Journal of Intelligent Computing and Information Systems
https://ejournal.dominexacademus.com/index.php/JICIS/index
Dominexacademus Publisher

Pomade Product Recommendation System Using the Collaborative Filtering Method

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Abstract

The rapid growth of digital technology has driven the adoption of recommendation systems across various platforms to assist users in finding products that match their preferences. This study develops a pomade product suggestion system by applying the *Collaborative Filtering* method using a *User-Based* approach. The choice of pomade as the study object is based on the increasing interest in men's hair care products and the wide variety of options available on e-commerce platforms, which often confuse consumers. The research data were collected through a *web scraping* process from Tokopedia, resulting in 4,375 user ratings for 20 pomade products. The preprocessing stage included data transformation, duplicate removal, and label encoding. User similarity was calculated using the *cosine similarity* method to identify groups of users with similar preference patterns. The system was evaluated using the *Mean Absolute Error* (MAE) metric to measure prediction accuracy. The results indicate that the system can provide relevant recommendations with an acceptable level of accuracy. These findings suggest that implementing *Collaborative Filtering* for pomade products can be an effective solution to assist consumers in selecting suitable products, while contributing to the advancement of recommendation technology in e-commerce.

Keywords: Recommendation System, Collaborative Filtering, User-Based, Cosine Similarity, Pomade, E-Commerce

1. Introduction

Advancements in information technology have made recommendation systems a crucial feature for assisting users in discovering products aligned with their preferences. This technology is widely implemented on e-commerce platforms due to its ability to provide more personalized recommendations by analyzing user behavior patterns and ratings. One commonly used method is Collaborative Filtering, which operates by leveraging rating data from other users to provide relevant recommendations. In the User-Based Collaborative Filtering approach, recommendations are generated by identifying users with similar rating patterns, enabling the system to predict suitable products for a specific user. Men's hair care products, particularly pomade, have experienced significant demand growth in recent years. The extensive variety of products—in terms of hold level, shine level, and base ingredients—often makes it difficult for consumers, especially new buyers on e-commerce platforms, to determine the right choice. Previous research by [Author(s), Year] has shown that the Collaborative Filtering method is effective in providing relevant recommendations based on user rating data. However, the specific application of this method to pomade products is still rarely discussed. Therefore, this study aims to develop a pomade product suggestion system based on Collaborative Filtering to assist consumers in selecting products that match their preferences.

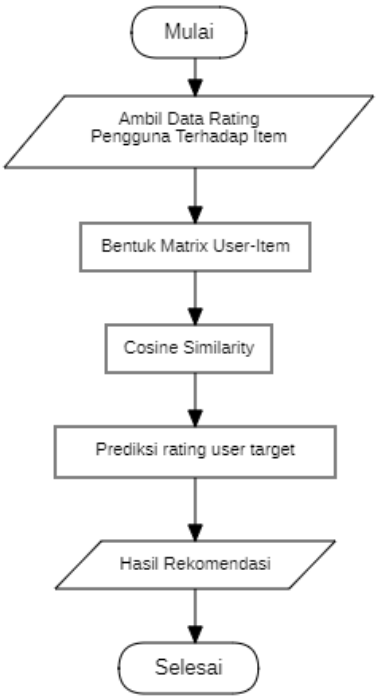
2. LITERATURE REVIEW

Recommendation systems have become a widely used technology to help users choose products or services according to their preferences. A commonly used method is Collaborative Filtering, which works by utilizing user interaction or rating data to provide relevant recommendations. (Hariri & Rochim, 2022) implemented a recommendation system in a marketplace application by leveraging product characteristics to improve recommendation accuracy. This approach demonstrated that recommendation systems can help users find suitable products even when available in very large quantities.

(Jayadi et al., 2021) used the Collaborative Filtering method to analyze consumer shopping data. The results showed that this method can identify similarity in preferences between users and provide relevant product suggestions. (Erlangga & Sutrisno, 2020) developed a Collaborative Filtering-based recommendation system for a beauty shop. This research proved that the User-Based Collaborative Filtering approach is effective in enhancing recommendation relevance based on user rating patterns. Meanwhile, (Ayuningrum et al., 2024) applied a similar method to recommend Korean skincare products on e-commerce. That study showed that using consumer rating data can improve the user experience in selecting products that meet their needs. Based on previous studies, the Collaborative Filtering method has proven effective across various product domains, from beauty products to daily necessities. However, the application of this method specifically to the pomade product category is still infrequent. Therefore, this research adopts the User-Based Collaborative Filtering approach to provide relevant pomade product recommendations based on user rating data.

3. RESEARCH METHOD

This research utilizes a User-Based Collaborative Filtering approach to build a pomade product recommendation system. The process begins with data collection from the Tokopedia e-commerce platform using web scraping techniques. The collected data is limited to three main attributes: username, product name, and the given rating value. The data is then processed through a preprocessing stage, which includes cleaning the data from duplicate entries and adjusting the format to make it ready for processing. Subsequently, the data is arranged into a user-item matrix to represent the relationship between users and the products they have rated. The calculation of similarity between users is performed using the cosine similarity method to find other users who have rating patterns similar to the target user. Based on this similarity data, the system predicts ratings for products not yet rated by the target user, then selects products with the highest predictions as recommendations. To assess system performance, the Mean Absolute Error (MAE) metric is used, which measures the average absolute difference between actual rating values and predicted rating values. A lower MAE value indicates more accurate recommendations.



Gambar 1 *Flowchart* metode Collaborative Filtering

Collection of User Ratings for Products

Rating data was collected through a web scraping process from the Tokopedia platform. The information retrieved includes usernames, pomade product names, and the given rating values. This data serves as the initial input in building the recommendation system.

Compilation of User-Item Matrix

After undergoing the preprocessing stage—which includes data transformation and the application of label encoding—the data is converted into a two-dimensional matrix representing interactions between users and products. Rows in the matrix represent users, while columns represent products. Values within the cells indicate the given ratings, while empty cells indicate products not yet rated by that user.

Calculation of User Similarity (Cosine Similarity)

After the user-item matrix is formed, the next step is to calculate the similarity between users using the Cosine Similarity method. This method measures the angle between two vectors of user preferences (ratings). The similarity value ranges from 0 to 1, where a value closer to 1 indicates a high degree of similarity. The formula is as follows:

$$similarity(A,B) = \frac{\sum_{i=1}^{n} A_i \cdot B_i}{\sqrt{\sum_{i=1}^{n} A_{u,i}^2} \cdot \sqrt{\sum_{i=1}^{n} B_{u,i}^2}} \qquad (1)$$

Keterangan:

A dan B: Vektor rating dari dua pengguna.

A_i dan B_i : Rating pengguna A dan B terhadap item ke-i.

n : Jumlah item (produk) yang digunakan dalam perhitungan.

$\sum_{i=1}^{n} A_i \cdot B_i$: Hasil perkalian titik (dot product) antara A dan B.

$\sqrt{\sum_{i=1}^{n} A_i^2}$: Panjang atau magnitudo dari vektor A.

$\sqrt{\sum_{i=1}^{n} B_i^2}$: Panjang atau magnitudo dari vektor B.

Nilai *cosine similarity* berkisar antara 0 hingga 1:

1 : Kemiripan sempurna

0 : Tidak ada hubungan

Prediction of Product Rating Values

Based on the similarity calculation results, the system predicts ratings for products not yet rated by the target user. The prediction is calculated using a weighted average of ratings given by users with high similarity, where the weight used is the similarity score. The formula is as follows:

$$\hat{r}_{\{u,i\}} = \frac{\sum_{v \in N} sim(u,v) \cdot r_{v,i}}{\sum_{v \in N} |sim(u,v)|} \qquad (2)$$

Keterangan:

$\hat{r}_{\{u,i\}}$:Prediksi rating pengguna u untuk item i

sim(u, v):Nilai kemiripan antara pengguna u dan pengguna v

$r_{v,i}$:Rating dari tetangga v terhadap item i

N :Kumpulan pengguna yang telah memberikan rating terhadap item i dan memiliki kemiripan dengan u

Hanya dihitung untuk tetangga yang sudah merating item i

Compilation of Product Recommendations

After the prediction process is complete, the system selects products with the highest predicted values to recommend to the user. These products are sorted based on prediction results, and those with higher predicted values are considered most suitable for the user's preferences and are displayed as primary recommendations.

4. RESULTS AND DISCUSSION

Pomade product data was obtained from the Tokopedia e-commerce platform using web scraping methods. The data collection process yielded 4,375 entries consisting of three main attributes: username, product name, and the given rating value. The ratings retrieved were still in text format (e.g., "bintang 5" - "5 stars") and needed conversion to numerical form for processing within the system. Details of the pomade product data used in this study are shown in Table 1.

Tabel 1 Dataset Produk Pomade

No	Nama Pengguna	Nama Produk	Rating
1	I	CHIEF BLUE - Pomade Water Based	bintang 5
2	A	Tezzen Mini Bravo	bintang 3
3	A	Morris Pomade Boy - Firm Hold	bintang 5
4	S	Kahf Matte Dapper	bintang 5
5	A	Captain Men's Care Clay Pomade	bintang 5
6	M	Tezzen Mini Delta	bintang 5
7	D	CHIEF PANTHERA HYBRID	bintang 5
8	H	SMITH - Fine Shine Hair Pomade Oil Based 85gr	bintang 5
9	Y	CHIEF BLUE - Pomade Water Based	bintang 5
10	D	CHIEF SPACE CLAY	bintang 5
...	.....	.....	...
4375	T	CHIEF SPACE CLAY	bintang 4

Label Encoding

The label encoding process is used to convert text data such as usernames and product names into numerical format. The goal is to enable the system to process the data in matrix form. Without this step, the system would struggle to recognize text data when calculating similarity between users and products.

Tabel 2 Transformation Data

No	Rating Awal	Rating Numerik
1	bintang 5	5
2	bintang 3	3
3	bintang 5	5
4	bintang 5	5

5	bintang 5	5
6	bintang 5	5
7	bintang 5	5
8	bintang 5	5
9	bintang 5	5
10	bintang 5	5
.....	...	.....
4375	bintang 4	4

4.1Pengkodean Label

User Label Encoding

Before the system can create a user-item matrix, a crucial step is to ensure that each user has a unique and consistent identity. In the raw data, it is possible for two users to have the same name, so if relying solely on the name, the system would consider them as the same user.

To address this issue, label encoding was performed on the username column. The system analyzes all user data and converts it into unique numerical IDs for each user entry. This way, even if there are users with similar names, they will still be considered separate entities if they come from different data entries.

For example, if there are two people with the same name "A", the system will still identify them as two separate users through the IDs generated from label encoding. This is crucial for maintaining accuracy in the predictions and recommendations generated by the system. See Table 3 for examples.

Table 3 Coding User Lable

No	Nama Pengguna	user_id
1	I	U1
2	A	U2
3	A	U3
4	S	U4
5	A	U5
6	M	U6
7	D	U7
8	H	U8
9	Y	U9
10	D	U10
.....	.....	.....
4375	T	U800

1. Pengkodean Produk

Product Encoding

After the user name recognition process is complete, the next step is to perform encoding or mapping of product names. Product names in the initial dataset were still long and varied text strings. To make it easier

for the system to read, process, and create interaction matrices, each product name is mapped to a shorter, standardized ID.

Product IDs use the format P1, P2, P3, and so on. This format allows different products with varying names to be uniquely and consistently identified by the system. See the example mapping in the table below (Note: The original table listed 20 products, P1 to P20).

No	Nama Produk	Produk_id
1	CHIEF BLUE - Pomade Water Based	P1
2	CHIEF CLASSIC - Pomade Oil Based	P2
3	CHIEF PANTHERA HYBRID	P3
4	Captain Men's Care Clay Pomade	P4
5	Captain Men's Care Curly Pomade	P5
6	CHIEF SOLID BLACK	P6
7	CHIEF SPACE CLAY	P7
8	Kaft Matte Dapper	P8
9	Kaft Sleek Classy	P9
10	Moris Pomade Boy – Firm Hold	P10
.....	.....	....
20	CHIEF SPACE CLAY	P20

added on the right side reflecting the total number of products rated by each user, and a "Total" row at the bottom showing how often each product has been rated by all users. See Table 4 for an example (abbreviated).

Product Encoding

After the user name recognition process is complete, the next step is to perform encoding or mapping of product names. Product names in the initial dataset were still long and varied text strings. To make it easier for the system to read, process, and create interaction matrices, each product name is mapped to a shorter, standardized ID. Product IDs use the format P1, P2, P3, and so on. This format allows different products with varying names to be uniquely and consistently identified by the system. See the example mapping in the table below (Note: The original table listed 20 products, P1 to P20).

Tabel 4 Matrix User Product

No	user_id \ produk_id	P1	P2	P3	P4	P5	P6	P7	….	P20	Jumlah
1	U1	5	5	0	0	0	0	5	….	0	3
2	U2	5	5	5	0	0	0	5	….	3	6
3	U3	5	0	5	0	0	0	5	….	5	9
4	U4	5	0	0	0	5	5	5	….	0	9
5	U5	5	5	5	5	0	5	0	….	5	14
6	U6	5	5	5	3	5	5	5	….	0	12

7	U7	5	0	5	0	0	5	0	….	0	7
8	U8	5	0	0	0	4	0	0	….	0	6
9	U9	5	0	0	0	0	0	0	….	0	4
.....	.....	.....	.....	.....	....	.....	.....	.....	….	.....	….
800	U800	0	0	0	0	0	0	4	….	5	6
										Total	4375

4.2Penghitungan Kesamaan (Cosine Similarity)

Similarity Calculation (Cosine Similarity)

Once the user-item matrix was created, the next step was to calculate the degree of similarity between users by applying the cosine similarity method. This approach serves to assess how similar the rating patterns of two users are for identical items. The cosine similarity value ranges between 0 and 1, where a value closer to 1 indicates that the two users tend to have similar preferences. In one calculation of similarity between U1 and U2, cosine similarity was used only on items where both had given ratings. To see the comparison of ratings between U1 and U2 used in this calculation, refer to Table 5.

Tabel 5 Perbandingan Nilai Pengguna U1 dan U2

user_id / [illegible]	P1	P2	P3	P7	P18	P20
U1	5	5	0	5	0	0
U2	5	5	5	5	5	3

Keterangan:

U : User

P : Produk

$$\text{Sim (U1,U2)} = \frac{(5\times5)+(5\times5)+(5\times5)}{\sqrt{5^2+5^2+0^2+5^2+0^2+0^2}\times\sqrt{5^2+5^2+5^2+5^2+5^2+3^2}}$$

$$\text{Sim (U1,U2)} = \frac{75}{8{,}660\times11{,}575}$$

$$\text{Sim (U1,U2)} = \frac{75}{100{,}239}$$

Sim (U1,U2) = 0,748

The value of 0.748 indicates a high level of similarity, suggesting that U2's rating pattern is almost similar to U1's.

In addition to the manual calculation shown previously, the results of the cosine similarity calculation for all users in the dataset performed automatically by the system can be seen in Table 6 below (abbreviated).

Tabel 6 Nilai Kemiripan Seluruh Pengguna

No	User_id	U1	U2	U3	U4	....	U800
1	U1	1	0.748132	0.3849	0.3849	....	0.239474
2	U2	0.748132	1	0.662299	0.431934	....	0.313526

3	U3	0.3849	0.662299	1	0.666667	....	0.518476
4	U4	0.3849	0.431934	0.666667	1	....	0.345651
...	....	....	....	....	....	....	....
800	U800	0.239474	0.313526	0.518476	0.345651	....	1

Product Rating Estimation (User-Based Collaborative Filtering)

After performing cosine similarity analysis between U1 and other users, the next stage was to predict ratings for products not yet rated by U1. This process applies the user-based collaborative filtering method, by comparing the target user with other users who have similar rating patterns. In one calculation, U1 had not rated product P5. Therefore, the system selected the five users with the highest similarity to U1 who had rated this product, as shown in Table 7.

*4.3*Tabel 7 Pengguna Sejenis yang Menilai Produk 5

User_id	Rating ke P5	Similarity dengan U1
U542	1	0.8893
U67	5	0.7293
U107	5	0.7293
U531	3	0.6556
U162	3	0.6326

$$\hat{r}U1, P5 = \frac{(0.8893 \times 1) + (0.7293 \times 5) + (0.7293 \times 5) + (0.6556 \times 3) + (0.6326 \times 3)}{0.8893 + 0.7293 + 0.7293 + 0.6556 + 0.6326}$$

$$\hat{r}U1, P5 = \frac{12.046}{3.6361}$$

$$\hat{r}U1, P5 = 3.31$$

4.4 Although many users gave positive ratings for this product, the presence of one user (U542) with the highest similarity but giving a low rating caused the predicted value to decrease to 3.31. This demonstrates how the system considers user similarity weights when calculating predictions

4.5

Product Recommendations

After conducting analysis to forecast ratings for various items that had not yet received reviews from each user, the next step was to provide item recommendations based on those forecast results.

This stage is the primary objective of the designed recommendation system, which is to display a list of items most suitable and likely to be preferred by each user. These recommendations are made by sorting items based on the highest predicted rating values. The higher the predicted rating value of an item, the greater the likelihood that the item suits the user's interests. The recommendation list for each user can be seen in Table 8.

Tabel 8 Rekomendasi Barang Seluruh User

User_id	Rekomendasi Produk	Prediksi Rating
U1	P3	4.7573
U2	P9	5
U3	P8	5
U4	P3	5
U5	P5	5

U6	P8	5
U7	P5	5
U8	P4	4.8093
U9	P20	5
U10	P5	5
....	.....	....
U800	P4	4.7897

The following displays the GUI results of the implementation of the collaborative filtering method in the built pomade product recommendation system.

System Evaluation

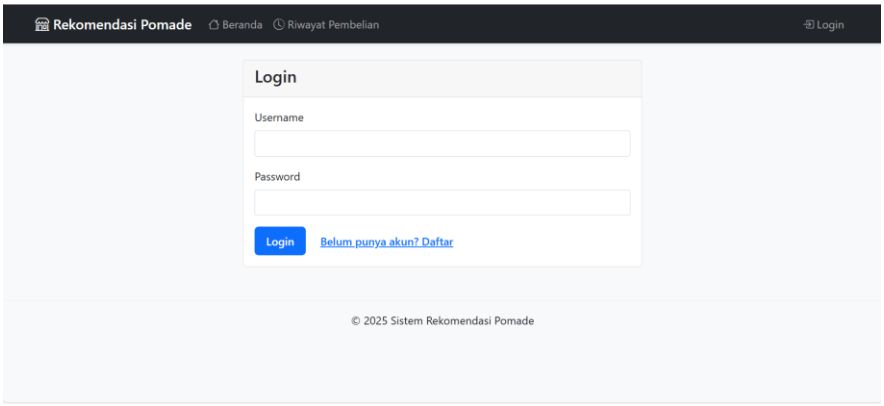
Evaluation was conducted to assess the accuracy of the developed recommendation system. The technique used was Mean Absolute Error (MAE), which measures the average absolute difference between the ratings predicted by the system and the actual ratings from users. The lower the MAE value, the more accurate the system is in predicting user preferences.

The evaluation process began by splitting the dataset into 80% for training data and 20% for test data using the train-test split method. The training data was used to create the user-item matrix and calculate cosine similarity between users, while the test data was used to assess prediction accuracy. This system set the number of most similar users (neighbors) to five for use in the rating prediction process for the test data.

From the evaluation results, an MAE value of 0.9755 was obtained, indicating that the average error in predictions is below one point. This value shows that the user-based collaborative filtering approach used successfully produces recommendations with a fairly good and reliable level of accuracy.The following displays the GUI results of the implementation of the collaborative filtering method in the built pomade product recommendation system.

Admin and User Login Page

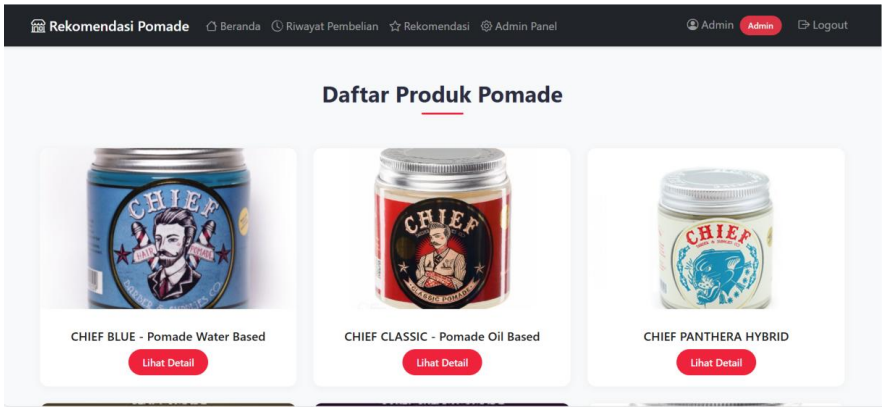
The login page is used by both users and admins to access the system by entering a valid username and password. The login page display can be seen in Figure 2.



Gambar 2 Login Admin dan User

Admin Page

The admin page provides a main menu accessible to manage product data, users, and recommendations. The admin page display is shown in Figure 3.



Gambar 3 Halaman Admin

Admin Add Product Page

On this page, the admin can add new products by filling in product details such as name, price, and description. The add product page display is shown in Figure 4.

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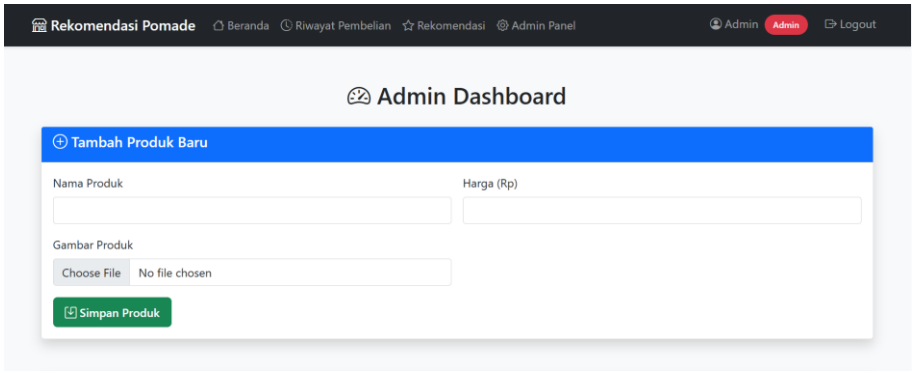

Gambar 4 Halaman Tambah Produk Admin

Admin Edit and Delete Page

This page allows the admin to modify product data or delete products that are no longer relevant. The interface of the edit and delete product page is shown in Figure 5.

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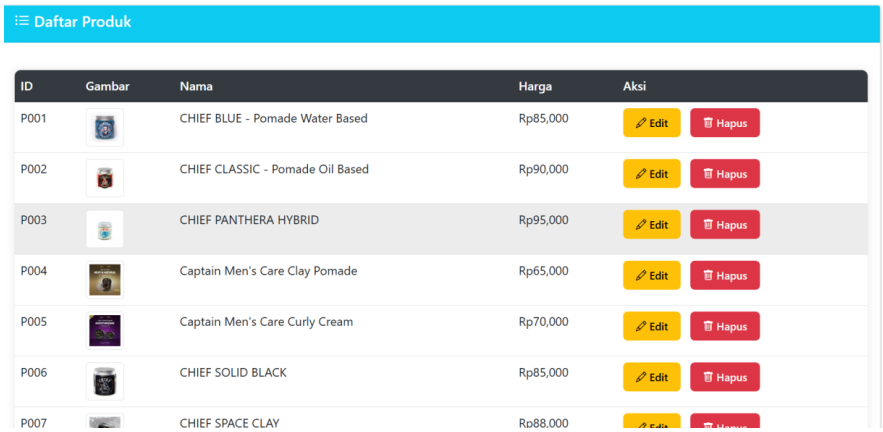
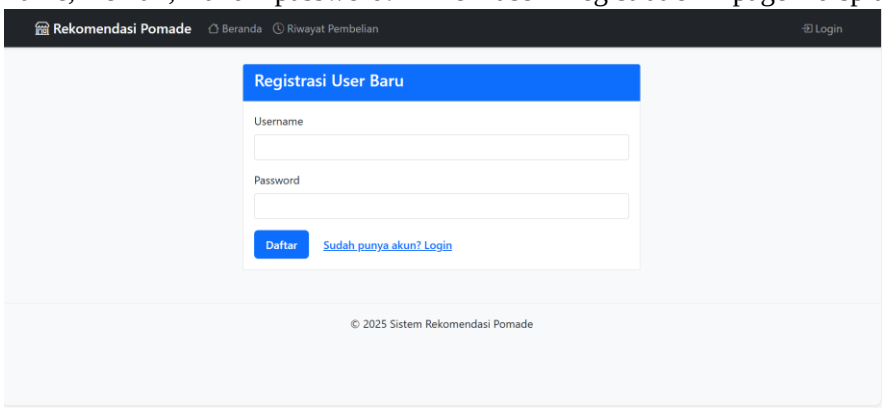


Gambar 5 Halaman Edit dan Hapus Admin

Register User Page

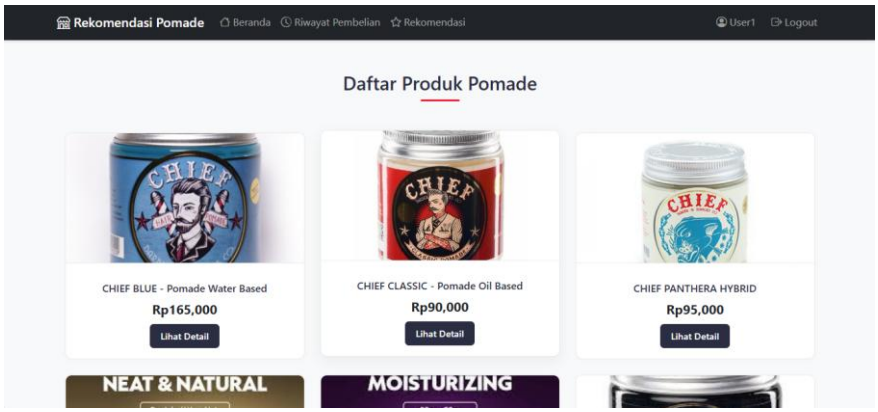
The registration page is used by new users to create an account by entering personal information such as name, email, and password. The user registration page display is shown in Figure 6



Gambar 6 Halaman Register User

User Page

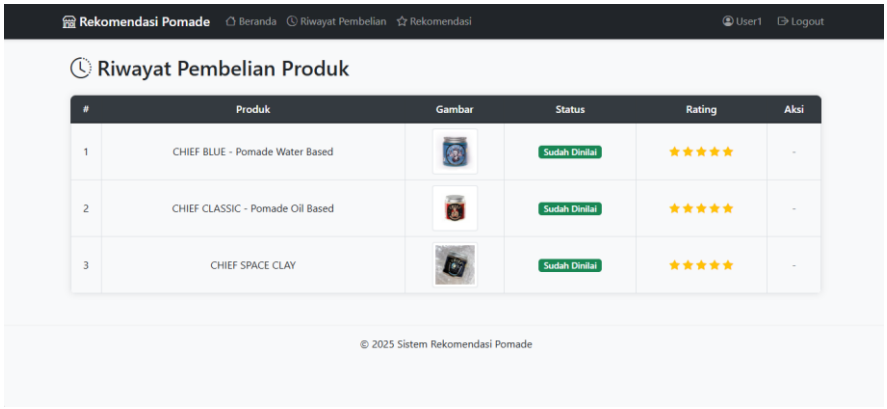
This page is the main dashboard for users after successful login, displaying various menus to access products and recommendations. The user page display is shown in Figure 7.



Gambar 7 Halaman User

Halaman Riwayat Pembelian

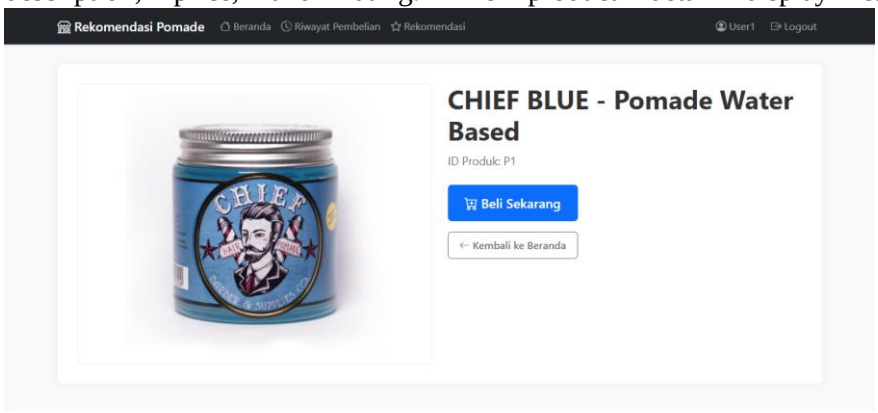
Purchase History Page This page displays a list of transactions or purchases previously made by the user. The purchase history display can be seen in Figure 8.



Gambar 8 Halaman Riwayat Pembelian

Halaman Detail Produk

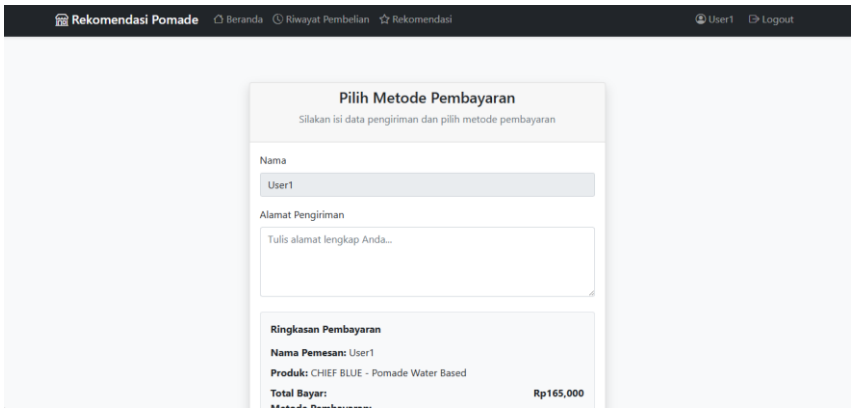
The product detail page displays complete information about the product selected by the user, including description, price, and rating. The product detail display can be seen in Figure 9



Gambar 9 Halaman Detail Produk

Payment Page

The payment page is used by the user to complete the transaction by selecting the available payment method. The payment page display is shown in Figure 10.



Gambar 10 Halaman Pembayaran

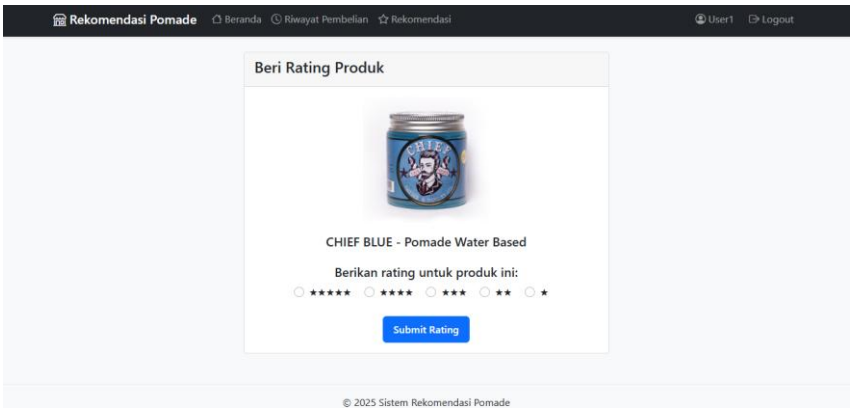
Awaiting Payment Page

This page appears after the user confirms a purchase, where the system waits for payment confirmation from the user. The awaiting payment page display is shown in Figure 11.

Gambar 11 Halaman Tunggu Pembayaran

Rating Submission Page

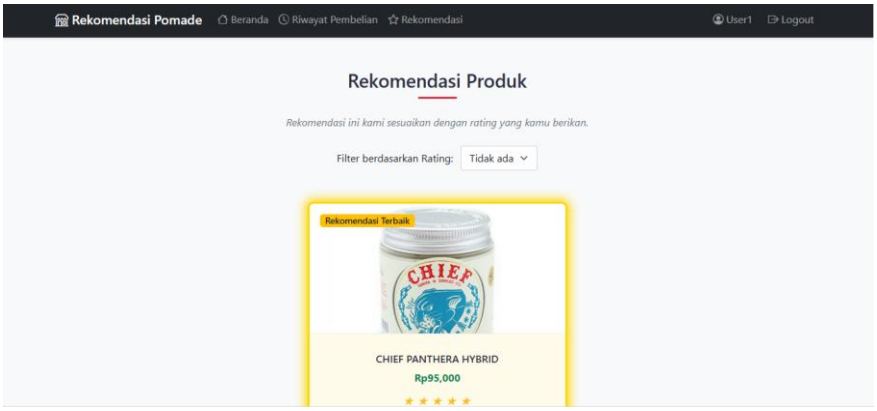
Users can provide ratings for products they have purchased through this page. Ratings will be used as input data for the recommendation system. The rating submission page display is shown in Figure 12.



Gambar 12 Halaman Pemberian Rating

Recommendation Page

The recommendation page displays a list of products suggested by the system based on ratings and preference patterns of other users with similar preferences. The product recommendation display is shown in Figure 13.



Gambar 13 Halaman Rekomendasi

4. CONCLUSION AND SUGGESTIONS

Based on the research findings, a pomade product recommendation system using the Collaborative Filtering method with a User-Based approach has been successfully created to provide personalized recommendations to users, utilizing rating data from other users with similar rating patterns. Evaluation using Mean Absolute Error (MAE) showed a value of 0.9755, indicating a relatively low prediction error rate, allowing the system to provide fairly accurate recommendations. However, the quality of recommendations heavily depends on the amount of available rating data; if data is limited, accuracy may decrease, and the system still cannot fully address the cold-start problem for new users. For future development, it is suggested to integrate with other methods such as Item-Based Collaborative Filtering or content-based approaches to make the system more flexible and able to provide relevant recommendations even with limited data.

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