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Decision Support System for Eligibility Determination of Working Contract Extensions in ISS Indonesia using SAW Method (Simple Additive Weighting)

Esera Gulo[1], Fristi Riandari[2]
[1,2]Informatics Engineering Study Program, STMIK Pelita Nusantara, Medan, Indonesia.

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ABSTRACT

Decision Support System (SPK) to determine the eligibility of a work contract extension at PT. ISS Indonesia is very much needed as a consideration before establishing or extending employment contracts for employees, especially in the Cleaning Service Department. Making this decision support system aims to help PT. ISS Indonesia to determine the feasibility of working contract extensions for its employees, especially in the Cleaning Service Department. The method used in completing this research is SAW (Simple Additive Weighting), which is often known as the weighted addition method. The simple additive weighting method is one of the solutions to problems in decision support systems that require the normalization process of the decision matrix (X) to a scale that is obtained compared to all alternative ratings in the SAW (Simple Additive Weighting) method. There are 6 (six) criteria as a measure for the feasibility of a work contract extension, namely the period of service, initiative, expertise, discipline, cooperation, quality of work, accompanied by the results of the implementation of this simple additive weighting method in the form of ratings against the alternatives used. The method is also implemented into an application that is built using the PHP programming language and MySQL database.

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Corresponding Author:

Esera Gulo,
Informatics Engineering Study Program,
STMIK Pelita Nusantara, Medan, Indonesia,
Jl. Iskandar Muda No.1, Merdeka, Kec. Medan Baru, Kota Medan, Sumatera Utara 20154.
Email: eseragulo03@gmail.com

1. INTRODUCTION

The development of technology until now has had an impact in various fields, one of which is in the field of providing human resources, where the quality of an employee or human resource will determine the success of a company going forward.

PT. ISS Indonesia is a company that provides human resources that was founded in 1901 in Copenhagen which has successfully developed its business and business, starting from Office support, Gardening, Pest Control, Security Services, Catering Services, Parking Services, Cleaning Services. Decision making in determining the feasibility of a work contract extension using the SAW (Simple Addtive Weighting) method is needed because this method is used to determine the weight value for each attribute and then rank it according to the results of the normalization matrix calculation. Therefore, the SAW (Simple Additive Weighting) method is highly recommended for use in the decision support system for determining the feasibility of a work contract extension at PT. ISS Indonesia Medan, especially in the Cleaning Service Department.

Based on the problems faced at this time, a research on contract extension will be conducted. Making decisions at PT. ISS Indonesia, especially in the Cleaning Service Department, by building a decision support system for determining employee work contract extensions using the SAW (Simple Additive Weighting) method so that it can be identified exactly which employees will be extended through the value obtained by adding up all the multiplication results between the rating and the weight of each attribute or the results of work while serving the company.

2. RESEARCH METHOD

2.1. Research Framework

The research framework in question is a method or steps a researcher uses in collecting research data and comparing it with the standards or measures that have been provided.

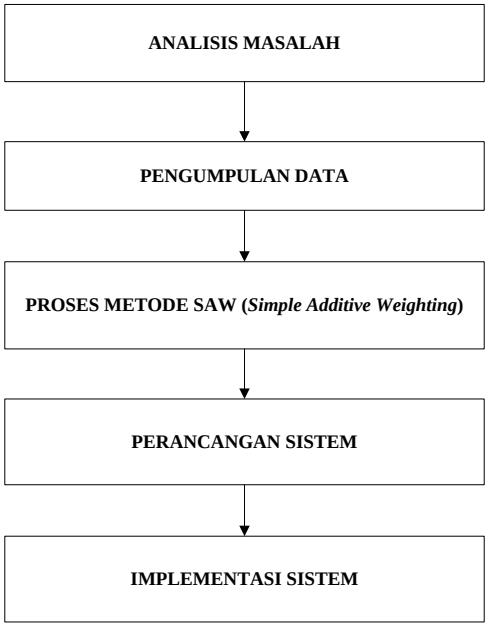

Figure 1. Research Framework

2.2. Description of the Framework

a. Problem Analysis

Problem analysis is divided into three stages, namely:

1. Identify the problem
   Namely providing a platform to investigate various interventions and generate options or options.
2. Formulate the problem
   The process of explaining in detail about the problems faced in determining the selection of new student admissions.
   Make study objectives and benefits
   Make goals about what will be achieved and make the benefits that will be obtained later from the system being built.

b. Data Collection

Data collection is divided into two stages, namely:

1. Literature Study
   Namely by studying books related to decision support systems using the SAW method.
2. Observation and Interview
   Namely by making direct observations at the research site by asking several questions related to research.

c. Process SAW Method

The SAW method process is carried out because it is a stage in analyzing a system in research by analyzing the application of the SAW method, analyzing data (processing and storing data) and analyzing the SAW method on data that has been previously analyzed.

d. System Design
System design is by modeling the proposed system using the UML (Unified Modeling Language) application and system design.

e. System Implementation
The final stage is the implementation of the system, which is the final activity of the process of implementing a new system where this stage is the stage of putting the system in place so that it is ready for operation and can be seen as an effort to realize the system that has been designed.

2.3. Simple Additive Weighting (SAW)

The basic concept of the SAW method is to find the weighted summation of the performance rating for each alternative on all criteria[4], [5]. The SAW method requires a decision matrix normalization process (X) to a scale that can be compared with all available alternative ratings[6], [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 Concept of Calculation with the SAW Method

The settlement steps in using the SAW method are as follows[9]–[12]:

1. Determine the alternative, namely Ai.
2. Determine the criteria that will be used as a reference in making decisions, namely Cj.
3. Determine the weight of preference or level of importance (W) of each criterion.
   W = [W1, W2, W3,…, Wj]
4. Create a table of suitability rating for each alternative on each criterion.
5. Make a decision matrix (X) which is formed from the results of the suitability rating table of each alternative on each criterion. The X value of each alternative (Ai) on each criterion (Cj) that has been determined where, i = 1,2,… m and j = 1,2,… n.

$$X=\begin{bmatrix} x_{11} & x_{12} & \dots & x_{1j} \\ . & & & . \\ . & & & . \\ x_{i1} & x_{i2} & \dots & x_{ij} \end{bmatrix}$$

6. Normalizing the decision matrix by calculating the normalized performance rating (r_{ij}) value of alternative A_i with the C_j criteria.

$$r_{ij} = \begin{cases} \frac{x_{ij}}{max_i x_{ij}} \\ \frac{x_{ij}}{min_i x_{ij}} \end{cases}$$

   Information :
   a. The profit criterion is carried out if the value provides an advantage for the decision maker. Conversely, the cost criterion is carried out if it incurs costs to decision makers.
   b. If it is a profit criterion, the value is divided by the value of each column. As for the cost criterion, the value of each column is divided by the value.
7. The results of the normalized performance rating (r_{ij}) form a normalized matrix (R).

$$R=\begin{bmatrix} r_{11} & r_{12} & \dots & r_{1j} \\ . & & & . \\ . & & & . \\ r_{i1} & r_{i2} & \dots & r_{ij} \end{bmatrix}$$

8. The final result of the preference value (V_i) is obtained from the addition and multiplication of the normalized matrix row elements (R) with the preference weight (W) corresponding to the matrix column element (W).

$$V_i = \sum_{j=1}^{n} W_j r_{ij}$$

The result of the calculation of a greater Vi value indicates that the alternative Ai is the best alternative.

3. RESULTS AND DISCUSSION

Analysis is a problem-solving technique by breaking the system into components with the aim of studying these components work and interacting to complete their goals. System design is a complement to system analysis into a complete system with the aim of getting a better system.

Data analysis is an effort or way to process data into information so that the characteristics of the data can be understood and are useful for solving problems, especially problems related to research.

Table 1. Employee data as an alternative

Kode	NIK	Nama	TTL
A_1	305103	Maylani	Medan, 27-05-1986
A_2	322688	Liusman Bawamenewi	Nias, 27-05-1992
A_3	322793	Desi Ratna Sari Sihotang	Medan, 17-05-1996
A_4	322644	Seftinus Hura	Nias, 27-09-1996
A_5	322691	Jeverlima Zai	Nias, 10-09-1996
A_6	323896	Ardiyanus Halawa	Nias, 13-11-1997

Table 2. Assessment criteria

No	Kode	Nama Kriteria
1	C_1	Masa Kerja
2	C_2	Inisiatif
3	C_3	Keahlian
4	C_4	Kedisplinan
5	C_5	Kerja Sama
6	C_6	Kualitas Kerja

After determining the alternative data and assessment criteria data, the importance (weight) of each criterion is given. The level of importance of each criterion is as follows:

1 = Very Low
2 = Low
3 = Medium
4 = Height
5 = Very High

The level of importance of each criterion is as follows:

Table 3. Weight of interest each criteria

Kode	Nama Kriteria	Kepentingan	Nilai	Bobot
C_1	Masa Kerja	Sangat Tinggi	Bulan	5
C_2	Inisiatif	Tinggi	1-10	4
C_3	Keahlian	Sedang	1-10	3
C_4	Kedisplinan	Tinggi	1-10	4
C_5	Kerja Sama	Rendah	1-10	2
C_6	Kualitas Kerja	Sangat Tinggi	1-10	5

a. Sub Criteria for Working Period

Table 4. Working sub criteria

Himpunan Kriteria	*Range*	Bobot
Sangat Rendah	> 12 – 24 Bulan	1
Rendah	> 24 – 30 Bulan	2
Sedang	> 30 – 36 Bulan	3
Tinggi	> 36 – 42 Bulan	4
Sangat Tinggi	> 42 Bulan	5

b. Initiative sub criteria

Table 5. Initiative sub criteria

Himpunan Kriteria	*Range*	Bobot
Sangat Rendah	≤ 2	1
Rendah	3 – 4	2
Sedang	5 – 6	3
Tinggi	7 – 8	4
Sangat Tinggi	9 – 10	5

c. Sub Expertise Criteria

Table 6. Sub criteria for expertise

Himpunan Kriteria	*Range*	Bobot
Sangat Rendah	≤ 2	1
Rendah	3 – 4	2
Sedang	5 – 6	3
Tinggi	7 – 8	4
Sangat Tinggi	9 – 10	5

d. Disciplinary Sub Criteria

Table 7. Discipline sub criteria

Himpunan Kriteria	*Range*	Bobot
Sangat Rendah	≤ 2	1
Rendah	3 – 4	2
Sedang	5 – 6	3
Tinggi	7 – 8	4
Sangat Tinggi	9 – 10	5

e. Sub Criteria for Cooperation

Table 8. Sub-criteria for cooperation

Himpunan Kriteria	*Range*	Bobot
Sangat Rendah	≤ 2	1
Rendah	3 – 4	2
Sedang	5 – 6	3
Tinggi	7 – 8	4
Sangat Tinggi	9 – 10	5

f. Sub Work Quality Criteria

Table 9. Sub criteria of working quality

Himpunan Kriteria	*Range*	Bobot
Sangat Rendah	≤ 2	1
Rendah	3 – 4	2
Sedang	5 – 6	3
Tinggi	7 – 8	4
Sangat Tinggi	9 – 10	5

SAW Method Analysis

Analysis of the SAW (Simple Additive Weighting) method requires a decision matrix normalization process (X) to a scale that can be compared with all available alternative ratings.

Table 10. Fitness ratings

Kode	Alternatif	KRITERIA					
		C_1	C_2	C_3	C_4	C_5	C_6
A_1	Maylani	36	7	9	10	7	4
A_2	Liusman Bawamenewi	30	8	10	9	8	5
A_3	Desi Ratna Sari Sihotang	30	9	7	10	10	7
A_4	Seftinus Hura	18	4	9	10	9	5
A_5	Jeverlima Zai	6	5	6	8	9	3
A_6	Ardiyanus Halawa	12	3	8	9	6	8

Based on Table 3, a decision maker gives preference weight for each criterion, namely W = (5, 3, 4, 4, 2, 5) with each type (cost / benefit).

Table 11. Weight of Determined Criteria

Kode	Deskripsi	Bobot	Atribut
C_1	Masa Kerja (Bulan)	5	*Cost*
C_2	Inisiatif	3	*Benefit*
C_3	Keahlian	4	*Benefit*
C_4	Kedisplinan	4	*Benefit*
C_5	Kerja Sama	2	*Benefit*
C_6	Kualitas Kerja	5	*Benefit*

Based on the value of the suitability data between the alternatives and the criteria in table 10, the decision matrix (X) is obtained, namely:

$$\boldsymbol{X} = \begin{bmatrix} \mathbf{36} & \mathbf{7} & \mathbf{9} & \mathbf{10} & \mathbf{7} & \mathbf{4} \\ \mathbf{30} & \mathbf{8} & \mathbf{10} & \mathbf{9} & \mathbf{8} & \mathbf{5} \\ \mathbf{30} & \mathbf{9} & \mathbf{7} & \mathbf{10} & \mathbf{10} & \mathbf{7} \\ \mathbf{18} & \mathbf{4} & \mathbf{9} & \mathbf{10} & \mathbf{9} & \mathbf{5} \\ \mathbf{6} & \mathbf{5} & \mathbf{6} & \mathbf{8} & \mathbf{9} & \mathbf{3} \\ \mathbf{12} & \mathbf{3} & \mathbf{8} & \mathbf{9} & \mathbf{6} & \mathbf{8} \end{bmatrix}$$

The next step is to perform normalization calculations to obtain a normalized value matrix (R), provided that:

To normalize the value, if the factor / attribute criteria is of type cost, the equation formula is used:

$R_{ij} = (\min \{X_{ij}\} / X_{ij})$

Meanwhile, if the factor / attribute criteria are of the benefit type, the following formula is used:

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

So that the normalized values (R) can be calculated for each criterion and alternative.

If the criteria for "Service Period" has a type of cost, the minimum value (min (X_{ij})) is sought first; in this case min (X_{ij}) = 6; that is obtained from the lowest value in the 1st column. The value so that it is normalized is by dividing the minimum value of the column by the value of each alternative as the following calculation:

$$R_{11} = \frac{6}{36} = 0.16667$$
$$R_{21} = \frac{6}{30} = 0.20000$$
$$R_{31} = \frac{6}{30} = 0.20000$$
$$R_{41} = \frac{6}{18} = 0.33333$$
$$R_{51} = \frac{6}{6} = 1.00000$$
$$R_{61} = \frac{6}{12} = 0.50000$$

In the criteria "Initiative" has a type of benefit, the maximum value (max (X_{ij})) is sought first; in this case max (X_{ij}) = 9; that is obtained from the highest value in the 2nd column. So that the normalized value is to divide the value of each alternative by the maximum value of the column as follows:

$$R_{12} = \frac{7}{9} = 0.77778$$
$$R_{22} = \frac{8}{9} = 0.88889$$
$$R_{32} = \frac{9}{9} = 1.00000$$
$$R_{42} = \frac{4}{9} = 0.44444$$
$$R_{52} = \frac{5}{9} = 0.55556$$
$$R_{62} = \frac{3}{9} = 0.33333$$

In the criterion "Expertise" has a benefit type, the maximum value (max (X_{ij})) is sought first; in this case max (X_{ij}) = 10; that is obtained from the highest value in the 3rd column. So that the normalized value is to divide the value of each alternative by the maximum value of the column as follows:

$$R_{13} = \frac{9}{10} = 0.90000$$
$$R_{23} = \frac{10}{10} = 1.00000$$
$$R_{33} = \frac{7}{10} = 0.70000$$
$$R_{43} = \frac{9}{10} = 0.90000$$
$$R_{53} = \frac{6}{10} = 0.60000$$
$$R_{63} = \frac{8}{10} = 0.80000$$

In the criteria "Discipline" has a type of benefit, the maximum value (max (X_{ij})) is sought first; in this case max (X_{ij}) = 10; that is obtained from the highest value in the 4th column. So that the normalized value is to divide the value of each alternative by the maximum value of the column as follows:

$$R_{14} = \frac{10}{10} = 1.00000$$
$$R_{24} = \frac{9}{10} = 0.90000$$
$$R_{34} = \frac{10}{10} = 1.00000$$
$$R_{44} = \frac{10}{10} = 1.00000$$
$$R_{54} = \frac{8}{10} = 0.80000$$
$$R_{64} = \frac{9}{10} = 0.90000$$

In the criteria "Cooperation" has a type of benefit, the maximum value (max (X_{ij})) is sought first; in this case max (X_{ij}) = 10; that is obtained from the highest value in the 5th column. So that the normalized value is to divide the value of each alternative by the maximum value of the column as follows:

$$\mathrm{R}_{15} = \frac{7}{10} = 0.70000$$
$$\mathrm{R}_{25} = \frac{8}{10} = 0.80000$$
$$\mathrm{R}_{35} = \frac{10}{10} = 1.00000$$
$$\mathrm{R}_{45} = \frac{9}{10} = 0.90000$$
$$\mathrm{R}_{55} = \frac{9}{10} = 0.90000$$
$$\mathrm{R}_{65} = \frac{6}{10} = 0.60000$$

The criteria for "Quality of Work" have a type of benefit, so look for the maximum value (max (X_{ij})) first; in this case max (X_{ij}) = 8; that is obtained from the highest value in the 6th column. So that the normalized value is to divide the value of each alternative by the maximum value of the column as follows:

$$\mathrm{R}_{16} = \frac{4}{8} = 0.50000$$
$$\mathrm{R}_{26} = \frac{5}{8} = 0.62500$$
$$\mathrm{R}_{36} = \frac{7}{8} = 0.87500$$
$$\mathrm{R}_{46} = \frac{5}{8} = 0.62500$$

$R_{56} = \frac{3}{8} = 0.37500$

$R_{66} = \frac{8}{8} = 1.00000$

From the results of these calculations, a normalized matrix (R) can be made as follows:

$$R = \begin{bmatrix} 0.16667 & 0.77778 & 0.90000 & 1.00000 & 0.70000 & 0.50000 \\ 0.20000 & 0.88889 & 1.00000 & 0.90000 & 0.80000 & 0.62500 \\ 0.20000 & 1.00000 & 0.70000 & 1.00000 & 1.00000 & 0.87500 \\ 0.33333 & 0.44444 & 0.90000 & 1.00000 & 0.90000 & 0.62500 \\ 1.00000 & 0.55556 & 0.60000 & 0.80000 & 0.90000 & 0.37500 \\ 0.50000 & 0.33333 & 0.80000 & 0.90000 & 0.60000 & 1.00000 \end{bmatrix}$$

The preference value (V) is obtained from the sum of the multiplication of the normalized value (R) with the criterion weight (W) for each alternative (A), according to the following equation:

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

The calculations for finding the preference value (V) for each alternative (A) are as follows:

$A_1 = 0.16667 * 5 + 0.77778 * 3 + 0.90000 * 4 + 1.00000 * 4 + 0.70000 * 2 + 0.50000 * 5$

$\boldsymbol{A_1 = 14.66667}$

$A_2 = 0.20000 * 5 + 0.88889 * 3 + 1.00000 * 4 + 0.99999 * 4 + 0.80000 * 2 + 0.62500 * 5$

$\boldsymbol{A_2 = 15.99167}$

$A_3 = 0.20000 * 5 + 1.00000 * 3 + 0.70000 * 4 + 1.00000 * 4 + 1.00000 * 2 + 0.87500 * 5$

$\boldsymbol{A_3 = 17.17500}$

$A_4 = 0.33333 * 5 + 0.44444 * 3 + 0.90000 * 4 + 1.00000 * 4 + 0.90000 * 2 + 0.62500 * 5$

$\boldsymbol{A_4 = 15.52500}$

$A_5 = 1.00000 * 5 + 0.55556 * 3 + 0.60000 * 4 + 0.80000 * 4 + 0.90000 * 2 + 0.37500 * 5$

$\boldsymbol{A_5 = 15.94167}$

$A_6 = 0.50000 * 5 + 0.33333 * 33 + 0.80000 * 4 + 0.99999 * 4 + 0.60000 * 2 + 1.0000 * 5$

$\boldsymbol{A_6 = 16.50000}$

From the results of the calculation of the previous preference value (V), ranking can be done in order of the largest value. The ranking results of the preference value are as follows:

Table 12. Rating

Rangking	Alternatif	Nilai
1	A3	17.17500
2	A6	16.50000
3	A2	15.99167
4	A5	15.94167
5	A4	15.52500
6	A1	14.66667

So that from the results of the ranking, if the HRD and Management of PT. ISS Indonesia extends the work contract for employees by looking at the results of the ranking above, namely for example being extended by 4 (four) people, then those who are entitled to be extended are those in rank 1-4 where rank 1-4 is A3 = Desi Ratna Sari Sihotang, A6 = Ardiyanus Halawa, A2 = Liusman Bawamenewi and A5 = Jeverlima Zai. Meanwhile, employees whose contracts were not extended were ranked 5-6, where the rank 5-6 were A4 = Seftinus Hura and A1 = Maylani.

4. CONCLUSION

After completing the design of a decision support system application to determine the feasibility of a work contract extension at PT. ISS Indonesia uses the SAW (Simple Additive Weighting) method, there are several things that can be concluded is that the application can be used to help PT. ISS Indonesia in determining the feasibility of a work contract extension at PT. ISS Indonesia uses the SAW (Simple Additive Weighting) method. The application has implemented the SAW (Simple Additive Weighting) method correctly in accordance with the analysis of the methods used in determining the extension of the work contract at PT. ISS Indonesia and Applications can

provide information on the results of analysis and calculation results of the SAW (Simple Addtive Weighting) method for decision-making officials and company leaders.

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