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A Product Recommendation-Based E-Commerce Application Using Collaborative Filtering at Izra Fashion Store

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ABSTRACT

The rapid digital transformation in trade has encouraged the growth of e-commerce platforms that enhance business efficiency and market reach. Izra Fashion Store, which specializes in hijab sales, currently relies on social media for marketing and customer interaction. However, this manual approach limits transaction management and personalized service. Therefore, this research aims to develop a web-based e-commerce application equipped with a product recommendation system using the Collaborative Filtering method. The study applies a quantitative approach supported by descriptive analysis, utilizing customer transaction data from Izra Fashion Store to identify product preference patterns. The Collaborative Filtering algorithm, implemented with PHP and MySQL, analyzes item relationships through the Item-Based approach using cosine similarity and weighted sum calculations. The results show that the developed system can recommend hijab products relevant to user preferences, improving the shopping experience and increasing customer engagement. Additionally, the system assists store owners in efficiently managing product data, transactions, and pre-orders. In conclusion, this e-commerce application successfully integrates recommendation features that enhance service personalization and operational effectiveness, supporting the digital competitiveness of Micro, Small, and Medium Enterprises (MSMEs).

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1. INTRODUCTION

The advancement of information technology has significantly transformed the business landscape, particularly in commerce [1]. Digital applications are now widely used to support marketing, transactions, and customer relationship management. E-commerce has become a vital platform that enables businesses to reach customers anytime and anywhere while improving efficiency and competitiveness [2] [3]. However, as product varieties and consumer demands continue to grow, customers often experience difficulties in finding products that match their preferences. To address this, recommendation systems have been developed to provide personalized suggestions that help users make purchasing decisions [4] [5].

Izra Fashion Store, a Micro, Small, and Medium Enterprise (MSME) specializing in hijab sales, still relies on social media platforms such as Facebook, WhatsApp, and Instagram for marketing and communication. While these platforms are useful for reaching customers, the sales process remains manual, making it inefficient and prone to human error. Competing in large marketplaces like Shopee presents additional challenges, including intense competition, difficulties in gaining reviews quickly, and low visibility for small businesses [6]. These conditions create a need for a more structured and automated system that can manage product data, transactions, and customer preferences effectively.

As the market grows, the variety of products offered also increases, so there are challenges in tailoring products to consumer desires [7]. One of the obstacles in e-commerce is helping to find products that match desires and preferences [8]. At Izra Fashion Store, customers often have difficulty choosing among many options. For this reason, this study applies a recommendation system based on Collaborative Filtering,

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specifically the Item-Based approach, which analyzes the relationship between products based on customer purchase history. This method allows the system to recommend products that are frequently purchased together or have similar characteristics. Transaction data and customer interactions are also collected to identify preference patterns that support the recommendation system [9].

To overcome these limitations, this research develops a web-based e-commerce application integrated with an item-based Collaborative Filtering recommendation system. This system automatically analyzes customer transaction data to identify relationships between products and provide personalized recommendations. Additionally, the developed e-commerce includes a pre-order scheduling feature, which allows customers to arrange delivery times according to their needs—an innovative functionality rarely found in similar small-scale e-commerce platforms. The novelty of this research lies in the integration of an Item-Based Collaborative Filtering algorithm with a pre-order scheduling mechanism within a single MSME-focused e-commerce system. Unlike previous studies that only implemented recommendation algorithms in mobile or general-purpose e-commerce applications [10], this system is specifically designed to address the operational and marketing challenges of small fashion retailers. The combination of personalized recommendations and flexible pre-order management provides a unique user experience, enhancing customer satisfaction and supporting sustainable digital business growth.

In summary, this research aims to improve the competitiveness of Izra Fashion Store through the implementation of a smart e-commerce platform that not only recommends products based on customer preferences but also optimizes order management and service personalization.

2. METHOD

2.1 Research Stages

This research applies a quantitative method, an approach that processes numerical data with the aim of analyzing patterns and relationships between data [11]. The quantitative approach in this study was implemented by utilizing hijab sales transaction data at the Izra Fashion Store as the basis for calculating the product recommendation system. This transaction data was analyzed to determine customer purchasing tendencies for various types of hijab products, thereby generating relevant recommendations that align with customer needs and preferences [12].

2.2 System Algorithm Method

Collaborative Filtering, often abbreviated as CF, is a method used to provide tailored recommendations to users based on the habits or activities of other users, such as purchase history or ratings. Interestingly, this technique does not require additional product information or user personal data to work [13]. This approach is used to assist customers in selecting multiple items.

2.3 Item Based Collaborative Filtering

This is a recommendation technique that emphasizes product relationships based on user interaction patterns [14]. This means the system will recommend products that are frequently linked to other products by many users. A frequently used calculation method is Cosine Similarity (measuring the angular similarity between product vectors). Cosine Similarity is a method for finding similarities between two vectors in a multidimensional space by looking at the angle between them. The smaller the angle, the more similar the two vectors are [15]. Weighted Sum is a method in recommendation systems that predicts user interest in unpurchased products by calculating the similarity weight between that product and other products previously purchased [16].

Cosine Similarity Formula:

$$\cos(\theta) = \frac{A \cdot B}{\|A\|\|B\|} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2}\sqrt{\Sigma_{i=1}^{n} B_i^2}}$$

Weighted Sum Formula:

$$P(U,j) = \frac{\Sigma_i \in I(Ru_1 i * si,j)}{\sum i \epsilon I \left| S_{i,j} \right|}$$

2.4 How the Method Works

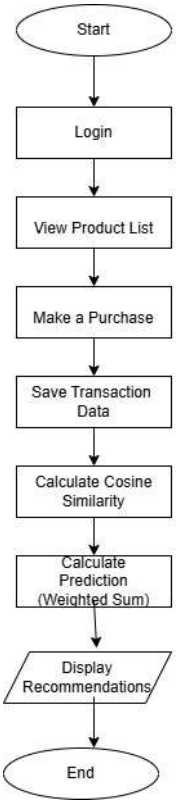

Figure 1. Product Recommendation Flowchart

The workflow of the proposed recommendation system is illustrated in Figure 1, which shows the overall process of the item-based Collaborative Filtering method used in this research [17]. The flow begins with collecting transaction data, forming a user–product matrix, calculating similarity between items using cosine similarity, and then generating product recommendations through weighted sum prediction. Each step in this process is designed to ensure that the system can accurately identify user preferences and provide relevant product suggestions.

3. RESULTS AND DISCUSSION

3.1 Collection Results

Through the researcher's observations, the problems faced by Izra Fashion Store include the difficulty in providing recommendations tailored to customer preferences and the lack of a system that optimizes the online shopping experience. Therefore, a product suggestion-based e-commerce system based on collaborative filtering is needed to help customers find products that match their interests and increase store sales. The system requirements are as follows:

Table 1. System Requirements

Actor	System Requirements
Admin/ Owner	1. The system can process admin logins. 2. The system can manage product data. 3. The system can manage orders. 4. The system can manage users. 5. The system can manage product recommendations. 6. The system can manage pre-orders. 7. The system can manage sales reports.
Customer	1. The system can register 2. The system can process customer logins 3. The system can view products 4. The system can display product recommendations

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5.	The system can display pre-orders
6.	The system can view orders
7.	The system can select payment and shipping options

3.1.1 Data Collection

This is a systematic process for obtaining accurate information. The data used in this study is secondary data obtained from purchase history at the Izra Fashion store.

Table 2. Product purchase simulation data

No	Product/User	PLG 1	PLG 2	PLG 3	PLG 4	PLG 5
H1	Bella Square	3	2	5	1	4
H2	Hijab Paris	5	4	3	2	1
H3	Segitiga Instan Ceruty	2	5	4	1	3
H4	Pashmina Ceruty	1	3	2	5	4
H5	Hijab Serut	4	1	2	5	3
H6	Pashmina Viscose	2	3	1	2	5
H7	Hijab Sport	3	2	4	1	5
H8	Pashmina Inner	2	1	3	4	2
H9	Segi empat Motif	4	2	1	3	5
H10	Segi empat Swareski	1	5	2	3	4

The first step is to search for user purchase history data and then organize it into a user-product matrix, as shown in Table 2. This matrix represents the number of purchases of each product by each user. The next step is to calculate the level of similarity between hijab products using the Cosine Similarity method. This technique is used to measure the similarity of purchasing patterns between one product and another. The calculation results will show a value between 0-1, so that a value closer to 1 will create a similar product pattern. The calculation of the similarity value between products is as follows:

H1= 3,2,5,1,4

H2= 5,4,3,2,1

equality H1.H2 = (3x5)+(2x4)+(5x3)+(1x2)+(4x1) = 15+8+15+2+4 =44

$||H1|| = \sqrt{\mathbf{3^2 + 2^2 + 5^2 + 1^2 + 4^2}} = \sqrt{\mathbf{9 + 4 + 25 + 1 + 16}} = \sqrt{\mathbf{55}} = 7.416$

$||H2|| = \sqrt{\mathbf{5^2 + 4^2 + 3^2 + 2^2 + 1^2}} = \sqrt{\mathbf{25 + 16 + 9 + 4 + 1}} = \sqrt{\mathbf{55}} = 7.416$

$\frac{\boldsymbol{H1xH2}}{\boldsymbol{||H1||x||H2||}} = \frac{\mathbf{44}}{\mathbf{7.416x7.416}} = \frac{\mathbf{44}}{\mathbf{54.997}} = 0.800 + 0.15$ (Category) = 0.950

If there are products in similar or identical categories, the similarity score between them will be increased by 0.15 as an adjustment. This addition aims to give more weight to products in the same category, allowing the recommendation system to produce more relevant results.

Table 3. Calculation of Similarity Between Hijabs

Product	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10
Segi Empat Bella Square	1.000	0.950	0.891	0.727	0.745	0.802	0.982	0.810	0.950	0.914
Segi Empat Paris	0.950	1.000	0.855	0.673	0.782	0.699	0.764	0.763	0.914	0.895
Instan Segitiga Ceruty	0.891	0.855	1.000	0.764	0.636	0.822	0.873	0.717	0.727	0.909
Pashmina Ceruty	0.727	0.673	0.764	1.000	0.873	1.000	0.764	1.000	0.855	0.927
Hijab Sport Serut	0.745	0.782	0.636	0.873	1.000	0.781	0.914	0.948	0.909	0.727
Pashmina Viscose	0.802	0.699	0.822	1.000	0.781	1.000	0.874	0.872	0.946	0.925
Hijab Sport	0.982	0.764	0.873	0.764	0.914	0.884	1.000	0.786	0.873	0.800
Pashmina Inner	0.810	0.763	0.717	1.000	0.948	0.882	0.786	1.000	0.810	0.763
Segi Empat Motif	0.950	0.914	0.727	0.855	0.909	0.946	0.873	0.810	1.000	0.968

Segi Empat Swareski	0.914	0.895	0.909	0.927	0.727	0.925	0.800	0.763	0.968	1.000

Based on the similarity calculations shown in Table 3, it can be concluded that products with the same or related categories tend to have higher cosine similarity values, indicating similar purchasing behavior among users. This finding confirms the reliability of the Item-Based Collaborative Filtering algorithm in identifying relationships between hijab products. These similarity results serve as the foundation for generating personalized product recommendations within the e-commerce system, ensuring that customers receive suggestions that align closely with their preferences and purchasing history.

Table 4. Highest Similarity Values

Kode	Hijab	Nilai Similaritas Tertinggi
H1	Segi Empat Bella Square	1. Hijab Sport (0.982)
		2. Segi Empat Paris (0.950)
		3. Segi Empat Motif (0.950)
H2	Segi Empat Paris	1. Segi Empat Bella Square (0.950)
		2. Segi Empat Motif (0.914)
		3. Segi Empat Swareski (0.895)
H3	Segitiga Instan Ceruty	1. Segi Empat Swareski (0.909)
		2. Segi Empat Bella Square (0.891)
		3. Hijab Sport (0.873)
H4	Pashmina Ceruty	1. Pashmina Viscose (1.000)
		2. Pashmina Inner (1.000)
		3. Segi Empat Swareski (0.927)
H5	Hijab Sport Serut	1. Pashmina Inner (0.948)
		2. Hijab Sport (0.914)
		3. Segi Empat Motif (0.909)
H6	Pashmina Viscose	1. Pashmina Ceruty (1.000)
		2. Segi Empat Motif (0.946)
		3. Segi Empat Swareski (0.925)
H7	Hijab Sport	1. Segi Empat Bella Square (0.982)
		2. Hijab Sport Serut (0.914)
		3. Pashmina Viscose (0.887)
H8	Pashmina Inner	1. Pashmina Ceruty (1.000)
		2. Hijab Sport Serut (0.948)
		3. Pashmina Viscose (0.882
H9	Segi Empat Motif	1. Segi Empat Swareski (0.968)
		2. Segi Empat Bella Square (0.950)
		3. Pashmina Viscose (0.946)
H10	Segi Empat Swareski	1. Segi Empat Motif (0.968)
		2. Pashmina Ceruty (0.927)
		3. Pashmina Viscose (0.925)

3.2 Design System

3.2.1 Use Case Diagram

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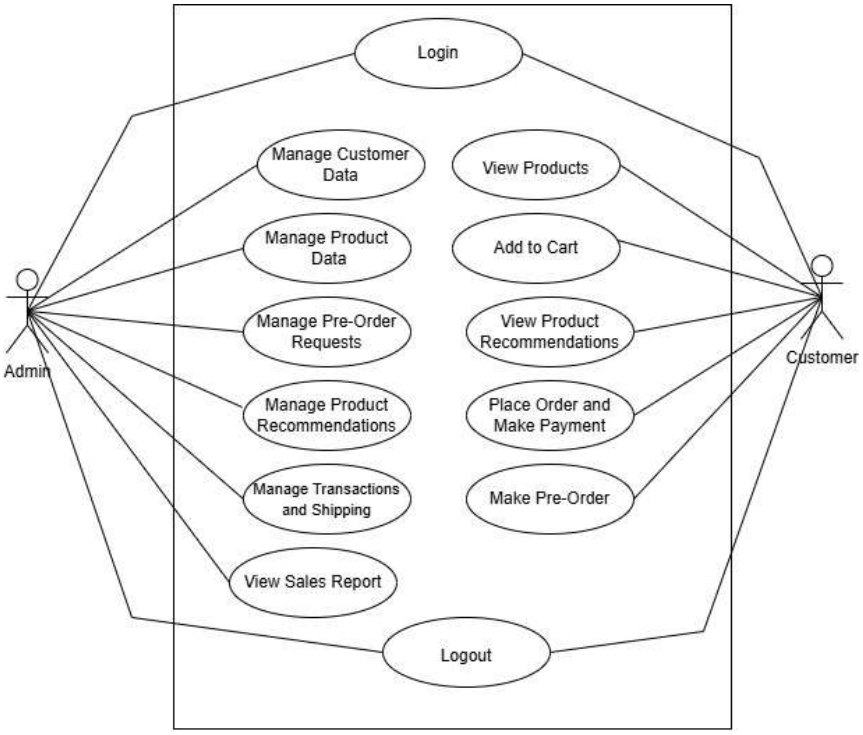

Figure 2. Use Case Diagram

The Use Case Diagram illustrates the overall interaction between system actors and system functionalities in the developed e-commerce application. As shown in Figure 2, the diagram represents how two primary actors, Admin and Customer interact with different system features, including login, product management, viewing product recommendations, placing pre-orders, and processing transactions [18]. This diagram serves to identify the main business processes and ensure that all functional requirements are aligned with user needs [19].

3.3 Implementation

3.3.1 Login Page

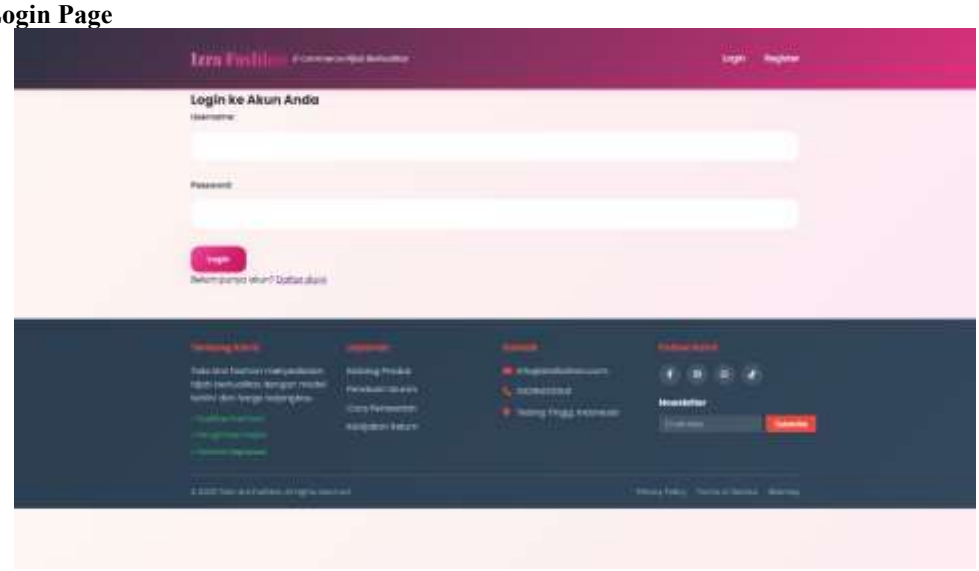

Figure 3. Halaman Login Page

The login page is the system's initial authentication process before accessing key features. Users enter their registered username and password to maintain security and restrict access. If the information matches, the user is logged in to the main page; if not, an invalid login notification appears.

3.3.2 Dashboard Page

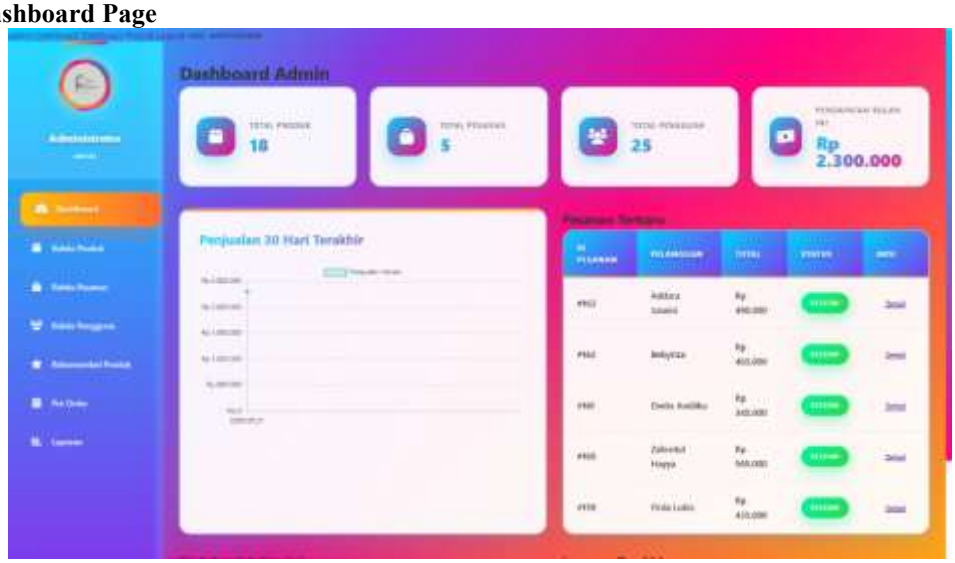

Figure 4. Dashboard Page

The admin dashboard serves as the main control center, displaying important system information. Admins can view a summary of total products, orders, registered users, and revenue generated. The Admin Dashboard page is shown below.

3.3.3 Product Management Page

Figure 5. Produk Page

The image above shows a recommendation page for admins, where they can view a list of hijab products along with the highest similarity levels between them (similar to table 4). These values change automatically when new customer transactions occur. As purchase data increases, the system will increasingly update product relationships, making recommendations more relevant.

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3.3.4 Product Recommendations

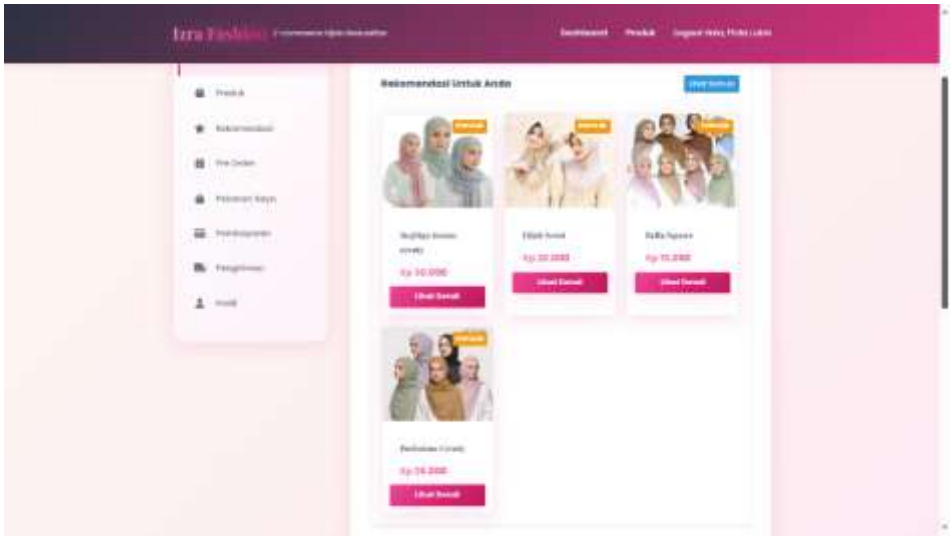

Figure 6. Popular Product Recommendations Page

The main page displays popular products as initial recommendations based on the most purchases. Customers can also view recommendations based on their purchase history. The system suggests relevant products to enhance the shopping experience. However, from the results and discussion, there is no table showing user testing of the software. To evaluate whether the system works well, it is suggested to add a simple system testing table involving several users.

4. CONCLUSION

This research succeeded in developing a web-based e-commerce system with product recommendation features using the Item-Based Collaborative Filtering method which is able to provide relevant hijab suggestions based on purchase history, thereby improving the shopping experience and supporting the digitalization of MSMEs. The results of data processing showed that the cosine similarity value between hijab products ranged from 0.636 to 1,000, with products in the same category such as Pashmina Ceruty and Pashmina Viscose having the highest similarity (1,000), while products in different categories such as Recti Bella Square and Hijab Sport also showed high similarity (0.982). The overall average similarity is around 0.87, which indicates a similar purchase pattern between products, proving that this collaborative filtering method is effective in identifying product similarities so that the recommendations given are in accordance with user preferences. Although the system functions effectively and contributes to service personalization, product management, and the competitiveness of small fashion businesses, quantitative evaluation of improved operational efficiency, sales performance, and user satisfaction has not been conducted, so further research needs to involve user testing and statistical analysis to quantitatively measure impact

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