JURNAL TEKNOLOGI DAN OPEN SOURCE
Vol. 7, No. 2, December 2024, pp. 125~137
e-ISSN: 2622-1659, accredited Four Grade by Kemenristekdikti, Decree No: 152/E/KPT/2023
DOI: 10.36378/jtos.v7i2.3873

Implementation of Python-Based Topsis Method for Best Stock Selection Analysis Using Yahoo Finance

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Article Info

Article history:

Received 11 13, 2024
Revised 11 18, 2024
Accepted 11 27, 2024

Keywords:

Decision Support System
Flask
Stock Analysis
TOPSIS
Yahoo Finance

ABSTRACT

This study developed a web-based application implementing the TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method for stock investment analysis and recommendations. The application was built using the Flask framework and integrated with the Yahoo Finance API for real-time stock data retrieval. The TOPSIS method evaluated stock alternatives based on criteria such as closing price, P/E ratio, revenue growth, and dividend per share. Testing included functional evaluation, response time analysis, and simulations of three investor scenarios: High Risk-High Return, Low Risk-Low Return, and Balanced. Results indicate that the application effectively delivers stock recommendations aligned with investor preferences, achieving an average response time of 1–4 seconds per feature. Simulations highlight its adaptability in adjusting criteria weights to match different risk profiles. Despite limitations due to external API dependencies, the application demonstrates effectiveness as a decision support tool for stock investment, offering accessibility and flexibility to investors.

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1. Introduction

Information technology developments have significantly impacted investment management, particularly in the stock market. One strategy to build wealth and accomplish long-term financial objectives is through investing.[1] Because of their potential for large returns and the flexibility they offer in managing a portfolio, stocks are a popular choice for investors.[2] However, investors, particularly novices, frequently find it challenging to make the best investment choices due to the stock market's complexity. Selecting the appropriate stock from the thousands of possibilities on the market is the biggest obstacle faced by investors.[3] This decision-making process entails examining a number of variables, including past performance, the state of the market, and the company's prospects for the future.[4][5] This intricacy may deter inexperienced investors and perhaps result in expensive mistakes of judgment. As a result, there is a demand for instruments and techniques that can assist investors in better analyzing and choosing investments.

The Decision Support System (DSS) is crucial in this situation. DSS is a computer program designed to assist with intricate decision-making by offering pertinent facts, analysis, and suggestions derived from mathematical models.[6] To help investors make decisions, a variety of analysis techniques have been created. Finding the elements associated with pertinent investment decisions is one of the most crucial concerns for persons as it has been acknowledged that investment decision-making is one of the key elements

influencing financial capability and well-being.[7] TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) is one approach that has been shown to be effective in DSS for multi-criteria decision-making. TOPSIS is a decision-making technique that selects options that are both the most distant from the negative ideal solution and the closest to the positive ideal solution.[8] By evaluating different investment options based on predetermined standards, this approach assists investors in making more unbiased and quantifiable choices. The TOPSIS approach is very applicable to stock investing since it can assess stocks using several financial factors, including dividends per share, earnings growth, and the price-earnings ratio.

Despite being used in many decision-making domains, TOPSIS's use in stock investment analysis still needs improvement. For individual investors, the use of contemporary technology, such as web-based apps, might facilitate the implementation of this strategy. Novice investors can benefit from a web-based tool that uses TOPSIS to assist close the gap between intricate investment theory and real-world implementation. However, user demands, analytical accuracy, and usability must all be considered in the application's design. Dynamic and adaptable web technologies like Flask can be used to create user-friendly systems and facilitate integration with libraries like Yfinance to deliver real-time stock data.

Designing a web-based tool that applies the TOPSIS approach for stock investment analysis and recommendations is the goal of this research. The purpose of the software is to help investors—beginners in particular—make better investment choices by using multi-criteria analysis. Flask and other contemporary web technologies are used in the construction of this application. A Python-based microweb framework is called Flask.[9] Common components like databases and form validation are by default absent from Flask.[10] The program can retrieve real-time stock data through integration with the YFinance library, giving users access to the most recent research. Through fugnsional testing and user input, the application will also assess how well the TOPSIS technique supports investment decision-making. It is anticipated that the findings of this study will contribute to the creation of advanced yet user-friendly investment analysis tools, enhancing the caliber of investment choices made by individual investors.

2. Research Method

In this project, the TOPSIS method is implemented to create a web-based stock investing analysis application using a system development approach. Data collection, and System Design.

2.1. Data Collection

Yahoo Finance provided the stock data for this study via an API that could be accessed with the yfinance library. Several financial variables utilized in the TOPSIS analysis are included in this data, including:

a. Closing Price
b. Price Profit Ratio (P/E)
c. Revenue Growth
d. Dividend Per Share

2.2. System Design

The Flask framework was used to create this system's back-end, which manages data and handles application logic. The instructions that run on an application exist in the back-end.[11] The data analysis procedure and results distribution to the front-end are also handled by the back-end. The display of a website that users will see directly is called the front-end.[12] The front-end is meant to give investors an intuitive user experience. A database is a collection of data that is methodically kept on a computer so that a computer program may control it and obtain data from it.[13][14] User information, investment choices, and TOPSIS analysis findings are all stored in the MySQL database. Making use of databases The following are some essential elements of system design:

2.2.1. Flowchart

Charts with flows that show the steps to solve an issue are called flowcharts. Algorithms can be presented using flowcharts.[15] The application's workflow, from user data entry to stock recommendations based on TOPSIS analysis, is explained by the flowchart system. Figure 1. Describe the steps involved, starting with the input of stock ticker data, followed by data retrieval via YFinance, analysis, and recommendation output.

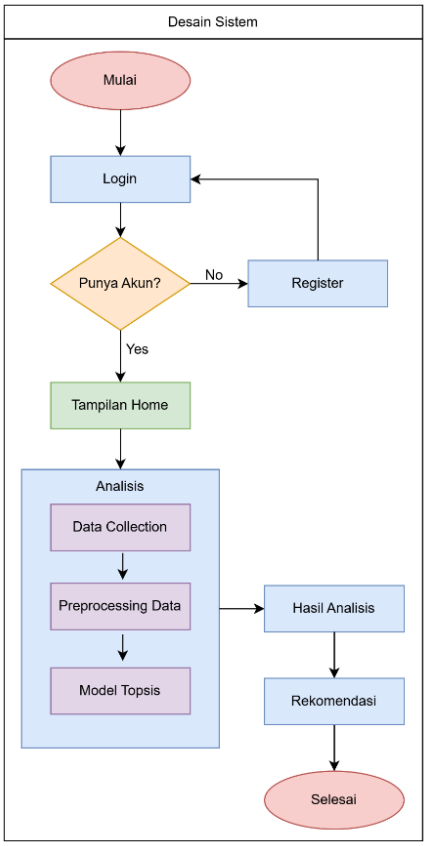


Figure 1. Flowchart

2.2.2. Use Case Diagram

A use case diagram is one that illustrates the advantages of the system from the viewpoint of actors or those not directly involved in it.[16][17] Figure 2 illustrates how the user and the system interact.

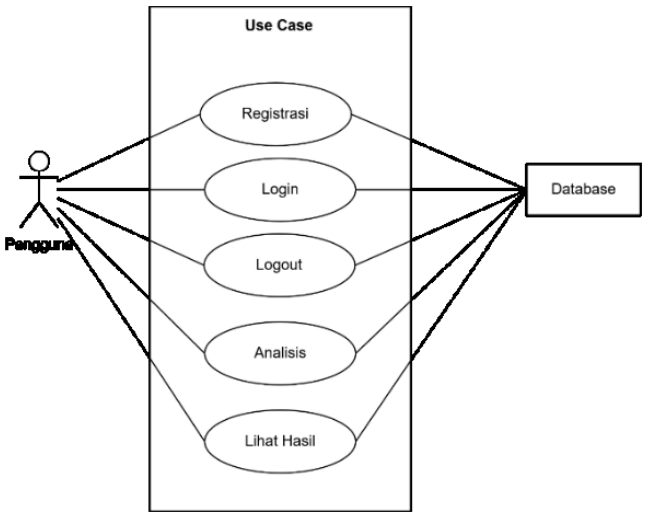


Figure 2. Use Case

2.2.3. Activity Diagram

An activity diagram is a diagram that shows the idea of organized, well-planned actions in a system, as well as data flow and control.[18] The system's primary operations, including the extraction of stock data from YFinance, data normalization, weighting criteria, TOPSIS computations, and suggestion appearance, are depicted in Figure 3.

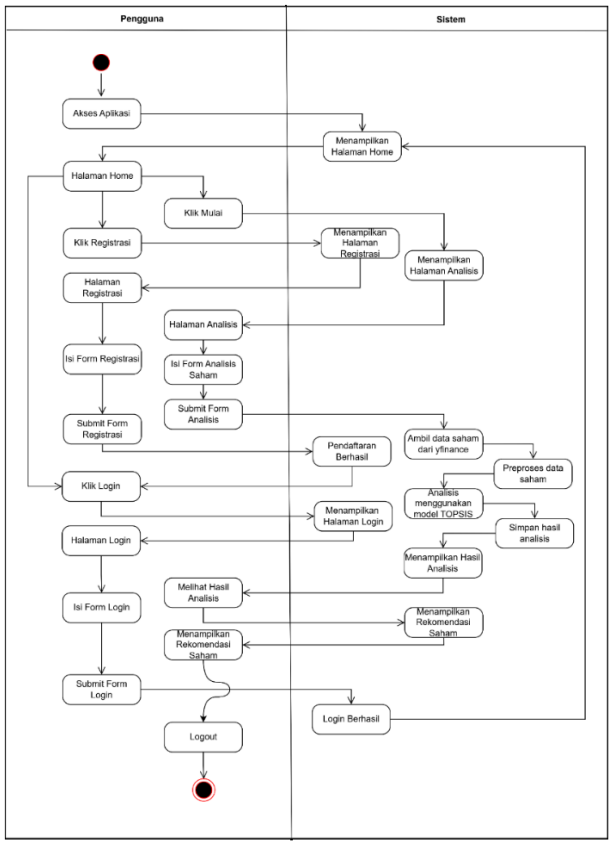


Figure 3. Activity Diagram

2.2.4. Sequence Diagram

A sequence diagram illustrates the communication or messages that exist between items by showing how they interact with one another.[19] Throughout the data gathering, stock analysis, and recommendation-making processes, it is part of the system. Key app scenarios, including the registration, login, analysis, and logout processes, are depicted in Figure 4.

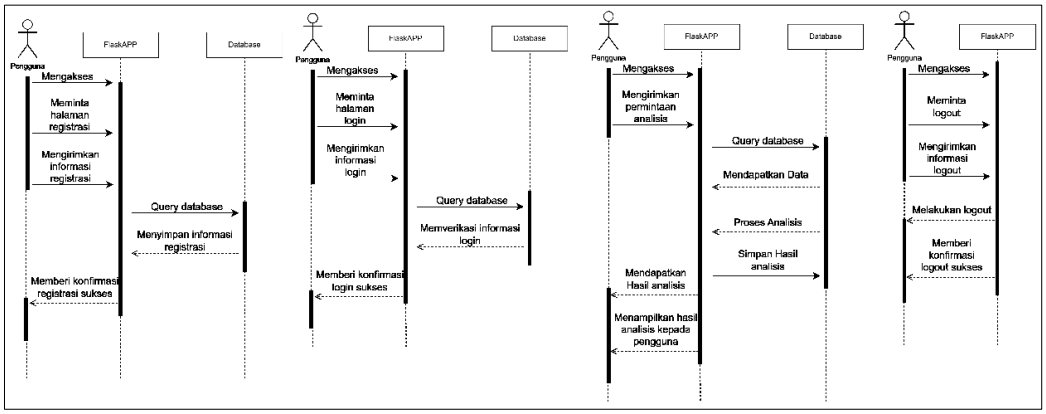


Figure 4. Sequence Diagram

2.2.5. Class Diagram

The most significant and popular way to describe an object-based system is via a class diagram.[20][21] The application's class structure is shown in Figure 5, along with the linkages between classes and methods used for database connections, data management, activity tracking systems, and user management.

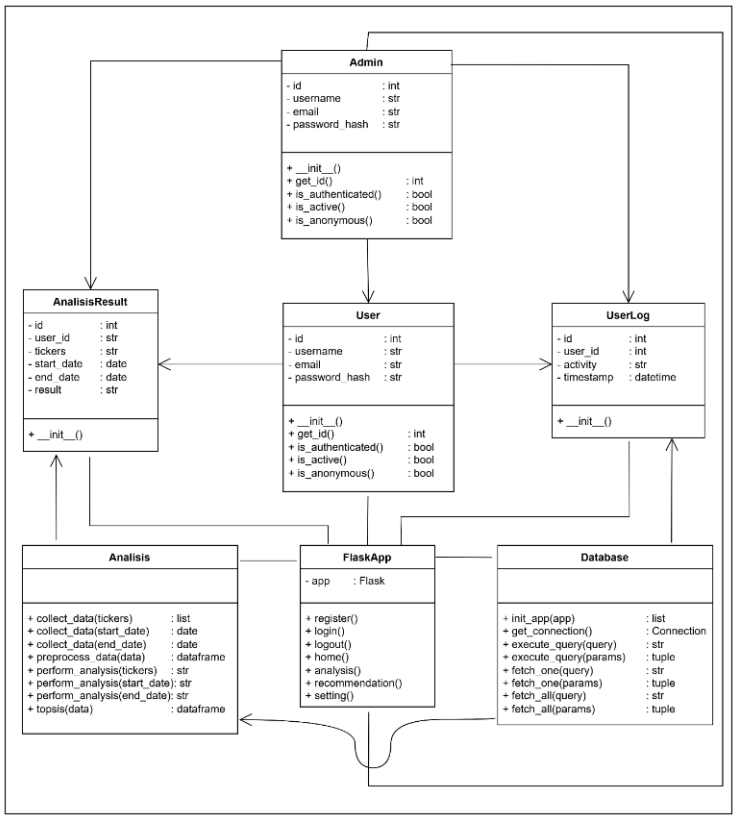


Figure 5. Class Diagram

2.2.6. Entity-Relationship Diagram (ERD)

One of the most popular methods for designing databases is ERD.[22] The application's database structure, including user entities, shares, criteria, and TOPSIS analysis findings, is described in the ERD. Additionally, ERD can be used as a tool for business process development and to describe and better understand current databases.[23] The Primary Key is represented by the yellow attribute in Figure 6, whereas the Foreign Key is represented by the blue attribute.

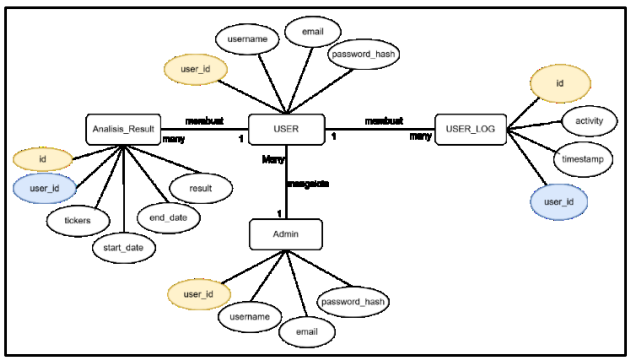


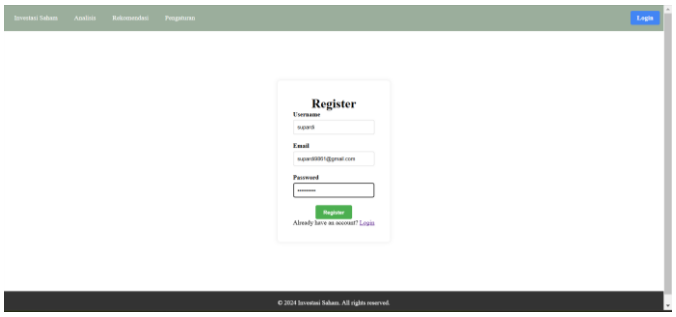
Figure 6. Entity-Relationship Diagram

3. Result and Discussion

Using the TOPSIS approach, this research successfully created a web-based stock analysis application that integrates with the Yahoo Finance API to capture stock data in real-time. In addition to discussing application evaluation based on functionality and user feedback, this chapter will give the findings of application creation and analysis utilizing the TOPSIS method.

3.1. Application Interface Implementation

Figure 7. Provide a registration form with input validation to protect data so that new users can create an account by entering their email address, username, and password.



Fig**ure** 7. Registration

In order for registered users to use the system, Figure 8 shows a straightforward form that requires the entry of an email address, username, and password.

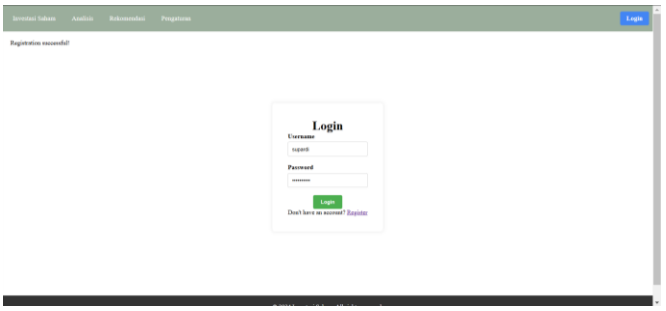


Figure 8. Login Menu

Figure 9 shows the application's main menu, which includes options to begin a fresh analysis and modify the application's preferences by altering the scenario on the settings layout to suit the investor's requirements.

Figure 9. Main Menu

To enter the ticker, start date, and end date that will be utilized in the TOPSIS computation, use the input form shown in Figure 10.

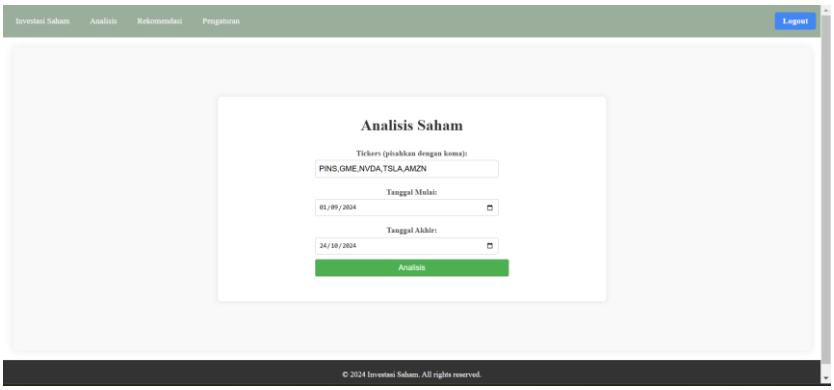


Figure 10. Analytics Menu

The TOPSIS computation results are shown in Figure 11 as a table with stock ratings and their desired values.

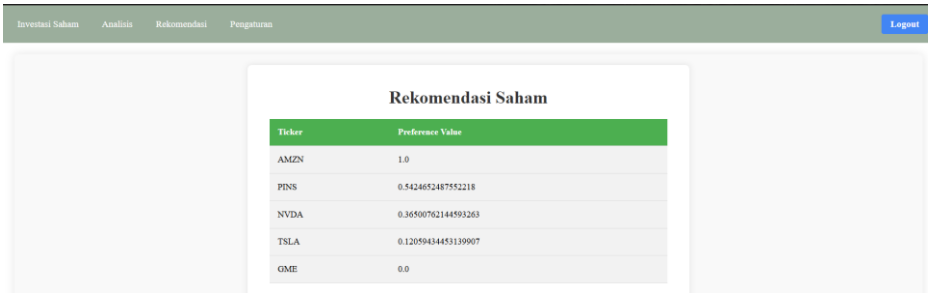


Figure 11. Recommendation Menu

3.2. Results of the Implementation of the TOPSIS method

Use TOPSIS in the application to rate stocks according to a number of multi-criteria standards. The primary phases in putting the TOPSIS technique into practice are as follows:

Table 1. Before Normalization

Ticker	Closing Price	P/E Ratio	Revenue Growth	Dividend Per Share
AAPL	150.75	30.50	12.5%	0.88
MSFT	250.20	35.00	15.0%	1.20
GOOGL	2800.50	28.40	10.0%	0.00

3.2.1. Data Normalization

The vector normalization approach was successfully used to normalize the Yahoo Finance data that was gathered. To ensure that every criterion has the same scale, normalization is done. Table 2 displays the outcomes of the stock data normalization process.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (1)$$

Information :

- r_{ij} is the normalization value of the alternative to the criterion,ij
- $x_{ij}$is the initial value of the alternative to the criterion,ij
- m is the total number of alternatives.

Normalization Calculation

$$\sqrt{150.75^2 + 250.20^2 + 2800.50^2} = \sqrt{7955097.31} = 2820.35$$

$$r_{AAPL,Closing\ Price} = \frac{150.75}{2820.35} = 0.0534$$

$$r_{MSFT,Closing\ Price} = \frac{250.20}{2820.35} = 0.0888$$

$$r_{GOOGL,Closing\ Price} = \frac{2800.50}{2820.35} = 0.9946$$

Table 2. Results of Stock Data Normalization

Ticker	Closing Price	P/E Ratio	Revenue Growth	Dividend Per Share
AAPL	0.0534	0.5604	0.5698	0.5913
MSFT	0.0888	0.6431	0.6837	0.8064
GOOGL	0.9946	0.5218	0.4558	0.0000

3.2.2. Determining the Weight of Criteria

Every criterion has a fixed weight, and the weight of a criterion determines another criterion in the comparison. Table 3 displays the outcomes of the criteria weights used in the analysis.

Table 3. Weighting Criteria

Criteria	Weight
Stock Closing Price	0.3
P/E Ratio	0.2
Revenue Growth	0.3
Dividend Per Share	0.2

3.2.3. Calculation of Positive and Negative Ideal Solutions

Calculating two reference points the positive ideal solution and the negative ideal solution comes next after the data has been normalized and weighted.[24] The position of each stock alternative is measured in relation to the ideal condition using these two reference points.

Positive Ideal Solution:

$$A^+ = \max(v_{ij})\ for\ benefit\ criteria\ , \min(v_{ij})\ for\ cost\ criteria\} \quad (2)$$

Negative Ideal Solution:

$$A^- = \{\min(v_{ij})\ for\ cost\ criteria, \max(v_{ij})\ for\ benefit\ criteria\} \quad (3)$$

Table 4. Calculation of the Ideal Solution

Criteria	A+ (Ideal Positif)	A- (Ideal Negatif)
Stock Closing Price	0.2983	0.0160
P/E Ratio	0.1286	0.1043
Revenue Growth	0.2051	0.1367
Dividend Per Share	0.1612	0.0000

3.2.4. Calculating the Distance to the Ideal Solution

The Euclidean formula is used to determine the distance between each alternative and the two reference points (positive and negative ideal solutions).[25][26] Distance values derived from Table 5.

computation. It then serves as the foundation for figuring out the preference value for every stock option under consideration.
Distance to Positive Ideal Solution:

$$D_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} - A_j^+)^2} \quad (4)$$

Distance to Negative Ideal Solution:

$$D_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - A_j^-)^2} \quad (5)$$

Where is the number of criteria n

Table 5. Ideal Solution Distance

Ticker	D+ (Positive Distance)	D- (Negative Distance)
AAPL	0.2880	0.1233
MSFT	0.2717	0.1771
GOOGL	0.1768	0.2823

3.2.5. Calculating Preference Values and Sorting Alternatives

A preference value that displays the stock's rating based on the TOPSIS computation is the analysis's final output.[27] The best options are thought to be the equities with the highest preference value. Table 6 displays the findings of the preference value computation for a few equities.

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (6)$$

Information:

- C_i is the alternate preference score to i,
- D_i^+ is the distance to a positive ideal solution,
- D_i^- is the distance to the negative ideal solution.

Table 6. Stock Prevence Values

Ticker	Preference
AAPL	0.7001
MSFT	0.6053
GOOGL	0.3851

3.3. Evaluation

3.3.1. Functional Testing

Table 7 contains the test results. It demonstrates that all of the app's main functions are functional and satisfy users' needs when it comes to stock suggestions.

Table 7. Functional Test Results

No	Feature	Test Case	Expected Result	Actual Result	Status
1	Registration	Valid registration data input	Account successfully created	Succeed	✓
2	Login	Log in with a valid account	Go to dashboard	Succeed	✓
3	Input Criteria	Criterion weight input	Stored weight	Succeed	✓

No	Feature	Test Case	Expected Result	Actual Result	Status
4	Data Acquisition	Fetch data from Yahoo Finance	Data was successfully retrieved	Succeed	✓
5	TOPSIS calculation	Calculation with selected criteria	The calculation results appear	Succeed	✓
6	Result Display	Displaying stock recommendations	A list of recommendations appears	Succeed	✓

3.3.2. Response Time Testing

Response time testing gauges how quickly each feature is processed by the system.

Table 8. Response Time Test Results

Feature	Average Response Time	Status
Login	1.5 seconds	Good
Take Stock Data	2.5 seconds	Good
TOPSIS calculation	4 seconds	Good
Show Results	1 second	Good

3.3.3. User Case Simulation

Table 9. Simulation Results

Scenario	Criteria & Weights	Top 3 Results	Analysis
High Return High Reward	- Closing Price (40%) - P/E Ratio (20%) - Revenue Growth (30%) - Dividends (10%)	1. GME = 1.0 2. NVDA = 0.60 3. TSLA = 0.40	Recommendations point to stocks with high growth and optimal P/E ratios.
Low Risk Low Reward	- Closing Price (20%) - P/E Ratio (30%) - Revenue Growth (20%) - Dividends (30%)	1. AMZN = 1.0 2. NVDA = 0.78 3. PINS = 0.40	The recommendation leads to stocks with high dividends and low P/E ratios.
Balanced	- Closing Price (25%) - P/E Ratio (25%) - Revenue Growth (25%) - Dividends (25%)	1. AMZN = 1.0 2. PINS = 0.54 3. NVDA = 0.36	Recommendations provide a balanced combination of growth and stability.

In order to produce outcomes that highlight stocks with a solid growth history, the High Return High Reward scenario places the most emphasis on returns while concentrating on high growth potential. with suggestions for the top ticker on GME (GameStop).

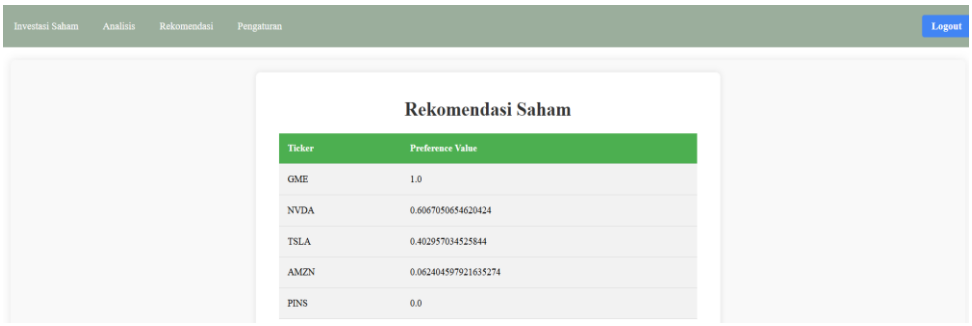


Figure 12. High Risk High Return

In order to display firms with solid fundamentals, the Low Risk Low Reward scenario places a high priority on stability and dividend income, giving the P/E ratio and dividends a significant weight. with AMZN (AMAZON), the top stock ticker on the recommendation.

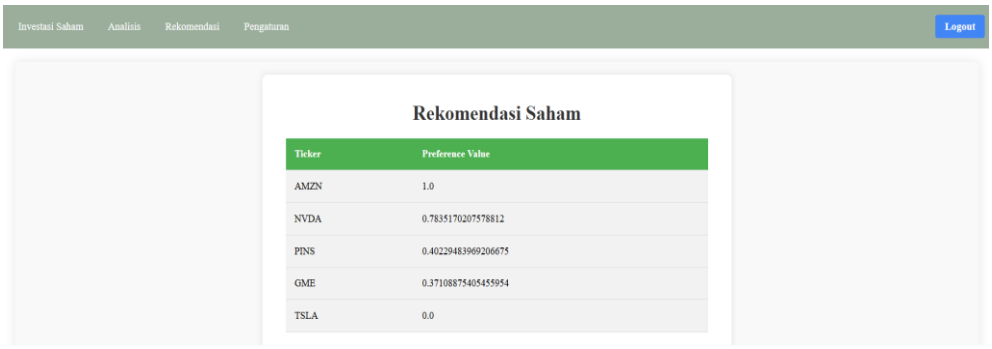


Figure 13. Low Risk Low Reward

By striking a balance between growth and stability, the balanced scenario equally distributes the weight across all criteria, resulting in a stock that performs well overall. with AMZN (AMAZON), the top stock ticker on the recommendation.

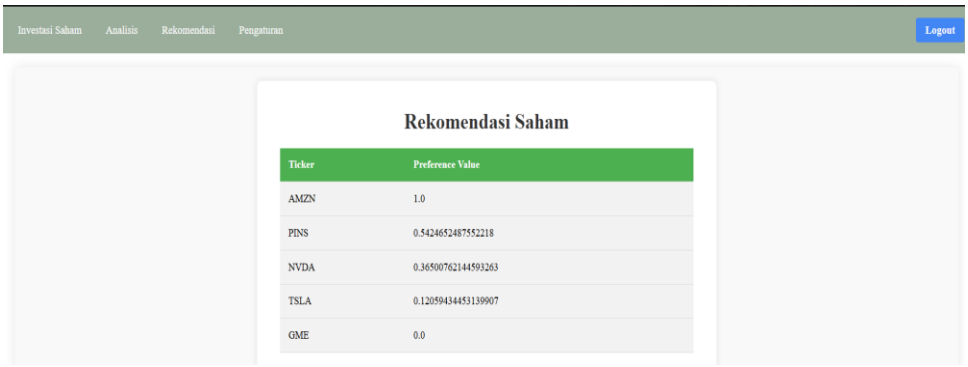


Figure 14. Balanced

3.4. Discussion

The efficacy and other significant features of the developed app are covered in this part.

3.4.1. Application Effectiveness in Stock Selection

The TOPSIS approach, which can process multiple factors at once, is the basis for this application's optimal stock recommendations. Users can view pertinent stock rankings based on current market conditions using real-time data from the Yahoo Finance API. Each analysis's findings demonstrate how accurate stock recommendations are, particularly for investors with varying tastes.

3.4.2. Data Validity and Consistency

Utilizing real-time data from Yahoo Finance lowers the risk of suggestions based on data usage by guaranteeing that the information produced by the application is always current. However, the dependence on external APIs also presents a problem with data availability. Testing demonstrates that the program can take data with different criteria and perform normalization correctly, producing preference values that are appropriate.

3.4.3. Functional Evaluation of Applications

The application's information is always current because to the usage of real-time data from Yahoo Finance, which lowers the possibility of making suggestions based solely on data. However, because it depends on other APIs, data availability is also a problem. The application's ability to handle data with different criteria and perform normalization correctly, producing suitable preference values, is demonstrated by testing.

3.4.4. Response Time Testing

The speed of an app is crucial, particularly when displaying suggestion results. According to web application standards, testing indicates that the app responds well to each function, with an average time of 1 to 4 seconds. This demonstrates that the application facilitates a seamless user experience and is effective enough for prompt decision-making.

3.4.5. User Case Simulation

Case examples demonstrate how the program may be tailored to the user's tastes by changing the weights. The outcomes of the simulated scenarios, which include Balanced, Low Risk Low Reward, and High Return High Reward, match the traits of each investor's risk profile. As a result, the program may be trusted to offer suggestions that are specific to the user's financial objectives.

4. Conclusion

By successfully integrating the TOPSIS approach with the Yahoo Finance API for real-time data collecting, a web application for stock analysis has been created. Based on a number of parameters, including stock closing price, P/E ratio, earnings growth, and dividend per share, this program is successful in offering stock recommendations that meet the preferences of investors. The analysis's findings demonstrate that the app can offer precise stock ratings, assisting users in making better financial choices. Furthermore, user case modeling and functional testing demonstrate that the application operates as intended, has the fastest possible response times, and is adaptable in modifying the weight of criteria in accordance with investor requirements and preferences.

With these features, this program might be a helpful tool for investors seeking quick and precise information in addition to being efficient in applying the TOPSIS approach for stock analysis. The study's findings demonstrate that, despite several drawbacks, such as its dependency on external APIs and subjective criterion weighting, this application can indeed aid in the investment decision-making process.

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