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RULE MODEL WITH FUZZY SIMPLE ADDITIVE WEIGHTING APPROACH AND WEIGHTED PRODUCT ON DETERMINATION OF POSITION IN HIGH EDUCATION INSTITUTION

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Abstract- The decision-making process is an activity that has a complex indicator and process, in which every decision-making is expected to get the best decision result. To solve this problem the model in decision-making is one of the solutions that can be used to construct mathematical logic, which can represent from every indicator to be used in planning, a fuzzy system is perfect for solving this problem especially in terms of deciding what is not Definitely (vaguely). Multiple Attribute Decision Making (MADM) is a fuzzy method used to find the optimal alternative of several alternatives with specific indicators. Simple Additive Weighting (SAW) method is one of the methods for MADM decision making that can be used to determine the best alternative from various alternatives and Weighted Product (WP) method is one of the multi-criteria analysis of the decision given to a limited set of decision alternatives described in terms of several decision criteria. Using these two methods the results are more accurate.
Keywords – Accuracy, DSS, MADM, Simple Additive Weighting, Weighted Product

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1. INTRODUCTION

College organizations or institutions in the election of official personnel to occupy positions such as the head of the study program and the secretary of the study program still use conventional means and use indicators that are not clear and are subjective. Where in such a way is very risky mistakes in selecting the appropriate personnel plus emotional linkage and family relationships are often the factors that greatly affect the results in the selection of personnel. As most companies or higher education still uses subjective judgments in measuring the effectiveness of their Human Resource (HR) strategies [1]. From this problem required model approach and rule in calculating what qualification indicator that must be fulfilled in determining the right human resources for head of the study program and secretary of study program. In the position of the head of the study program and the secretary of the study program, several indicators are needed, which indicator is usually used in selecting someone in a position with common criteria such as loyalty, discipline, honesty and ability Soft skill such as level of education, rank and field of science according to each candidate who will occupy the post. Given the indicators it will be determined How to model the right and optimal rules in determining who is eligible to occupy the position as chairman, head of department and secretary within the educational organization with predefined qualification parameters, to obtain accurate and precise results.

In using Simple Additive Weighting (SAW) method [2] this algorithm is used to determine the best alternative from various alternatives and Weighted Product algorithms where this algorithm uses multiplication to attribute attribute rating, where the rating of each attribute must be raised first with the attribute weights, both methods contained in Multi Attribute Decision Making (MADM).

Research using Multi Attribute Decision Making (MADM) continues to experience rapid development, such as research conducted research on "Modeling Decision Support System Group with Fuzzy Weighted Product Method for Diagnosis of Pneumonia Disease"[3] This study discusses how the right roles in making decisions. Research on the same topic is also done by [4] who examines the "Strategies for Applying Talent Management in Companies" This research discusses how to recruit and develop existing human resources to consider who is retained and who will be released under the title "Determination of Scholarship Recipients Using Simple Additive Weighting and Weighted Product "in this study discusses how the decision support model will be used as a reference in determining who is eligible for a scholarship [5]. From several previous studies, researchers now see that within the Higher Education Institution environment also needs to get special attention. This research will be conducted to get an approach model in order to generate the right rule to determine who is appropriate to occupy certain

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positions within a Higher Education Institution. It is hoped that with the results of this research will be able to produce an innovative approach model to get more optimal results in supporting final decision later.

2. PROPOSED ALGORITHM

Research is done to give value in each criterion at every position using SAW and WP method whereby this method, whether decision result get same value or not, for determination of the value of each criterion can be done with steps as in following picture:

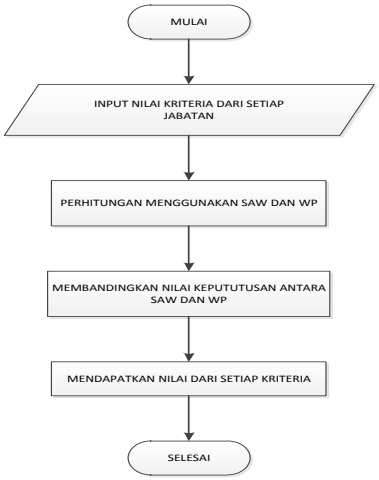


Figure 1 Research Methodology

Input Value of each criterion

This value is a criterion consisting of the Head of STTH, Head of Study Program, and Secretary of Study Program, each value will be re-evaluated for the determination of the value of each criterion to be calculated using SAW and WP Method.

Calculation using SAW and WP

Th calculation will be done through 2 stages, the first calculation is to use the SAW method with several steps that will be done carefully and correctly that is with the formula of weighting as follows:

$$Vi = \sum_{j=1}^{n} w_j \, r_{ij}$$

The second calculation is to use a WP Method with several stages to be performed carefully and correctly that is with the formula of weighting as follows:

Comparing Results SAW and WP

$$W_J = \frac{wj}{\sum wj}$$

After getting the calculation result between SAW and WP, then from each criterion will be compared whether the calculation using SAW and WP gets the same result or not.

Obtain the Value of each criterion

After comparing the results of the SAW and WP then the authors will get a decision of each criteria in the count.

2.1 Multi Attribute Decision Making

Multiple Attribute Decision Making (MADM) is a method used to find the optimal alternative of many alternatives with certain criteria. The essence of MADM is to determine the weight value for each attribute, then proceed with the ranking process that will select the alternatives already given. Basically, there are 3 approaches to finding attribute weight value, that is subjective approach, objective approach and approach of integration between subjective & objective [6][7]. Each approach has its advantages and disadvantages. In a subjective approach, the weighted value is determined by the subjectivity of the decision-makers, so that several factors in the alternative ranking process can be determined freely. Whereas in the objective approach, the weight value is calculated mathematically so that it ignores the subjectivity of the decision maker. There are several methods that can be used to solve MADM problems which is [8][9]:

a. Simple Additive Weighting Method (SAW)

b. Weighted Product (WP)
c. ELECTRE
d. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).
e. Analytic Hierarchy Process (AHP)

2.2 Simple Additive Weighting Method (SAW)

The advantages of the Simple Additive Weighting (SAW) Method compared with other decision-making models lies in its ability to conduct judgments more precisely because they are based on predetermined criteria and preference values, in addition SAW can also select the best alternative from many alternatives because of the ranking process after determining the weight value for each attribute [10]. The result is obtained from each ranking process that is the sum of normalized matrix multiplication with preference weight so that the larger value of V_i indicates that A_i alternative is the best alternative. The difference between profit attributes and cost attributes is it is said to attribute the advantage if the attribute given is intended to increase the profitability of the decision taken. If the value of each criterion matches the higher the value, the better or the more prioritized then the criterion is said criteria or attribute of profit [11]. It then says the cost attribute if the attribute given is meant to increase the reduction of operational cost of decision making taken. If the value of each criterion matches the smaller the value the better, then the criterion is said to be cost criteria. There are several steps in using the SAW method to solve the problem, the steps are as follows [12]:

1. Determine the alternative, A_i.
2. Determine the criteria that will be used as a reference in decision making, namely C_i.
3. Give weight value on each criterion.
4. Determine the weight of preference or importance level (W_j) of each criterion.
5. Create a match rating table of each alternative on each criterion.
6. Create a decision matrix based on criteria (Ci).
7. Perform normalization of matrix based on equations that adjust to the criteria type (profit criterion or cost criterion) to obtain a normalized matrix R.

The result obtained from the ranking process is the sum of the matrix multiplication normalized R with the weight vector to obtain the largest value selected as the best alternative (Ai) as a solution.

2.3 Weighted Product

Weighted Product is one of the methods used to solve the problem of Multi Attribute Decision Making (MADM). Weighted Product algorithm uses multiplication to attribute attribute rating, where the rating of each attribute must first be lifted with the corresponding attribute weights [13]. This process is like the normalization process. Preferences for alternative Ai are given as follows:

$$W_j = W_j / \sum W_j$$

$$S_i = \prod_{j=1}^{n} X_{ij}^{\,w_j}$$

Where $\sum W_j = 1$ wj is a positive-valued rank for the attribute of profit and is negatively valued for the cost attribute. The relative preferences of each alternative are given in the formula

$$V_i = \frac{\prod_{j=1}^{n} X_{ij}^{\,w_j}}{\prod_{j=1}^{n} \left(X_{ij}^{\,*}\right)^{wj}}$$

With i = 1,2, ...,n.....(2)

The weighted product algorithm is one of the most well-known multi-criteria decision analysis. The Multiple Attribute Decision Making (MADM) given is a limited set of decision alternatives described in terms of many decision criteria. Weighted Product algorithm steps. In short, the Weighted Product algorithm is as follows [14]:

a. Normalize the weights to generate values $\sum W_i - 1_{\,wj} = 1$ Where j = 1,2,...,n is many alternative.
b. Determine the categories of each criterion, whether included in the profit criteria or cost criteria.
c. Determine the value of the vector S by multiplying all criteria for an alternative with a weight as a positive rank for profit criteria and the weight serves as a negative rank on the cost criterion.
d. Specifies the value of the vector V to be used for ranking.
e. Find the best alternative order that will be the decision.

2.4 Human Resource Management (HR)

The ultimate goal of HR is to improve organizational effectiveness through individual performance because human resources are a key component of the organization. HR deals with many aspects of managing people such as recruitment and selection, resources (manpower planning), maintaining high motivation to improve overall performance, developing reward systems, and so on. In short, HR is an organizational function that aims to improve the quality of working life in general. HR is a strategic approach that directly relates to managing the work processes and development of people who can and will affect the performance level of all other organizational resources [15]. Meanwhile, HR involves all management decisions that affect the nature of relationships between employees and organizations. HR based on activation and employee appraisal at the optimal level [16]

3. EXPERIMENT AND RESULT

Here is a classification in the implementation of the research that will used is as follows: The SAW and WP Methods:

3.1 SAW Testing Process

Then the value obtained in the form of a matrix as follows:

$$\begin{bmatrix} 90 & 85 & 70 & 80 & 85 & 85 \\ 80 & 75 & 70 & 80 & 80 & 80 \\ 90 & 80 & 75 & 80 & 80 & 80 \\ 85 & 80 & 75 & 85 & 80 & 80 \\ 85 & 90 & 80 & 80 & 70 & 90 \\ 75 & 85 & 85 & 80 & 75 & 85 \\ 80 & 80 & 85 & 90 & 75 & 85 \\ 80 & 80 & 80 & 75 & 75 & 85 \\ 80 & 85 & 80 & 75 & 75 & 85 \end{bmatrix}$$

Here is the calculation of normalization of decision matrix by calculating the normalized performance rating value (rij) of each alternative based on Cost and Benefit criteria, in this writing Cost criteria not found, so all calculations using Benefit: The benefit criterion is (V1, V2, V3, V4, V5 and V6). To normalize the value, if factor benefit criteria used formulation

$R_{ii} = (X_{ij} / \max\{X_{ij}\})$

From Column V1 the maximum value is 90, then each row of column V1 is divided by the maximum value of column V1

R_{11} = 90 / 90 = 1
R_{21} = 80 / 90 = 0.88
R_{31} = 90 / 90 = 1
R_{41} = 85 / 90 = 0.94
R_{51} = 85 / 90 = 0.94
R_{61} = 75 / 90 = 0.83
R_{71} = 80 / 90 = 0.88
R_{81} = 80 / 90 = 0.88
R_{91} = 80 / 90 = 0.88

$$\begin{bmatrix} 1 \\ 0.88 \\ 1 \\ 0.94 \\ 0.94 \\ 0.83 \\ 0.88 \\ 0.88 \\ 0.88 \end{bmatrix}$$

Then obtained the first column matrix

Next, we will use the calculation from the second column to the sixth column so that the result is as follows:

In column V6 the maximum value is 90, then each row of column V6 is divided by the maximum value of Column

$V6R_{16}$ = 85 / 90 = 0.94
R_{26} = 80 / 90 = 0.88
R_{36} = 80 / 90 = 0.88
R_{46} = 80 / 90 = 0.88
R_{56} = 90 / 90 = 1
R_{66} = 85 / 90 = 0.94
R_{76} = 85 / 90 = 0.94
R_{86} = 85 / 90 = 0.94
R_{96} = 85 / 90 = 0.94

$$R = \begin{bmatrix} 1 & 0.94 & 0.82 & 0.88 & 1 & 0.94 \\ 0.88 & 0.83 & 0.82 & 0.88 & 0.94 & 0.88 \\ 1 & 0.88 & 0.88 & 0.88 & 0.94 & 0.88 \\ 0.94 & 0.88 & 0.88 & 0.94 & 0.94 & 0.88 \\ 0.94 & 1 & 0.94 & 0.88 & 0.82 & 1 \\ 0.83 & 0.94 & 1 & 0.88 & 0.88 & 0.94 \\ 0.88 & 0.88 & 1 & 1 & 0.88 & 0.94 \\ 0.88 & 0.88 & 0.94 & 0.83 & 0.88 & 0.94 \\ 0.88 & 0.94 & 0.94 & 0.83 & 0.88 & 0.94 \end{bmatrix}$$

Then obtained the fifth column matrix
Having obtained the matrix of each column, will multiply each column in the table by the weight of the previously declared criteria.

Value Weight preference (W) = 20, 20, 20, 10, 20, 10

$$Vi = \sum_{j=1}^{n} w_j \, r_{ij}$$

The value of the vector will be used as the highest value calculation in the table
V1 = (1 * 20) + (0,94 * 20) + (0,82 * 20) + (0,88 * 10) + (1 * 20) + (0,94 * 10) = 93.4
V2 = (0,88 * 20) + (0,83 * 20) + (0,82 * 20) + (0,88 * 10) + (0.94 * 20) + (0,88 * 10) = 87
V3 = (1 * 20) + (0,88 * 20) + (0,88 * 20) + (0,88 * 10) + (0.94 * 20) + (0,88 * 10) = 91.6
V4 = (0,94 * 20) + (0,88 * 20) + (0,88 * 20) + (0,94 * 10) + (0.94 * 20) + (0,88 * 10) = 91
V5 = (0,94 * 20) + (1 * 20) + (0,94 * 20) + (0,88 * 10) + (0.82 * 20) + (1 * 10) = 92.8
V6 = (0,83 * 20) + (0,94 * 20) + (1 * 20) + (0,88 * 10) + (0.88 * 20) + (0.94 * 10) = 91.2
V7 = (0,88 * 20) + (0,88 * 20) + (1 * 20) + (1 * 10) + (0.88 * 20) + (0.94 * 10) = 92.2
V8 = (0,88 * 20) + (0,88 * 20) + (0,94 * 20) + (0,83 * 10) + (0.88 * 20) + (0.94 * 10) = 89.3
V9 = (0,88 * 20) + (0,94 * 20) + (0,94 * 20) + (0,83 * 10) + (0.88 * 20) + (0.94 * 10) = 90.5
Here's a table of each of the Vector values

Table 1 Vector's Value

Vector ($V_{i)}$	Vector Value (Vi)
V_1	93.4
V_2	87
V_3	91.6
V_4	91
V_5	92.8
V_6	91.2
V_7	92.2
V_8	89.3
V_9	90.5

The value of V4 shows the largest value up to the Selected A4 Variable in Being Chairman.

3.2 Testing Process Using Weight Product Method (WP)
The following will be tested using Product Method (WP) can be seen in the explanation below:
Fixed Weight so$\sum w$ = 20, 20, 20, 10, 20, 10

$$W_J = \frac{w_j}{\sum w_j}$$

$$W1 = \frac{20}{20+20+20+10+20+10} = \frac{20}{100} = 0.2$$

$$W2 = \frac{20}{20+20+20+10+20+10} = \frac{20}{100} = 0.2$$

$$W3 = \frac{20}{20+20+20+10+20+10} = \frac{20}{100} = 0.2$$

$W4 = \frac{10}{20+20+20+10+20+10} = \frac{10}{100} = 0.1$

$W5 = \frac{20}{20+20+20+10+20+10} = \frac{20}{100} = 0.2$

$W6 = \frac{10}{20+20+20+10+20+10} = \frac{10}{100} = 0.1$

$$V=\begin{bmatrix} 1 & 0.94 & 0.82 & 0.88 & 1 & 0.94 \\ 0.88 & 0.83 & 0.82 & 0.88 & 0.94 & 0.88 \\ 1 & 0.88 & 0.88 & 0.88 & 0.94 & 0.88 \\ 0.94 & 0.88 & 0.88 & 0.94 & 0.94 & 0.88 \\ 0.94 & 1 & 0.94 & 0.88 & 0.82 & 1 \\ 0.83 & 0.94 & 1 & 0.88 & 0.88 & 0.94 \\ 0.88 & 0.88 & 1 & 1 & 0.88 & 0.94 \\ 0.88 & 0.88 & 0.94 & 0.83 & 0.88 & 0.94 \\ 0.88 & 0.94 & 0.94 & 0.83 & 0.88 & 0.94 \end{bmatrix}$$

Determination of Vector S for alternative preferences

$$S_i = \prod_{J=1}^{n} X_{ij}^{w_j}$$

$S_1 = (1^{0,2}) + (0{,}94^{0,2}) + (0{,}82^{0,2}) + (0{,}88^{0,1}) + (1^{0,2}) + (0{,}94^{0,1}) = 5.9299$
$S_2 = (0.88^{0,2}) + (0{,}83^{0,2}) + (0{,}82^{0,2}) + (0{,}88^{0,1}) + (0{,}94^{0,2}) + (0{,}88^{0,1}) = 5.8615$
$S_3 = (1^{0,2}) + (0{,}88^{0,2}) + (0{,}88^{0,2}) + (0{,}88^{0,1}) + (0{,}94^{0,2}) + (0{,}88^{0,1}) = 5.9118$
$S_4 = (0.94^{0,2}) + (0{,}88^{0,2}) + (0{,}88^{0,2}) + (0{,}94^{0,1}) + (0{,}94^{0,2}) + (0{,}88^{0,1}) = 5.9060$
$S_5 = (0.94^{0,2}) + (1^{0,2}) + (0{,}94^{0,2}) + (0{,}88^{0,1}) + (0{,}82^{0,2}) + (1^{0,1}) = 5.9237$
$S_6 = (0.83^{0,2}) + (0{,}94^{0,2}) + (1^{0,2}) + (0{,}88^{0,1}) + (0{,}88^{0,2}) + (0{,}94^{0,1}) = 5.9070$
$S_7 = (0.88^{0,2}) + (0{,}88^{0,2}) + (1^{0,2}) + (1^{0,1}) + (0{,}88^{0,2}) + (0{,}94^{0,1}) = 5.9181$
$S_8 = (0.88^{0,2}) + (0{,}88^{0,2}) + (0{,}94^{0,2}) + (0{,}83^{0,1}) + (0{,}88^{0,2}) + (0{,}94^{0,1}) = 5.8873$
$S_9 = (0.88^{0,2}) + (0{,}94^{0,2}) + (0{,}94^{0,2}) + (0{,}83^{0,1}) + (0{,}88^{0,2}) + (0{,}94^{0,1}) = 5.9002$

The following is a normalization table

Table 2 Normalization Value

S_i	Nilai S_i
S1	5.9299
S2	5.8615
S3	5.9118
S4	5.9060
S5	5.9237
S6	5.9070
S7	5.9181
S8	5.8873
S9	5.9002

The vector value S is used for Highest Value Search using the following formula:

$$V_i = \frac{\prod_{J=1}^{n} X_{ij}^{wj}}{\prod_{J=1}^{n} (X_j*)^{wj}}$$

$V1 = \frac{5.9299}{5{,}9299+5.8615+5.9118+5.9060+5.9237+5.9070+5.9181+5.8873+5.9002} = \frac{5.9299}{53.1455} = 1.1157$

$V2 = \frac{5{,}8615}{5{,}9299+5.8615+5.9118+5.9060+5.9237+5.9070+5.9181+5.8873+5.9002} = \frac{5.8615}{53.1455} = 0.1102$

$V3 = \frac{5.9118}{5{,}9299+5.8615+5.9118+5.9060+5.9237+5.9070+5.9181+5.8873+5.9002} = \frac{5.9118}{53.1455} = 1.1123$

$$V4=\frac{5.9060}{5,9299+5.8615+5.9118+5.9060+5.9237+5.9070+5.9181+5.8873+5.9002}=\frac{5.9060}{53.1455}=0.1111$$

$$V5=\frac{5.9237}{5,9299+5.8615+5.9118+5.9060+5.9237+5.9070+5.9181+5.8873+5.9002}=\frac{5.9237}{53.1455}=0.1114$$

$$V6=\frac{5.9070}{5,9299+5.8615+5.9118+5.9060+5.9237+5.9070+5.9181+5.8873+5.9002}=\frac{5.9070}{53.1455}=0.1111$$

$$V7=\frac{5.9181}{5,9299+5.8615+5.9118+5.9060+5.9237+5.9070+5.9181+5.8873+5.9002}=\frac{5.9181}{53.1455}=0.1113$$

$$V8=\frac{5.8873}{5,9299+5.8615+5.9118+5.9060+5.9237+5.9070+5.9181+5.8873+5.9002}=\frac{5.8873}{53.1455}=0.1107$$

$$V9=\frac{5.9002}{5,9299+5.8615+5.9118+5.9060+5.9237+5.9070+5.9181+5.8873+5.9002}=\frac{5.9002}{53.1455}=0.1110$$

Table 3 Vector Value

Vector (V_i)	Vector Value (V_i)
V_1	**1.1157**
V_2	0.1102
V_3	1.1123
V_4	0.1111
V_5	0.1114
V_6	0.1111
V_7	0.1113
V_8	0,10144
V_9	0.1107

The value of V1 shows the greatest value so that Variable A1 is Chosen in the General Chair.

3.3 Result

Below is the author will explain the results of the use of the program, here are the candidates who will be selected in the eligibility process of 9 candidates, and can be seen in the picture as follows:

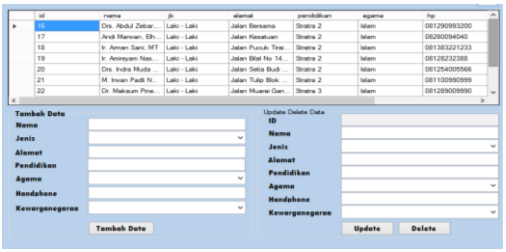


Figure 2 Candidate Data

Figure 2 describes candidate data consisting of 9 candidates and the data will be entered the general requirements process.

1. General Requirements Process
   The following is the general process requirements stage performed in the selection, and can be seen in the picture as follows:

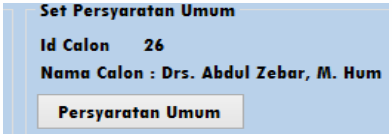


Figure 3 General Requirement

The Requested General Requirements are:

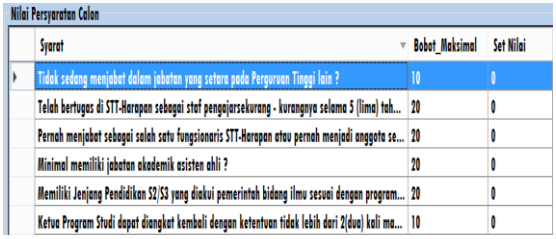
1. What is an Indonesian Candidate?
2. Is the candidate believing and fearing Allah SWT?
3. Is the Candidate not in the process of punishment?
4. Is the candidate not a member of a political party?
5. Is the candidate not in a position as a member of government institutions?
6. Is the candidate not in S2 or S3?

7. Is the candidate domiciled at the place where the STT Harapan college is located?
8. Is the candidate a permanent lecturer of hope education foundation?

Once processed above requirements and all worth "yes" then it will go into the set of candidate value requirements.

2. Set Candidate Eligibility Value

The following is a set of candidate requirements, and can be seen in the explanation as shown below:


Nilai Persyaratan Calon

Syarat	Bobot_Maksimal	Set Nilai
Tidak sedang menjabat dalam jabatan yang setara pada Perguruan Tinggi lain ?	10	0
Telah bertugas di STT-Harapan sebagai staf pengajarsekurang - kurangnya selama 5 (lima) tah...	20	0
Pernah menjabat sebagai salah satu fungsionaris STT-Harapan atau pernah menjadi anggota se...	20	0
Minimal memiliki jabatan akademik asisten ahli ?	20	0
Memiliki Jenjang Pendidikan S2/S3 yang diakui pemerintah bidang ilmu sesuai dengan program...	20	0
Ketua Program Studi dapat diangkat kembali dengan ketentuan tidak lebih dari 2(dua) kali ma...	10	0

Figure 4 Set Candidate Eligibility Value

Set the value of candidate requirements is the value of input taken from the manual results in the eligibility selection process positions, and this value will be in the process, using SAW and WP Method.

3. Calculation Using SAW Method

Here is a calculation using SAW Method and can be seen in the picture as follows:

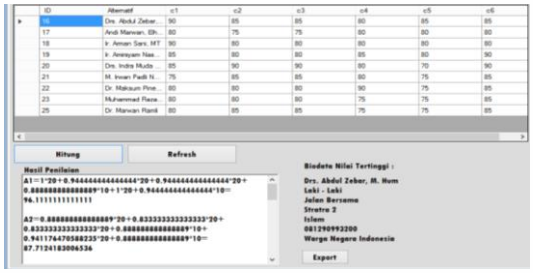


Figure 5 Calculation Process Using SAW

Figure 5 describes the data of candidates and manual values that have been inputted manually, the value is calculated using SAW Method and the results obtained are on candidates named Drs Abdul Zebar, M. Hum is the highest value of bios with the results of the assessment 96.1111111111111. after calculation using SAW method is done then the next process will be calculated by using WP method.

4. Calculation Process Using WP

Here is the calculation process using WP and can be seen in the picture as follows:

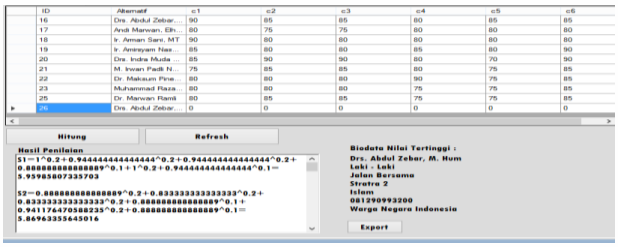


Figure 6 Calculation Using WP

Figure 6 describes the data of candidates and manual values that have been input with the manual, the value is calculated using WP Method and the results obtained are on candidates named Drs Abdul Zebar, M. Hum is the highest value of bios with the assessment of 5.95985807335703.

4.CONCLUSION

The result of the use of SAW and WP Method resulted in the same results of the same result of Alternative 1 was decided as the eligibility to occupy the position of Chairman A very important indicator in the selection is the level of education and years of service. The results of the use of SAW and WP Methods obtain more accurate results, optimal and not subjective. The result of comparison of SAW Manual and Program amounted to 4,529,418, and the comparative amount of manual WP calculation and program normalization value amounted to 0.051343, while manual calculation of WP and program value of vector totaled 0.004759.

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