http://ejournal.seaninstitute.or.id/index.php/InfoSains
Jurnal Info Sains : Informatika dan Sains, Volume 13, No 03 2023
E-ISSN.2797-7889, P-ISSN.2089-3329

Decision Support System for Selection of Scholarship Awardees and Residents of Nusantara Surabaya Student Dormitory

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Keywords

Nusantara Student Dormitory, AHP Method, Decision Support System, TOPSIS

Abstract. Nusantara Student Dormitory (AMN) is a scholarship and boarding program intended for the nation's best children. The program has a rigorous selection to ensure that only the best candidates get the scholarship. However, the manual selection process can slow down the announcement of the graduation of the admission selection. This research aims to build a Decision Support System (DSS) to assess AMN scholarship candidates. The SPK was built using a combined method between AHP and Topsis. The results showed that the SPK built can provide quite good results. The system can provide ranking results in accordance with the criteria, namely academic ability in the form of report cards, ideological mental conditions, achievements, interests, health, personality, and color blindness test results. The system has also been tested and shows consistent results. Based on the results of the study, it can be concluded that SPK can be used to provide decisions on scholarship awardees and residents of AMN Surabaya.

1. INTRODUCTION

In 2022, the government will implement Presidential Regulation no. 106 of 2021 by inaugurating a scholarship and dormitory program for the nation's best sons and daughters, known as the Nusantara Student Dormitory (AMN). This program provides 264 scholarship quotas every year, with at least 50% of recipients coming from Indigenous Papuans, with the aim of improving the quality of education evenly throughout the province.

The management team carries out strict selection to ensure that only the best candidates receive the AMN scholarship. They assess candidates based on academic abilities in the form of report cards and ideological mental conditions through interviews covering aspects of health, personality, loyalty to the Republic of Indonesia, achievements, interests and color blind test results. However, various assessment components and the involvement of various assessment teams can slow down the announcement of graduation. Participants who wish to register must do so via the official AMN website and fill in the required data. After that, the management team will carry out an assessment according to the mechanism previously explained to determine potential scholarship recipients.

Based on this, this research aims to build a Decision Support System (SPK) to assess potential AMN scholarship recipients. Prospective students register through the existing system, the data is evaluated by the management team, and the results are used to determine the ranking of prospective students who are worthy of receiving the AMN scholarship. DSS is an interactive system that provides access to information, modeling and data processing[1]. DSS is designed to assist managerial decision makers in semi-structured decision situations and situations where there are no clear guidelines for decision making[2]–[4]. DSS can also be used to help management make decisions more quickly, accurately and convincingly for decision makers, thereby saving time, energy and costs.[5]–[7].

Algorithms have an important role in creating DSS that suit the problem and are able to provide accurate recommendations. In this research, a combined method was used between the Analytical Hierarchy Process (AHP) and the Topsis method. AHP is a method used to decompose complex and unstructured situations into hierarchical components, by providing a subjective assessment of the relative importance of each variable, as well as determining the variables that have the highest priority in influencing the outcome in the situation.[8]. AHP is designed to help decision makers integrate qualitative and quantitative factors in complex problems and produce solutions from various factors that can conflict with each other.[9], [10]. This method can determine the weight value for each

criterion that will be used to select the best alternative[11], [12]. The AHP method can solve complex or unstructured problems into smaller problems arranged according to hierarchy. This method can also be depicted graphically, so that it is easy to understand by all parties involved in decision making[13].

In 1981, Yoon and Hwang introduced the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) as a multi-criteria SPK method.[14]. This method facilitates more efficient and accurate decision making, by meeting or approaching the desired criteria[15]. The Topsis method takes into account the relative closeness of an alternative to positive and negative ideal solutions by considering the distance[16]. The best alternative is the alternative that has the closest distance to the positive ideal solution and the farthest distance to the negative ideal solution from a geometric point of view. Using Euclidean distance (the distance between two points) to determine the relative closeness of an alternative[17], [18]. The Topsis method has the advantage that the concept is easy to understand, computationally efficient, and can measure the relative performance of decision alternatives in simple mathematical form.[19]. The Topsis method requires criteria weights for the ranking process which can affect the accuracy of the recommendation results. Therefore, the AHP method is used to help determine optimal criteria weights. By using the AHP method, it is hoped that it can produce more accurate recommendations for scholarship recipients.

2. METHODS

Requirement Analysis

Interviews with dormitory managers were conducted to identify features that needed to be developed. Apart from that, direct observation at the research location was used to get an idea of the condition of the dormitories and potential SPK users. The results of interviews and observations are used to identify problems that will be resolved through the development of this information system. All of these requirements are recorded in the software requirement specification (SRS) document.

Data collection

To build the SPK for awardees and dormitory residents in this research, data was taken from the registration system provided by the management on the amn.upnjatim.ac.id website. In this registration system, class XII students upload the required data. Then the data that meets the criteria for scholarship recipients is processed using the AHP and TOPSIS algorithms to rank students who are entitled to receive scholarships and live in dormitories.

Apart from data collection, a literature study was carried out to ensure the suitability of the SPK with existing theory. The literature needed includes the algorithms used, namely AHP and topsis, as well as system design theories such as CDM, PDM, DFD, and databases.

System planning

At this stage, the system is designed to be easy to implement. The system design results are in the form of structured design diagrams, namely conceptual data models, physical data models, and data flow diagrams. The general system workflow design can be seen in**Error! Reference source not found.**.

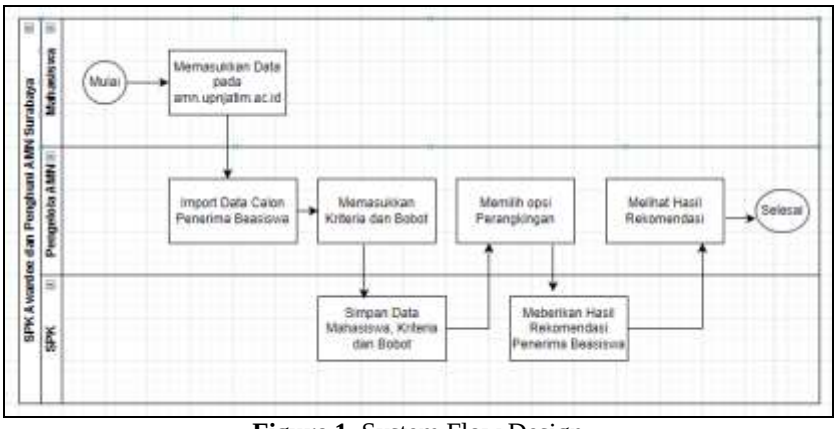


Figure 1. System Flow Design

In **Error! Reference source not found.** It can be seen that AMN managers are in charge of importing data from the registration system for prospective students receiving AMN scholarships and determining the criteria and weights used. After all the data is entered into the system, the results of the ranking of recommendations for scholarship recipients will appear which are calculated using the AHP and Topsis methods.

System Implementation

The next step is to implement the design into a programming language. System implementation was carried out using the CodeIgniter framework, the PHP programming language, and the MariaDB database. The result of this stage is the AMN Surabaya Awardee and Resident Decision Support System which meets user needs as stated in the SRS. This system applies the AHP and TOPSIS algorithms. Following are the AHP steps[20]:

1. Building a hierarchical structure starts from the general goal, then reduces subgoals, criteria and alternatives to the lowest level of criteria.
2. Create a pairwise comparison matrix for intensities. This comparison is based on the decision maker's subjective assessment regarding the level of importance of the elements being compared. The number of these assessments is n * [(n-1)/2], where n is the number of elements being compared. Next, determine the local priority and calculate its consistency.
3. Multiply the local priority matrix of criteria and the local intensity/alternative priority matrix to obtain global priorities.
4. Checking matrix consistency by testing whether aij * ajk = aik. If the criteria do not meet consistency, then the calculation is carried out using the formula for calculating the consistency ratio. If the value exceeds 10%, the data assessment needs to be corrected.

The steps for the Topsis method are:[21]:

1. The elements of the normalization matrix rij calculated by normalizing the decision matrix R using the Euclidean length of a vector method are:

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

   Where i = 1,2, … , m and j = 1,2, … , n
2. Build a normalized weight rating (Yij) to determine the positive ideal solution A+ and negative ideal solution A- with the equation:

$$y_{ij} = w_i r_{ij} \quad (2)$$

3. Positive ideal solution (A') and the negative ideal solution (A^-) can be determined based on the normalized weight rating with the following equation:

$$A' = (y_1', y_2', \dots, y_n') \quad (3)$$

$$A^- = (y_1^-, y_2^-, \dots, y_n^-) \quad (4)$$

4. Determine the distance between the value of each alternative and the positive ideal solution matrix and negative ideal matrix. The calculation between alternative Ai and the positive ideal solution is:

$$D_j^+ = \sqrt{\sum_{j=1}^{n} (y_1^+ - y_{ij})^2} \quad (5)$$

   The calculation between alternative Ai and the negative ideal solution is:

$$D_j^- = \sqrt{\sum_{j=1}^{n} (y_1^- - y_{ij})^2} \quad (6)$$

5. Calculate the closeness of each alternative to the ideal solution to find the preference value for each alternative using the equation:

$$V_1 = \frac{D_i^-}{D_i^- + D_i^+} \quad (7)$$

System Testing

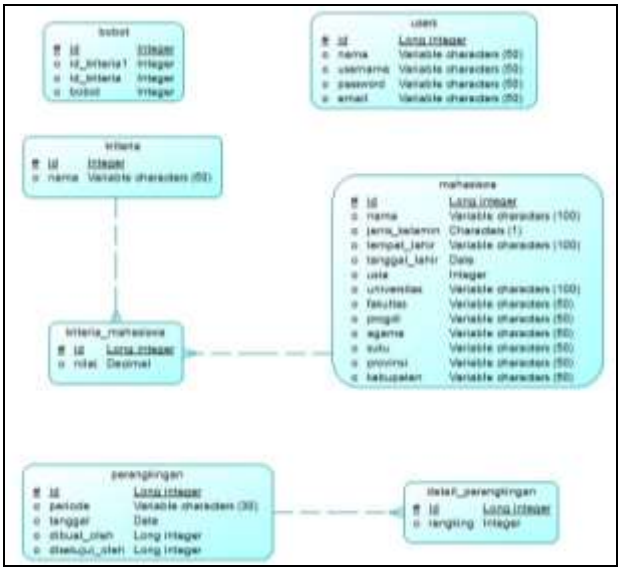
The final stage is system testing to ensure that the system that has been built operates well and meets user needs as stated in the SRS document. Testing includes testing system functionality using

the black box testing method. Apart from that, the system was also tested to measure accuracy by comparing the results of the system's recommendations with decisions taken manually by the dormitory management team against data on scholarship recipients in 2022.

3. RESULTS AND DISCUSSION

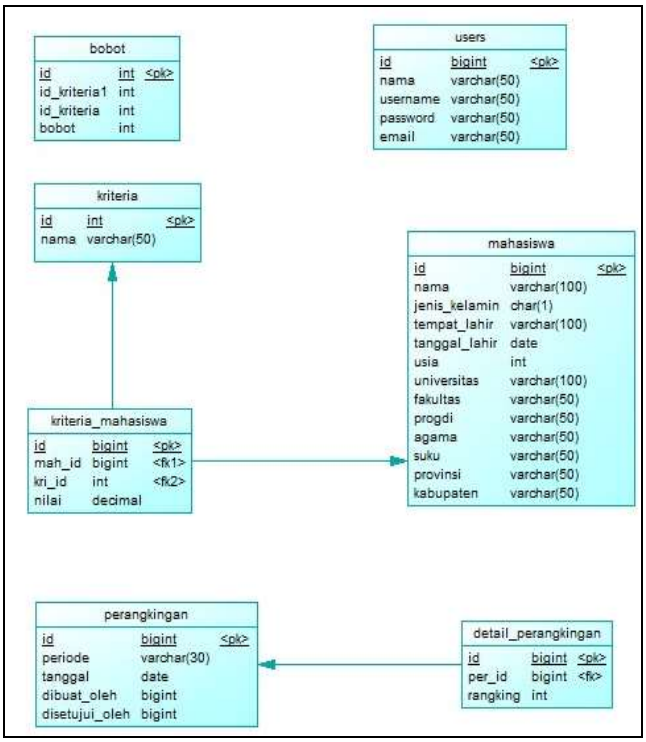
Database Design

The data design used in this decision support system is shown in the Conceptual Data Model (CDM) and Physical Data Model (PDM).



Figures 1. Conceptual Data Model Design

On **Error! Reference source not found.**There are seven entities involved in the awardee decision support system, including the user table which stores user data, criteria data and student criteria to store criteria data and values. There is also ranking data and detailed rankings as a result of student rankings, as well as student data which contains student information whose rankings will be calculated to determine whether they are accepted as awardees at AMN Surabaya.

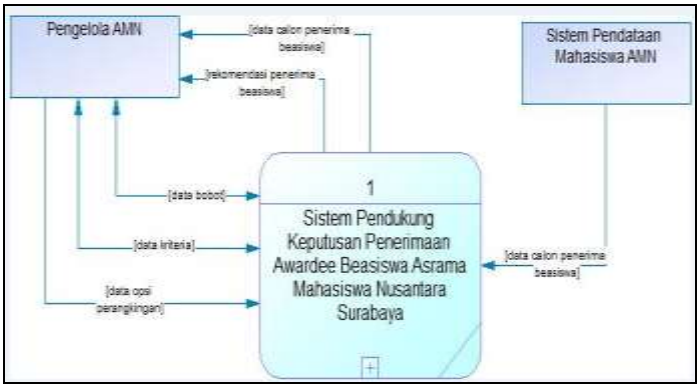


Figures 2. Physical Data Model Design

Based on PDM on**Error! Reference source not found.**which is formed from derivative results from CDM, it can be seen that there are 7 tables involved in the decision support system for AMN Surabaya awardee recipients. The table is a table of weights, users, criteria, student criteria, students, ranking, and ranking details.

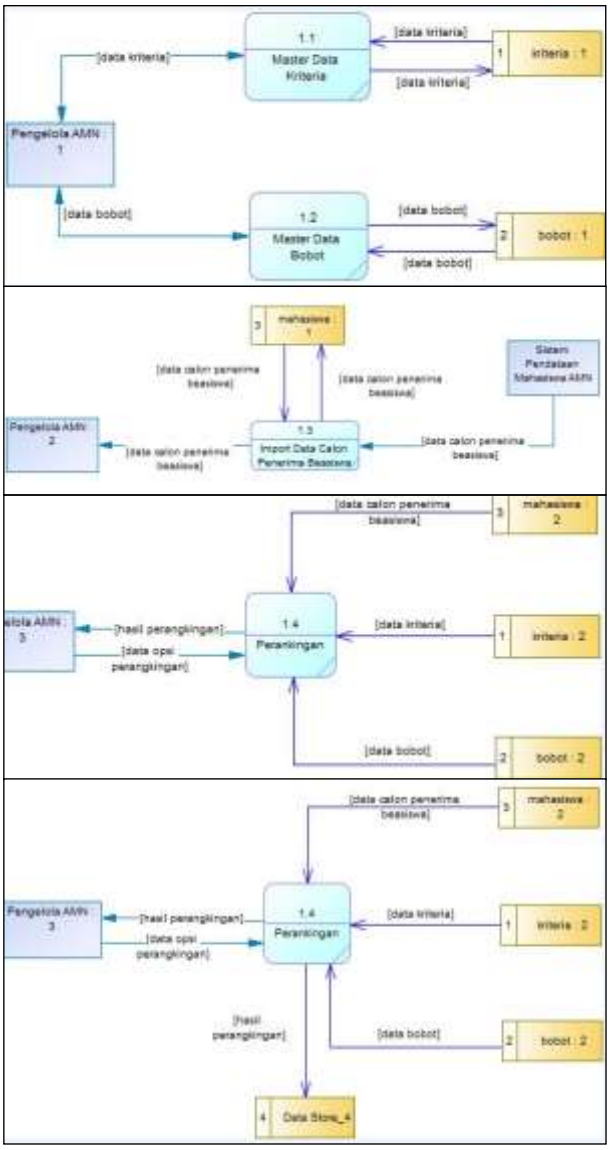
Designing Data Flow Diagrams

Apart from CDM and PDM, a Data Flow Diagram (DFD) was also designed which describes the process flow and data flow from the existing database.**Error! Reference source not found.**is the Context Diagram of the AMN Surabaya awardee decision support system developed in this research.



Figures 3. Context Diagrams

In the system being built, there are two external entities involved, namely AMN managers and AMN students. The data required as system input includes weight data, criteria data, ranking option data, and data on prospective scholarship recipients. Meanwhile, the output produced by the system is data on prospective scholarship recipients and information on recommendations for scholarship recipients. The Context Diagram is then depicted in DFD level 0 as in**Error! Reference source not found.**which consists of master data DFD, candidate import DFD, ranking process DFD, and ranking DFD.



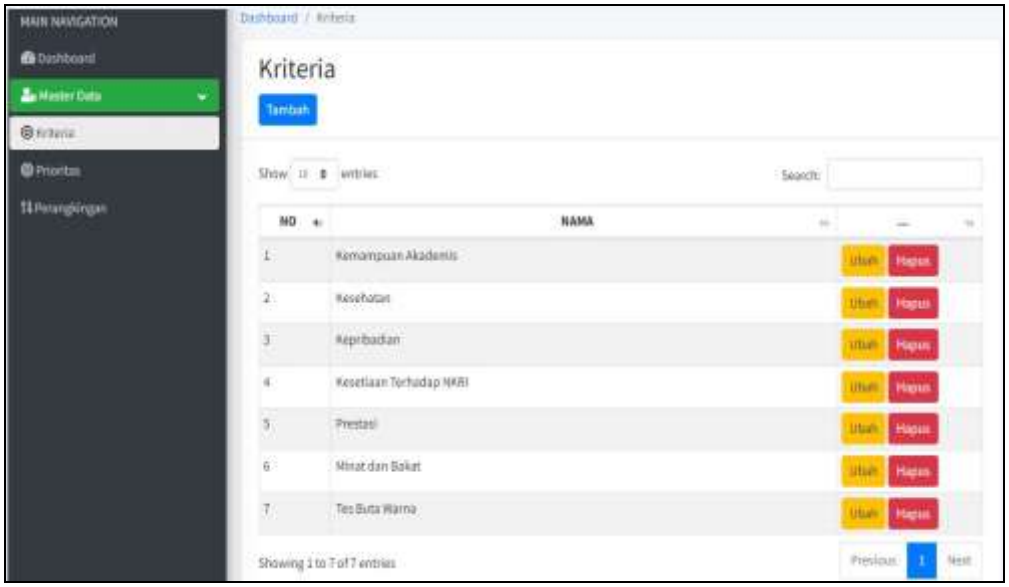
Figures 4. DFD Level 0

System Implementation Results

Criteria are components that will be assessed by a prospective scholarship recipient. The criteria for potential scholarship recipients are determined by the AMN management and entered into the decision support system via a form as shown**Error! Reference source not found.**.

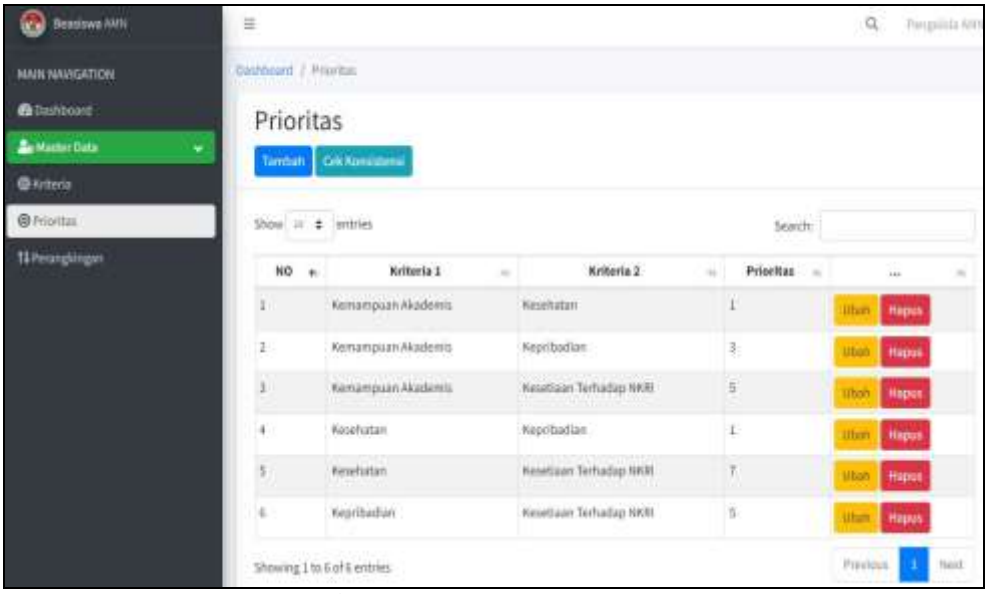
Figures 5. Add Criteria Form

After the criteria are entered, a criteria page will appear which can be seen at**Error! Reference source not found.**.



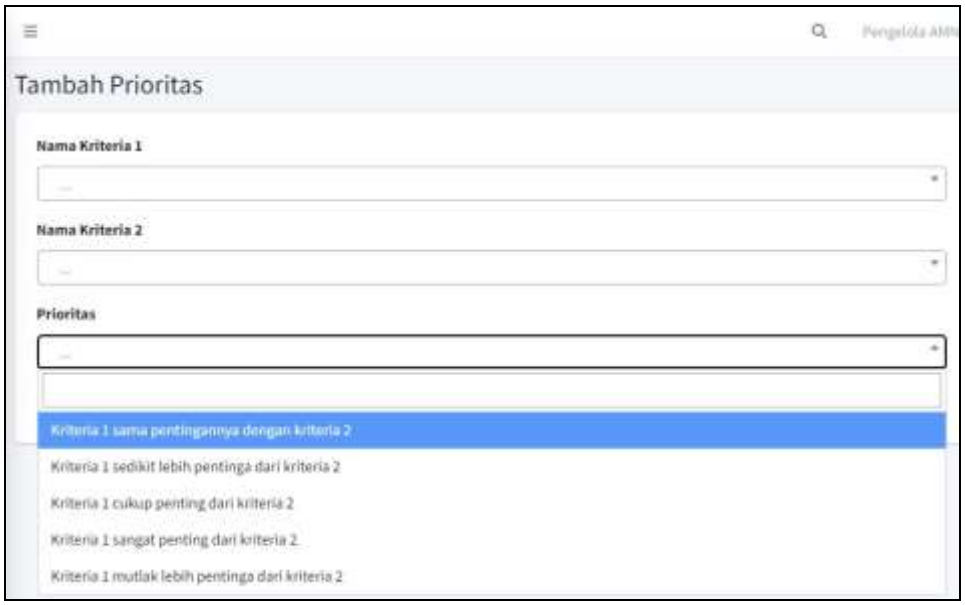
Figures 6. Criteria Page

The criteria used can be adjusted according to the decision of the AMN management. To change or delete saved criteria, users can use the change or delete buttons, as shown in**Error! Reference source not found.**.



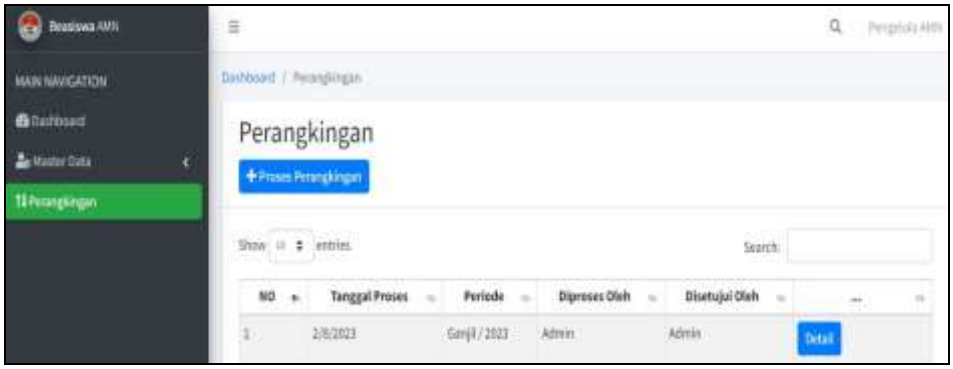
Figures 7. Criteria Priority Page

Each criterion in the database has a different weight or priority according to the decision of the AMN manager. Therefore, there is a menu to set the priority of each criterion as seen in**Error! Reference source not found.**. Priority additions can be made by filling in the form shown below**Error! Reference source not found.**.



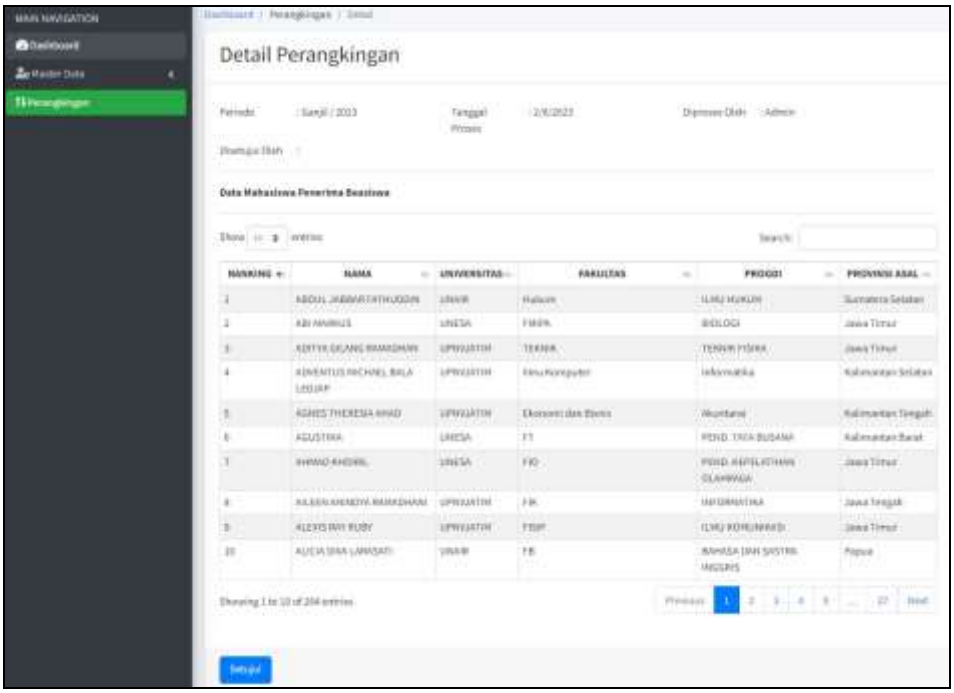
Figures 8. Add Priority Form

Each criterion will be given a priority level relative to other criteria, so that it will produce criteria with the highest and lowest priority as input for the system. The ranking process is carried out by importing student data from an Excel file into the system via the form shown in**Error! Reference source not found.**.



Figures 9. Ranking Process Page

The final feature that the awardee decision support system has is the ranking results based on imported student data along with the criteria and priority of each criterion, as shown in**Error! Reference source not found.**.



Figures 10. Ranking Results Page

System Testing

Black box testing is carried out to evaluate system functionality. The test results show that the system can meet the established standards. System testing results can be seen at**Error! Reference source not found.**.

Table 1. Black Box Testing Results

No.	Testing Scenarios	Test Cases	Test result	Expected results	Status
1.	Fill out the Add Criteria Form	Fill in the available fields, then click the "Save" button	The data that has been filled in is entered into the database.	The data that has been filled in is entered into the database.	Succeed
2.	View the Criteria Page	Click the "Criteria" menu in the sidebar.	Displays the Criteria page	Displays the Criteria page	Succeed
3.	View the Criteria Priority Page	Click the "Priority" menu in the sidebar.	Displays the Criteria Priority page	Displays the Criteria Priority page	Succeed
4.	Fill out the Add Priority Form	Fill in the available fields, then click the "Save" button	The data that has been filled in is entered into the database.	The data that has been filled in is entered into the database.	Succeed
5.	Viewing the Rankings Page	Click the "Ranking" menu in the sidebar.	Displays the Ranking page	Displays the Ranking page	Succeed
6.	Import Data for Ranking	Click the "Ranking Process" button to import data.	The data that has been imported goes into the database.	The data that has been imported goes into the database.	Succeed
7.	View the Ranking Results Page	Click the "Details" button on one of the rows in the Ranking table.	Displays the Ranking Results page	Displays the Ranking Results page	Succeed

In**Error! Reference source not found.**It can be seen that there are six test scenarios. Each test scenario produces a success status. It can be concluded that the features in the SPK scholarship awardee and AMN Surabaya residents have run well and are in line with the expected results.

4. CONCLUSION

Based on research that has been carried out on the Decision Support System for scholarship awardees and residents of AMN Surabaya, it can be seen that the AHP and Topsis methods applied provide quite good results. The system can provide ranking results for scholarship awardees and residents of AMN Surabaya properly according to the criteria and data entered. The system created is in accordance with the design and needs. This can be known based on Black Box testing which provides success status for each test scenario. Thus, it can be concluded that the system can be used to make decisions regarding scholarship awardees and residents of AMN Surabaya.

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