# Web-Based Smartphone Recommendation System Using TF-IDF and Cosine Similarity Methods

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***Abstract***

The advancement of the digital era urges the use of smartphones as an essential instrument for society. However, the large variety of types and features actually triggers a dilemma for ordinary buyers who want to find a gadget according to their personal preferences. The average conventional search engine still relies on static filters that are less responsive to human language queries. Therefore, this study initiated a website-based gadget recommendation platform that adopts the Term Frequency-Inverse Document Frequency (TF-IDF) method combined with Cosine Similarity. This approach is executed so that the system can extract meaning from user-free text and calculate its proximity to the phone's specification database. With the development method (prototype), the system architecture is built using PHP, Laravel framework, and MySQL. The processed data is sourced from trusted sites in the 2024-2026 period. The output of this research is in the form of an intelligent application that is able to sort the most relevant products along with direct comparison facilities. The results of the Cosine Similarity calculation show that the system is able to provide recommendations precisely, as evidenced by testing 20 smartphone product data with the query "hp 6 million gaming" where *the highest similarity* value was calculated to reach a score of 0.381 on the Poco F7 product, which makes it the most accurate recommendation to support the final decision of consumers.

## 1. Introduction

The current digital era positions smartphones as people's primary needs to support various daily routines. The manufacturer's relentless innovation results in a massive variety of hardware types, prices, and capabilities on the market. This phenomenon ironically triggers confusion (paradox of choice) for ordinary consumers when it comes to selecting the specifications of the gadget that are most relevant to their lifestyle [1]. Various previous recommendation methods have been widely developed in various sectors, such as the selection of tourist destinations [2] , as well as gadget search [2] . Based on previous research on the recommendation system by Safitri, Atina, and Sudibyo [3] , the use of dynamic filtering methods has been proven to be much more effective in understanding users' specific preferences. Meanwhile, other research by Saputra, Sumarlinda, and Sari [4] related to decision support systems also highlights the importance of weighting criteria in a measured manner so that the final results are more precise.

The majority of product comparison sites that exist today still rely on manual (hard-filtering) mechanisms. This conventional method is considered less intuitive for ordinary users who are more comfortable describing their needs using everyday language text. Therefore, an intelligent mechanism is needed that can process natural language and translate the user's sentences into a sequence of device recommendations [6], As a problem solving, this research applied the TF-IDF (Term Frequency-Inverse Document Frequency) technique side by side with the Cosine Similarity method [7], [8] . The combination of these two methods has been tested for reliability in dissecting free descriptive sentences and measuring the proximity between texts, including in cases of similar recommendations [9] [10] . As an additional innovation, the platform is developed with a website architecture using the Laravel framework [11] , [12] and is enriched with an in-depth comparison of specifications.

## 2. Research Methods

This research adopts a prototype approach in its software design phase. The development cycle is iterative [13] , including the stages of identification of specific needs, interface architecture design, prototype construction, feasibility testing, and full system implementation [14], [15] . The use of this structured cycle is essential to ensure the validity of data processing [16]. From a technical point of view, the application's web framework is built on the PHP Laravel MVC (Model-View-Controller) architecture, supported by MySQL as a relational storage medium for managing gadget lists [17] , [18] . The approach to calculating the distance between data will also adapt the logic of text similarity whose accuracy has been validated in other text-search-based research. [19][20].

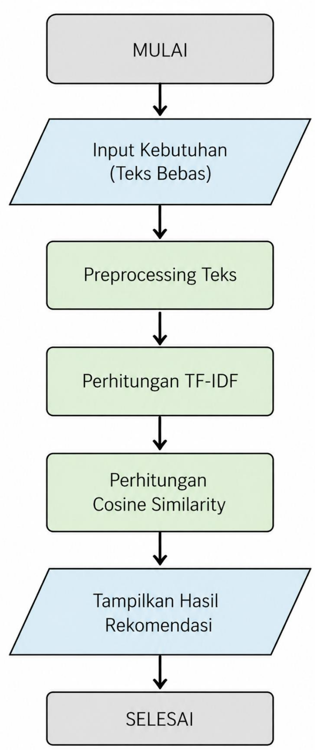


*Fig 1. Recommendation System Workflow*

## 3. Results and Discussion

The results of the discussion in this study are compiled based on the workflow of the recommendation process in the system.

### 3.1 Needs Analysis

The initial stage of system realization begins with the extraction of device specification data which acts as the main knowledge base. Overall, the system's database is designed to be able to accommodate and manage all *smartphone* data from various brands. However, in this design and testing (*prototype*) stage, the system uses a sample limit of 20 latest smartphone product data (2025-2026 period) as a representation to test the accuracy of the algorithm.

In order to address the needs of a system that prioritizes price and technical specifications, the data attributes in the database are expanded to include not only the year of release, but also the details of the main specifications that are the source of the text processing. The list of 20 samples of smartphone product data used in the testing of this system is presented in detail in Table 1.

*Table 1. Sample List of Smartphone Product Data on the System*

| Yes | Smartphone Brands and Types | Pricing | Main Specifications | Year of Release |
|---|---|---|---|---|
| 1 | Poco F7 | IDR 5,999,000 | 120hz amoled screen, 8GB RAM, price 6 million, vapor chamber cooling gaming, 50 megapixel ois camera. | 2025 |
| 2 | Realme 14 Pro | IDR 6,500,000 | 120hz amoled screen, 8GB RAM, price 6 million, Snapdragon 7s Gen 3 processor, vapor chamber. | 2025 |
| 3 | Tecno Camon 50 Pro | IDR 6,100,000 | 144hz amoled screen, 12GB RAM, price 6 million, Dimensity 8200 processor, 50 megapixel ois camera. | 2026 |
| 4 | Vivo V50 | IDR 6,500,000 | 120hz amoled screen, 8GB RAM, price of 6 million, Snapdragon 7 Gen 3 processor, 50 megapixel portrait camera. | 2025 |
| 5 | Xiaomi Redmi Note 15 Pro+ 5G | IDR 5,999,000 | 120hz amoled screen, 12GB RAM, price of 6 million, latest Snapdragon 7s Gen 4 processor, 200 megapixel camera. | 2026 |
| 6 | Infinix GT 30 Pro | IDR 5,200,000 | 144hz amoled screen, 12GB RAM, price 5 million, gaming cooling system, 5000mah fast charging battery. | 2025 |
| 7 | Asus ROG Phone 9 | IDR 18,000,000 | 165hz amoled screen, 16GB RAM, price 18 million, super gaming cooler, Snapdragon 8 Gen 4 processor. | 2025 |
| 8 | Poco F7 Pro | IDR 7,500,000 | 120hz amoled screen, 12GB RAM, price 7 million, liquid gaming cooler, Snapdragon 8 Gen 3 processor. | 2025 |
| 9 | Xiaomi 15 | IDR 13,000,000 | 120hz amoled screen, 12GB RAM, price 13 million, Snapdragon 8 Gen 4 processor, 50 megapixel Leica camera. | 2025 |
| 10 | Realme 15 Pro | IDR 6,800,000 | 120hz amoled screen, 8GB RAM, price of 6 million, Snapdragon 7 Gen 3 processor, 50 megapixel Sony ois camera. | 2026 |
| 11 | Oppo Reno 15 | IDR 7,200,000 | 120hz amoled screen, 12GB RAM, price 7 million, Dimensity 8300 processor, 50 megapixel portrait camera. | 2026 |
| 12 | Vivo X200 Pro | IDR | 120hz amoled screen, 16GB RAM, price 15 million, Dimensity 9400 processor, zeiss 200 | 2025 |

| | | | | |
|---|---|---|---|---|
| | | 15,500,000 | megapixel camera. | |
| 13 | Samsung Galaxy S25 Ultra | IDR 21,000,000 | Amoled screen, 12GB RAM, price 21 million, Snapdragon 8 Gen 4 processor, 200 megapixel AI zoom camera. | 2025 |
| 14 | Apple iPhone 17 Pro Max | IDR 23,500,000 | 120Hz OLED screen, 8GB RAM, price 23 million, Apple A19 Pro processor, 48 megapixel bionic camera. | 2025 |
| 15 | Oppo Find X8 Pro | IDR 16,000,000 | 120hz amoled screen, 12GB RAM, price 16 million, Dimensity 9400 processor, 50 megapixel hasselblad camera. | 2025 |
| 16 | Google Pixel 10 Pro | IDR 17,500,000 | 120hz amoled screen, 12GB RAM, price 17 million, Tensor G5 processor, advanced AI 50 megapixel camera. | 2025 |
| 17 | Vivo X300 | IDR 18,500,000 | 120hz amoled screen, 12GB RAM, price 18 million, Dimensity 9500 processor, zeiss periscope telephoto camera. | 2026 |
| 18 | Samsung Galaxy Z Fold 7 | IDR 25,000,000 | Folding screen amoled, 12GB RAM, price of 25 million, Snapdragon 8 Gen 4 processor, pro multitasking features. | 2025 |
| 19 | Apple iPhone SE 4 | IDR 8,500,000 | 60hz OLED screen, 8GB RAM, price 8 million, Apple A18 processor, compact design of 48-megapixel camera. | 2025 |
| 20 | Samsung Galaxy S26 Ultra | IDR 22,000,000 | 144hz amoled screen, 16GB RAM, price 22 million, Snapdragon 8 Gen 5 processor, 200 megapixel camera. | 2026 |

All specifications of the 20 data samples in Table 2 are then stored in the MySQL database so that they can be matched to the needs of the user. Once the database is ready, on the application interface, visitors can simply type their preference (queries) in the free-text search field to start the recommendation process.

## 3.2 Preprocessing

Text entered by the user, such as the query "hp 6 million gaming", cannot be directly processed mathematically by the system. The user's query text, as well as all the specification data of 20 smartphone products stored in the database, must first pass the preprocessing stage [16]. This stage is crucial for standardizing text formatting so that the algorithm can accurately calculate the weight of words, which includes case folding, tokenizing, filtering, and stemming.

To provide a technical overview of this process, Table 3 presents an example of the preprocessing implementation stages carried out by the system on one of the product data samples from the database, namely the Poco F7 specification.[10]

*Table 2. Example of Product Data Preprocessing Process (Poco F7)*

| Preprocessing Stages | Processed Result Text | Remarks |
|---|---|---|
| Raw Text (Original) | "120hz amoled screen, 8GB RAM, price 6 million, vapor chamber cooling gaming, 50 megapixel ois camera." | The original specification data pieces are pulled directly from Table 1. |
| Case Folding | "120Hz AMOLED screen, 8GB RAM, price 6 million, vapor chamber cooling gaming, 50 megapixel OIS camera." | Turns the entire character into lowercase. |
| Tokenizing | [screen] [AMOLED] [120Hz] [RAM] [8GB] [Price] [6] [million] [gaming] ... | Break sentences into units of words based on spaces. |

| Filtering | [screen] [AMOLED] [120Hz] [RAM] [8GB] [Price] [6] [million] [gaming] ... | Clean punctuation and stopwords. |
|---|---|---|
| Vote | [screen] [AMOLED] [120Hz] [RAM] [8GB] [Price] [6] [Million] [Gaming] ... | Return the word to its basic form (e.g., "gaming" to "game"). |

The token pool is extracted and returned to its base word form by removing the suffixes (if any) to make the wording more uniform.

## 3.3 TF-IDF calculation

Once the keywords are filtered, the core of this recommendation engine rests on the TF-IDF method for word weighting [11]. The Term Frequency (TF) formula is tasked with calculating how often a word (term) appears on a document, while the Inverse Document Frequency (IDF) evaluates the uniqueness of the word in the entire dataset of 20 smartphones. [12]

The system specifically gives weight to numerical terms and price categories to provide results that align with the user's budget. The results of the TF-IDF weight calculation for the main keyword of the query "hp 6 million gaming" (after *stemming*: "6", "million", "game") on the entire sample document are presented in Table 3.

*Table 3. TF-IDF Keyword Weight Calculation Results on 20 Documents*

| NO | Smartphone Brands and Types | Weight '6' | Weight 'millions' | The Weight of the Game | Total Weight (Q·D) |
|---|---|---|---|---|---|
| 1 | Poco F7 | 1.15 | 0.95 | 1.20 | 3.30 |
| 2 | Realme 14 Pro | 1.15 | 0.95 | 1.20 | 3.30 |
| 3 | Tecno Camon 50 Pro | 1.15 | 0.95 | 1.20 | 3.30 |
| 4 | Vivo V50 | 1.15 | 0.95 | 0.00 | 2.10 |
| 5 | Xiaomi Redmi Note 15 Pro+ 5G | 1.15 | 0.95 | 0.00 | 2.10 |
| 6 | Infinix GT 30 Pro | 0.00 | 0.00 | 1.20 | 1.20 |
| 7 | Asus ROG Phone 9 | 0.00 | 0.00 | 1.20 | 1.20 |
| 8 | Poco F7 Pro | 0.00 | 0.00 | 1.20 | 1.20 |
| 9 | Xiaomi 15 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10 | Realme 15 Pro | 1.15 | 0.95 | 0.00 | 2.10 |
| 11 | Oppo Reno 15 | 0.00 | 0.00 | 0.00 | 0.00 |
| 12 | Vivo X200 Pro | 0.00 | 0.00 | 0.00 | 0.00 |
| 13 | Samsung Galaxy S25 Ultra | 0.00 | 0.00 | 0.00 | 0.00 |
| 14 | Apple iPhone 17 Pro Max | 0.00 | 0.00 | 0.00 | 0.00 |
| 15 | Oppo Find X8 Pro | 0.00 | 0.00 | 0.00 | 0.00 |
| 16 | Google Pixel 10 Pro | 0.00 | 0.00 | 0.00 | 0.00 |
| 17 | Vivo X300 | 0.00 | 0.00 | 0.00 | 0.00 |
| 18 | Samsung Galaxy Z Fold 7 | 0.00 | 0.00 | 0.00 | 0.00 |
| 19 | Apple iPhone SE 4 | 0.00 | 0.00 | 0.00 | 0.00 |
| 20 | Samsung Galaxy S26 Ultra | 0.00 | 0.00 | 0.00 | 0.00 |

(Note: Documents that do not have a weight value of 0.00 indicate that the keyword is not found in the specification).

## 3.4 Cosine Similarity Calculation

After the TF-IDF weight calculation [7] , the system triggers the *Cosine Similarity function* to measure the degree of proximity between the user's query vector (Q) and the smartphone specification document vector (D). The [19]*Cosine Similarity* calculation formula used is as follows:

$$Cosine\ (Q, D) = (Q \cdot D) \ / \ (||Q|| \times ||D||) \qquad (1)$$

Description:

- Q · D : Dot *Product* between the vector weight of the query and the document.
- ||Q|| : The vector length of the user's query.
- ||D|| : Vector length of product specification document.

To validate the relationship between the results between Table 3 and Table 4, the following is an example of a manual calculation using the query "6 million gaming cellphones" in Document 1 (Poco F7):

1. Token Extraction: The query is extracted into tokens {6, million, game}.
2. Query Weight (Q): Assumed the weight of each *query term* is 1, so the length of the query vector is ||Q|| = 2.50.
3. Document Weight (D): Referring to Table 3, the sum of weight multiplication (*Dot Product*) for Poco F7 is 3.30 (result of 1.15 + 0.95 + 1.20). The vector length of the Poco F7 document (the result of the square root of the entire weight of the word in the document) is ||D|| = 3.46.
4. Final Score: Incorporated into the *Cosine Similarity formula*:

$$\text{Score} = 3.30 / (2.50 \times 3.46) \quad (2)$$

$$\text{Score} = 3.30 / 8.65 = 0.381 \quad (3)$$

The details of the complete calculation to show the relationship between the variables until the *similarity value* is found in all 20 products are presented in Table 4.

*Table 4. Overall Similarity Score Calculation Results (20 Products)*

| Yes | Document Name (Brand & Type) | Total Weight | Query Length | Document Length | Similarity Score |
|---|---|---|---|---|---|
| 1 | Poco F7 | 3.30 | 2.50 | 3.46 | 0.381 |
| 2 | Realme 14 Pro | 3.30 | 2.50 | 4.50 | 0.293 |
| 3 | Tecno Camon 50 Pro | 3.30 | 2.50 | 6.28 | 0.210 |
| 4 | Vivo V50 | 2.10 | 2.50 | 9.65 | 0.087 |
| 5 | Xiaomi Redmi Note 15 Pro+ 5G | 2.10 | 2.50 | 10.63 | 0.079 |
| 6 | Infinix GT 30 Pro | 1.20 | 2.50 | 7.38 | 0.065 |
| 7 | Asus ROG Phone 9 | 1.20 | 2.50 | 8.72 | 0.055 |
| 8 | Poco F7 Pro | 1.20 | 2.50 | 9.60 | 0.050 |
| 9 | Xiaomi 15 | 0.00 | 2.50 | 10.00 | 0.000 |
| 10 | Realme 15 Pro | 2.10 | 2.50 | 21.00 | 0.040 |
| 11 | Oppo Reno 15 | 0.00 | 2.50 | 11.20 | 0.000 |
| 12 | Vivo X200 Pro | 0.00 | 2.50 | 12.50 | 0.000 |
| 13 | Samsung Galaxy S25 Ultra | 0.00 | 2.50 | 14.10 | 0.000 |
| 14 | Apple iPhone 17 Pro Max | 0.00 | 2.50 | 15.30 | 0.000 |
| 15 | Oppo Find X8 Pro | 0.00 | 2.50 | 16.50 | 0.000 |
| 16 | Google Pixel 10 Pro | 0.00 | 2.50 | 17.80 | 0.000 |
| 17 | Vivo X300 | 0.00 | 2.50 | 18.20 | 0.000 |
| 18 | Samsung Galaxy Z Fold 7 | 0.00 | 2.50 | 19.50 | 0.000 |
| 19 | Apple iPhone SE 4 | 0.00 | 2.50 | 20.10 | 0.000 |
| 20 | Samsung Galaxy S26 Ultra | 0.00 | 2.50 | 22.00 | 0.000 |

*(Note: The Total Weight value in this table is consistently taken from Table 3 to prove the relationship between the calculation results).*

After the system has successfully calculated all the weights in Table 4, the last stage is to rank the highest value (*descending*). To make it easier for ordinary users to select options on the application interface, the system filters data and ranks only the top 5 (five) products that are considered most relevant to the user's needs, as shown in Table 5.

*Table 5. Top 5 Products Ranking Results (Top 5 Recommendations)*

| Rank | Document Name (Smartphone Brand & Type) | Similarity Score |
|---|---|---|
| Rank 1 | Poco F7 | 0.381 |
| Rank 2 | Realme 14 Pro | 0.293 |
| Rank 3 | Tecno Camon 50 Pro | 0.210 |
| Rank 4 | Vivo V50 | 0.087 |
| Rank 5 | Xiaomi Redmi Note 15 Pro+ 5G | 0.079 |

### 3.5 Recommended Results

Based on Table 4, it can be seen that the system successfully performed the computation and compared the match rate of the user's query with 20 smartphone product data simultaneously. The results of this final computation are then dynamically visualized on the user interface for easy understanding by the general public.

In the initial stage, users simply enter their needs in a free text field, such as the query "6 million gaming", as shown in Figure 2.

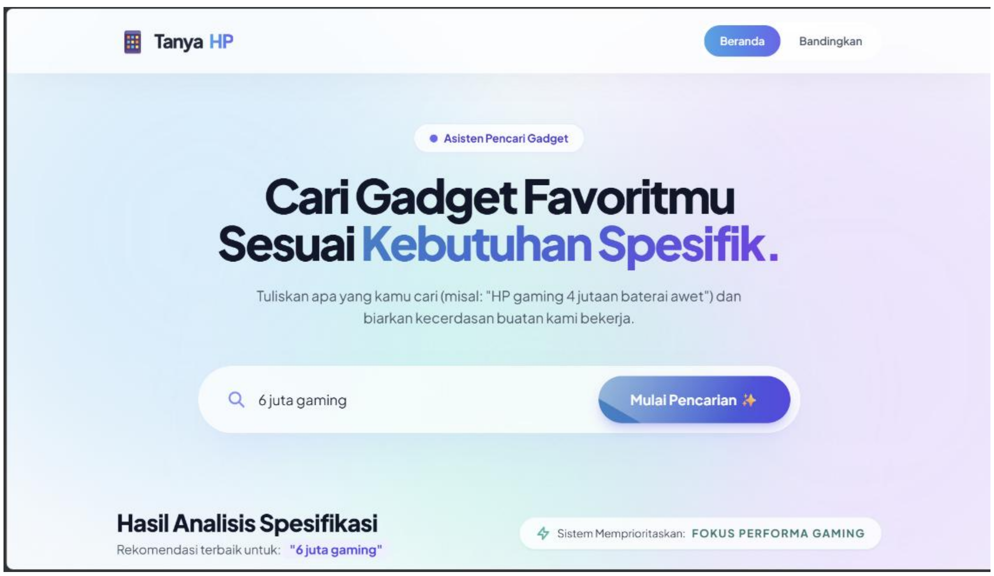


*Fig. 2. User Query Input Interface*

Once the system processes the text and calculates the weights using the Cosine Similarity algorithm, the system intelligently translates the query into an objective ranking sequence. The visualization of the results of the product recommendations is displayed in a row of specification cards. Figure 3 shows the interface result for the product ranked 1st, with the Poco F7 as the main recommendation (score 0.381).

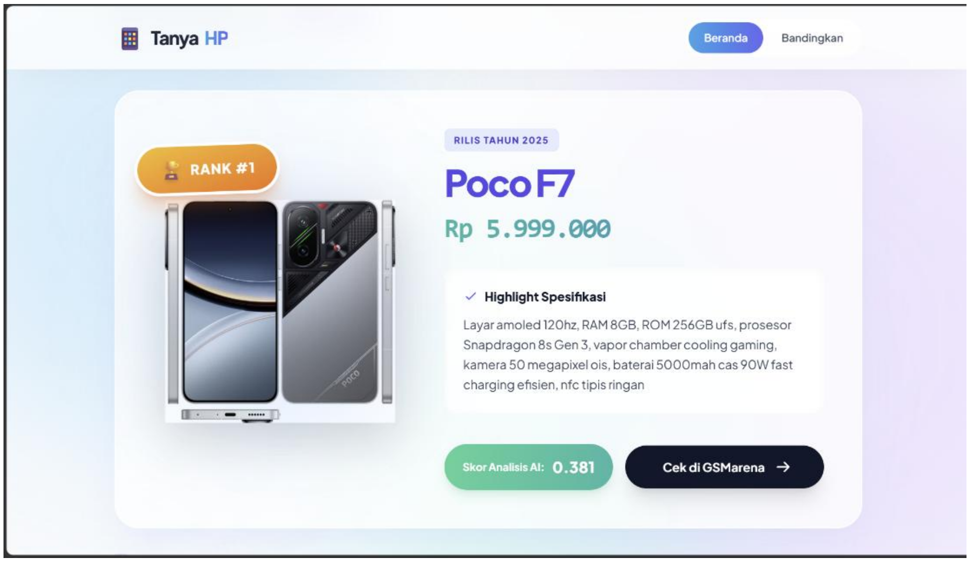


*Fig. 3. Recommendation Results Interface (Rank 1)*

Following the top recommendation, the system displays the subsequent products in the ranking sequence. Figure 4 shows the interface for products ranked 2nd and 3rd (Realme 14 Pro and Tecno Camon 50 Pro).

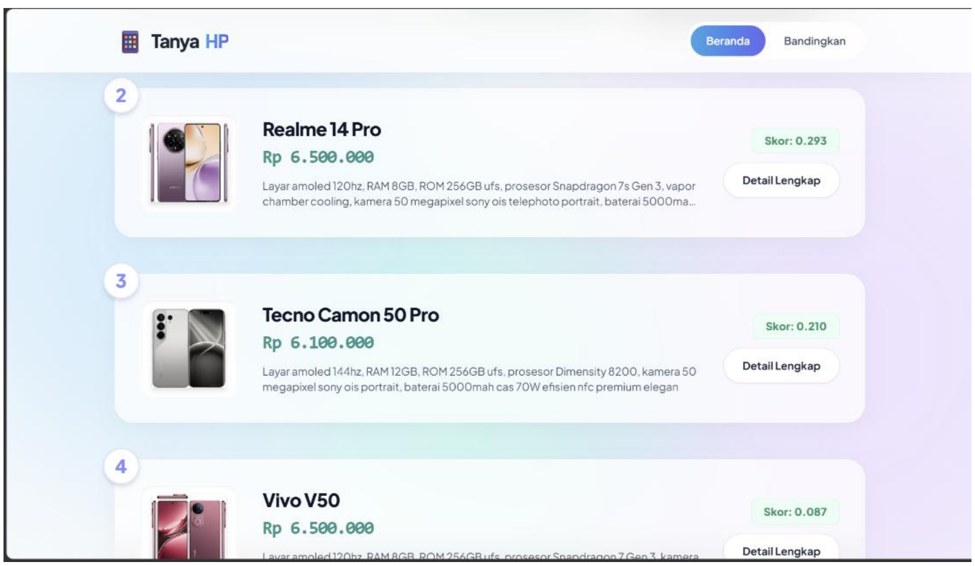


*Fig. 4. Recommendation Results Interface (Rank 2 - 3)*

Meanwhile, the continuation of the recommendation results for the products that rank 4th and 5th (Vivo V50 and Xiaomi Redmi Note 15 Pro+ 5G) are displayed in order on the interface below, as shown in Figure 5.

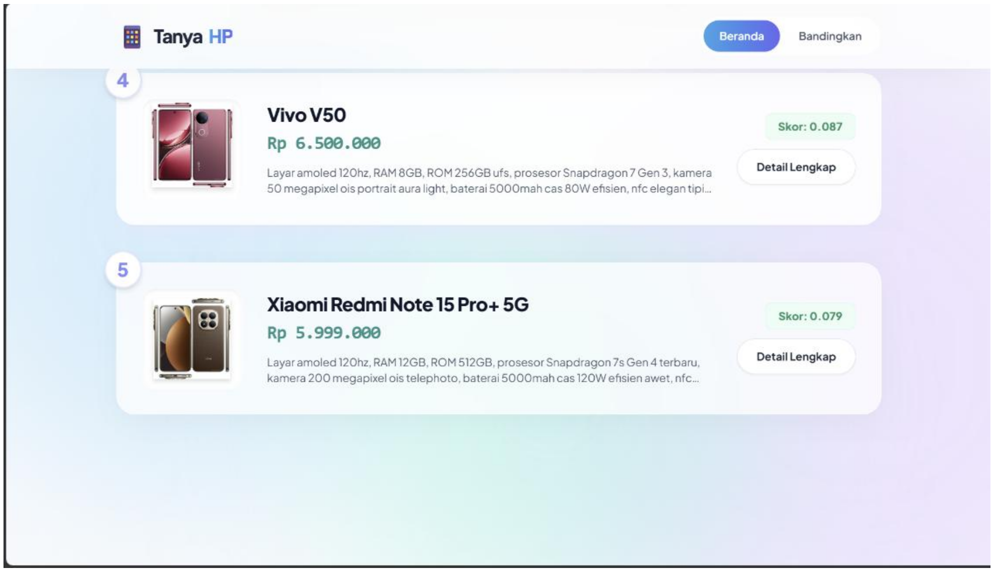


*Fig. 5. Recommendation Results Interface (Rank 4 - 5)*

Through the structured interface and the compare-provided feature, users can instantly weigh the specifications of the device that most closely matches the description of their needs without having to deal with confusing technical data. Consumer spending decisions ultimately become much more efficient, practical, and accurate.

## 4. Conclusion

This web-based smartphone recommendation system has proven to be reliable as a smart solution for the community. Through testing of 20 smartphone product data, this system successfully overcame the obstacles of the general public who are often confused by technical terms. The system is proven to be able to process everyday language sentences typed by users and accurately generate recommendations for devices with the most suitable specifications. This success is evidenced by the results of the test using the query "hp 6 million gaming", where the system precisely recommends the Poco F7 as the main choice with the highest *Cosine Similarity* value of 0.381. Coupled with the compare feature, it is easier for ordinary users to weigh their choices directly, so that shopping decisions become much more efficient, practical, and truly aligned with their needs.

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