



Simple Additive Weighting on The Selection of Candidate Students in The Job Skills Training Program

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Abstract

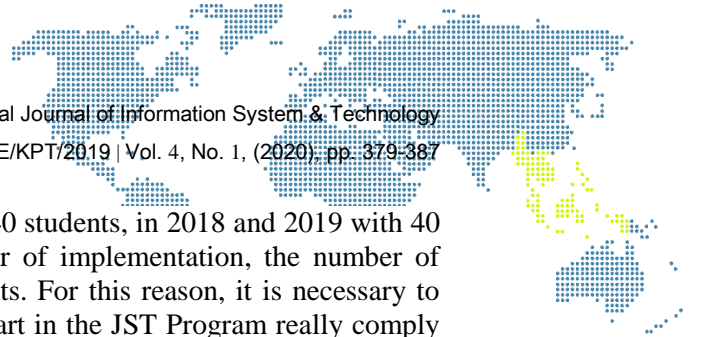
The Job Skills Training Program (JST) is an education and training service program that is oriented towards the development of job skills in accordance with industrial needs, given to students so that they have competence in certain skill areas as evidenced by a certificate of competence to work and be absorbed in the business and industry. Course institutions that receive assistance from this program often experience problems in the selection of potential candidates because the number of applicants is large enough to meet the same criteria while students are limited. The Simple Additive Weighting (SAW) method is one of the decision support methods used in this study to obtain alternative candidate students who match the criteria. From the results of calculations using the SAW Method, it is concluded that the SAW Method can be used to support decision making in the selection of JST Program candidates that produce the highest ranking scores.

Keywords: Job Skills Training, Simple Additive Weighting, Candidate students

1. Introduction

The Job Skills Training Program (JST) is an education and training service program that is oriented towards the development of job skills in accordance with industrial needs, given to students so that they have competence in certain skill areas as evidenced by a certificate of competence to work and be absorbed in the business and industry. The JST Program is a skills training program under the commitment of the Directorate of Courses and Training of the Directorate General of Vocational Education, Ministry of Education and Culture. For Fiscal Year 2020 this program will be implemented from June to December 2020[1]. The objectives of the JST Program are to educate and train students with vocational skills that are in line with the needs of the employment, ensure that JST students take competency tests, and they are absorbed in the employment. The learning process is carried out in theory and practice, and uses facilities and infrastructure in accordance with the established curriculum. The learning process is carried out in the administering institutions, by the Nonformal Education Unit, the Formal Education Unit, the Technical Implementation Unit for Vocational Education, the Business and the Industrial Employment, as well as Government-owned Education and Training Institutions, organizations or communities that have valid permits. The learning method can use conventional learning and/or online learning, followed by practice and competency test.

To become students, there are several criteria that must be fulfilled by candidates, namely 15 to 30 years old, having a National Identity Number, having an Electronic Identity Card, having a Family Card, Indonesian citizens, not currently attending formal education, unemployment, from underprivileged families as evidenced by a reference letter from the sub-district head or village head, have never participated in a similar program. One of the organizing institutions for the JST Program is the Widyaloka Solok Course and Training Institute. Widyaloka Solok has been organizing the JST Program



since 2016. In 2016 with 40 students, in 2017 with 40 students, in 2018 and 2019 with 40 students. And in 2020 with 30 students. Each year of implementation, the number of applicants reaches almost twice the quota of students. For this reason, it is necessary to make a selection so that candidates who will take part in the JST Program really comply with the set criteria. With so many applicants, it often makes it difficult for the management of Widyaloka Solok in making decisions to decide on candidates because they meet the same criteria. One method that is widely used in decision support is the Simple Additive Weighting Method (SAW). The basic concept of the SAW method is to find the weighted number of performance ratings on each alternative and all attributes that require a decision matrix normalization process to a scale comparable to the existing alternative rankings[2]. Previous studies using the SAW Method include the Simple Additive Weighting approach to Personnel Selection Problem by Alireza Afshari, Majid Mojahed and Rosnah Mohd Yusuff who examined the personnel selection process in companies in Iran with the conclusion that the selection of qualified personnel is a key factor in the success of an organization. . The complexity and importance of the problem requires analytical methods rather than intuitive decisions by applying seven criteria namely qualitative and positive to select one of the best from five personnel and also rank it[3].

Hermanto and Izzah, through their research, concluded that the decision support system for motorbike product selection was the Simple Additive Weighting (SAW) method which made it easier for users to carry out a decision support system for selecting the best motorbike products and supporting the decision of a motorcycle buyer in choosing a motorbike according to the desired criteria[4].

Dede and Adrian have also concluded through their studies that the SAW method is more suitable for use in credit cases where the results given are clearer because they are based on predetermined ratings and weights[5]

Based on the results of previous studies and the problems encountered by Widyaloka Solok, the authors used the SAW method to help solve problems.

2. Research Methodology

Simple Additive Weighting (SAW), also known as weighted linear combination or scoring method, is the simplest and most frequently used multi attribute decision technique. This method is based on a weighted average. The evaluation score is calculated for each alternative by multiplying the scale value assigned to the alternative attribute by the weight of relative importance directly assigned by the decision maker followed by the sum of the products for all criteria. The advantage of this method is that it is a proportional linear transformation of the raw data which means that the relative order of magnitude of the standard scores remains the same[2]. The SAW method is often 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 all attributes. The SAW method requires a decision matrix normalization process (X) to a scale that is comparable to all available alternative ratings[6]. The SAW Method is a weighted addition method. The basic concept of the SAW method is to find the weighted sum of the performance ratings for each alternative on all criteria [7]. The SAW method recognizes 2 (two) attributes, namely the benefit criteria and the cost criteria. The fundamental difference between these two criteria is in the selection of criteria when making decisions[8]. The SAW process by the following steps:

- a) Determine alternatives, A_i .
- b) Determine the criteria that will be used as a reference in making decisions, C_j .
- c) Assess the suitability rating of each alternative on each criteria.
- d) Determine the weight of preference or level of importance (W) of each criteria.

$$W = [W_1 \quad W_2 \quad W_3 \quad \dots \quad W_j] \quad (1)$$
- e) Creating a match rating table for each alternative on each criteria.

- f) Creating a decision matrix formed from the suitability rating table of each alternative on each criteria. The value of each alternative (A_i) on each criteria (C_j) that has been determined, where $i=1,2,\dots,m$ dan $j=1,2,\dots,n$.

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1j} \\ \vdots & \ddots & \vdots \\ x_{i1} & \cdots & x_{ij} \end{bmatrix} \quad (2)$$

- g) Normalizing the decision matrix by calculating the normalized performance rating (r_{ij}) value of the alternative A_i on the C_j criterion.

$$r_{ij} = \begin{cases} \frac{x_{ij}}{\text{Max}_i(x_{ij})} & \text{if } j \text{ is the benefit criteria} \\ \frac{\text{Min}_i(x_{ij})}{x_{ij}} & \text{if } j \text{ is the cost criteria} \end{cases} \quad (3)$$

Information:

- It is said that the profit criteria is if the value of x_{ij} provides an advantage for the decision maker, on the contrary the cost criteria if x_{ij} raises costs for the decision maker.
 - If it is a profit criteria, the x_{ij} value is divided by the Maximum value (x_{ij}) of each column, while for the cost criteria, the Minimum value (x_{ij}) of each column is divided by the x_{ij} value.
- h) The results of the normalized performance rating value (r_{ij}) form a normalized matrix (R).

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1j} \\ \vdots & \ddots & \vdots \\ r_{i1} & \cdots & r_{ij} \end{bmatrix} \quad (4)$$

- i) The final result of preference value (V_i) is obtained from the sum of the normalized matrix line elements (R) with the preference weight (W) corresponding to the matrix column element (W).

$$V_i = \sum_{j=1}^n w_j r_{ij} \quad (5)$$

The result of the calculation of a larger V_i value indicates that the alternative A_i is the best alternative [6]

This methodology is designed to select and consider the criteria for JST Program candidate students at Widyaloka Solok. The data collection method applied for this stage is a questionnaire. The framework is shown in Figure 1.

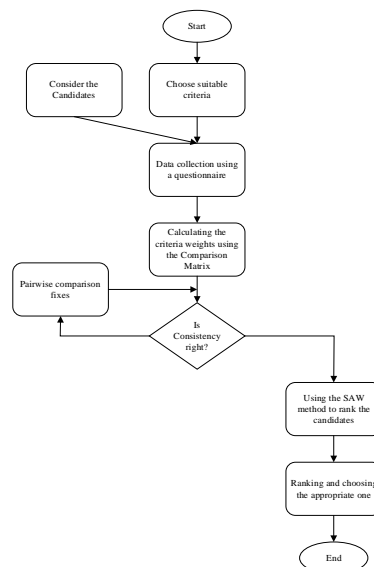


Figure 1. Framework



3. Results and Discussion

3.1. Determining Criteria

The data used in this study were obtained from Widyaloka Solok based on data on the selection of candidate students for the 2020 JST Program. The Directorate of Courses and Training, Directorate General of Vocational Education, Ministry of Education and Culture has set 5 criteria to become a candidate students for JST Program. However, Widyaloka Solok as a organizing institution of JST Program in 2020 for the skill area of Office Management Automation added two special criteria for candidate students, namely basic computer skills and changing the age limit of 18 to 25 years and willingness to take part in an apprenticeship for one month in the business or industry employment as appropriate with the Technical Guidelines for the Implementation of the JST Program for the 2020 Fiscal Year [9]. These criteria have been mentioned in table 1.

Table 1. Criteria names

Criteria	Information	Document
C1	18 to 25 years old	Copy of Birth certificate
C2	Have a National Identity Number	Copy Electronic Identitiy Card
C3	Not currently attending formal education	Copy of latest diploma and statement letter
C4	Unemployment	Statement Letter
C5	From underprivileged families	Reference letter from the sub-district head or village head
C6	Basic computer skills	Practical Test
C7	Willingness to take part in an apprenticeship	Statement Letter
C8	Have never participated in a similar program	Statement Letter

a) 18 to 25 years old

18 to 25 years old are given a maximum weight of 2 provided that:

None: 0

Unsuitable: 1

Suitable: 2

Information:

None : Copy of birth certificate was not available at registration

Unsuitable : there is a copy of birth certificate but the age does not match what is required

Suitable : Age is in accordance with the requirements and a copy of the birth certificate is available

Age is classified in the benefit criteria because the suitable age, the higher the benefits, where the age requirement can be used as an indicator of candidates pass.

b) Have a National Identity Number

Have a National Identity Number are given a maximum weight of 2 provided that:

None: 0

Unsuitable: 1

Suitable: 2

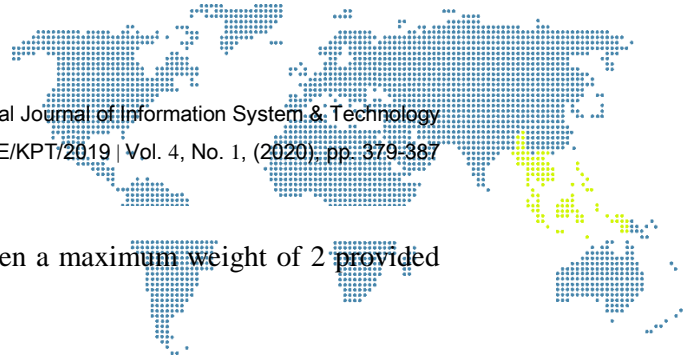
Information:

None : do not have a National Identity Number and proof of recorded data from the Civil Registration Office

Unsuitable : has a reference letter of Data Recording from the Civil Registration Office but does not yet have an Electronic Identity Card

Suitable : Have a National Identity Number and Electronic Identity Card

Have a National Identity Number and Electronic Identity Card isclassified in the profit criteria because by having a National Identity Number and an Electronic Identity Card, the higher the benefits obtained, which can be used as an indicator of candidates pass.



c) Not currently attending formal education

Not currently attending formal education are given a maximum weight of 2 provided that:

None: 0

Unsuitable: 1

Noen Suitable: 2

Information:

None : unable to show a copy of the latest education diploma or a statement letter that they are not currently studying in college

Unsuitable : have a copy of the latest education diploma but cannot show a statement letter that is not currently studying in college

Suitable : have a copy of the last diploma and can show a statement letter that is not currently studying in college

Not currently attending formal education is classified as an benefit criteria because this requirement can be used as an indicator of candidates pass.

d) Unemployment

Unemployment are given a maximum weight of 2 provided that:

None: 0

Unsuitable: 1

Suitable: 2

Information:

None : have employment

Unsuitable : unemployment but cannot show a reference letter from the sub-district head or village head

Suitable : unemployment and can show a reference letter from the sub-district head or village head

Unemployment is classified as a benefit criteria because this requirement can be used as an indicator of candidate pass.

e) From underprivileged families

From underprivileged families are given a maximum weight of 2 provided that:

None: 0

Unsuitable: 1

Suitable: 2

Information:

None : from a well family through evaluation of parents income and parents employment history on the Family Card

Unsuitable : from underprivileged families but cannot show a reference letter from the sub-district head or village head

Suitable : from underprivileged families and can show a reference letter from the sub-district head or village head

From underprivileged families is classified as a benefit criteria because this requirement can be used as an indicator of candidate pass.

f) Basic computer skills

Basic computer skills are given a maximum weight of 2 provided that:

None: 0

Unsuitable: 1

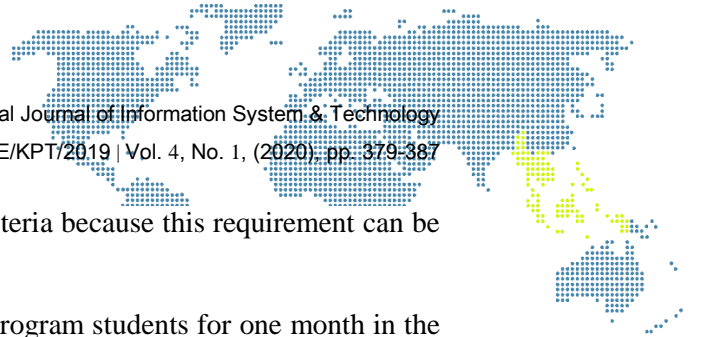
Suitable: 2

Information:

None : have never used a computer

Unsuitable : Ever studied basic computers but lacked basic computer skills

Suitable : have basic computer skills because they can operate office applications through basic computer practice tests



Basic computer skills is classified as a benefit criteria because this requirement can be used as an indicator of candidate pass.

g) Willingness to take part in an apprenticeship

This apprenticeship must be carried out by JST Program students for one month in the Business or Industrial Employment after completing the computer application practice and taking the information and communication technology competency test. Willingness to take part in an apprenticeship are given a maximum weight of 2 provided that:

None: 0

Unsuitable: 1

Sesuai : 2

Information :

None : not willing to take part in an apprenticeship

Unsuitable : willingness to take part in an apprenticeship but not in fulltime

Suitable : willingness to take part in an apprenticeship and willing to make a willingness statement letter

Willingness to take part in an apprenticeship is classified as a benefit criteria because this requirement can be used as an indicator of candidate pass.

h) Have never participated in a similar program

Similar activities referred to are programs implemented by the Ministry of Education and Culture, such as Job Skill Training and Entrepreneurship Training.

Have never participated in a similar program are given a maximum weight of 2 provided that:

None: 0

Unsuitable: 1

Suitable: 2

Information:

None : have participated in similar activities

Unsuitable : Have never participated in a similar program but have attended training from other ministries or regional service offices

Suitable : Have never participated in a similar program from government agencies

i) Have never participated in a similar program is classified as a benefit criteria because this requirement can be used as an indicator of candidate pass.

From the evaluation that has been done above, it will be entered into a matrix for calculations in the SAW method, with the following examples:

a) In this study, the alternative candidates were A1 to A5.

b) Criteria coded with C1 to C8 are used as a reference in decision making.

c) Provide a rating of the suitability of each alternative for each criteria. For each criteria by adding up the score of each criteria assessed with 0 to 2, namely as follows:

0 = None

1 = Unsuitable

2 = Suitable

d) Determine the weight of preference or level of importance of each criteria, with the values:

1 = Very Low

2 = Low

3 = Medium

4 = High

5 = Very High

The weight of preference or level of importance in this calculation is given a minimum value for each criteria (1,1,1,1,1,1,1), where the weight of preference or level of

importance is taken from the results of the selection team's assessment at the implementation of the selection of candidate students of JST Program at Widyalyoka Solok.

3.2. The Weighting of Each Criteria

After determining the criteria, each criteria is weighted as follows in table 2.

Table 2. Bobot Kriteria

Criteria	C1	C2	C3	C4	C5	C6	C7	C8
Weight	10%	5%	5%	10%	20%	10%	20%	20%

3.3. Alternative Value Table

Tabel 3. Alternative Value

Alt	Criteria							
	C1	C2	C3	C4	C5	C6	C7	C8
A1	2	2	2	2	2	1	2	2
A2	2	2	2	2	2	1	2	2
A3	2	1	2	2	0	2	2	2
A4	2	2	1	2	0	2	2	2
A5	2	2	1	2	1	2	2	1

After that a decision matrix is made which is formed from the suitability rating table of each alternative on each criteria based on formula (2).

$$X = \begin{pmatrix} 2 & 2 & 2 & 2 & 2 & 1 & 2 & 2 \\ 2 & 2 & 2 & 2 & 2 & 1 & 2 & 2 \\ 2 & 1 & 2 & 2 & 0 & 2 & 2 & 2 \\ 2 & 2 & 1 & 2 & 0 & 2 & 2 & 2 \\ 2 & 2 & 1 & 2 & 1 & 2 & 2 & 1 \end{pmatrix}$$

3.4. Perform Normalization

At this step, the decision matrix is normalized using formula (3) as follows:

$$r_{11} = \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1$$

$$r_{12} = \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1$$

$$r_{13} = \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1$$

$$r_{14} = \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1$$

$$r_{15} = \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1$$

$$r_{22} = \frac{2}{\max(2;2;1;2;2)} = \frac{2}{2} = 1$$

$$r_{21} = \frac{2}{\max(2;2;1;2;2)} = \frac{2}{2} = 1$$

$$r_{24} = \frac{2}{\max(2;2;1;2;2)} = \frac{2}{2} = 1$$

$$r_{23} = \frac{1}{\max(2;2;1;2;2)} = \frac{1}{2} = 0,5$$

$$r_{32} = \frac{2}{\max(2;2;2;1;1)} = \frac{2}{2} = 1$$

$$r_{31} = \frac{2}{\max(2;2;2;1;1)} = \frac{2}{2} = 1$$

$$r_{34} = \frac{1}{\max(2;2;2;1;1)} = \frac{1}{2} = 0,5$$

$$r_{33} = \frac{2}{\max(2;2;2;1;1)} = \frac{2}{2} = 1$$

$$r_{35} = \frac{1}{\max(2;2;2;1;1)} = \frac{1}{2} = 0,5$$

$$r_{41} = \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1$$

$$r_{42} = \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1$$

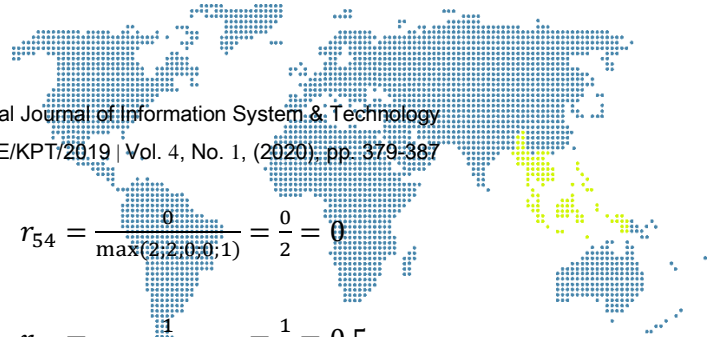
$$r_{43} = \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1$$

$$r_{44} = \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1$$

$$r_{45} = \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1$$

$$r_{51} = \frac{2}{\max(2;2;0;0;1)} = \frac{2}{2} = 1$$

$$r_{52} = \frac{2}{\max(2;2;0;0;1)} = \frac{2}{2} = 1$$



$$\begin{aligned} r_{53} &= \frac{0}{\max(2;2;0;0;1)} = \frac{0}{2} = 0 \\ r_{55} &= \frac{1}{\max(2;2;0;0;1)} = \frac{1}{2} = 0,5 \\ r_{61} &= \frac{1}{\max(1;1;2;2;2)} = \frac{1}{2} = 0,5 \\ r_{63} &= \frac{2}{\max(1;1;2;2;2)} = \frac{2}{2} = 1 \\ r_{65} &= \frac{2}{\max(1;1;2;2;2)} = \frac{2}{2} = 1 \\ r_{71} &= \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1 \\ r_{73} &= \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1 \\ r_{75} &= \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1 \\ r_{81} &= \frac{2}{\max(2;2;2;2;1)} = \frac{2}{2} = 1 \\ r_{83} &= \frac{2}{\max(2;2;2;2;1)} = \frac{2}{2} = 1 \\ r_{85} &= \frac{1}{\max(2;2;2;2;1)} = \frac{1}{2} = 0,5 \end{aligned}$$

$$\begin{aligned} r_{54} &= \frac{0}{\max(2;2;0;0;1)} = \frac{0}{2} = 0 \\ r_{62} &= \frac{1}{\max(1;1;2;2;2)} = \frac{1}{2} = 0,5 \\ r_{64} &= \frac{2}{\max(1;1;2;2;2)} = \frac{2}{2} = 1 \\ r_{72} &= \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1 \\ r_{74} &= \frac{2}{\max(2;2;2;2;2)} = \frac{2}{2} = 1 \\ r_{82} &= \frac{2}{\max(2;2;2;2;1)} = \frac{2}{2} = 1 \\ r_{84} &= \frac{2}{\max(2;2;2;2;1)} = \frac{2}{2} = 1 \end{aligned}$$

The results of normalization can be showed in table 4.

Table 4. Normalization Table

Alt	Criteria							
	C1	C2	C3	C4	C5	C6	C7	C8
A1	1	1	1	1	1	0,5	1	1
A2	1	1	1	1	1	0,5	1	1
A3	1	0,5	1	1	0	1	1	1
A4	1	1	0,5	1	0	1	1	1
A5	1	1	0,5	1	0,5	1	1	0,5

The normalization matrix is as follows:

$$R = \begin{pmatrix} 1 & 1 & 1 & 1 & 1 & 0,5 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 0,5 & 1 & 1 \\ 1 & 0,5 & 1 & 1 & 0 & 1 & 1 & 1 \\ 1 & 1 & 0,5 & 1 & 0 & 1 & 1 & 1 \\ 1 & 1 & 0,5 & 1 & 0,5 & 1 & 1 & 0,5 \end{pmatrix}$$

3.5. The Final Result

The final result is obtained from ranking the sum of the matrix multiplication R by the weights using the formula (5)

$$\begin{aligned} V_1 &= (1)(0,1)+(1)(0,05)+(1)(0,05)+(1)(0,1)+(1)(0,2)+(0,5)(0,1)+(1)(0,2)+(1)(0,2) \\ &= 0,925 \\ V_2 &= (1)(0,1)+(1)(0,05)+(1)(0,05)+(1)(0,1)+(1)(0,2)+(0,5)(0,1)+(1)(0,2)+(1)(0,2) \\ &= 0,925 \\ V_3 &= (1)(0,1)+(0,5)(0,05)+(1)(0,05)+(1)(0,1)+(0)(0,2)+(1)(0,1)+(1)(0,2)+(1)(0,2) \\ &= 0,775 \\ V_4 &= (1)(0,1)+(1)(0,05)+(0,5)(0,05)+(1)(0,1)+(0)(0,2)+(1)(0,1)+(1)(0,2)+(1)(0,2) \\ &= 0,775 \\ V_5 &= (1)(0,1)+(1)(0,05)+(0,5)(0,05)+(1)(0,1)+(0,5)(0,2)+(1)(0,1)+(1)(0,2)+(0,5)(0,2) \\ &= 0,85 \end{aligned}$$

From the calculation using the SAW method obtained the highest end result is $V_1 = 0.925$ (A1) and $V_2 = 0.925$ (A2) with the best alternative value.



4. Conclusion

Results of the research can be concluded as follows :

- a) Simple Additive Weighting method that has been done the calculation shows differences in ranking results on the alternative obtained based on the criteria and data that aims to find the best alternative.
- b) The SAW method can be used to support decision making in the selection of candidates in the Work Skills Training Program
- c) Simple Additive methods can be compared with other Decision Support System methods and can use more data samples.

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