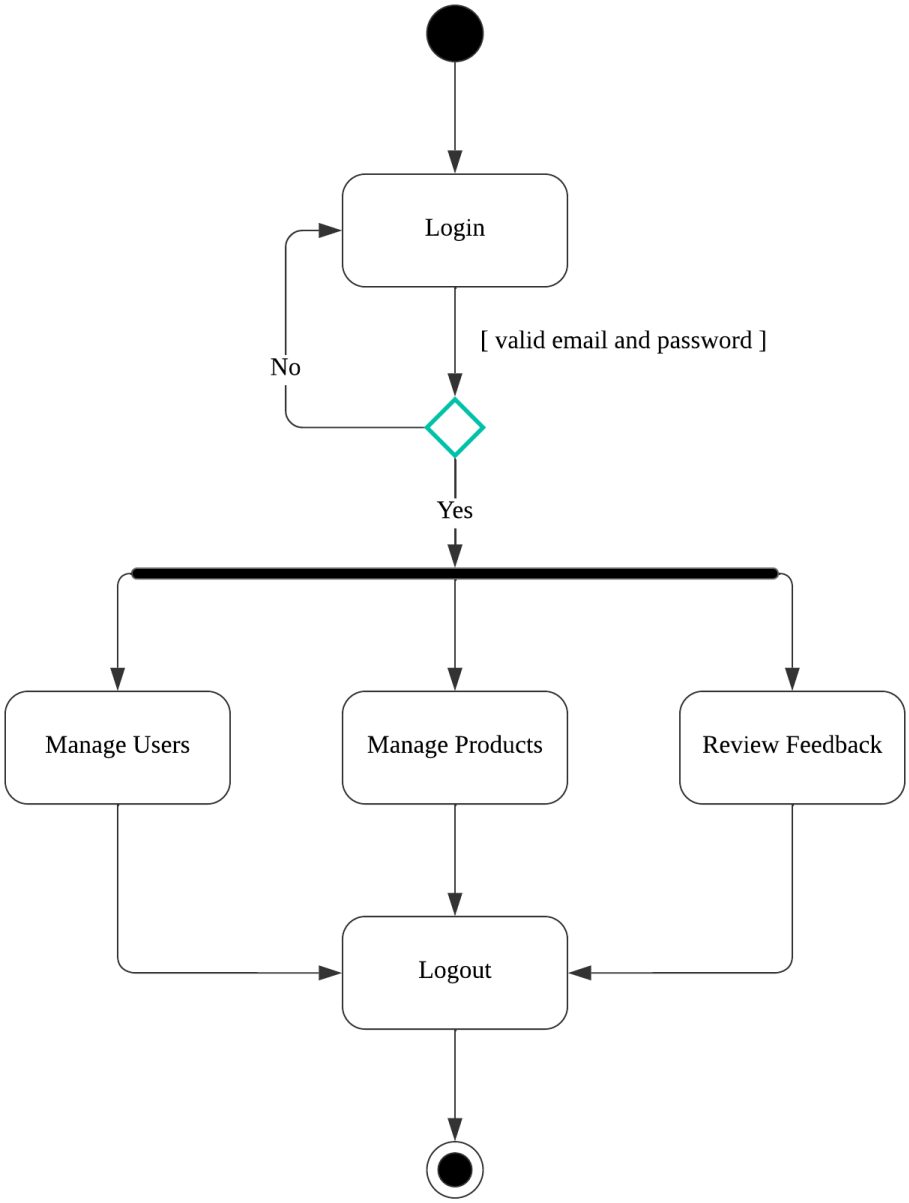

Figure 3.26: Activity Diagram for Admin

3.4.4 User Interface (UI) Design

The User Interface (UI) of BeautyBot is designed to be user-friendly, intuitive and visually appealing, focusing on minimalistic and ease of navigation.

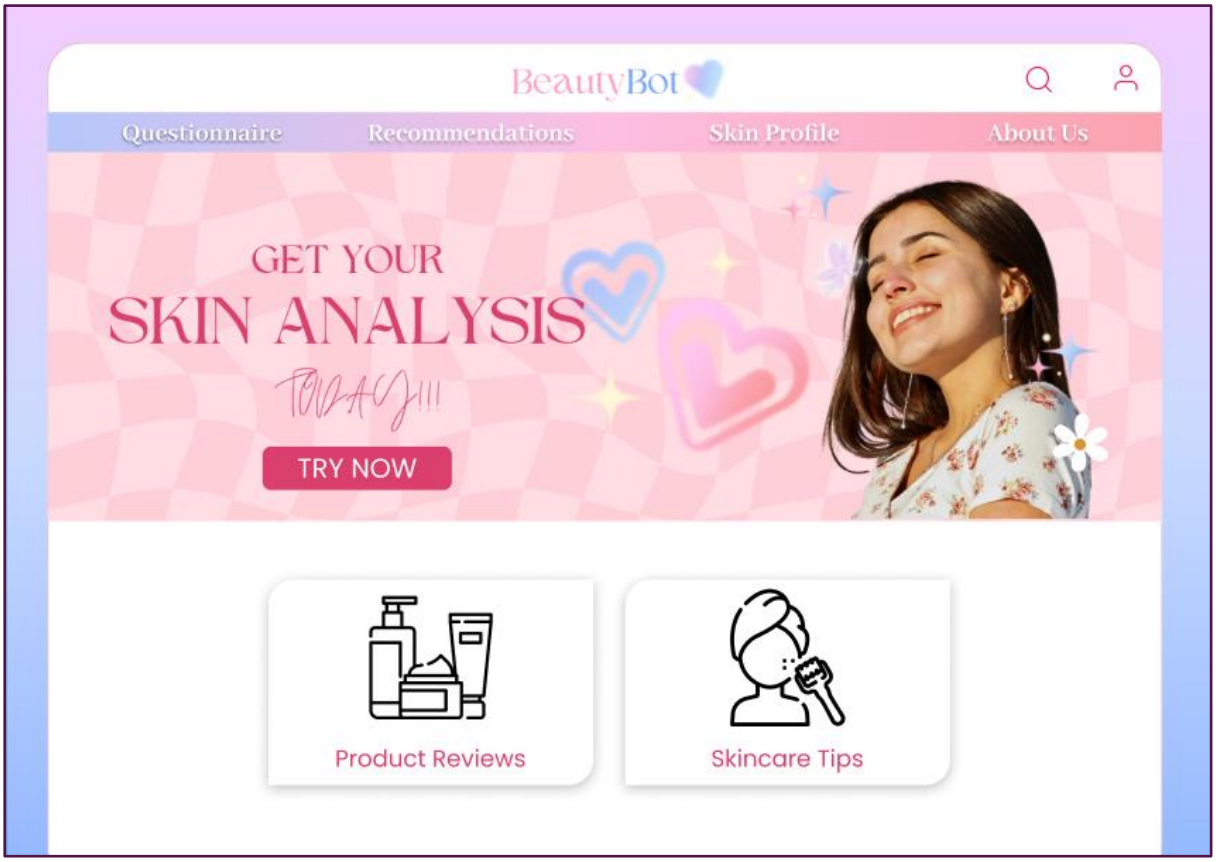

Figure 3.27: Homepage Wireframe

The homepage is designed to captivate users upon entry, with its vibrant and cheerful aesthetic. The header prominently features the BeautyBot logo, enhancing brand recognition, along with a navigation bar for easy access to core sections such as the Questionnaire, Recommendations, Skin Profile, and About Us. The design ensures that users can explore various features effortlessly.

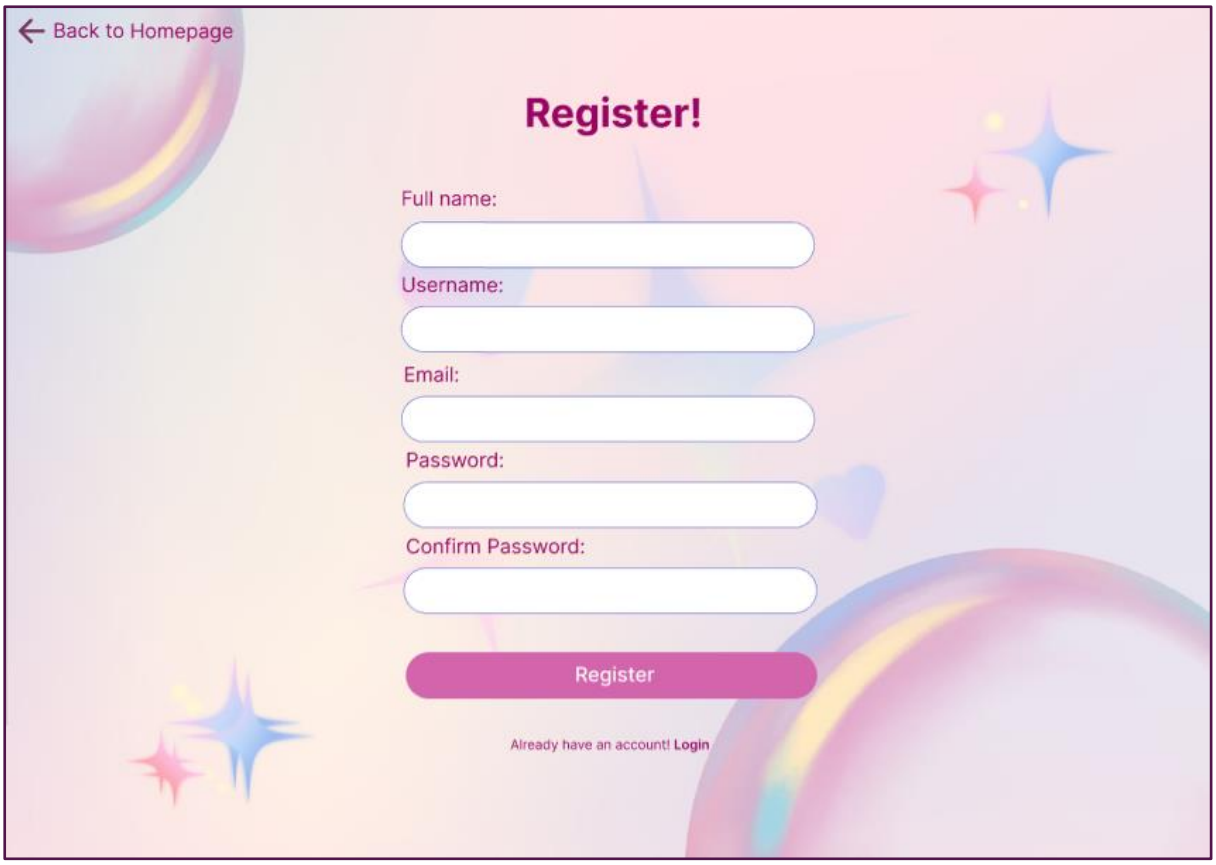

Figure 3.28: Register Wireframe

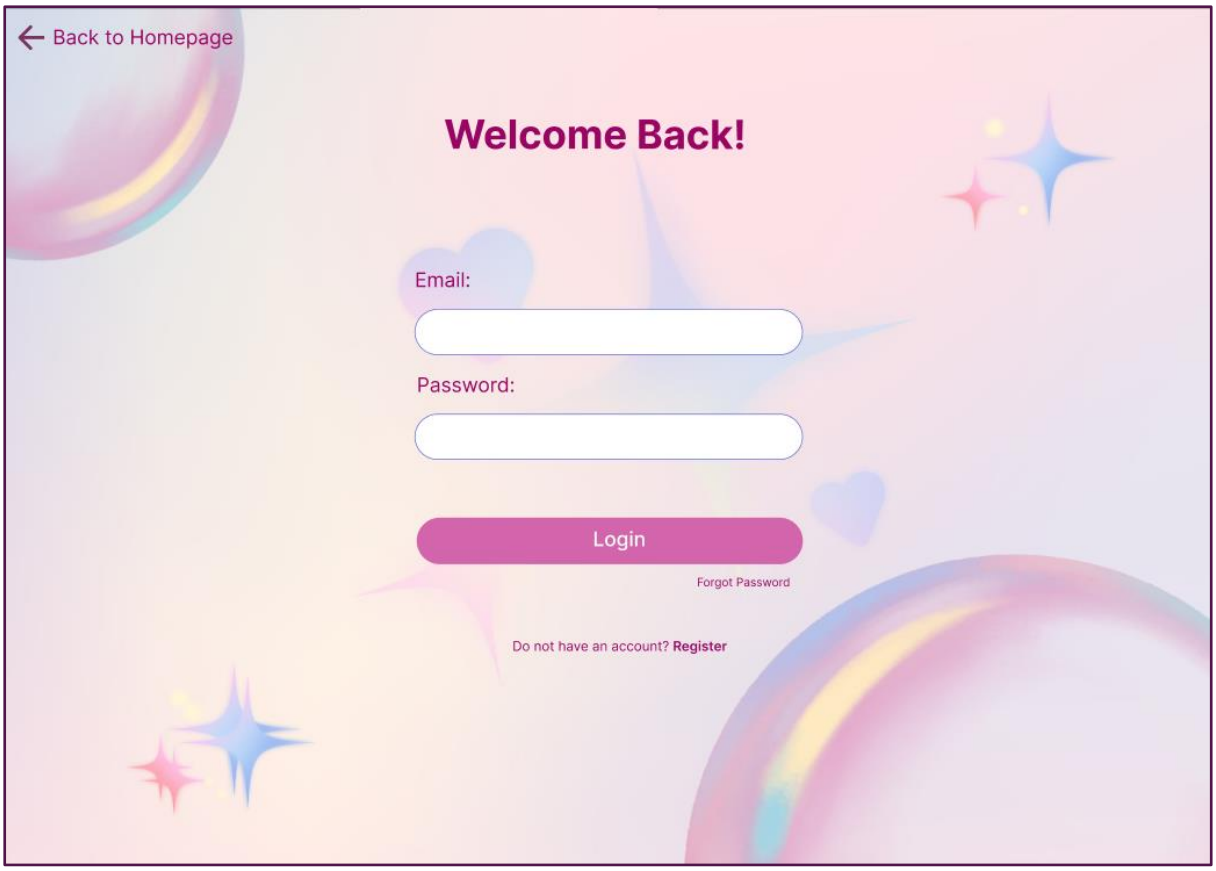

Figure 3.29: Login Wireframe

The Register and Login pages ensure secure access for new and returning users. The registration page allows new users to create an account by providing their full name, username, email, and password, offering a straightforward and minimal layout for ease of use. Meanwhile, the login page includes fields for email and password, along with an option for password recovery, ensuring returning users can access their accounts without hassle.

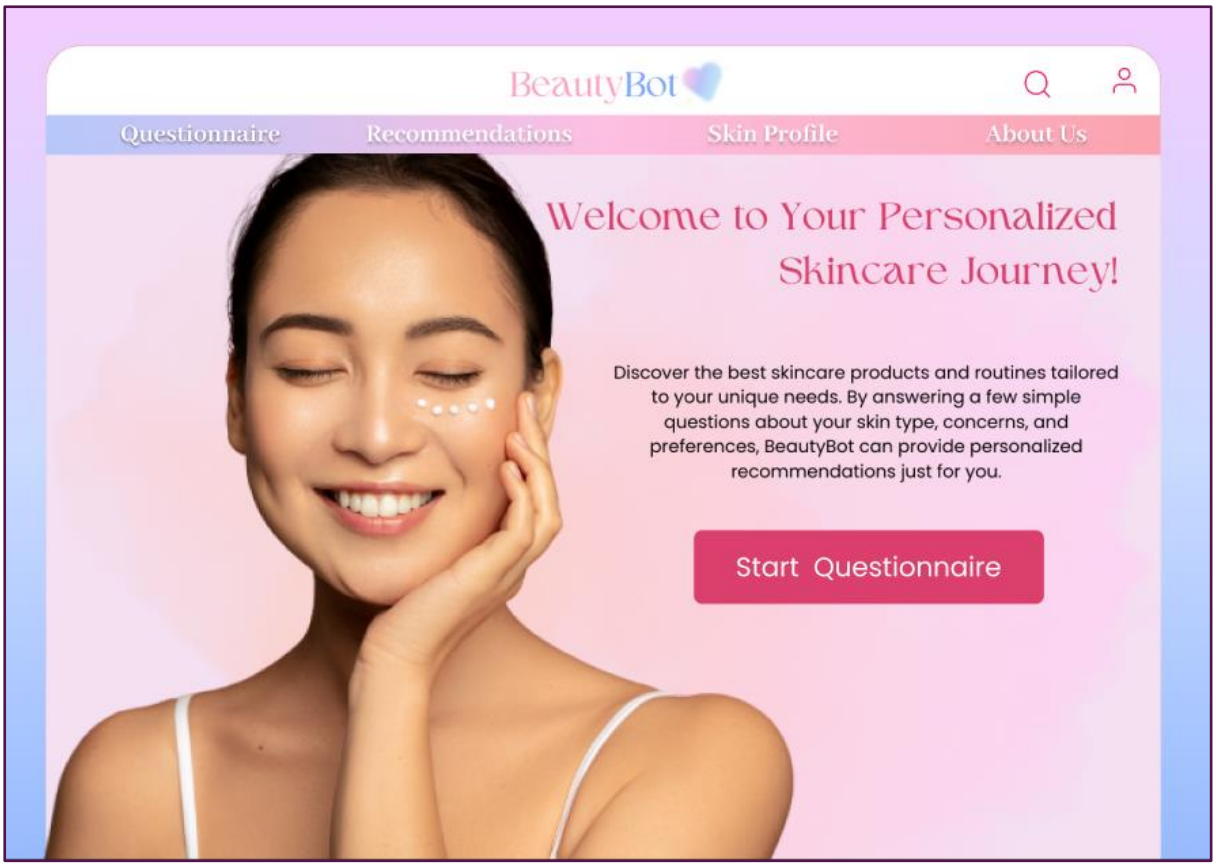

Figure 3.30: Questionnaire Wireframe

The Questionnaire Page is the core of the personalization process, designed to guide users in providing key skincare details such as skin type, concerns, preferences, and budget. Reflecting the current design, the page features a welcoming headline and a brief description to emphasize the purpose of the questionnaire, making the process approachable and user-friendly. A prominent “Start Questionnaire” button simplifies navigation and encourages users to engage. Though the detailed step-by-step form isn't visually depicted in this static design, the structure would include clear progress indicators and validation checks to ensure users can confidently and accurately complete their input. The soothing pastel palette and imagery complement the overall experience, ensuring users feel at ease while beginning their personalized skincare journey.

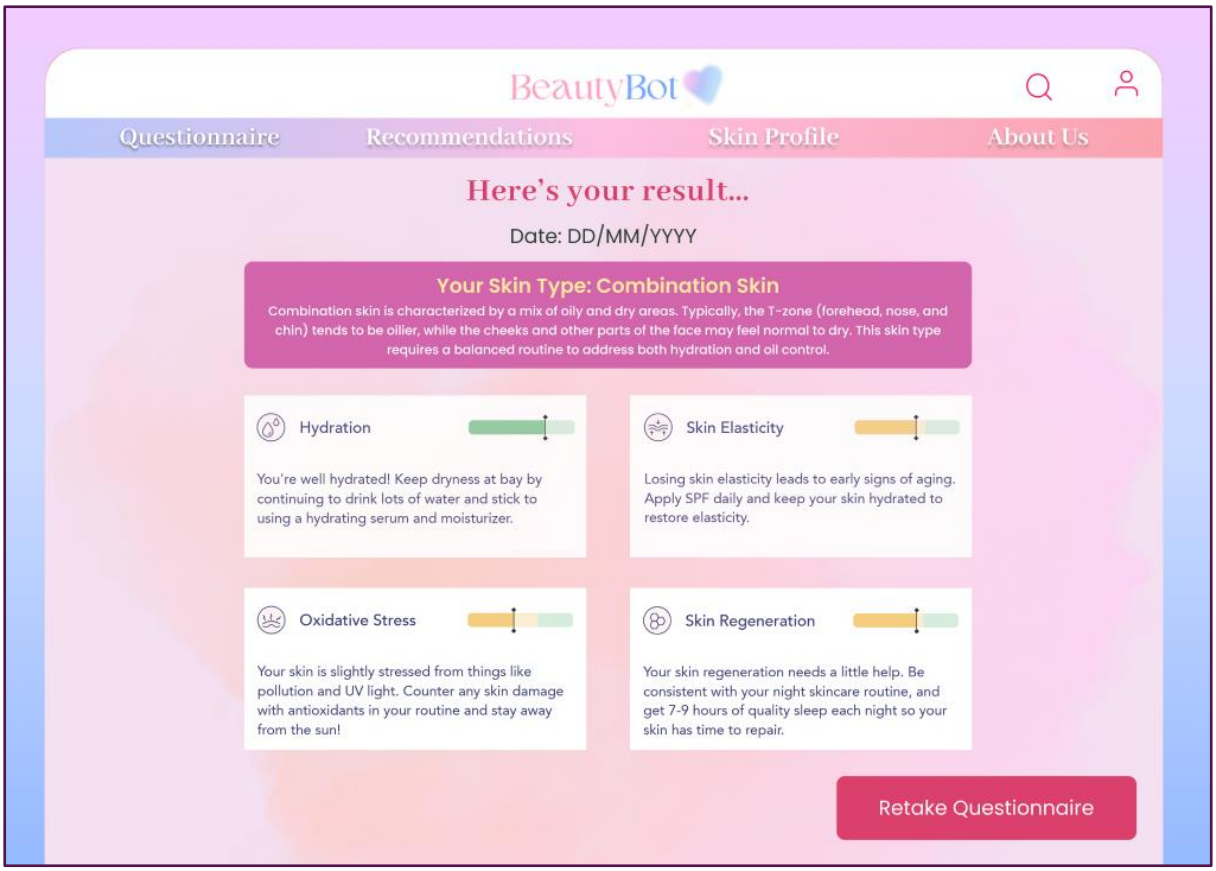

Figure 3.31: Results Wireframe

The Results Page presents personalized skincare routines generated by the system. Reflecting the current design, the page starts with a clear and welcoming headline, such as “Here’s your result,” followed by the user's skin type and a brief explanation of its characteristics. Below this, detailed insights are provided in a structured format, including specific skin factors such as hydration, elasticity, oxidative stress, and regeneration. Each factor is accompanied by tailored advice and visual progress indicators to help users understand their skin’s condition. Recommendations are displayed in a structured format, separating routines into morning and evening sections for clarity. Each product recommendation includes details such as ingredients and usage instructions, providing users with actionable and practical advice. The layout is designed to ensure recommendations are easy to understand and follow, enhancing the overall user experience.

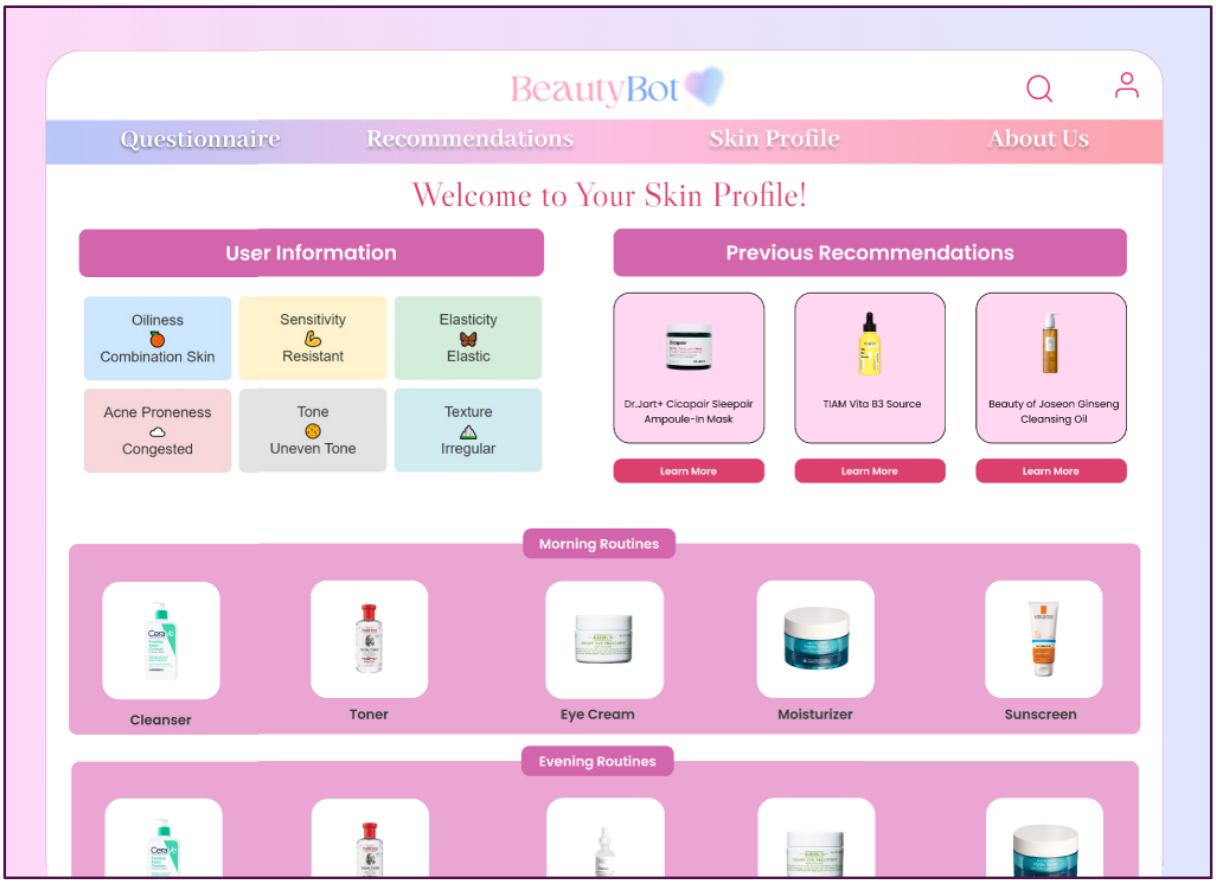

Figure 3.32: Skin Profile Wireframe

The Skin Profile Page allows users to view and manage their saved data. It displays user information such as skin type, previous recommendations, and feedback history, with options to update preferences or retake the questionnaire. This feature ensures the system remains adaptive to evolving user needs. It also shows the personalized skincare routines for the users.

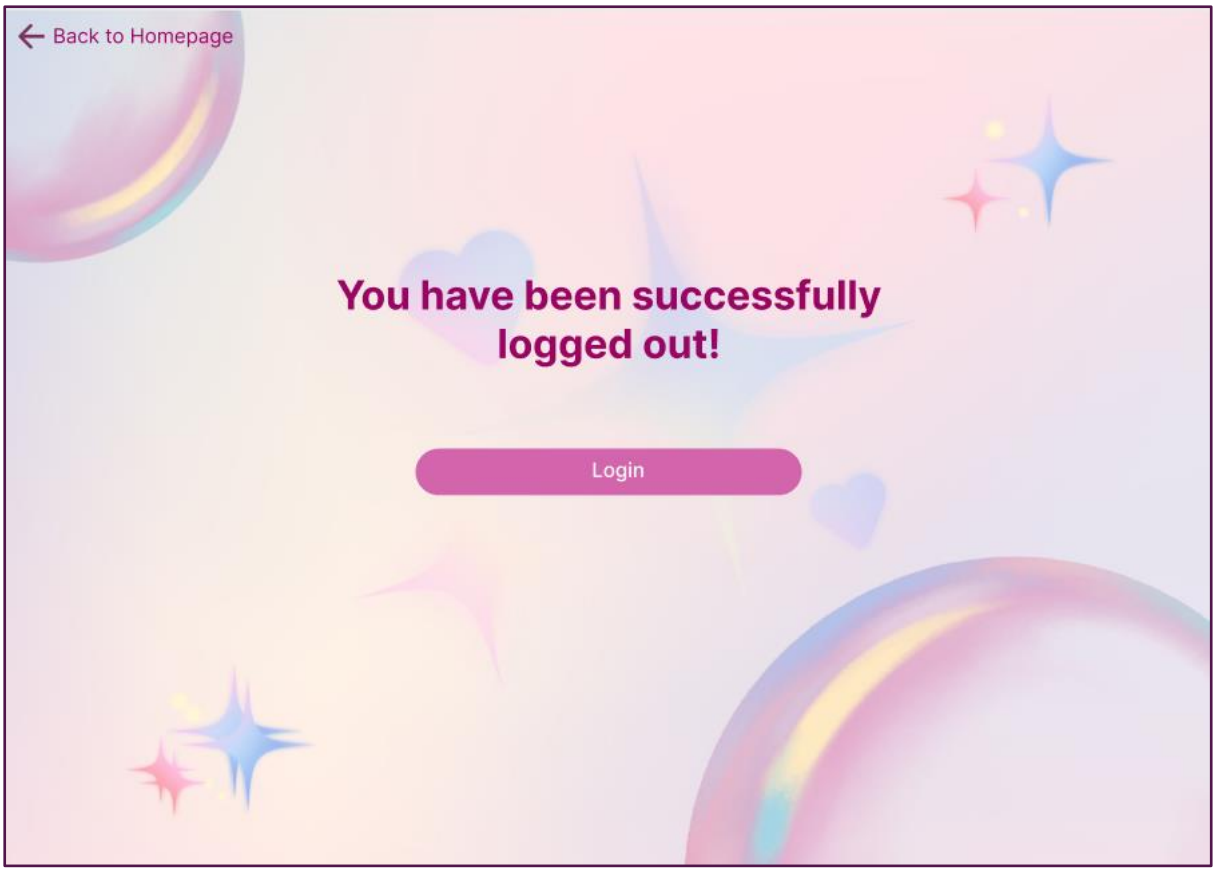

Figure 3.33: Logout Wireframe

A logout functionality is available on all pages, enabling users to securely log out of their accounts, redirecting them to the homepage upon completion.

3.5 AI Workflow

The Artificial Intelligence (AI) component of BeautyBot is the foundation of its ability to deliver a user-centric skincare recommendation system. The AI enables BeautyBot to analyse user data, match it with product attributes, and dynamically adapt to feedback, ensuring personalized recommendations that evolve with user needs.

The workflow begins with data collection through an interactive questionnaire, followed by data preprocessing and feature engineering to prepare the information for analysis. The core AI process utilizes a Hybrid Recommendation System to generate personalized recommendations, combining Content-Based Filtering (CBF) and Collaborative Filtering (CF). The recommendations are then presented to the user, and their feedback is incorporated into a feedback loop to improve future predictions.

3.5.1 AI Algorithm

Recommendation systems are pivotal in enhancing user experience across various applications by suggesting relevant products or items. Two widely used methods in this domain are Content-Based Filtering (CBF) and Collaborative Filtering (CF). While effective in many scenarios, both approaches encounter challenges when insufficient data limits the ability to establish clear relationships between users and items (Sharma et al., 2023).

To address these limitations, a Hybrid Recommendation System integrates Content-Based Filtering (CBF) and Collaborative Filtering (CF) techniques, combining their strengths to overcome individual shortcomings. This hybrid approach ensures improved accuracy, diversity, and overall effectiveness in generating recommendations (Sharma et al., 2023).

For BeautyBot, a website designed to provide personalized skincare product recommendations, the Hybrid Recommendation System serves as the core algorithm. By merging CBF and CF, BeautyBot leverages user preferences, historical interactions, and product attributes to deliver

tailored recommendations. This sophisticated system not only enhances user satisfaction but also fosters deeper engagement, making it an invaluable feature for entertainment-driven platforms and beyond.

Content-Based Filtering (CBF)

Content-Based Filtering (CBF) focuses on matching a user's preference with the attributes of items, such as skincare products in the context of BeautyBot. According to Lee et al., (2023), each product is represented as a vector containing features like rating, ingredients and suitability for specific skin types. Similarly, a user profile is constructed based on the data they provide, including their skin type, primary concerns (e.g., acne, aging), and preferences for product attributes (e.g., natural ingredients, specific brands).

$$\mathrm{Cos}(a,b) = \frac{\vec{a}\cdot\vec{b}}{||\vec{a}||\,||\vec{b}||} = \frac{\sum_1^l a_i b_i}{\sqrt{\sum_1^l a_i^2}\,\sqrt{\sum_1^l b_i^2}}$$

The algorithm calculates the similarity between the user skin profile and product attributes using mathematical measures such as cosine similarity. This measure determines how closely a product's attributes align with the user's stated preferences. For example, if a user indicates they have oily skin and are concerned about acne, the system identifies products containing ingredients like salicylic acid or niacinamide, which are known to target those issues. These products are then ranked based on their similarity scores, with the most relevant recommendations displayed to the user.

However, CBF has limitations. It struggles to make recommendations for new users who have not provided detailed preferences, known as the cold start problem for users. Additionally, it tends to focus on products like those already in the user skin profile, potentially limiting

diversity and innovation in the recommendations. This is especially problematic in a domain like skincare, where users may benefit from discovering products they would not typically consider.

Collaborative Filtering (CF)

Collaborative Filtering (CF) generates recommendations by analysing patterns in user behaviour and interactions. Unlike CBF, which relies on item attributes, CF focuses on user-product relationships. It identifies similarities between users or products based on historical interactions, such as ratings, feedback, or usage data. CF operates in two main forms:

1. User-Based Collaborative Filtering: Identifies users with similar preferences and recommends products they have liked.
2. Item-Based Collaborative Filtering: Suggests products similar to those the user has previously interacted with.

CF uses techniques like matrix factorization, such as Singular Value Decomposition (SVD), to reduce a large user-product interaction matrix into latent factors that reveal hidden relationships. For instance, in BeautyBot, if two users with oily skin rate a specific cleanser highly, the system can recommend that cleanser.

While CF excels at leveraging user behaviour to generate diverse and innovative recommendations, it has its challenges. It suffers from the cold start problem for products, where new products with no historical interaction data cannot be recommended. Additionally, sparse interaction matrices (i.e., when only a few users provide feedback or ratings) can limit the algorithm's accuracy other users with similar profiles.

Hybrid Recommendation System

A Hybrid Recommendation System that combines Content-Based Filtering (CBF) and Collaborative Filtering (CF) is an ideal solution for BeautyBot, addressing the limitations of each method while amplifying their strengths. By integrating these techniques, the system can generate more personalized, diverse, and accurate skincare recommendations.

The Hybrid Recommendation System effectively resolves the cold start problem (Lee et al., 2023). For new users with no historical interactions, CBF generates recommendations based on explicit preferences collected through the questionnaire. For example, if a new user indicates they have sensitive skin, CBF can recommend products with calming ingredients like aloe vera or ceramides, even without prior user interactions. On the other hand, CF addresses the cold start issue for new products. If a new moisturizer has no direct data, CF can recommend it based on similar products that users with comparable preferences have liked, leveraging patterns in user-product interactions.

By combining the strengths of both methods, the Hybrid Recommendation System ensures that recommendations are both relevant and varied. CBF provides highly accurate suggestions tailored to the user's preferences, ensuring that recommendations match explicit needs. Meanwhile, CF introduces diversity by incorporating products that similar users have interacted with, even if those products do not align perfectly with the user's stated preferences. This balance is particularly important in skincare, where users often seek a mix of familiar solutions and innovative products to address their unique concerns.

How It Works:

Step 1: Generate recommendations using Content-Based Filtering based on the user's skin profile and preferences.

Step 2: Generate recommendations using Collaborative Filtering based on similar user's preferences or behaviour.

Step 3: Combine the results from both algorithms using a weighted score.

Formula:

Let R_{hybrid} be the final recommendation score: $R_{hybrid} = \alpha \cdot R_{CBF} + (1 - \alpha) \cdot R_{CF}$

Where:

- R_{CBF}: Score from Content-Based Filtering
- R_{CF}: Score from Collaborative Filtering
- α: Weight assigned to Content-Based Filtering (e.g., 0.6 for initial recommendations)

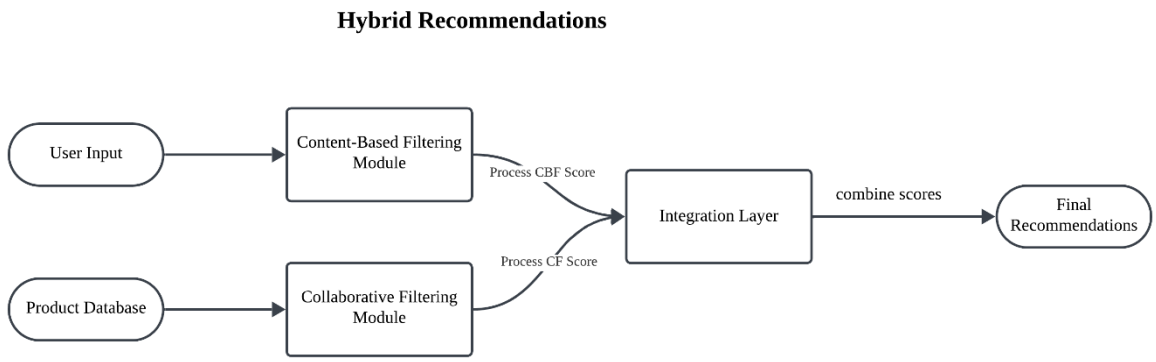

Figure 3.34: Hybrid Recommendations Diagram

3.5.2 Tools and Frameworks

To implement AI in BeautyBot, the following tools and frameworks are utilized:

1. Programming Language:
    - Python is chosen for its simplicity and extensive support for AI development.
2. AI Framework:
    - PyTorch is selected due to its ease of use, flexibility and dynamic computation graph, which make debugging and experimentation straightforward. PyTorch is suitable for both beginners and advanced users, offering efficient tools for model building, training and evaluation.
3. Data Preprocessing Libraries:
    - Scikit-learn: Used for cleaning and transforming data into a format suitable for machine learning models.
    - Pandas: For data manipulation and analysis.
4. Database:
    - My SQL is used for storing user profiles, questionnaire data, product attributes and feedback.
5. Development Framework:
    - Django: Facilitates backend development and integration of the AI model with the web application.

AI Workflow Steps

1. Data Collection

Data is collected from users through an interactive questionnaire. Key data points include:

- Skin type (e.g., oily, dry, combination).

- Skincare concerns (e.g., acne, aging).
- Budget and product preferences.

This data, along with product attributes such as ingredients and rating are stored in a secure database.

2. Data Preprocessing

Collected data is preprocesses to ensure consistency and accuracy. Steps include:

- Cleaning: Removing incomplete or invalid entries.
- Encoding: Converting categorical data (e.g., skin type) into numerical values using label encoding or one-hot encoding.

3. Model Training

Algorithm Selection: A hybrid recommendation model is implemented, combining:

- Content-Based Filtering: Matches user preferences with product attributes like ingredients and cost.
- Collaborative Filtering: Suggests products based on similar users' preferences.

Training the Model:

- The model is trained on user-product interaction data and product features using PyTorch.

4. Generating Recommendations

- User input is fed into the trained model.
- The model predicts suitable skincare products based on the input and product database.
- Personalized routines (morning and evening) are generated with step-by-step product usage instructions.

5. Feedback Integration
    - Users provide feedback on the recommended products.
    - Feedback data is stored and periodically used to retrain the model, ensuring continuous improvement and adaptability to user needs.

The AI workflow in BeautyBot leverages PyTorch to build a robust, flexible, and efficient recommendation engine. By combining user and product data with advanced machine learning techniques, the system ensures personalized and accurate skincare suggestions. The seamless integration of AI into the web application enhances user satisfaction and simplifies the skincare selection process.

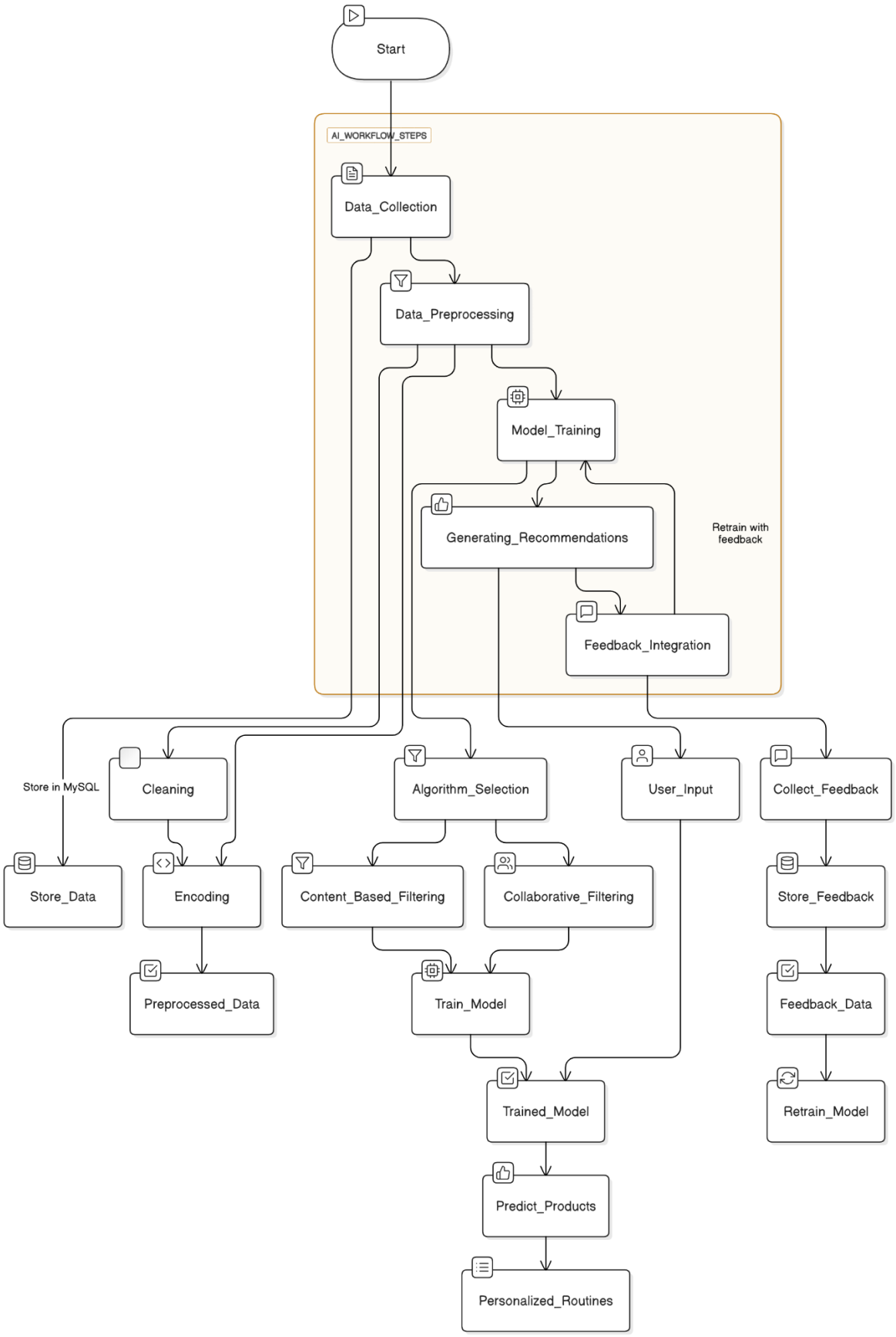

Figure 3.35: AI Workflow Diagram

3.6 Summary

This chapter outlined the requirements and system design for the BeautyBot project. The requirement analysis covered user demographics, functional and non-functional requirements, and system specifications. The system design presented a three-tier architecture and detailed interaction diagrams. This foundation provides a clear blueprint for the development phase, ensuring that BeautyBot will meet the users' needs and provide a scalable, secure, and user-friendly solution.

CHAPTER 4: IMPLEMENTATION AND TESTING

4.1 Introduction

In this chapter, the implementation phase of the proposed system, BeautyBot: AI-Based Skincare Product Analyzer and Recommender will be discussed in detail. The focus will be on translating the system requirements defined in previous chapters into a fully functional application. Both the frontend user interface and backend functionalities, including AI integration, will be developed to ensure the system operates as intended and is ready for subsequent testing. While the testing phase is planned for the next chapter, this chapter lays the foundation by explaining the development process, technologies used, and the architectural setup. This approach ensures that the system meets all specifications and prepares it for a thorough evaluation to identify any areas for improvement.

4.2 Technologies Used

4.2.1 ReactJS

ReactJS was used to develop the frontend of BeautyBot. It enabled the creation of dynamic, responsive user interfaces that enhance the user experience. React allowed developers to build reusable components, manage state effectively, and deliver a seamless navigation experience across modules such as the skincare questionnaire, personalized results page, and profile management system. Its component-based structure also facilitated maintainability and scalability, which are essential in evolving applications.

4.2.2 Django

Django, a Python-based web framework, served as the foundation for the backend of BeautyBot. It was selected for its robust features including an object-relational mapper (ORM), built-in authentication system, and efficient request handling. Django enabled the rapid

development of secure and maintainable server-side logic. It handled functions such as user login and registration, processing questionnaire inputs, communicating with the AI model, and managing feedback.

4.2.3 PyTorch

PyTorch was employed as the main framework for building and training the AI recommendation model. Its flexibility, dynamic computation graph, and wide adoption in the research community made it ideal for implementing the hybrid recommendation engine. The model analysed user inputs and matched them with product features to generate personalized skincare suggestions. PyTorch also facilitated experimentation and model tuning, which were crucial during development (Yasar & Lewis, 2022).

4.2.4 Pandas

Pandas was extensively used for data manipulation and preprocessing throughout the system development. It was particularly effective in cleaning and organizing the questionnaire responses and skincare product metadata. Pandas enabled efficient structuring of large datasets into DataFrames, allowing the development team to filter, group, and transform data to prepare it for machine learning model input. This contributed to enhancing the reliability and quality of the recommendations generated by the AI engine (Gubrani, 2024).

4.2.5 Scikit-learn

Scikit-learn played a supporting role in preprocessing and evaluation tasks. It was primarily used for transforming categorical data such as skin type and skincare concerns into numerical format using encoding techniques. It also assisted in computing similarity scores for content-based filtering, validating algorithm performance, and applying foundational machine learning processes where deep learning was not required. Although it does not support deep neural networks directly, it complemented PyTorch effectively during hybrid model development.

4.2.6 MySQL

MySQL was selected as the database management system for BeautyBot due to its robustness and compatibility with Django's ORM. It was responsible for storing structured data, including user accounts, questionnaire responses, skincare product information, and user feedback. The relational nature of MySQL ensured efficient and reliable data transactions, and its integration with Django allowed developers to manage database queries directly through Python, which simplified backend operations and contributed to the system's overall stability.

	product_id	name	ingredients	description	skin_type	category	price	rating	cf_score	routine_type
Edit Copy Delete	1	Cosrx Low pH Good Morning Gel Cleanser	Water, Glycerin, Tea Tree Oil, Salicylic Acid	A gentle gel cleanser that helps to maintain the s...	All	Cleanser	15.00	4.50	4.37	morning
Edit Copy Delete	2	Cosrx Advanced Snail 96 Mucin Power Essence	Snail Secretion Filtrate, Water, Glycerin	A moisturizing essence that helps repair damaged s...	All	Essence	22.00	4.70	4.37	both
Edit Copy Delete	3	Cosrx AHA/BHA Clarifying Treatment Toner	AHA, BHA, Water, Glycerin	A toner that exfoliates and refreshes the skin to ...	Oily, Combination	Toner	18.00	4.60	4.37	morning
Edit Copy Delete	4	Cosrx Hydrium Watery Toner	Water, Sodium Hyaluronate, Glycerin	A hydrating toner that refreshes and balances the ...	Dry, Sensitive	Toner	17.50	4.60	4.37	both
Edit Copy Delete	5	Cosrx Triple C Lightning Liquid	Ascorbic Acid, Niacinamide, Water	A brightening serum that reduces the appearance of...	All	Serum	28.00	4.80	4.41	both
Edit Copy Delete	6	Cosrx Propolis Light Ampule	Propolis Extract, Water, Glycerin	An ampule that deeply nourishes and moisturizes th...	Dry, Sensitive	Serum	24.00	4.70	4.37	evening
Edit Copy Delete	7	Cosrx Ultimate Moisturizing Honey Overnight Mask	Honey Extract, Water, Butylene Glycol	An overnight mask that provides intense moisture a...	Dry, All	Mask	19.00	4.50	4.37	evening
Edit Copy Delete	8	Cosrx Centella Blemish Cream	Centella Asiatica Extract, Zinc Oxide, Water	A cream that soothes irritated skin and reduces bl...	Sensitive, Acne-prone	Cream	20.00	4.40	4.37	evening
Edit Copy Delete	9	Cosrx Natural BHA Skin Returning A-Sol	Salicylic Acid, Tea Tree Oil, Water	A gentle acne treatment that targets blemishes whi...	Oily, Acne-prone	Treatment	21.00	4.30	4.37	both

Figure 4.36: Product Data in MySQL

4.2.7 Other Tools and Libraries

Several additional tools and libraries were used to support system development and deployment. Visual Studio Code (VS Code) served as the integrated development environment (IDE) throughout the project. Its extensive plugin ecosystem, support for multiple programming languages, and Git integration made it ideal for writing, debugging, and managing both frontend and backend code. Axios, a promise-based HTTP client for JavaScript, was used in the React frontend to make asynchronous API calls to the Django backend, facilitating smooth

data exchange. The Django REST Framework played a central role in setting up API endpoints quickly and securely, while Bootstrap was used to ensure responsive design across different devices.

4.3 System Modules

BeautyBot was designed using a modular architecture to ensure that each component could function independently while contributing to the overall system objectives. The main modules of the system include the user authentication module, the skincare questionnaire, the AI-based recommendation engine, the results display module, the user profile management module, and the administrator dashboard.

4.3.1 Frontend Implementation

The frontend of BeautyBot was built entirely using ReactJS to deliver a dynamic, responsive, and user-friendly interface. The interface components were carefully designed in Figma and then translated into functional components using React's modular system. Key screens include the homepage, user registration and login forms, the skincare questionnaire interface, the result display page, and the user profile section. Each of these components was built to be reusable and responsive, ensuring consistency in layout and interaction across different devices. Axios was used to handle HTTP requests from the frontend to the backend, allowing smooth and asynchronous communication with the Django server. Additionally, Bootstrap and custom CSS styling were applied to improve the overall visual appeal and usability of the platform. The frontend also integrates with routing libraries such as React Router DOM to ensure seamless navigation between pages.

The user experience was prioritized by ensuring short load times, intuitive design, and feedback mechanisms for form submissions and error handling. By structuring the frontend into clean, maintainable components, future updates or enhancements can be introduced with minimal

refactoring. Overall, the ReactJS-based frontend successfully fulfilled its role in making BeautyBot engaging and accessible to users.

The user authentication module handles account registration, login, and session management using Django's built-in authentication system. The skincare questionnaire is a structured form that captures user details, including skin type, major skincare concerns, product preferences, and budget range. These responses are stored in the database and passed to the AI model for analysis. The recommendation engine processes this input and matches it against the product database to generate tailored suggestions. These suggestions are categorized into morning and evening routines, including product names, application steps, and relevant ingredient information.

The results display module presents the personalized recommendations in an organized format, ensuring clarity and ease of understanding for the user. The profile management module allows users to update their personal information or retake the questionnaire as needed. The administrator dashboard, accessible only to admin users, provides functionality to add, update, or delete product entries, as well as monitor user feedback and assess recommendation performance over time.

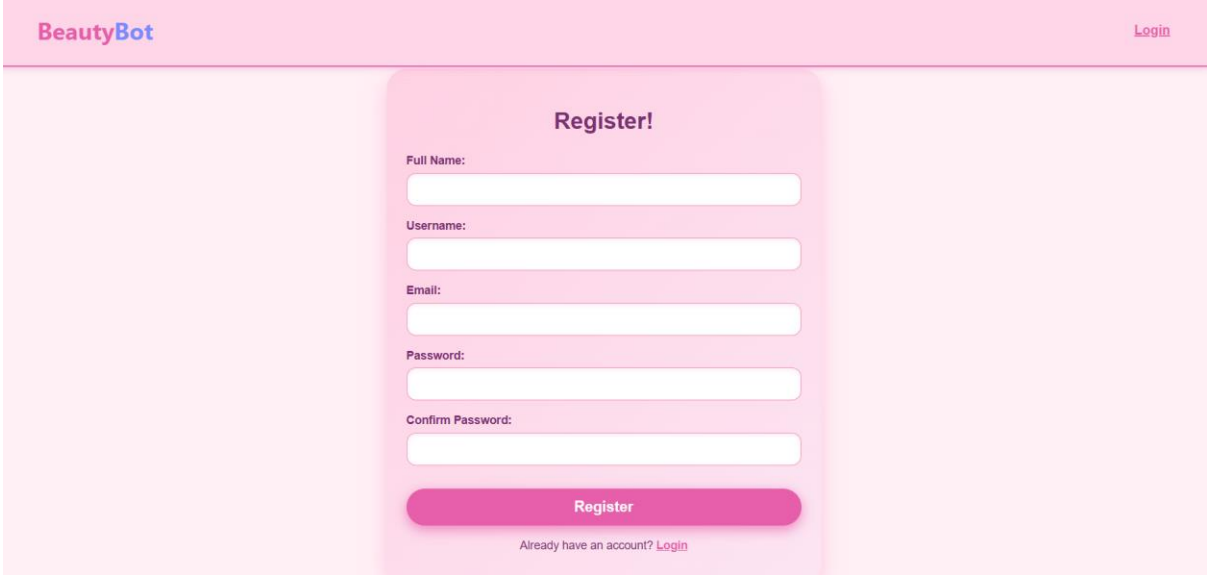

Figure 4.37: Register Page

Figure 4.2 displays the user registration form where new users input their full name, username, email, and password. Input validation ensures secure and complete registration.

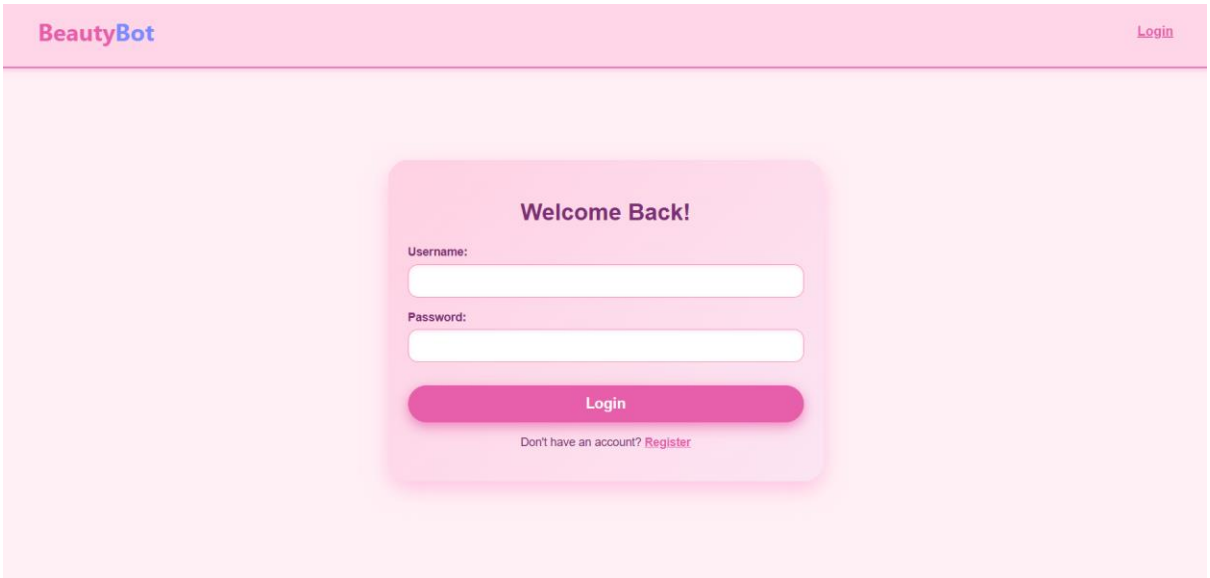

Figure 4.38: Login Page

Figure 4.3 displays login interface for returning users features email and password fields, with options for password recovery, ensuring smooth and secure access.

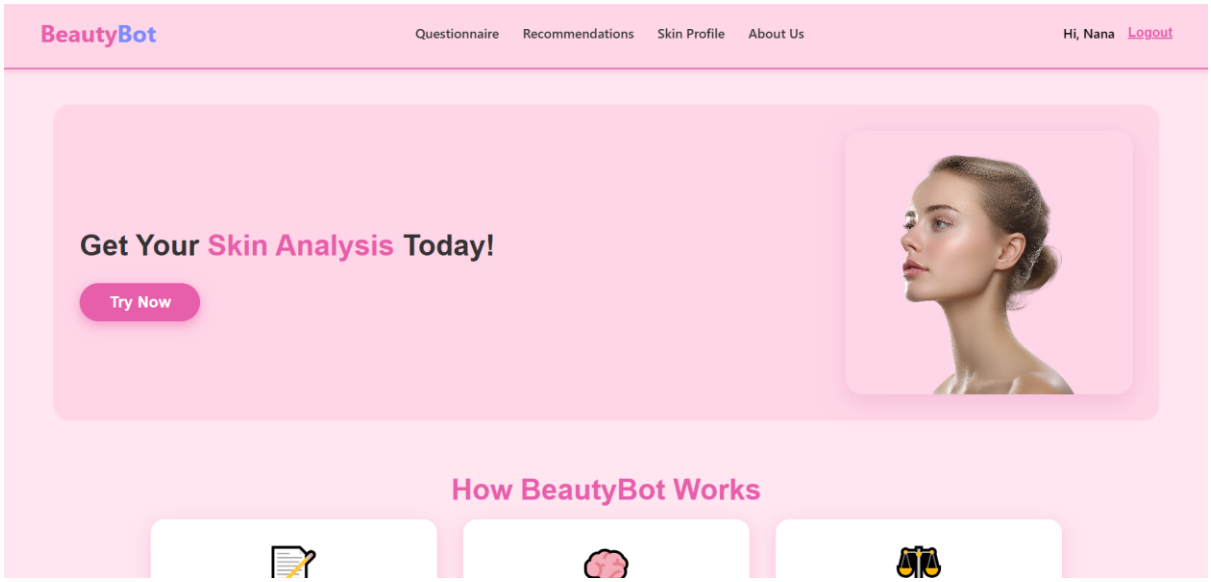

Figure 4.39: Homepage

Figure 4.4 displays the homepage that provides an overview of the platform with easy navigation to the questionnaire, recommendations, skin profile, and other areas.

```
const questions = [
  {
    id: 1,
    question: "How does your skin usually feel a few hours after washing?",
    options: [
      "Tight or dry",
      "Comfortable and balanced",
      "Oily or shiny in some areas",
      "Oily all over",
    ],
    multiSelect: false,
  },
  {
    id: 2,
    question: "How often do you notice visible flakes or dry patches on your skin?",
    options: ["Often", "Sometimes", "Rarely", "Never"],
    multiSelect: false,
  },
  {
    id: 3,
    question: "How frequently do you experience breakouts or pimples?",
    options: [
      "Very often (more than twice a month)",
      "Occasionally (once or twice a month)",
      "Rarely (a few times a year)",
      "Never",
    ],
    multiSelect: false,
  },
  {
    id: 4,
    question: "When you press your skin, does it leave an indentation or look shiny?",
    options: [
```

Figure 4.40: Frontend Questionnaire Component Code

Figure 4.5 shows ReactJS component handles the skincare questionnaire, managing state, validating user inputs, and asynchronously submitting responses to the backend.

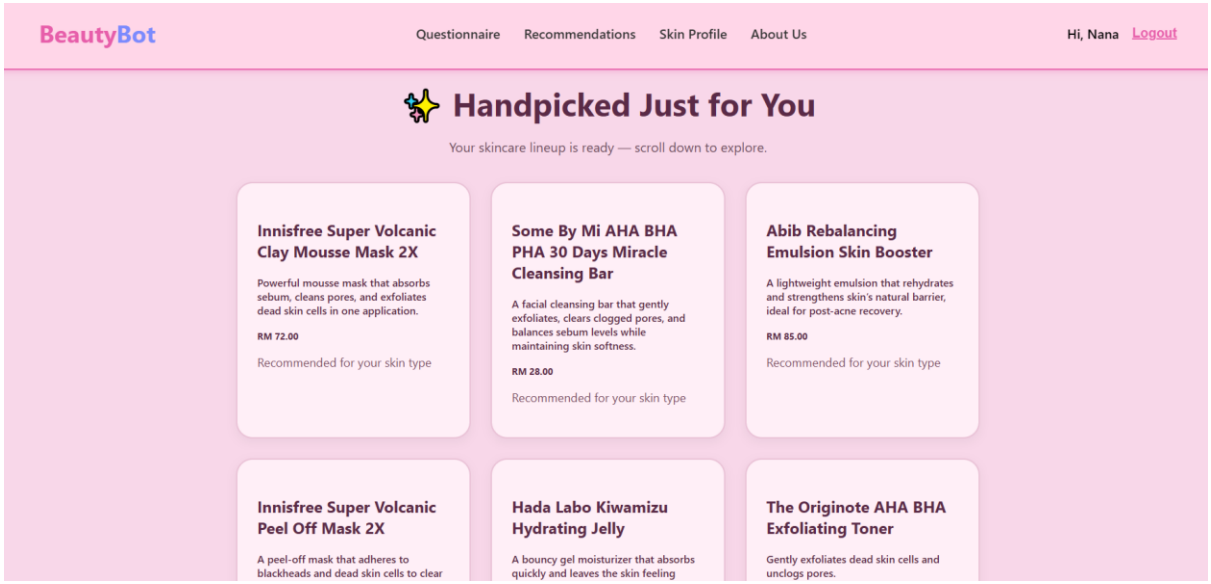

Figure 4.41: Skincare Product Recommendations

Figure 4.6 displays the recommendations page displaying personalized skincare suggestions generated by the system after the user completes the questionnaire.

```
        # === Step 4: Hybrid score ===
        df["cf_score"] = df["cf_score"].fillna(0)
        alpha = 0.6
        df["hybrid_score"] = alpha * df["cbf_score"] + (1 - alpha) * df["cf_score"]

        # === Step 5: Return Top Recommendations ===
        top = df.sort_values("hybrid_score", ascending=False).head(20)

        print("🎯 Top Hybrid Results:")
        for i, row in top.iterrows():
            print(f"- {row['name']} (Hybrid: {row['hybrid_score']:.3f})")


        # added routine_type
        # return jsonify(top[["product_id", "name", "routine_type"]].rename(columns={"product_id": "id"}).to_dict(orient="records"))
        top = df.sort_values("hybrid_score", ascending=False).head(20)
        top["id"] = top["product_id"]  # keep this alias if React expects it
        return jsonify(top.to_dict(orient="records"))


    except Exception as e:
        print("❌ Error:", e)
        return jsonify({"error": str(e)}), 500
    finally:
        if conn.is_connected():
            cursor.close()
            conn.close()

if __name__ == "__main__":
    app.run(debug=True)
```

Figure 4.42: Hybrid Recommendation Algorithm Component Code

Figure 4.7 shows Python code snippet calculates hybrid recommendation scores by combining Content-Based Filtering and Collaborative Filtering with a weighted average. It generates balanced and personalized product suggestions critical to the AI engine.

4.4 Flow of Execution

4.4.1 User Flow

The user flow begins when an individual accesses the BeautyBot platform. If the user does not already have an account, they are required to register by providing personal details such as a username, email, and password. Upon successful login, the user is directed to a dashboard where they are prompted to complete the skincare questionnaire. This questionnaire collects key information about their skin type, concerns (such as acne, dryness, or aging), preferred ingredients, and budget for skincare products. Once submitted, this data is processed and forwarded to the AI engine.

The AI module, built using PyTorch, evaluates the user profile and compares it with the skincare product database. The model outputs a set of recommended products, structured into morning and evening routines. Each recommendation includes usage instructions and highlights ingredients that match the user's preferences or should be avoided based on sensitivities. Users can view these routines on their dashboard and are encouraged to provide feedback to improve future recommendations. They also have the option to update their skin profile at any time by revisiting the questionnaire.

4.4.2 Administrator Flow

Administrators follow a separate execution path through a secure portal. After logging in, they can add, update, or remove product information, view and analyse user feedback, and assess the system's recommendation accuracy. The administrator dashboard ensures the skincare

product database remains current, and the feedback received from users is used to continuously refine and improve the AI recommendation model over time. Administrators can log out once their tasks are complete.

4.5 Code Structure and Organization

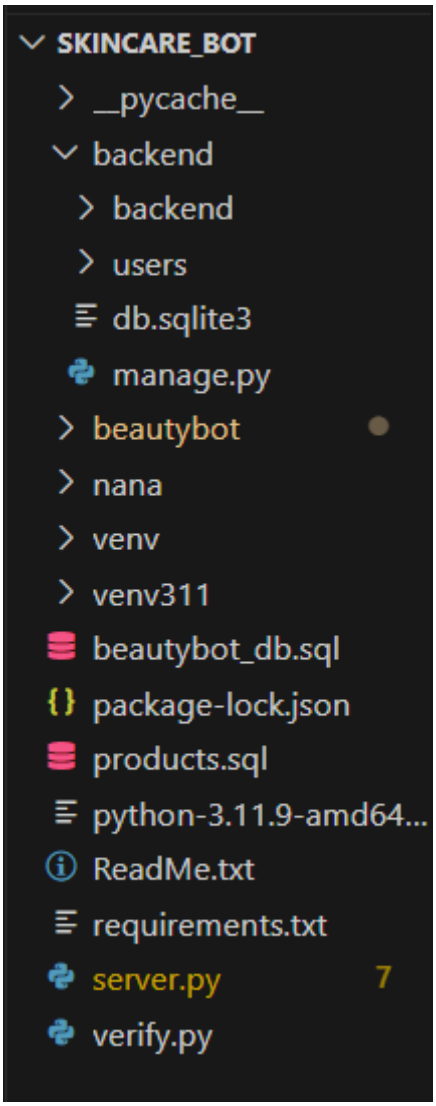

Figure 4.43: Code Files Repository

The architecture of BeautyBot follows the Model-View-Controller (MVC) paradigm. In this setup, the model layer contains all data definitions and schemas for user profiles, product

listings, questionnaire responses, and feedback records. This layer is managed using Django's ORM and stored in MySQL.

The view layer consists of the frontend interface developed in ReactJS. It includes components such as forms, dashboards, recommendation pages, and navigation elements. React's reusable component model enables a clean separation of concerns, simplifying UI development and maintenance.

The controller layer resides in Django and handles the logic between user requests and the model. This includes processing questionnaire inputs, session management, and communication with the AI engine. RESTful APIs were built using Django REST Framework to provide secure and efficient communication between frontend and backend.

The project folder is organized into two main parts: beautybot_backend for the backend Django application and beautybot_frontend for the React frontend. Inside the backend, separate Django apps manage users, products, recommendations, and feedback. The frontend contains folders for components, pages, services (for API calls), and styling, promoting a well-structured and maintainable codebase.

4.6 Testing

In this section, the testing has been conducted on the system to ensure its functionality, performance, and user satisfaction. The system was subjected to various types of testing, including functional testing, integration testing, performance testing, and user acceptance testing (UAT). These tests aimed to identify issues in the system and ensure it meets the specified requirements.

4.6.1 Functional Testing

Functional testing was conducted to verify that each feature of BeautyBot works as expected. The following key functionalities were tested:

- User Registration and Login: Ensured that the user registration and login features were functioning correctly. New users were able to create accounts by entering required details, and existing users could log in using their credentials.
- Skincare Questionnaire: Verified that the questionnaire collected accurate and complete data from users regarding their skin type, concerns, and preferences. The form included validation checks to ensure users could only submit valid data.
- AI Recommendation System: The core functionality of BeautyBot is the personalized recommendation engine. Functional testing focused on checking that the AI engine generated appropriate skincare routines based on user inputs. The system's ability to suggest morning and evening routines, including product names, descriptions and price.
- Product Comparison Tool: Ensured that users could view a list of recommended products and compare them based on product descriptions, prices, and other relevant attributes. Users were able to view details such as product name, description, ingredients, and price.

- Profile Management: The profile management feature was tested to ensure that users could view, update, and save their skin profiles. This included testing the ability to retake the skincare questionnaire or modify preferences as needed.
- Logout and Session Management: Functional testing was performed to ensure that the logout functionality was working correctly. The system should terminate the user's session and direct them to the homepage after logging out.

4.6.2 Test Cases and Results

Table 4.14: User Registration - Functionality

Module Name: User Registration **Test Case Description:** Ensure that a new user can successfully register with valid details. **Testing Objective:** To verify that the registration functionality works as expected and registers new users correctly. **Remarks:** Image and background noise are not involved, purely data entry.								
Test Case ID	**Test Scenario**	**Test Steps**	**Test Data**	**Expected Result**	**Actual Result**	**Status**	**Severity**	**Notes**
TC1	Register with valid username, email, and password.	• Enter a valid username. • Enter a valid email.	Valid username, email, and password (“user1”, “user1@example.com”, “Password123”)	User is successfully registered and redirected to the login page.	User is successfully registered and redirected to the login page.	Pass	Low	Make sure to check if validation works properly for each field.

		• Enter a valid password. • Click on the "Register" button.						

Table 4.15: User Login - Reliability

Module Name: User Login **Test Case Description:** Ensure that a registered user can reliably log in with correct credentials. **Testing Objective:** To verify that the system does not allow users to log in with incorrect credentials. **Remarks:** Test for robustness of the login process against incorrect input.								
Test Case ID	**Test Scenario**	**Test Steps**	**Test Data**	**Expected Result**	**Actual Result**	**Status**	**Severity**	**Notes**

TC2	Log in with correct email but incorrect password.	• Enter a valid email. • Enter an incorrect password. • Click on the "Login" button.	Valid email, incorrect password ("user1@example.com", "WrongPassword123")	The system should display an error message indicating incorrect credentials.	The system displays an error message indicating incorrect credentials.	Pass	Medium	Ensure that error messages are clear and not revealing unnecessary information.

Table 4.16: Invalid User Login - Functionality

Module Name: User Login
Test Case Description: Ensure that the system prevents login with incorrect credentials.
Testing Objective: To verify that the system does not allow users to log in with incorrect credentials.
Remarks: Test for robustness of the login process against incorrect input.

Test Case ID	Test Scenario	Test Steps	Test Data	Expected Result	Actual Result	Status	Severity	Notes
TC3	Log in with correct email but incorrect password.	• Enter a valid email. • Enter an incorrect password. • Click on the "Login" button.	Valid email, incorrect password (“user1@example.com”, “WrongPassword123”)	The system should display an error message indicating incorrect credentials.	The system displays an error message indicating incorrect credentials.	Pass	High	Ensure that error messages are clear and not revealing unnecessary information.

Table 4.17: Skincare Questionnaire Submission - Usability

Module Name: Questionnaire **Test Case Description:** Ensure that users can easily complete the skincare questionnaire and submit it. **Testing Objective:** To verify that the questionnaire can be completed and submitted by users without difficulty.

Remarks: No technical issues should occur while submitting the form.								
Test Case ID	**Test Scenario**	**Test Steps**	**Test Data**	**Expected Result**	**Actual Result**	**Status**	**Severity**	**Notes**
TC4	Complete and submit the skincare questionnaire.	• Complete the questionnaire with valid responses (skin type, concerns, preferences). • Click the "Submit" button.	Skin type: "Oily", Concerns: "Acne", Preferences: "Natural Ingredients".	The system should accept the inputs and proceed to the next page (recommendations).	The system accepts the inputs and proceeds to the recommendations page.	Pass	Low	Ensure that the form validation is working for each field.

Table 18: Product Comparison Tool - Functionality

Module Name: Product Comparison **Test Case Description:** Ensure that users can view recommended products and compare them based on product descriptions, prices, and other relevant

attributes.

Testing Objective: To verify that the product comparison tool is functioning and displays detailed attributes for comparison.

Remarks: Make sure that no data is missing in the product comparison.

Test Case ID	Test Scenario	Test Steps	Test Data	Expected Result	Actual Result	Status	Severity	Notes
TC5	Compare multiple products from the recommended list.	• View the list of recommended products generated by the AI model. • Select multiple products. • View the comparison details (name, description,	Recommended Products: “Product A”, “Product B”, “Product C”.	Users should be able to compare product attributes (name, description, ingredients, and price) side by side.	Users can compare product attributes (name, description, and price) side by side.	Pass	Low	Test that the comparison layout is user-friendly and clear.

		ingredients, price).						

Table 19: Profile Management - Usability

Module Name: User Profile **Test Case Description:** Ensure that users can easily view, update, and save their skin profiles. **Testing Objective:** To verify that users can successfully update their profile information. **Remarks:** Make sure the profile page is easy to navigate.								
Test Case ID	**Test Scenario**	**Test Steps**	**Test Data**	**Expected Result**	**Actual Result**	**Status**	**Severity**	**Notes**
TC6	Update the skin profile with new preferences.	• Navigate to the skin profile page.	Updated Skin Type: "Dry".	The system should save and display the updated information.	The system saves and displays the updated information.	Pass	Low	Verify that changes are persistent and visible after refreshing the profile page.

		• Update skin type, concerns, or preferences. • Save the changes.						

Table 4.20: Performance of Recommendation System - Efficiency

Module Name: Recommendation System **Test Case Description:** Ensure that the recommendation engine provides results efficiently within an acceptable time frame. **Testing Objective:** To verify that the recommendation engine generates results quickly. **Remarks:** The system should not take more than 3 seconds to generate recommendations.								
Test Case ID	**Test Scenario**	**Test Steps**	**Test Data**	**Expected Result**	**Actual Result**	**Status**	**Severity**	**Notes**

TC7	Submit the questionnaire and measure response time for product recommendations.	• Complete the skincare questionnaire. Wait for the system to generate recommendations.	Skin Type: "Combination", Concerns: "Aging", Preferences: "Vegan".	Recommendations should be generated within 3 seconds.	Recommendations were generated within 2 seconds.	Pass	High	Test on different devices and browsers to ensure consistent performance.

Table 4.21: System Scalability - Efficiency

Module Name: Scalability **Test Case Description:** Ensure that the system can scale efficiently with an increasing number of users. **Testing Objective:** To verify that the system can handle multiple concurrent users without performance issues. **Remarks:** System should be tested under heavy load.								
Test Case ID	**Test Scenario**	**Test Steps**	**Test Data**	**Expected Result**	**Actual Result**	**Status**	**Severity**	**Notes**

TC8	Simulate multiple users registering and submitting questionnaires concurrently.	• Simulate the addition of new users to the system. • Monitor system performance.	Simulated user registrations and questionnaire submissions.	The system should remain responsive and functional even as the user base grows.	The system remained responsive with minimal lag during the test.	Pass	High	Test on cloud environments or production-like settings to ensure scalability.

4.6.3 Usability Testing

Usability testing was conducted through a survey using a Google Form, which was distributed to a group of 32 participants. The goal of this survey was to gather valuable feedback on the user experience, preferences, and challenges faced while using the system. The survey focused on understanding how users interacted with the system, their preferences, and the effectiveness of the personalized skincare recommendations provided by the AI system.

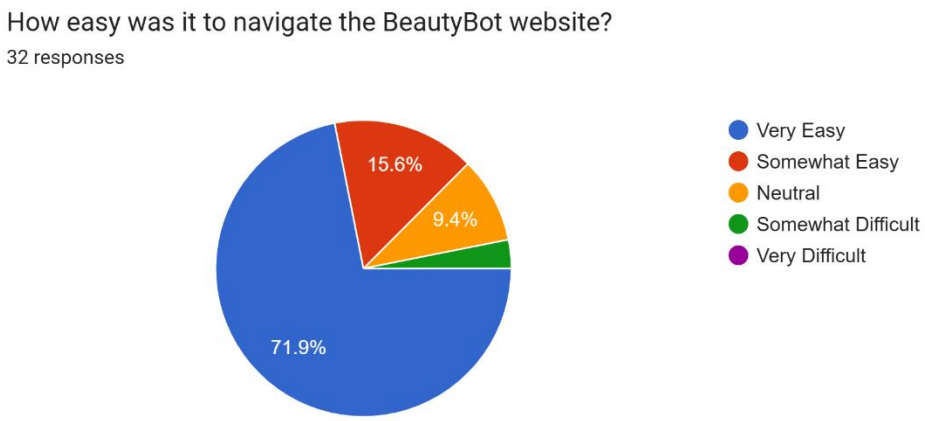

Figure 4.44: User feedback on navigation of the system

In terms of ease of navigation, most respondents found the BeautyBot website to be user-friendly. A significant 71.9% (23 out of 32) of users reported that they found it very easy to navigate, indicating a seamless and intuitive experience. Additionally, 15.6% (5 out of 32) felt that the navigation was somewhat easy, suggesting that even users who experienced slight challenges still found the website relatively accessible. Only a small percentage, 9.4% (3 out of 32), remained neutral, while no participants reported finding the navigation very difficult**.** These results highlight the website's strong usability, with most users finding it straightforward and efficient to use.

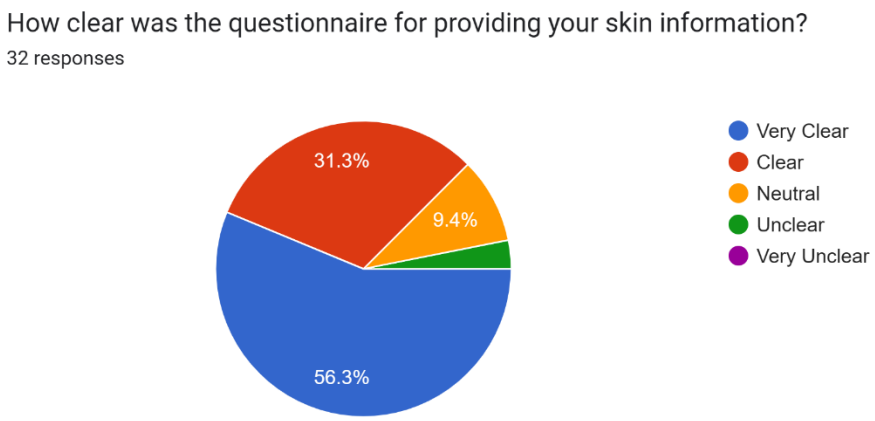

Figure 4.45: User feedback for questionnaire

Based on the 32 responses collected, most users (56.3%) found the questionnaire "Very Clear." This indicates that most participants had no difficulty understanding the questions and providing accurate information about their skin. However, 31.3% of participants felt the questionnaire was "Clear," suggesting a smaller portion of users found it slightly less intuitive but still manageable. A smaller group, 9.4%, rated the clarity as "Neutral," which may imply some areas of ambiguity or room for improvement in user understanding. Overall, these results suggest that the questionnaire was relatively easy to navigate and understood by most users, but further refinement could ensure even better clarity for all users.

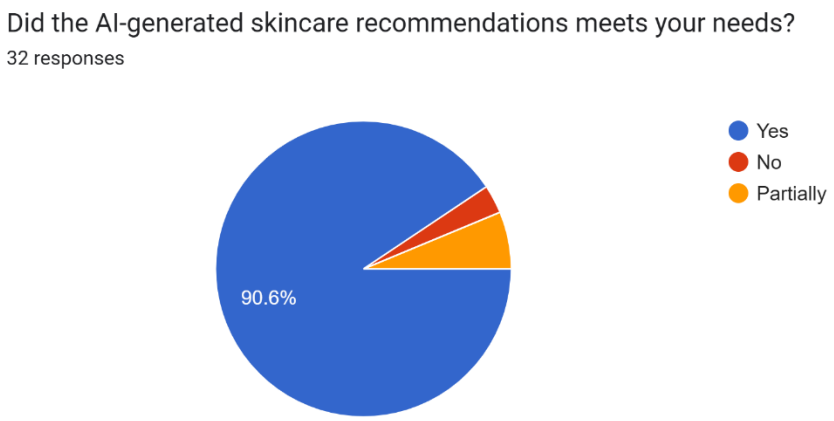

Figure 4.46: User feedback on AI recommendations system

Figure above shows that most users (90.6%) found AI-generated skincare recommendations to meet their needs. A small portion, 6.3%, felt the recommendations were partially helpful, while 3.1% were dissatisfied, indicating that the system was largely effective, with only a few users not fully satisfied.

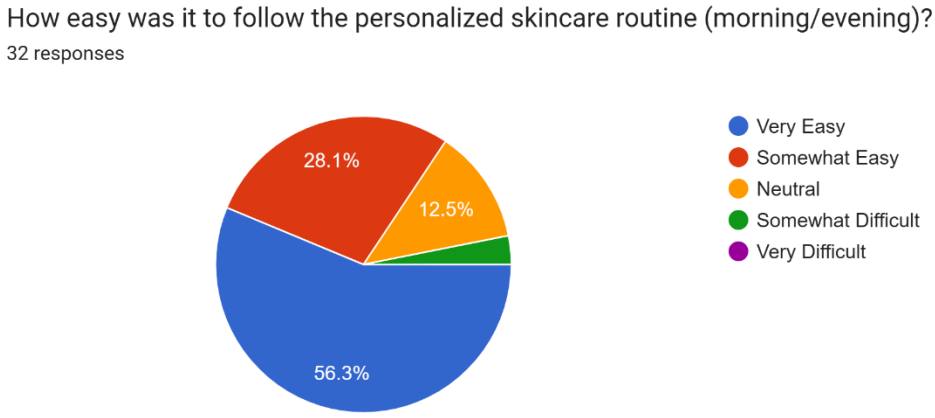

Figure 4.47: User feedback on personalized routine

Figure above shows that a significant portion, 56.3%, found it very easy to follow, while 28.1% thought it was somewhat easy. Only 12.5% had a neutral opinion, and a small fraction found it somewhat difficult (3.1%), with no respondents reporting it as very difficult. This suggests that most users experienced ease in adhering to the suggested routines, highlighting the user-friendliness of the personalized skincare recommendations.

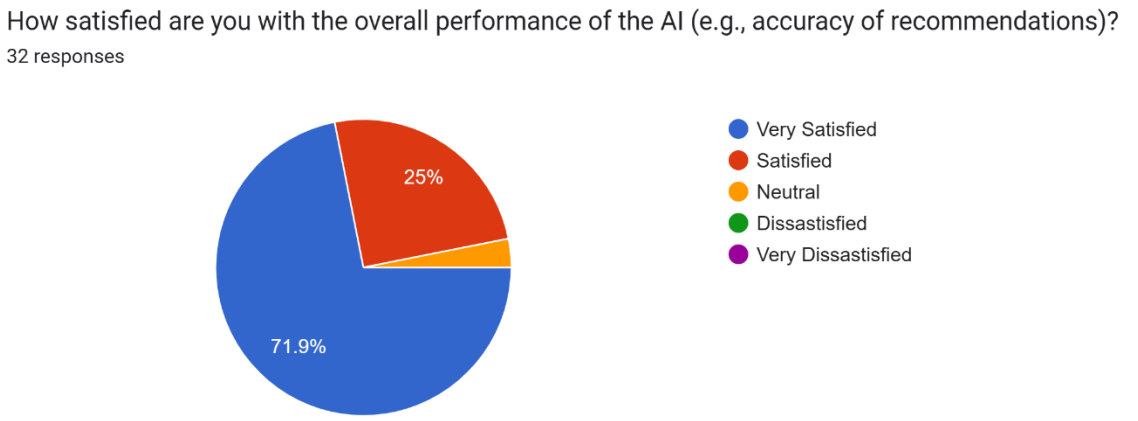

Figure 4.48: User feedback on overall performance of the system

The survey results indicate that a significant majority, 71.9%, are "Very Satisfied" with the overall performance of the AI used in the skincare product recommendations. Meanwhile, 25% of respondents are "Satisfied," suggesting that while the system performs well for most users, there is still room for improvement to achieve complete satisfaction for everyone. The results show a high level of contentment with the accuracy of the recommendations provided by BeautyBot, with only a small portion of users rating it as neutral or unsatisfied.

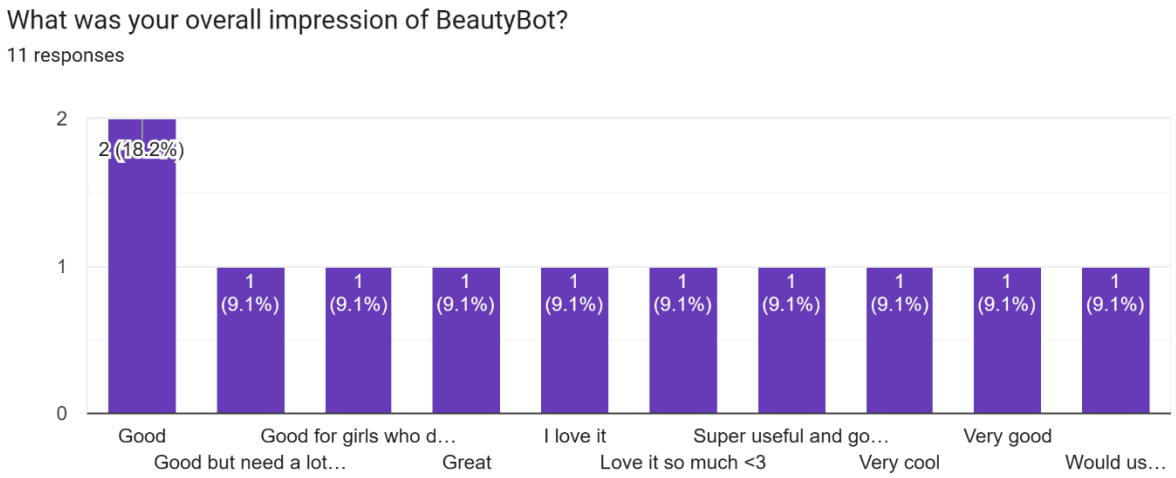

Figure 4.49: User feedback on their impression of the system

The graph above illustrates the overall impressions of users about BeautyBot, based on 11 responses. Most respondents (18.2%) rated it as "Good," but with suggestions for improvement. Other impressions include a mix of positive feedback like "I love it" and "Very cool," along with more specific comments such as "Good for girls who d..." and "Would use..." each contributing 9.1% of the responses. The results indicate that while the system is appreciated, there is a general sense that it can be further enhanced for a better user experience.

4.7 Summary

In summary, this chapter has detailed the implementation journey of BeautyBot, focusing on the integration of frontend, backend, and AI components. The use of ReactJS provided an interactive user experience, while Django efficiently managed backend operations. PyTorch enabled the construction of a flexible hybrid recommendation engine, supported by data manipulation with Pandas and Scikit-learn. MySQL served as the reliable database system linking all parts together. Throughout development, challenges such as the cold start problem and real-time integration were successfully addressed through model improvements and streamlined data flows. While testing has yet to be conducted, the implementation phase has laid a strong technical foundation. The system is now functionally complete and ready to proceed to the evaluation phase, where its performance and accuracy will be rigorously tested.

CHAPTER 5: CONCLUSION

5.1 Introduction

This chapter summarizes the final outcomes, contributions, and experiences gained throughout the development of BeautyBot. It also discusses the achievements relative to the project objectives, the limitations and constraints encountered, and suggestions for future enhancements. The project aimed to offer a personalized skincare recommendation system powered by AI to address the limitations of existing skincare platforms and enhance user satisfaction in choosing suitable skincare products.

5.2 Project Achievements

This project has successfully met its objectives:

Table 5.22: Achievement of Project Objective

Objectives	Achievements
To develop an AI-powered skincare product analyser that evaluates product ingredients and recommends personalized options based on user skin data (type, concerns, and preferences) collected through an easy-to-complete questionnaire.	A hybrid recommendation engine combining Content-Based Filtering (CBF) and Collaborative Filtering (CF) was implemented using PyTorch. This engine analyses user input collected through an interactive questionnaire including skin type, skin concerns, and preferences and recommends suitable skincare products.
To develop a system that generates personalized morning and evening skincare	This system successfully generates structured and personalized routines for

routines based on the user's skin type and concerns, recommending specific products and techniques. The system will adapt and improve over time based on user feedback.	both morning and evening. These routines are tailored to each user' skin profile. Additionally, user feedback is integrated into the system, allowing the AI to iteratively learn and enhance future recommendations, ensuring adaptability over time.
To offer a comparative analysis tool where users can compare products side-by-side in terms of ingredients, suitability, and cost.	A product comparison feature was implemented that enables users to view multiple products side-by-side. This tool provides detailed insights into ingredients, price ranges, and suitability for the user's skin profile helping users make informed decisions without trial-and-error.

These accomplishments validate the feasibility and effectiveness of an AI-driven personalized skincare platform tailored for a diverse user base.

5.3 Limitations and Constraints

While the system successfully met its primary goals, several limitations and technical constraints were encountered throughout its development. These constraints affected the project's progress and the overall functionality of certain features.

One of the significant challenges was the complexity in creating and managing skin profiles. Developing personalized skincare routines based on a user's skin profile, including their specific concerns, was a particularly challenging task. The system required careful consideration of various skin types, such as oily, dry, and sensitive skin, and how these types would influence product recommendations. However, it was difficult to accurately categorize and create routines for each skin type, as well as recommend the right techniques, especially when trying to understand the different ways skin behaves. These complexities led to delays in finalizing the functionality of personalized skincare routines, as creating a dynamic system that adapts to evolving skin conditions over time was more challenging than initially anticipated.

Another major issue faced during development was the difficulty in implementing a unique user ID system. Generating and managing a unique ID for each user presented several technical challenges, especially in ensuring secure and efficient data handling. The user authentication process initially lacked seamless integration, which affected the registration and login processes. Additionally, securing user data, ensuring privacy, and handling authentication errors were key obstacles that delayed some expected functionalities

Furthermore, while the system offered real-time personalized recommendations, there were limitations related to scalability and system performance. As the user base grows, the system's capacity to handle a large volume of requests without slowing down was not fully tested. Though performance testing was conducted, it was done under relatively low usage conditions,

and the real-world load may introduce new challenges. Additionally, the product database was somewhat limited during the project's development phase, restricting the breadth of product recommendations. Integrating a larger variety of products and brands from third-party sources would greatly improve the system's flexibility.

Lastly, the absence of real-time skin condition analysis was another constraint. While the system relied on a questionnaire-based approach to gather user information, it did not incorporate advanced technologies like image recognition or skin scanning to assess real-time skin conditions. This meant that BeautyBot could not offer the highly accurate, immediate product adjustments that could have been achieved by using computer vision or dermatological tools, making the system less adaptive compared to real-time solutions available in some competing systems.

These limitations highlighted the need for further research and development to overcome the existing challenges and improve the overall performance and adaptability of BeautyBot. While these constraints were significant, they also provided valuable insights into areas that require further refinement and enhancement in future development of the system.

5.4 Future Works

To extend the capabilities and enhance the reliability of BeautyBot, the following future improvements are proposed:

i. Incorporate AI-powered image processing to assess skin conditions from uploaded selfies, providing more precise recommendations.
ii. Develop a mobile version of BeautyBot for better accessibility and engagement, especially among young adult users.
iii. Integrate with third-party APIs from major skincare retailers to continuously update the product database with new formulations and prices.
iv. Implement deep learning models that dynamically learn from user feedback, enhancing prediction accuracy and personalization.
v. Add features such as streaks, reminders, and rewards to encourage consistent skincare routines and profile updates.

5.5 Conclusion

The BeautyBot project demonstrates the effectiveness of combining artificial intelligence and user-centred design to solve real-world challenges in the skincare industry. Through a robust questionnaire, adaptive recommendation engine, and dynamic skincare routine generator, the system significantly reduces the guesswork in product selection. While the system achieved most of its objectives, it also opened doors for improvement, especially in terms of real-time skin analysis, system scalability, and deeper personalization.

This project not only contributes to the growing field of smart skincare technology but also offers valuable insights into user behaviour, AI integration, and system usability. With further enhancements, BeautyBot has the potential to evolve into a comprehensive skincare assistant that empowers users to make confident and informed choices in their skincare journey.

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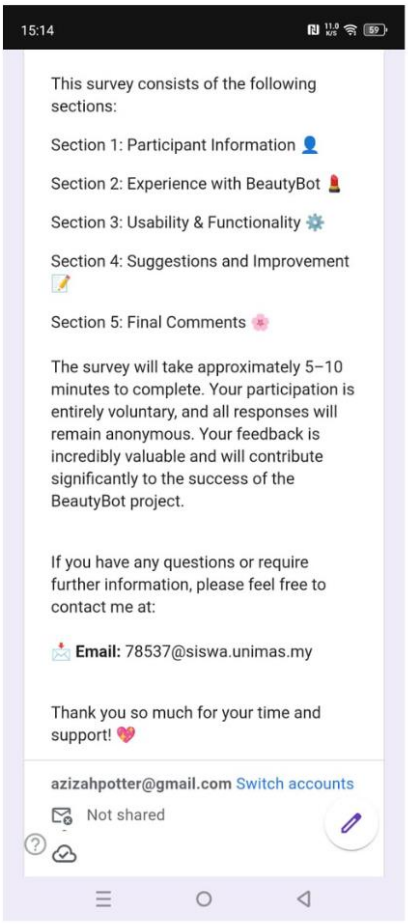
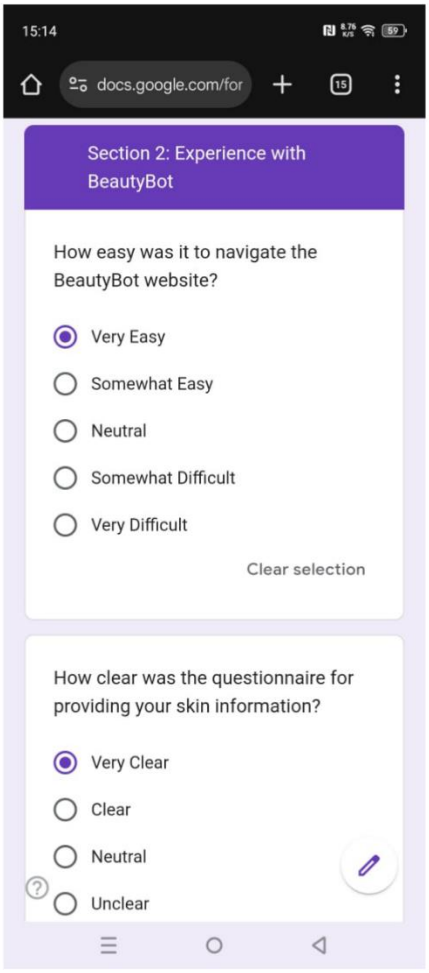
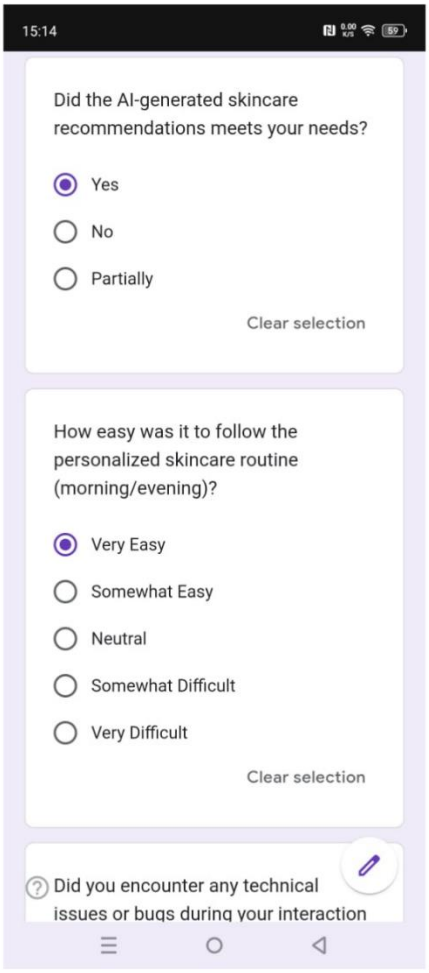
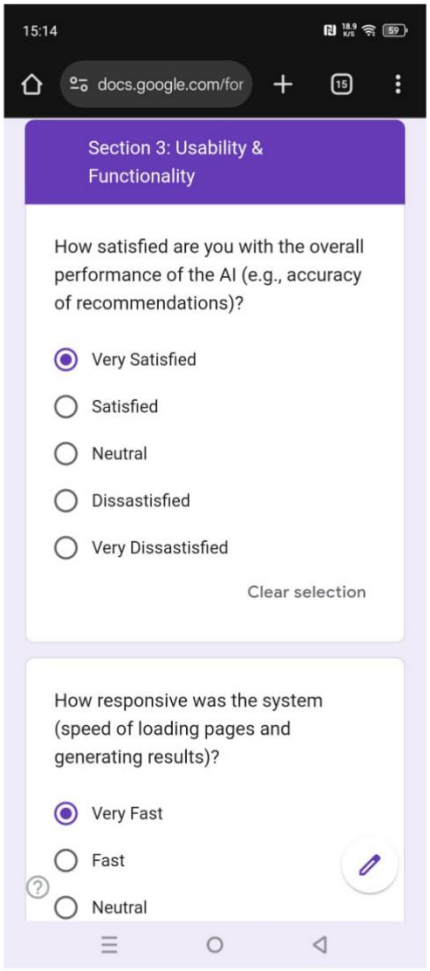
APPENDICES

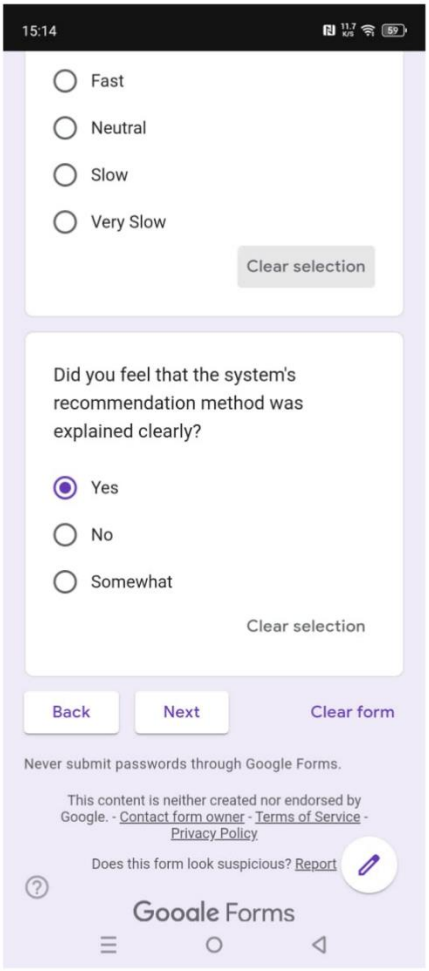
Appendix A: Usability Testing Survey




15:14
docs.google.com/for
Section 2: Experience with BeautyBot
How easy was it to navigate the BeautyBot website?
Very Easy
Somewhat Easy
Neutral
Somewhat Difficult
Very Difficult
Clear selection
How clear was the questionnaire for providing your skin information?
Very Clear
Clear
Neutral
Unclear


15:14
Did the AI-generated skincare recommendations meets your needs?
Yes
No
Partially
Clear selection
How easy was it to follow the personalized skincare routine (morning/evening)?
Very Easy
Somewhat Easy
Neutral
Somewhat Difficult
Very Difficult
Clear selection
Did you encounter any technical issues or bugs during your interaction


15:14
docs.google.com/for
Section 3: Usability & Functionality
How satisfied are you with the overall performance of the AI (e.g., accuracy of recommendations)?
Very Satisfied
Satisfied
Neutral
Dissatisfied
Very Dissatisfied
Clear selection
How responsive was the system (speed of loading pages and generating results)?
Very Fast
Fast
Neutral


15:14
Fast
Neutral
Slow
Very Slow
Clear selection
Did you feel that the system's recommendation method was explained clearly?
Yes
No
Somewhat
Clear selection
Back
Next
Clear form
Never submit passwords through Google Forms.
This content is neither created nor endorsed by Google. - Contact form owner - Terms of Service - Privacy Policy
Does this form look suspicious? Report
Google Forms