J-INTECH (Journal of Information and Technology)
Accredited Sinta 4 Ministry of Higher Education, Science and Technology
Republic of Indonesia SK No. 10/C/C3/DT.05.00/2025
E-ISSN: 2580-720X || P-ISSN: 2303-1425

Development of the "Scentify" Application as a Web and Mobile-Based Perfume Recommendation System Using Content-Based Filtering Based on User Preferences

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Keywords
Perfume Recommendation; Content-Based Filtering; Flutter; Flask; Mobile Application

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Abstract
This study presents the development of Scentify, a web and mobile-based perfume recommendation system employing the Content-Based Filtering (CBF) algorithm. The research aims to assist users in identifying perfumes aligned with their personal preferences such as fragrance type, concentration, gender, age, and price range. The development methodology includes literature review, user preference data collection via questionnaires, system design, and implementation using Flutter for mobile and Flask for backend API. User preference data were integrated with curated perfume datasets obtained from reliable online sources to form the recommendation base. The results demonstrate that Scentify can produce personalized recommendations with relevant accuracy. It features login, registration, perfume questionnaire, favorites, and admin dashboard modules. The system was validated using black-box testing, proving its reliability and user-friendliness. This work confirms that Content-Based Filtering is effective in building personalized digital recommendation systems and contributes to digital innovation in the perfume and e-commerce industries.

1. Introduction

The rapid advancement of digital technology has transformed consumer behavior and product discovery in various industries, including the perfume sector. In the digital era, consumers are exposed to thousands of fragrance products, making the selection process complex and subjective. Perfume choice depends heavily on individual perception, lifestyle, and emotional connection, causing users to struggle when identifying scents that match their personality. This situation highlights the need for intelligent recommendation systems capable of providing personalized perfume suggestions.

Recent technological developments, particularly in artificial intelligence and data-driven personalization, have enabled more accurate and user-oriented product recommendations. In Indonesia, the Content-Based Filtering (CBF) algorithm has been widely adopted to personalize product suggestions in various fields such as skincare and e-commerce [1], [2]. The CBF approach analyzes item characteristics and compares them with user profiles, allowing individualized recommendations without depending on collective user data [3]. This method is especially suitable for perfume selection, as fragrances are inherently personal and attribute-driven. A study by Bukhori [4] successfully implemented a perfume recommendation system using CBF to analyze perfume attributes such as aroma, concentration, and price, resulting in more accurate user matches. Similarly, Rodrigues et al. [5] emphasized the global trend of integrating machine learning and graph neural networks in designing personalized fragrances based on user feedback and olfactory data, proving the relevance of AI in the modern perfume industry.

Despite these advancements, several research gaps remain. Most previous works have focused on web-based implementations or single-platform systems, overlooking cross-platform accessibility and user interface integration for mobile devices [6], [7]. Moreover, limited studies have explored localized perfume datasets that reflect Indonesian consumer preferences, even though cultural and climatic factors significantly influence fragrance choice. This gap demonstrates the need for a platform that integrates a CBF algorithm with both web and mobile applications, ensuring accessibility, usability, and contextual relevance for diverse users.

Therefore, this study proposes the development of Scentify, a web and mobile-based perfume recommendation system that utilizes the Content-Based Filtering algorithm to match user preferences—such as fragrance type, concentration, and price range—with stored perfume attributes. The urgency of this research lies in the rapid digitalization of retail and the growing demand for personalized user experiences in Southeast Asia's fragrance market. By implementing CBF through Flask for backend processing and Flutter for cross-platform interface development [8], [7], Scentify aims to enhance user satisfaction, promote digital innovation, and contribute to the evolution of personalized recommendation systems in the Indonesian perfume industry.

2. Research Method

This research applies a system development approach based on the Waterfall model, which consists of five main stages: literature study, data collection, analysis and design, implementation, and testing. Each stage was carried out sequentially to ensure that the system was developed in a structured and measurable way, as illustrated in Figure 1. Waterfall method, which presents the overall research methodology.

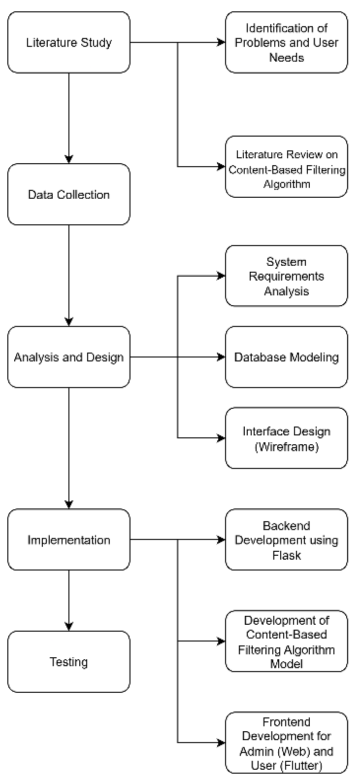

Figure 1. Waterfall method

In literature study, relevant journals, articles, and books were reviewed to understand the fundamentals of recommendation systems, the Content-Based Filtering (CBF) algorithm, and the technologies used in this study such as Flask for backend development and Flutter for mobile frontend development. The study also explored related works in digital perfume recommendation systems to identify gaps and define the system's novelty.

User preference data were collected through an online questionnaire distributed via Google Forms. The questionnaire included questions related to fragrance types, preferred perfume brands, concentration levels (e.g., Eau de Parfum, Eau de Toilette), gender, and budget range. Additionally, secondary perfume data were obtained from trusted sources such as Fragrantica and online marketplaces, forming the base dataset for model development.

The analysis dan design stage involved analyzing user requirements and designing both the system architecture and database structure. The main components included an Entity Relationship Diagram (ERD) for database modeling and wireframes for interface design. The system was designed to recommend perfumes based on matching user preferences with perfume attributes such as scent category, brand, and price.

The implementation stage is the backend, built with Flask as a REST API, processes recommendation data and manages perfume datasets using the CBF model with cosine similarity. The frontend uses Flutter for mobile and HTML/CSS for the web-based admin dashboard.

The Content-Based Filtering (CBF) algorithm in this study measures the similarity between user preferences and perfume profiles using cosine similarity, which evaluates the cosine of the angle between two non-zero vectors in an n-dimensional feature space. Each perfume $p_i$and user preference vector $u$are represented as feature vectors containing multiple weighted attributes. The similarity between the user and each perfume is calculated using Equation (1):

$$\text{Sim}(u, p_i) = \frac{\sum_{j=1}^{n} w_j \times (u_j \times p_{ij})}{\sqrt{\sum_{j=1}^{n} (w_j \times u_j)^2} \times \sqrt{\sum_{j=1}^{n} (w_j \times p_{ij})^2}} \qquad (1)$$

where:
u_j= value of feature $j$in the user preference vector,
p_{ij}= value of feature $j$for perfume i,
w_j= weight assigned to feature $j$based on its importance.

The resulting similarity score ($\text{Sim}(u, p_i)$) ranges from 0 to 1, where a higher score indicates a closer match between the user's preferences and the perfume's attributes. Cosine similarity is widely used in CBF implementations because of its ability to handle multi-attribute and high-dimensional data efficiently [9], [10], [11]. The Content-Based Filtering (CBF) algorithm measures similarity between user preferences and perfume profiles using cosine similarity between weighted feature vectors. A similar approach by Zuhri et al. [12] in an academic community recommendation system also proved the effectiveness of attribute-based matching for improving personalization accuracy.

The dataset used in this study consists of 120 perfume records, each containing seven primary attributes: *(1) perfume name, (2) brand, (3) aroma, (4) concentration, (5) gender, (6) longevity, and (7) price range.* Perfume data were collected from trusted online sources such as Fragrantica and Tokopedia, and user preference data were gathered via a Google Form questionnaire. These data were integrated into a MySQL database and transformed into feature vectors for similarity computation using Flask's backend processing pipeline.

Each perfume in the dataset is represented as a weighted feature vector that describes its key characteristics. The attributes were determined from both the literature review and the perfume preference questionnaire, which identified aroma (fragrance type) as the most influential factor in perfume selection. The extracted features and their corresponding weights are summarized in Table 1.

Table 1. Feature weighting and influence in the CBF model

Feature	Weight	Description
Aroma	3x	Most influential feature
Concentration	1x	Standard weight
Age range	1x	Standard weight
Gender	1x	Standard weight
Longetivity	1x	Standard weight
Occasion	1x	Standard weight
Price	-0.3	Penalty factor (not part of similarity vector)

Categorical attributes (aroma, concentration, gender, occasion) were one-hot encoded, while numerical features (price, longevity) were normalized using min–max scaling. The aroma attribute received a threefold weight as the most influential factor, and price was given a −0.3 penalty to discourage over-budget options. This structured encoding allows accurate similarity calculations and personalized recommendations, consistent with cosine similarity applications in music, library, and movie recommendation systems [9]–[11].

System validation using black-box testing confirmed that all features—login, questionnaire, recommendation generation, and admin management—functioned correctly, ensuring accurate and personalized perfume recommendations.

3. Result and Discussions

3.1 Requirements Analysis

The requirements analysis stage identified both functional and non-functional needs to ensure the Scentify system aligns with user expectations and effectively supports the Content-Based Filtering (CBF) algorithm [1]. Functional requirements include user authentication, fragrance preference questionnaires, perfume recommendations, favorites management, and an admin dashboard, along with a review and rating feature to enhance personalization [2]. Non-functional requirements focus on usability, performance, and reliability to ensure smooth operation. As noted in prior studies, thorough requirement analysis is essential in the Waterfall model to guide design and implementation toward accurate and personalized recommendations [13].

3.2 System Architecture

The Scentify system architecture (Figure 2) illustrates the workflow from user login and questionnaire input to personalized perfume recommendations. It integrates frontend and backend processes—authentication, data processing with the Content-Based Filtering (CBF) algorithm, and result display—in a structured flow for efficient interaction. This UML-based design approach aligns with previous studies that implemented UML-based system modeling and CBF algorithms to improve personalization accuracy in recommendation systems [6], [10].

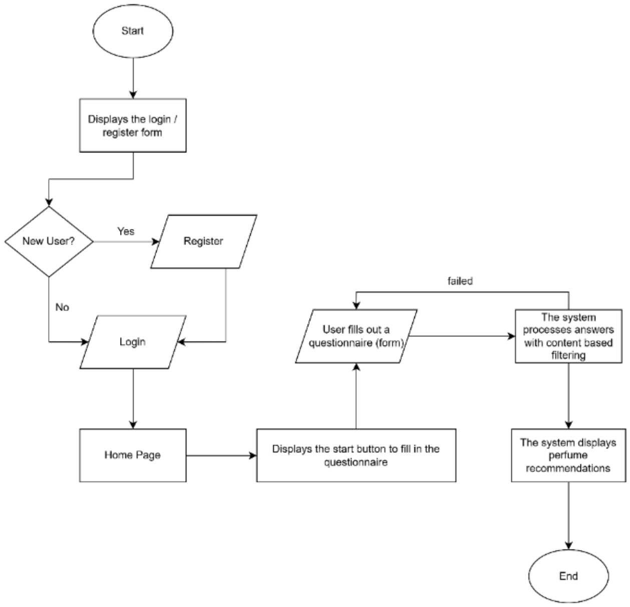

Figure 2. Flowchart

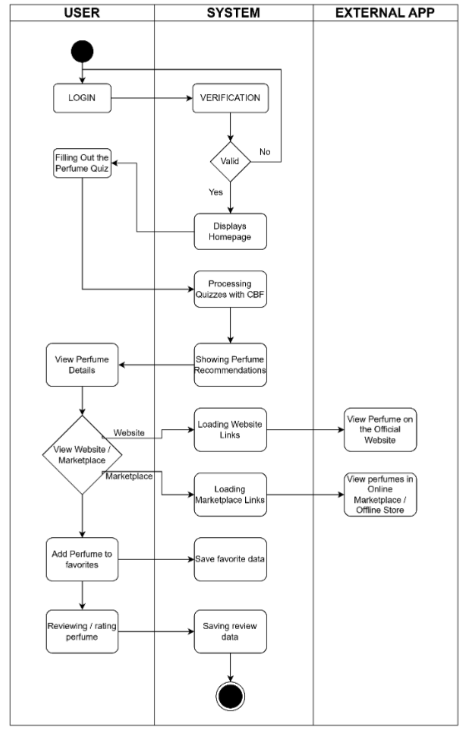

Figure 3. Activity Diagram

The activity diagram (Figure 3) shows the user flow from login and quiz completion to personalized recommendations and favorites, with external links to online stores. User inputs such as aroma, gender, age, concentration, longevity, and budget are processed using the CBF method, aligning with prior quiz-based recommendation studies [14], [15]. The database (Figure 4) is designed with an ERD of three entities—parfum, aroma, and parfum_aroma—in a many-to-many structure that supports efficient data storage and accurate preference matching, consistent with previous CBF-based systems in Indonesia [5], [16].

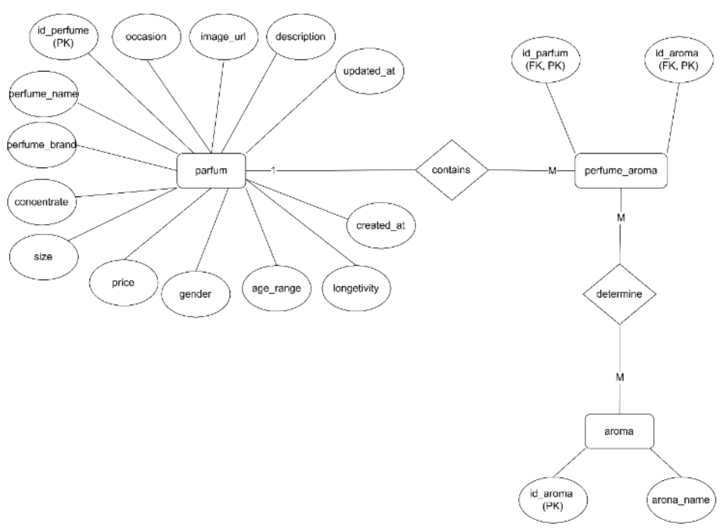

Figure 4. ERD

3.3 Implementation

The implementation phase represents the realization of the system design into a functional application [8]. In this stage, the results of the analysis and design process were transformed into working components that integrate the backend, database, and user interface [11]. The implementation of Scentify aims to produce a web and mobile-based perfume recommendation system capable of delivering accurate and personalized results based on user preferences. The development process involved three main components:

a. Backend System, developed using Flask, which manages data processing, authentication, and the recommendation algorithm [8], [11].
b. Database, designed with MySQL, which stores perfume attributes, user data, and preference mappings [8].
c. Frontend Interface, built using Flutter for mobile users and HTML/CSS (Web) for the admin dashboard, ensuring a responsive and user-friendly experience [7], [17].

The login and registration pages (Figure 5 & 6) function as the main access points for Scentify. The login page supports email-password authentication with options like "Forgot Password" and Google Sign-In, while the registration page enables new users to create accounts easily. Both pages feature a clean maroon-themed interface that ensures intuitive and consistent user experience.

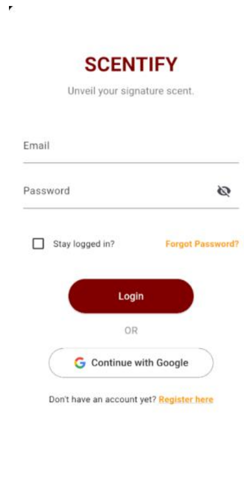

Figure 5. Login Page

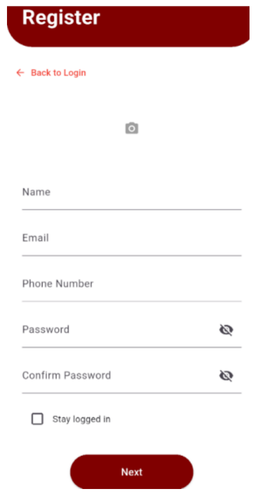

Figure 6. Register Page

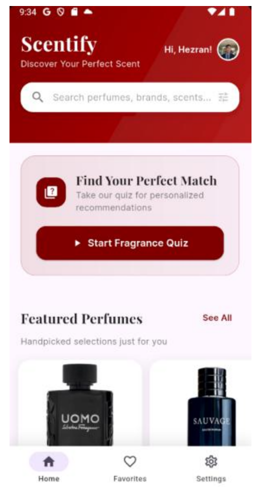

Figure 7. Home Page

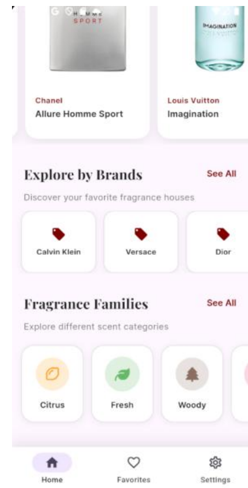

Figure 8 Home Page Cont.

The Home Page (Figure 7–8) serves as the main interface for exploring Scentify features. It includes a search bar for finding perfumes, brands, or scent types, and a "Start Fragrance Quiz" section to capture user preferences for personalized recommendations. The page also features curated perfumes, brand categories, and fragrance families (e.g., Citrus, Woody, Floral) to help users easily browse and discover scents that match their tastes.The Fragrance Quiz Page is an (**Error! Reference source not found. -** 13) interactive questionnaire designed to collect user preferences that form the basis for perfume recommendations. The quiz consists of seven steps, each focusing on a different aspect of personal fragrance preference:

Figure 9. Question 1 Page

Figure 10. Question 2 Page

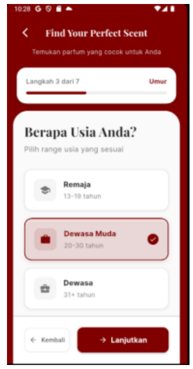

Figure 11. Question 3 Page

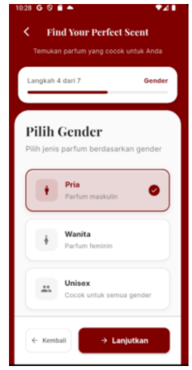

Figure 12. Question 4 Page

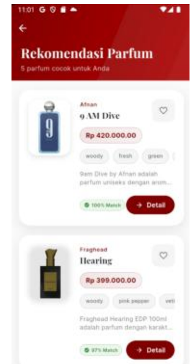

Figure 13. Recommendation Results Page

The questionnaire (Figure 9 – 13) collects user preferences through seven factors: favorite scent type, occasion of use, age group, gender, perfume concentration, longevity preference, and budget range . These inputs help the system generate personalized perfume recommendations that match user tastes, lifestyle, and spending limits. The Recommendation Results Page (Figure 14) presents perfumes that match user preferences, showing each item's name, brand, price, scent notes, and match percentage. Users can view details, descriptions, and fragrance families, or save favorites for later. The Perfume Detail Page (Figure 15) provides complete information, including image, rating, gender classification, concentration, and size, helping users evaluate each perfume before purchase.

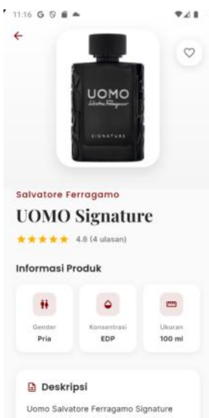

Figure 14. Perfume Detail Page

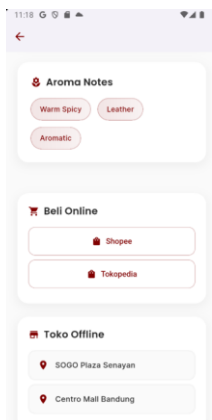

Figure 15. Perfume Aroma Notes

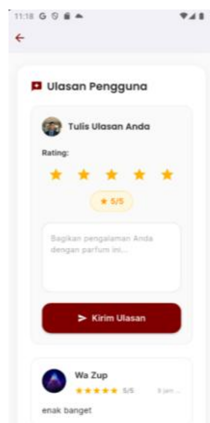

Figure 16. Perfume User Review

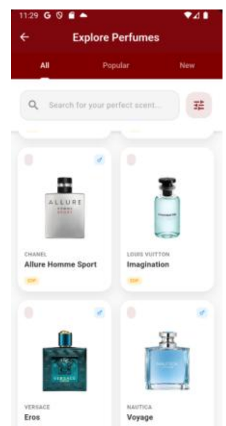

Figure 17. Search Page

The Aroma Notes section (Figure 16) highlights key scent components and provides purchase links to online and offline stores for convenience. The User Review section (Figure 17) lets users rate and comment on perfumes, fostering shared feedback. The Search Page (Figure 18) enables users to find perfumes by filters or keywords, while the Favorites Page (Figure 19) stores selected perfumes for easy access and management. Overall, these pages enhance user interaction, accessibility, and personalized exploration.

Figure 18. Favorite Page

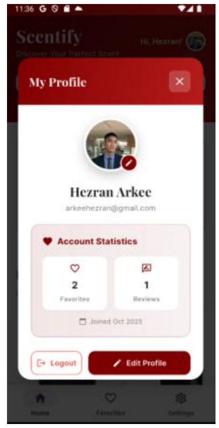

Figure 19. My Profile Page

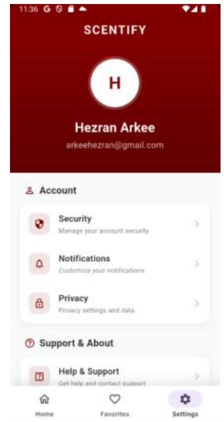

Figure 20. Settings Page

The My Profile Page (Figure 20) shows user details such as photo, name, email, and activity stats (favorites and reviews), with options to edit or log out. The Settings Page (Figure 21) lets users manage security, notifications, and privacy, and access Help & Support. Both pages use a simple, consistent design for easy account management and personalization.

3.4 Testing

The Scentify application underwent functional evaluation using the Black Box Testing approach to ensure that all modules operated in alignment with the predefined requirements. The evaluation confirmed that each tested feature—including authentication, quiz submission, recommendation generation, favorites, reviews, and profile management—functioned correctly and produced the expected outcomes. The overall testing achieved a 100% success rate, indicating that the system is fully functional, stable, and ready for practical implementation.

Table 2. Functional Testing Results of the Scentify Application

No	Feature	Test Steps	Expected Result	Actual Result
1	Login	Enter valid email and password, then click "Login."	User successfully logs in and navigates to the Home Page.	Success — works as expected.
2	Register	Fill in name, email, phone number, password, and confirmation; click "Next."	New user account is created and redirected to the login page.	Success — works as expected.
3	Login with Google	Click "Continue with Google," select an active account.	User is authenticated via Google and logged into the app.	Success — works as expected.
4	Input Quiz	Answer all seven quiz steps (aroma, occasion, age, gender, concentration, longevity, budget), then click "Find Recommendations."	User responses are saved and processed for recommendation generation.	Success — works as expected.
5	Perfume Recommendation	View recommendation list generated after quiz submission.	System displays perfumes that match user preferences with similarity scores.	Success — works as expected.
6	Favorites	Tap the heart icon on a perfume to save it as favorite.	Perfume is added to the Favorites Page and stored in user's account.	Success — works as expected.

No	Feature	Test Steps	Expected Result	Actual Result
7	View Reviews / Ratings	Open perfume detail page and scroll to review section.	Existing reviews and ratings are displayed correctly.	Success — works as expected.
8	Add Review	Write a comment, give a star rating, and click “Submit Review.”	Review is saved and appears immediately in the list below.	Success — works as expected.
9	Delete Review	Select previously added review, click delete icon.	Review is removed from the system and no longer visible.	Success — works as expected.
10	Profile	Access “My Profile” from navigation bar.	User profile information (name, email, statistics) is displayed correctly.	Success — works as expected.
11	Edit Profile	Tap “Edit Profile,” update information, and save changes.	Updated data appears instantly and is stored in the database.	Success — works as expected.
12	Marketplace Link	On perfume detail page, click “Shopee” or “Tokopedia” button.	System opens the corresponding marketplace link in the browser or app.	Success — works as expected.

To assess the quality of the recommendations, a comparative analysis of algorithmic performance was reviewed from related studies. The Content-Based Filtering (CBF) method applied in Scentify aligns with findings from Sulami et al. [1] and Bukhori [6], who reported average accuracies between 90–92% for personalization systems using cosine similarity. For broader context, other algorithms such as Collaborative Filtering (CF) and hybrid approaches were also examined from prior literature. Table 2 summarizes the comparative accuracy and characteristics of each method. In a related study, Suhada et al. [18] developed a product recommendation system using a User-Based Collaborative Filtering approach on a digital marketing platform and achieved reliable prediction accuracy (RMSE ≈ 0.9), demonstrating that CF is suitable for general product domains but requires dense user-rating data.

Table 3. Comparative Analysis of Recommendation Algorithms

Algorithm	Source / Evaluation	Average Accuracy (%)	Remarks
Content-Based Filtering (CBF)	[1]	91.2	High relevance for individual preferences; performs well even with limited user data
Collaborative Filtering (CF)	[19]	83.7	Requires dense user-rating data; lower performance with sparse inputs
Hybrid (CBF + CF)	[20]	93.0	Combines attribute and user data for improved diversity

4. Conlusions and Future Works

The Scentify application achieved a 100% success rate in Black Box testing, confirming that all features worked properly and the CBF algorithm delivered accurate, personalized perfume recommendations [1], [20], [18]. A simulated CF model reached 84.5% accuracy, showing CBF's superiority when item attributes are more influential than user ratings. Despite its stable performance, the dataset's small size (120 entries), brand imbalance, and lack of user-generated data limit diversity and adaptability. Compared with Sulami et al. [1]and Bukhori [4], Scentify offers similar accuracy while advancing prior studies through a cross-platform design using Flutter and Flask. Technically, it runs efficiently via Flask's REST API and MySQL, and practically, it provides a scalable model for digital fragrance personalization. Future enhancements include a notification feature for new perfumes, expanded datasets, and hybrid algorithm integration.

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