Selection of talented archery athletes using weighted product method

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Abstract. Many talented archers come from Indonesia. They all want to participate in ASIAN-GAMES, SEA-GAMES, or the Olympics. Sometimes, the coach needs to choose the most talented athlete who will take part in the competition. Each athlete has several different advantages and its uniqueness. Based on the reason for the coach's difficulties, we built a decision support system that can help coaches choose talented archer athletes. It is based on information technology. The method that has the simplest complexity and the fastest computing time is the Weighted Product Method. The parameters/criteria used in the selection of talented archery athletes include mentality, flexibility, endurance, equipment, and technique. The Decision Support Systems are made with the Delphi Programming Language while storing databases using MySQL. We tested the Decision Support System that was built using the BlackBox method. Based on the results of the BlackBox test, the Decision Support System for talented Archery Athletes Selection using Weighted Product (WP) Method has a success percentage of 100%.

1. Introduction

Indonesia is a country in Southeast Asia that actively participates in archery sports in the Sea Games, Asian Games, and Olympic events. In Indonesia, there is an Indonesian archery association called PERPANI (Persatuan Panahan Indonesia), including PERPANI for the city of Madiun. Now, in recording the talent score for each athlete still using the manual method, so that it is considered ineffective and inefficient. Also, coaches are often confused in choosing athletes who will compete and that are most likely to have the potential to become champions. According to the coach's assessment standard, each athlete has their strengths and uniqueness.

In connection with the rapid development of information technology, various problems can be overcome easily. In this study, a system has been built that can help coaches in choosing talented archery athletes. This Decision Support System provides choices based on the results of the calculation of several criteria used. The system automatically considers to solving a case. In this case the selection of talented archery athletes. According to experience, the Decision Support System is considered capable of helping in deciding a problem [1]. The purpose of this study is to build a Decision Support System that can help coaches in choosing talented archery athletes. Especially for
the area of Madiun city. Furthermore, we want to measure the validity of the functionality of the system using BlackBox.

The Decision Support System in selecting archery athletes has been made using Analytical Hierarchy Process (AHP) [1]. In the project, the design and construction of a web-based decision support system are carried out. The system has been tested using the Black Box method [1]. The disadvantage, the research was considered to require a long computation time. So that as the contribution of this study, we tried using the Weighted Product Method to build a Decision Support System. The consideration is the Weighted Product Method has a fast computing time [2, 3].

In the following paragraph written some reviews of the literature. All of them have implemented WP in their research. First, Monica D, Sudrajat, and Suarna N have built a Decision Support System for determining the health status of newborn babies. It was based on anthropometric examination. It used Weighted Product Method [2]. Hatta H R, Rizaldi M, and Khairina D N have implemented the Weighted Product (WP) Method for the selection of new locations for Muslim cemeteries. They used the visualization of Google Maps [3]. The reason for the study is using the WP method because it can get more efficient results by using a shorter calculation time than other methods. The output produced is the location of the selected land. Khairina D M, Ivando D, Maharani, and Septya reviewed the implementation of Weighted Product Methods for the applications of the selection of an Android smartphone [4]. The criteria obtained from the results of the questionnaire include the price, the internal memory, RAM, the camera, and the battery capacity. The results obtained are the recommendations for consideration to the user of the Android smartphone [4].

Yoni D C and Mustafidah H wrote about the Application of the WP (Weighted Product) Method for the selection of the best graduates in the Faculty of Engineering of the Purwokerto Muhammadiyah University [5]. The criteria used for selecting the best graduates include GPA, study interval, no D score, and a maximum of one C score [5]. Arsyad M has built a Decision Support System for selection of candidates for the Student Executive Board (BEM) at STMIK Banjarbaru city. It used Weighted Product (WP) Method also [6]. The system uses the criteria of frequency of participation in Basic Leadership Training, GPA, Vision and Mission of each candidate, Non–Academic Achievement, and the initial support from students. So that the results obtained are two candidates for the Chair of Student Executive Board (BEM). They are MHS8 and MHS13 [6].

Syafitri N A, Sutardi, and Dewi A P, they have the project about the application of Weighted Product Methods in the Decision Support Systems for web-based laptop selection [7]. The level of accuracy is 100% and the criteria used include price, RAM, processor, hard disk, and VGA [7]. Mustafidah, Hindayati, and Hadyan H N have a study of the Decision Support System for determining high achievement students at Purwokerto Muhammadiyah University using Weighted Product (WP) Method [8]. The criteria used include GPA, scientific papers that have been made, excellent achievements, and English language skills. The system can be implemented in real terms at the Purwokerto Muhammadiyah University [8]. Jalil A, Ningrum I P, and Muchtar M have researched the Decision Support System on credit provision using the WP (Weighted Product) Method in the Mu’amalah Sejahtera BMT in Kendari city [9]. The testing in these studies uses comparisons to the manual calculations [9]. Based on many previous types of research, the WP (Weighted Product) method is implemented in the decision support system for the selection of the archery athletes.

In the city of Madiun of the East Java province of Indonesia, there is a branch of PERPANI with young members from elementary, middle, high school and general participants among adults. In recent years, it seems that archery sports enthusiasts in the area of Madiun city are increasing. One of the archery activities in PERPANI Madiun can be seen in Figure 1.
Figure 1. The archery training activities from PERPANI members of Madiun city.

All the data used in the study were obtained from PERPANI Madiun city. So that the system can act as archery sports experts, the Decision Support Systems using the weight product method. The reason is that the WP calculation requires a shorter computing time than other methods. According to Monica E et al., in [2], the steps are as the following.

1. It needs to fix the weight of a criterion using Eq. (1).

\[
W_j = \frac{w_j}{\sum w_j}
\]  

(1)

2. The next step is to calculate vector S using Eq. (2).

\[
S_j = \prod_{j=1}^{n} 1.X_j w_j \text{ which } i = 1, 2, .. m
\]  

(2)

3. The next step is to calculate vector S using Eq. (2).

\[
V_j = \frac{\prod_{j=1}^{n} x_j w_j}{\sum_{j=1}^{n} (x_j^*) w_j} \text{ which } i = 1, 2, .. m
\]  

(3)

\[\sum w_j = 1.w_j\] is the rank to determine the achievements of archery athletes.

Eq. (3) can be written as Eq. (4).

\[
V_j = \frac{S_1}{S_1 + S_2 + S_3}
\]  

(4)

Which S = the alternative preference which is analogous as the vector S.

V = the alternative preference which is analogous to the vector V.

X = the value of the criteria.

W = the weight of the criteria.

i = the alternative.

j = the criteria.

n = the number of the criteria.

* = the number of the criteria that have been valued on the vector S.
2. Research method
The three stages applied in this study include:
1. Analysis and Design of the System.
2. Weighted Product Implementation in Decision Support Systems.
3. Testing of Decision Support Systems that have been built using the Blackbox Method.

In the stage of Analysis and Design of the system, data and cases are analyzed first. Next, system design is done using the Unified Modeling Language (UML) implementation. One of the UML designs is the Use Case Diagram.

The second stage is the implementation of the Weighted Product method on the Support System Decision on the selection of archery athletes. The system is built using the Delphi programming language and for the database using MySQL. In the third stage, after implementing the system, the system is tested using the Black Box method. It is selected testing using BlackBox because it can measure the results of the functionality of the system. There are nine test items, including homepage, login, criteria data page, input data criteria, alternative data pages, alternative data input and values, selection results page, print results, and logout.

3. Result and discussion
The design, the results of system implementation, and the system testing are presented in this results and discussion section. System design is presented as a Use Case Diagram which can be seen in Figure 2.

![Figure 2. The Use Case Diagram System.](image)
In Fig. 3, an Entity Relationship Diagram has been presented with entities including alternatives, Criteria, and Users. Alternative entities have attributes such as id_alternative and name. For attributes of the Criteria Entity including id_criteria, attribute, weight, weight_score. As for the user entity has attributes including username and password. In designing a decision support system (DSS), there is a decision support system architecture design as shown in Figure 4.

Figure 4. Decision Support System architecture for selection of archery athletes.

The DSS architecture in Figure 4 has explained the required data and user interface pages. The display of the Decision Support System for the selection of talented archery athletes using the WP method can be seen in Figure 5. The user must Login first to enter the system as shown in Figure 3. While for the Login display can be seen in Figure 6.

Figure 5. The Initial display of system
Figure 6. The display of Login
After Login, the system will go to Home. Several facilities have been provided for users including managing criteria data, managing alternative data, and performing final system calculations. The Home display can be seen in Figure 7. The menus have been displayed which users can use to make the decisions. Before making a decision, the user must complete alternative criteria and data as shown in Figure 8 and Figure 9.

Figure 7. Home.

![Home](image)

**Figure 8.** Manage criteria data

**Figure 9.** Manage alternative data.

For more details, display data on Criteria and Alternatives can be seen in Table 1 and Table 2.

### Table 1. The data of the criteria

| No. | Criteria_name | Attribute | Weight     | Weight score |
|-----|---------------|-----------|------------|--------------|
| 1   | Mentality     | Achievement | Very low   | 1            |
| 2   | Define        | Achievement | Low        | 2            |
| 3   | Durability    | Achievement | Fair       | 3            |
| 4   | Equipment     | Achievement | High       | 4            |
| 5   | Technique     | Achievement | Very high  | 5            |

### Table 2. Data alternatives

| No | Name | Mentality | Define | Durability | Equipment | Equipment | Technique |
|----|------|-----------|--------|------------|-----------|-----------|-----------|
| 1  | Bayu | 85        | 70     | 75         | 85        | 95        |           |
| 2  | Alan | 75        | 80     | 85         | 90        | 80        |           |
| 3  | Ridwan | 80    | 80     | 75         | 85        | 80        |           |
| 4  | Usman | 70      | 85     | 85         | 80        | 85        |           |
| 5  | Danu  | 90       | 70     | 80         | 85        | 75        |           |
After determining the criteria and alternative data, a comparison is made between the weight score and the sum of weights using Formula in Eq. (1). The following are the results:

\[
W_1 = \frac{1}{15} = 0.0666667, \quad W_2 = \frac{2}{15} = 0.1333333, \quad W_3 = \frac{3}{15} = 0.2, \quad W_4 = \frac{4}{15} = 0.2666667, \quad \text{and} \quad W_5 = \frac{5}{15} = 0.3333333
\]

The results of the weight comparison with the sum of weights are used to calculate the value of a temporary vector using Formula in Eq. (2). The following are the results:

\[
S_1 = 85 \times 0.0666667 \times 70 \times 0.1333333 \times 75 \times 0.2 \times 85 \times 0.2666667 \times 95 \times 0.3333333 = 83.8312937
\]
\[
S_2 = 75 \times 0.0666667 \times 80 \times 0.1333333 \times 85 \times 0.2 \times 90 \times 0.2666667 \times 80 \times 0.3333333 = 83.20086966
\]
\[
S_3 = 80 \times 0.0666667 \times 80 \times 0.1333333 \times 75 \times 0.2 \times 85 \times 0.2666667 \times 80 \times 0.3333333 = 80.2611342
\]
\[
S_4 = 70 \times 0.0666667 \times 85 \times 0.1333333 \times 80 \times 0.2 \times 80 \times 0.2666667 \times 85 \times 0.3333333 = 82.56129246
\]
\[
S_5 = 90 \times 0.0666667 \times 70 \times 0.1333333 \times 80 \times 0.2 \times 85 \times 0.2666667 \times 75 \times 0.3333333 = 78.78545328
\]

After getting a temporary vector, the final vector value is calculated using Formula in Eq. (4). The following are the results:

\[
V_1 = \frac{83.8312937}{409.6400433} = 0.205147036, \quad V_2 = \frac{83.20086966}{409.6400433} = 0.203604299, \quad V_3 = \frac{80.2611342}{409.6400433} = 0.196410351, \quad V_4 = \frac{82.56129246}{409.6400433} = 0.202039163, \quad \text{and} \quad V_5 = \frac{78.78545328}{409.6400433} = 0.192799151.
\]

Based on the above the data retrieval, the results of V1 have the highest value. So according to the system, Bayu was chosen. The following is a display of the results of the decision making. It can be seen in Figure 10.

![Figure 10. Manage final.](image)

The system that has been built, then tested using the BlackBox method. Which is shown in Table 3.

| No. | Test Item                                      | Description of Results |
|-----|-----------------------------------------------|------------------------|
| 1   | Main Menu                                     | Valid                  |
| 2   | Login                                         | Valid                  |
| 3   | Criteria Data Display                         | Valid                  |
| 4   | The Input of the Criteria Data                | Valid                  |

Table 3. Blackbox testing results
| No. | Test Item               | Description of Results |
|-----|-------------------------|------------------------|
| 5   | Alternative Data Display| Valid                  |
| 6   | Alternative Data Input  | Valid                  |
| 7   | Display of Selection Results | Valid            |
| 8   | Print Results           | Valid                  |
| 9   | Logout                  | Valid                  |

Based on Table 3, it can be concluded that the Decision Support System for the selection of talented archery athletes using the Weighted Product method has a 100% success.

4. Conclusion
The following are the conclusions that can be taken in this study.
1. Decision Support System that uses Weighted Product (WP) Method has been successfully built with Delphi Programming Language and MySQL Database.
2. Testing Results of Decision Support Systems that use Weighted Product (WP) Method have a success rate of 100%.

Future research is combining WP methods with expert systems, fuzzy logic. This project is very useful because everyone can use it online.

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