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# Implementation of Simple Additive Weighting (SAW) and Weighted Aggregated Sum Product Assessment (WASPAS) Methods in Selection of Young Lecturers with Achievements

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*Abstract*

*Lecturers are resources owned by the University. One of the efforts to improve the quality of lecturers is by giving appreciation in the form of rewards or awards to the best lecturers or lecturers who excel. However, to be able to provide these rewards, of course there are several assessments that will be given to lecturers. The problem is how to give the assessment so that the lecturer is declared worthy to receive a reward or award. There is a decision support system or abbreviated as DSS where in the system there are several methods that can be used to provide an assessment of course with the determined assessment criteria. In this research, the method used is the Simple Additive Weighting (SAW) and Weighted Aggregated Sum Product Assessment (WASPAS) with several criteria into consideration. The results showed that alternative A3 and A2 were selected as outstanding young lecturers.*

***Keywords:*** *Outstanding Young Lecturer, SPK, SAW, WASPAS*

## 1. Introduction

Budi Darma University is a higher education institution that has lecturers, both from the fields of computer science and social science. The lecturer is a resource owned by Budi Darma University, which aims to provide knowledge to students. So that the lecturers at the University have good motivation and performance, the lecturer can be given an award or reward. The best/achieveable lecturers can be selected from the existing lecturers. Until now, Budi Darma University has never given special rewards to young lecturers who have achievements, or who are considered to have the best performance among existing lecturers. Indicators in selecting the best young lecturers have several criteria[1]. These include 1) fulfilling the tridharma of higher education, 2) having a good track record of publications, 3) not having a bad history at the institution, 4) working period, and others. In order for the selection of the best lecturers to be more objective, of course it requires a tool, namely an information system that aims to process existing data so as to produce the required information, in the form of ranking of lecturers. This information system is known as a decision support system (DSS).

DSS is a computer-based system that is intended for management in making decisions on the problems at hand [2]–[4]. At this time the application of DSS is quite often encountered in solving problems related to decisions. In completing the SPK using methods such as Weighted Product (WP), Simple Additive Weighting (SAW), TOPSIS, ELECTRE, Preference Selection Index (PSI), Promethee, and others[5]–[7]. In the research conducted by DM Rajagukguk in 2017 regarding the implementation of the Simple Additive Weighting (SAW) Method on the Best Lecturer Selection Decision Support System where the criteria are superior achievement work, teaching, research, dedication, support, the results obtained from normalization are the highest value is 97.55

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for rank 1[8]. Subsequent research conducted by Muhamad Fuat Asnawiv and M. Alif Muwafiq in 2019 with the same discussion and method as that carried out by Rajagukguk but with 9 criteria and the results obtained were 0.86 as the highest value was ranked 1 [9]. Next is the research conducted by Tundo using the WASPAS method in determining the best rice, where the results of normalization with this method get the highest yield value of 7.12 and automatically rank 1[10].

In this study, the authors use the Simple Additive Weighting (SAW) and Weighted Aggregated Sum Product Assessment (WASPAS) methods to determine young lecturers who excel or are judged to have the best performance with young lecturers at Budi Darma University. The results of the research are expected to be able to provide effective decisions that are useful for management in making decisions for the best young lecturers.

## 2. Research Methodology

### 2.1. Research Stages

In conducting research at Budi Darma University, the authors carried out several stages including:

1) Field Research, in the early stages the author conducted several methods including observations, interviews with high school leaders, related to lecturer data that the writer would use as an alternative in the selection of outstanding lecturers.
2) Literature Research, at this stage the author reads literature related to research studies that have been carried out previously by several experts, including reading related books about outstanding lecturers, as well as their relation to the method the author uses in the decision support system for selecting young outstanding lecturers
3) Stages of Analysis and Testing, in this section, the author selects several data samples. A total of 7 samples of data on data of young lecturers at Budi Darma University, the authors took including the attributes that the authors used as criteria in selecting outstanding young lecturers. The author also conducted a test in this case applying the Simple Additive Weighting (SAW) and Weighted Aggregated Sum Product Assessment (WASPAS) methods to the alternatives and criteria used. At this stage, the author also ranks the alternative young lecturers, so that the final result in the form of young lecturers who have the highest ranking of 2 young lecturers can be recommended as Outstanding Young Lecturers.
4) Stages of Determination of Results and Research Resume, in this final stage, the authors determine the results of 3 outstanding young lecturers and make a report (resume) of the research conducted.

From the stages above, it can be illustrated in Figure 1, below:

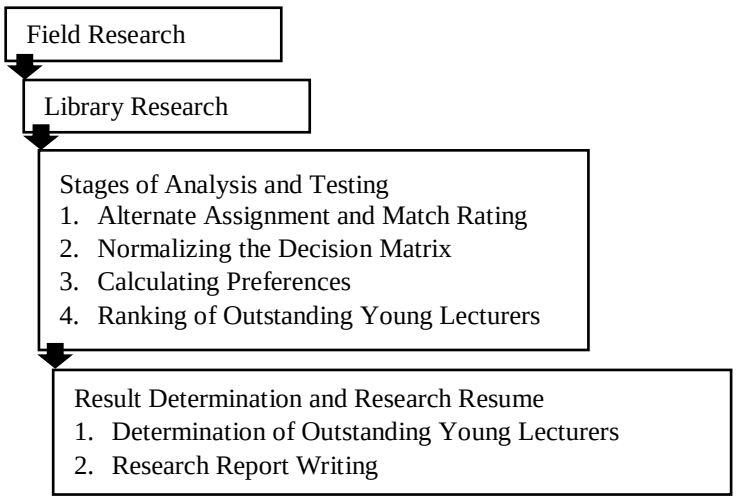


**Figure 1.** Research Stages

### 2.2. Rank Order Centroid (ROC) Method

Rank Order Centroid is a method that is quite simple from some other simple methods. This method emphasizes that the first criterion is more important than the second criterion, the second criterion is more important than the third criterion, and so on [11], [12], [13]. To get the value of the weight W, equation 3 is used, as follows:

$$W_m = \frac{1}{m}\sum_{1=1}^{m}\left(\frac{1}{i}\right) \quad (1)$$

### 2.3. Simple Additive Weighting (SAW) Method

The Simple Additive Weighting (SAW) method is often also known as the weighted addition method. The basic concept of the saw method is to find the weighted sum of the performance ratings for each alternative on an attribute. as for the steps in solving the problem using the Simple Additive Weighting (SAW) method[14]–[17], as follow:

1) Prepare the Decision Matrix

$$x_{ij} = \begin{bmatrix} x_{11} & x_{12} & . & x_{1n} \\ x_{21} & x_{22} & . & x_{2n} \\ . & . & . & . \\ x_{m1} & x_{m2} & . & x_{mn} \end{bmatrix} \quad (2)$$

Information:

| | |
|---|---|
| $x_{ij}$ | : Decision Matrix |
| i | : Alternative(row) |
| j | : Attributes/criteria (column) |
| n | : Number of attributes |
| m | : Number of Alternatives/Rows |

2) Calculating the Normalization Matrix (Rij).

For Benefit criteria

$$r_{ij} = \frac{x_{ij}}{\max_i x_{ij}} \quad (3)$$

For Cost criteria

$$r_{ij} = \frac{\min_i x_{ij}}{x_{ij}} \quad (4)$$

Information:

| | |
|---|---|
| $r_{ij}$ | : Normalized Matrix |
| Max Xij | : The highest value in the column to [j] |
| Min Xij | : The lowest value in column [j] |
| Xij | : Decision matrix |

3) Calculating Preferences (Vi)

In the final stage to determine the ranking value of each alternative, a larger Vi value indicates that alternative Ai is more selected.

$$v_i = \sum_{i=0}^{n} w_j . r_{ij} \quad (5)$$

Information:

| | |
|---|---|
| $v_i$ | : Preference Value |
| $w_j$ | : Weight |
| $r_{ij}$ | : Normalized Matrix |
| j | : Criteria/Attributes |
| n | : Number of Criteria/Attributes |

### 2.4. Weighted Aggregated Sum Product Assessment (WASPAS) Method

The Weighted Aggregated Sum Product Assessment (WASPAS) method is a combined method between the SAW method and the WP method. This method can reduce errors in estimation for determining the highest and lowest values [18]–[24].

a) Determine the normalization of the matrix in decision making, as shown in equation 2
b) Normalize the xij matrix so that it becomes a normalized matrix as shown in the following equation 6.

$$x_{ij}^{*} = \begin{bmatrix} x_{11} & x_{12} & . & x_{1n} \\ x_{21} & x_{22} & . & x_{2n} \\ . & . & . & . \\ x_{m1} & x_{m2} & . & x_{mn} \end{bmatrix} \quad (6)$$

To calculate the value on the benefit criteria

$$x_{ij}^{*} = \frac{x_{ij}}{\max_i x_{ij}} \quad (7)$$

To calculate the value on the cost criteria

$$x_{ij}^{*} = \frac{\min_i x_{ij}}{x_{ij}} \quad (8)$$

c) Calculating Qi Value

$$Qi = 0{,}5 \sum_{j=1}^{n} x_{ij}^{*} w_j + 0{,}5 \prod_{j=1}^{n} x_{ij}^{*\,wj} \quad (9)$$

## 3. Result and Discussion

### 3.1 Determination of Criteria, Weights and Alternatives

At the stage of generating effective information, the decision support system (DSS) requires data in the form of attribute data, the weight of the importance of each attribute along with alternative data. In this study, the author will analyze several alternatives for young lecturers at Budi Darma University, who only have a working period of less than 3 years. This young lecturer is a lecturer who already has a Decree (SK) on the appointment of permanent lecturers from the Budidarma PTN Foundation and has a master's degree in accordance with government regulations. After the author took data at Budi Darma University, there were 7 young lecturers, which can be seen in table 3.

The author also takes attribute data, which can be seen in table 1. There are 8 attributes/criteria that the author will discuss. In the case of selecting outstanding young lecturers, the 8 attributes have benefits. The following attributes are discussed by the author:

**Table 1.** Attributes/Criteria for selecting outstanding young lecturers

| Criteria | Description | Type |
|---|---|---|
| $C_1$ | H-Index Scopus | Benefit |
| $C_2$ | H-Index GS | Benefit |
| $C_3$ | Scopus Document | Benefit |
| $C_4$ | Number of Books with ISBN | Benefit |
| $C_5$ | Dedication of Journal | Benefit |
| $C_6$ | Certificate of Competence | Benefit |
| $C_7$ | External Speaker | Benefit |
| $C_8$ | Membership of Lecturer Profession | Benefit |

Table 1 shows all the attributes needed in the selection of outstanding young lecturers. These attributes do not have a weight of importance, for this reason, in this study the author uses the Rank Order Centroid (ROC) method [11], [13], [25] to generate the weighted value. The results of the weighting of the attributes in table 1 can be seen in table 2 below

**Table 2.** Attribute Weight

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | $C_7$ | $C_8$ |
|---|---|---|---|---|---|---|---|---|
| **Weight** | 0.34 | 0.22 | 0.15 | 0.11 | 0.08 | 0.05 | 0.03 | 0.02 |

The following is data for young lecturers at Budi Darma University. After conducting field research, it was found that there were 7 young lecturers, who had only taught under 3 years at Budi Darma University.

**Table 3**. Alternative Young Lecturer

| Lecturer Name | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | $C_7$ | $C_8$ |
|---|---|---|---|---|---|---|---|---|
| Bister ($A_1$) | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| Alwin ($A_2$) | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 1 |
| Annisa ($A_3$) | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Dito Putro ($A_4$) | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 |
| Meryance ($A_5$) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sarwandi ($A_6$) | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 |
| Rian ($A_7$) | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |

Source: Budi Darma University, June 2020

From the data in table 3, it is the data for the suitability rating shown in table 4.

**Table 4.** Match Rating

| Alternative | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | $C_7$ | $C_8$ |
|---|---|---|---|---|---|---|---|---|
| $A_1$ | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| $A_2$ | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 1 |
| $A_3$ | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| $A_4$ | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 |
| $A_5$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $A_6$ | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 |
| $A_7$ | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |

### 3.2. Penerapan Metode SAW

After the supporting data are met, namely in the form of alternative data, attributes and weights of each attribute, then at the next stage by applying the Simple Additive Weighting (SAW) method, effective information can be obtained on the ranking of young lecturers who excel. The stages of using the SAW method are as follows:

1) Define the decision matrix ($x_{ij}$)

**Table 5. Decision Matrix ($x_{ij}$)**

$$x_{ij} = \begin{vmatrix} 0 & 0 & 0 & 0 & 1 & 1 & 0 & 1 \\ 0 & 2 & 0 & 0 & 1 & 1 & 0 & 1 \\ 1 & 0 & 2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 3 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 20 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 1 \end{vmatrix}$$

2) Perform calculations to obtain a normalized matrix (rij) using equation 3.
Here to get the calculation of $C_1$.

$r_{1,1} = 0 / 1 = 0.00$
$r_{2,1} = 0 / 1 = 0.00$
$r_{3,1} = 1 / 1 = 1.00$
$r_{4,1} = 0 / 1 = 0.00$
$r_{5,1} = 0 / 1 = 0.00$
$r_{6,1} = 0 / 1 = 0.00$
$r_{7,1} = 0 / 1 = 0.00$

$C_2$ calculation
$r_{1,2} = 0 / 3 = 0.00$
$r_{2,2} = 2 / 3 = 0.67$
$r_{3,2} = 0 / 3 = 0.00$
$r_{4,2} = 3 / 3 = 1.00$

$r_{5,2}$ = 0 / 3 = 0.00
$r_{6,2}$ = 0 / 3 = 0.00
$r_{7,2}$ = 0 / 3 = 0.00

The process on C1 and C2 is carried out until $C_8$ so that the results of the calculations to obtain a normalized matrix are shown in the following rij matrix:

**Table 6.** Normalized Matrix ($r_{ij}$)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $r_{ij}$ | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 | 0.000 | 1.000 |
| | 0.000 | 0.667 | 0.000 | 0.000 | 1.000 | 1.000 | 0.000 | 1.000 |
| | 1.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 | 0.000 | 1.000 |

3) Calculating Preference value ($v_i$)
To get the preference value, use the 5th equation, as follows:
$V_1$ = (0.34 * 0.0) + (0.22*0.0) + (0.15*0.0) + (0.11*0.0) + (0.08*1.0) + (0.05*1.0) + (0.03*1.0) + (0.02*1.0)
= 0.150
$V_2$ = (0.34 * 0.0) + (0.22*0.67) + (0.15*0.0) + (0.11*0.0) + (0.08*1.0) + (0.05*1.0) + (0.03*0.0) + (0.02*1.0)
= 0.297

Furthermore, the calculation process is continued until the value of V7. The final result of the calculation can be seen in table 7 below.

**Table 7**. Preference Value ($v_i$)

| Lecturer Name | Preference Value | Rank |
|---|---|---|
| Bister ($A_1$) | 0.150 | 4 |
| Alwin ($A_2$) | 0.297 | 2 |
| Annisa ($A_3$) | 0.490 | 1 |
| Dito Putro ($A_4$) | 0.250 | 3 |
| Meryance ($A_5$) | 0.000 | 6 |
| Sarwandi ($A_6$) | 0.110 | 5 |
| Rian ($A_7$) | 0.150 | 4 |

From the calculation results above, it is obtained that there are two young lecturers who have the highest score, namely Annisa ($A_3$) with a value of 0.490 and Alwin ($A_2$) with a value of 0.297. From the information provided above, it can be recommended that young lecturers who excel are Annisa ($A_3$) and Alwin ($A_2$).

### 3.3. Implementation of the WASPAS method

The following are the stages of ranking using the WASPAS method

1) The initial stage provides the Xij decision matrix. For this decision matrix can be seen in table 5.
2) Then normalize the decision matrix. At this stage, equation 7 is used as shown below.
$C_1$ criteria calculation
$x^*_{1,1}$ = 0 / 1 = 0
$x^*_{2,1}$ = 0 / 1 = 0
$x^*_{3,1}$ = 1 / 1 = 1
$x^*_{4,1}$ = 0 / 1= 0

$x^*_{5,1} = 0 / 1 = 0$
$x^*_{6,1} = 0 / 1 = 0$
$x^*_{7,1} = 0 / 1 = 0$
$C_2$ criteria calculation
$x^*_{1,2} = = 0 / 3 = 0$
$x^*_{2,2} = 2 / 3 = 0.7$
$x^*_{3,2} = 0 / 3 = 0$
$x^*_{4,2} = 3 / 3 = 1$
$x^*_{5,2} = 0 / 3 = 0$
$x^*_{6,2} = 0 / 3 = 0$
$x^*_{7,2} = 0 / 3 = 0$

This process is carried out until the calculation of criteria C8, and produces a normalized matrix $x^*_{ij}$ as follows.

**Table 8**. Normalized Matrix ($x^*_{ij}$)

$$x^*_{ij} = \begin{vmatrix} 0.000 & 0.000 & 0.000 & 0.000 & 1.000 & 1.000 & 0.000 & 1.000 \\ 0.000 & 0.667 & 0.000 & 0.000 & 1.000 & 1.000 & 0.000 & 1.000 \\ 1.000 & 0.000 & 1.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 \\ 0.000 & 1.000 & 0.000 & 0.000 & 0.000 & 0.000 & 1.000 & 0.000 \\ 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 \\ 0.000 & 0.000 & 0.000 & 1.000 & 0.000 & 0.000 & 0.000 & 0.000 \\ 0.000 & 0.000 & 0.000 & 0.000 & 1.000 & 1.000 & 0.000 & 1.000 \end{vmatrix}$$

3) The next step is to optimize the attributes by multiplying the weights of each criterion. This process uses equation 9.
$Q_1 = 0.5 \sum ((0 * 0.34) + (0 * 0.22) + (0 * 0.15) + (0 * 0.11) + (1 * 0.08) + (1 * 0.05) + (0 * 0.03) + (1 * 0.02)) + 0.5 \prod ( (0^{0.34}) * (0^{0.22}) * (0^{0.15}) * (0^{0.11}) * (1^{0.08}) * (1^{0.05}) * (0^{0.03}) * (1^{0.02}) ) = 0.075 + 0 = 0.075$
$Q_2 = 0.5 \sum ((0 * 0.34) + (0.7 * 0.22) + (0 * 0.15) + (0 * 0.11) + (1 * 0.08) + (1 * 0.05) + (0 * 0.03) + (1 * 0.02)) + 0.5 \prod ( (0^{0.34}) * (0^{0.22}) * (0.7^{0.15}) * (0^{0.11}) * (1^{0.08}) * (1^{0.05}) * (0^{0.03}) * (1^{0.02}) ) = 0.148 + 0 = 0.148$

Qi calculation is carried out until the value of $Q_8$ is obtained. The final result of the calculation, the results obtained for each lecturer who are included in the achievement category can be seen in table 9 below.

**Table 9**. Final score (Qi)

| Lecturer Name | Preference Value | Rank |
|---|---|---|
| Bister ($A_1$) | 0.075 | 4 |
| Alwin ($A_2$) | 0.148 | 2 |
| Annisa ($A_3$) | 0.245 | 1 |
| Dito Putro ($A_4$) | 0.125 | 3 |
| Meryance ($A_5$) | 0.000 | 6 |
| Sarwandi ($A_6$) | 0.055 | 5 |
| Rian ($A_7$) | 0.075 | 4 |

From the analysis of several lecturers, there are two lecturers who have the same value, namely 0.075 and are in fourth place because the alternative values of the two lecturers are the same. The first rank was held by the $A_3$ lecturer on behalf of Annisa, and the second rank with a value of 0.148 on behalf of Alwin ($A_2$).

**Table 10**. The final score of the SAW and WASPAS method of ranking

| Lecturer Name | SAW Method | Rank | WASPAS Method | Rank |
|---|---|---|---|---|
| Bister ($A_1$) | 0.150 | 4 | 0.075 | 4 |
| Alwin ($A_2$) | 0.297 | 2 | 0.148 | 2 |
| Annisa ($A_3$) | 0.490 | 1 | 0.245 | 1 |
| Dito Putro ($A_4$) | 0.250 | 3 | 0.125 | 3 |
| Meryance ($A_5$) | 0.000 | 6 | 0.000 | 6 |
| Sarwandi ($A_6$) | 0.110 | 5 | 0.055 | 5 |
| Rian ($A_7$) | 0.150 | 4 | 0.075 | 4 |

From the rankings carried out by the two methods above, both SAW and WASPAS give the same ranking results, although with different values.

## 4. Conclusion

From the results of the analysis above, it can be concluded that the decision support system using the SAW and WASPAS methods gave the same results, with the first rank held by the A3 lecturer on behalf of Annisa, and the second rank with a value of 0.148 on behalf of Alwin. There are the same steps in getting the value from the normalized matrix.

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