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IMPLEMENTATION OF SIMPLE ADDITIVE WEIGHTING METHOD FOR BEST PERFORMING EMPLOYEE SELECTION (CASE STUDY AT NATIONAL STANDARDIZATION AGENCY OF INDONESIA)

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Abstract
Technological developments can help human in their work. National Standardization Agency of Indonesia often gives awards for each employee based on the achievements of an employee. With the award given, it is expected that employees will motivated to provide the best work results for the company. The current rating system for National Standardization Agency of Indonesia employees is still by distributing questionnaires, then the results of the questionnaire are recapitulated and ranked based on the highest score to the lowest value. The assessment process currently take a long time so the information obtained is not fast. With the existing problems, we need a system that can help the company in determining the best employees with predetermined criteria. Based on the problems that occur, it need decision support system that can help the company to choose the best employee. The method used in decision making is Simple Additive Weighting (SAW). Decision making with Simple Additive Weighting method is used for decision making using the weighted addition method. Calculations in employee evaluations are carried out directly by superiors with prescribed considerations. The system developed can determine the employees who have the best performance, and helpful for decision maker to make final decision.

1.0 INTRODUCTION

Total population that increase, and increasingly fierce competition requires companies to continue to survive and be able to compete with other companies, especially with companies that have the same business field [1]. In the management of company, it is important to give awards to employees who have achievements such as diligence, hard work, leadership and others. The award will motivate the employees, and even support the company's performance. If the company's performance increases, then it will be the benefit of the company. A company cannot run without help from others. We cannot work alone in achieving our goals. Therefore, as an employee required to be able to work in teams, open to other members.

The National Standardization Agency of Indonesia (BSN) is an Indonesian non-ministerial government institution. There is an assessment of employees in each section to support the performance of BSN employees. it is conducted so that the competencies of each employee can be identified. The process of evaluating employee performance is carried out in an objective way, by looking at employee activities every day at the company so that the results obtained can be accurate [2].

Decision Support Systems can be used in various aspects, such as determining the best employees [3], assisting in the selection of high school majors [4], determine the majors in school [5], and Acceptance of Prospective Corporate Employees [6]. Decision Support Systems can also be used to assist the employee recruitment process, where DSS can provide recommendations to companies when there are many applicants by providing recommendations to the most qualified applicants[7].

The selection system of outstanding employees in BSN still using questionnaires that distribute to the leader of the employees. The result of the questionnaire results is recapitulated and ranked according to the highest score to the lowest value. The assessment process take a long time so the information obtained is not fast. With the existing problems, it need a system or application that can help BSN in determining the best employees with predetermined criteria.

2.0 THEORETICAL

2.1. Decision Support System

Decision Support Systems usually built to find solutions of the problem, and in general the decision support system application used to decision making. Decision support system applications using Computer Based Information System to support solutions to unstructured management problems [8].

Multiple Criteria Decision Making (MCDM) is a method to assess several alternatives or to choose the best alternative from a number of alternatives[9][10]. Some examples of MCDM are Simple Additive Weighting (SAW), Technique for Order of Similarity to Ideal Solution (TOPSIS), Preference Ranking Organization METHod for Enrichment of Evaluations (PROMETHEE) and Analytic Hierarchy Process (AHP) [7]. The purpose of a decision support system is [11]:

1) To Help Managers in making decisions on semi-structured problems.
2) Provide support for manager's consideration.
3) Computational speed.
4) To Help Managers in making decisions on semi-structured problems.
5) Provide support for manager's consideration.
6) Computational speed.
7) Competitive

The components of a decision support system can consist of [12]:

1) Data Management Subsystem
2) Model Management Subsystem.
3) User Interface Subsystem.
4) User Knowledge Based Management Subsystem

Below is Characteristics of decision support system [13]:

1) Focus on decisions.
2) Emphasize flexibility, adaptability and fast response.
3) Able to support various decision-making styles and individual managers.

2.2. Simple Additive Weighting

The basic concept of Simple Additive Weighting (SAW) Method is to find a weighted sum of performance ratings on each alternative on all attributes. The SAW method requires the process of normalizing the decision matrix (X) to a scale that can be compared with all available alternative ratings [14]. SAW Method Calculation FormulanThe formulas for normalizing are as follows:

$$r_{ij}= \begin{cases} \frac{X_{ij}}{Max\ X_{ij}}, if\ j\ is\ benefit\ attribute \\ \frac{Min\ X_{ij}}{X_{ij}}, if\ j\ is\ cost\ attribute \end{cases} \quad (1)$$

rij is a normalized performance rating from alternative Ai on the criteria / attributes Cj, i = 1,2,3 ..., m and j = 1,2,3 ..., n.
explanation
Max X_{ij} : The biggest value of each criterion.
Min X_{ij} : The smallest value of each criterion.
X_{ij} : The attribute value of each attribute.
Benefit : If the biggest value is the best value.
Cost : If the smallest value is the best value.

The following is the preference value formula for each alternative (Vi):

$$V_i = \sum_{j=1}^{n} w_j r_{ij} \quad (2)$$

explanation
Vi : ranking for each alternative.
Wj : the weight value of each criterion.
Rij : normalized performance rating value.
A larger V value indicates that the alternative Ai is selected [15].

Advantages of SAW Method
The advantage of the Simple Addtive Weighting method compared to other decision support systems is the ability to make assessments more precisely because it is based on the criteria value and the level of importance needed. Simple Addtive Weighting method carries out the selection process for the best alternative of the number of alternatives available, then ranking process, where the weighted values of all criteria are summed after determining the weight values of each criterion [16].

3.0 RESEARCH METHODOLOGY

System Development Life Cycle (SDLC) used as system development methodology [12], and the method used is waterfall. The stages of the life cycle of the development of the waterfall system used as a stage in this research are as follows:

1) Planning
   Creating schedule which will later be used as a guide to develop application. This step also starts by making the desired functionality of the application such as User Interface and Database. Those schedule with the desired functionality will be sorted in order and the estimated time needed
2) Analysis.
   After having a rough idea of the functionalities, this step will do those rough idea to reality. By designing those functionalities, there will be guides which will later be used for coding process. The design of the functionalities will be made based on analyzing the filled-out questionnaire. After analyzing the questionnaires, designing the database and user interface will be the next job.
3) Design.
   This step is where coding takes place. Design that is made in the previous step will be the guide.
4) Implementation
   This step will testing the program, and programmer will do functionality test and logic test. By doing a specific test, programmer will be having an easy time to fix any problem they faced.

4.0 RESULANTS AND DISCUSSION

The steps in the SAW method are:

1) Determine criteria will be used as a reference in decision making process. The criteria are:
   C1: Employee Work Targets
   C2: Work Behavior (Service Orientation, Integrity, Commitment, Discipline, Cooperation)
2) Determining the Candidate of Best Performing Employee. The candidate are:
   A1 : Indra; A2 : Azmi; A3 : Pane; A4 : Rizky; A5 : Pras

Table 1 Match Rating Scale

Score	Description
91 - 100	The work is perfect, there are no errors, no revisions, and quality of service exceeds established standards.
76 - 90	The work has 1 or 2 small mistakes, no big mistakes, require revisions and quality of service according to predetermined standards.
61 – 75	The work has 3 or 4 small mistakes, and there is no a big mistake, make revisions and quality of service simply meet the specified standards.
51 – 60	The work has 5 small errors and there is a big mistake, require revisions and quality of service do not quite meet the specified standards.
Below 60	The work has more than 5 small mistakes and there is big a mistake, unsatisfactory, require revision, the quality of service is below the specified standard

There are 5 assessment criteria at the National Standardization Agency of Indonesia. The assessment criteria are perfect, jobs have 1 or 2 small mistakes, jobs have 3 or 4 small mistakes, jobs have 5 small mistakes and there are big mistakes, and jobs have more than 5 small mistakes and there are big mistakes.

1) Test of Employee Work Target Criteria (C1)

Table 2 Employee Work Targets

No	Employee Name	Score
A1	Indra	80
A2	Azmi	84
A3	Pane	85
A4	Rizky	80
A5	Pras	95

Table 2 is a test for Employee Work Target criteria by inputting the value of Employee Work Targets criteria from the best performing employee candidates.

2) Test of Service Orientation Criteria (C2)

Table 3 Service Orientation

No	Employee Name	Score
A1	Indra	95
A2	Azmi	87
A3	Pane	76
A4	Rizky	83
A5	Pras	94

Table 3 is a test for work behavior criteria by inputting the value of Service Orientation sub criteria from the best performing employee candidates.

Table 4 Integrity

No	Employee Name	Score
A1	Indra	87
A2	Azmi	85
A3	Pane	83
A4	Rizky	88
A5	Pras	84

Table 4 is a test for integrity from work behavior sub criteria by inputting the value of Integrity from the best performing employee candidates.

Table 5 Commitment

No	Employee Name	Score
A1	Indra	90
A2	Azmi	95
A3	Pane	80
A4	Rizky	81
A5	Pras	85

Table 5 is a test for Commitment criteria by inputting the value of Commitment from the best performing employee candidates.

Table 6 Discipline

No	Employee Name	Score
A1	Indra	80
A2	Azmi	95
A3	Pane	88
A4	Rizky	83
A5	Pras	80

Table 6 is a test for Discipline criteria by inputting the value of Discipline from the best performing employee candidates.

Table 7 Cooperation

No	Employee Name	Score
A1	Indra	88
A2	Azmi	87
A3	Pane	82
A4	Rizky	83
A5	Pras	78

Table 7 is a test for Cooperation criteria by inputting the value of Cooperation from the best performing employee candidates. Based on the tables above, a match rating will be formed for each alternative as shown in Table 8 below:

Table 8 Match Rating each Alternative

Alterantif	Kriteria					
	C1 (Max)	C2 (Max)	C3 (Max)	C4 (Max)	C5 (Max)	C6 (Max)
A1	80	95	87	90	80	88
A2	84	87	85	95	95	87
A3	85	76	83	80	88	82
A4	80	83	88	81	83	83
A5	95	94	84	85	80	78

Table 8 is the match rating of each alternative, where at this stage gives the value of each alternative.

Table 9 Weight Vector for Each Criteria

	C1	C2	C3	C4	C5	C6
W	60%	8%	8%	8%	8%	8%

In table 9 is a weight vector for each criterion that explains the weight of the value of each criterion. The next step is to create a decision matrix X. This matrix is made from the match rating table (table 8) as follows:

$$X = \begin{pmatrix} 80 & 95 & 87 & 90 & 80 & 88 \\ 84 & 87 & 85 & 95 & 95 & 87 \\ 85 & 76 & 83 & 80 & 88 & 82 \\ 80 & 83 & 88 & 81 & 83 & 83 \\ 95 & 94 & 84 & 85 & 80 & 78 \end{pmatrix}$$

The next step is to normalize the X matrix to calculate each criterion, based on the criteria assumed to be the benefit and cost criteria. The following is the normalization calculation to find the value of R.

The formula for finding Min values: $\frac{\text{Rmin} = \text{Min}\ (C1A1, C1A2, \ldots C1An)}{CnAn}$

The formula for finding Max values: $\frac{CnAn}{\text{Rmax} = \text{Max}\ (C1A1, C1A2, \ldots C1An)}$

Alternative 1

$$R_{11} = \frac{80}{\text{Max}\ (80,84,85,80,95)} = \frac{80}{95} = 0{,}84$$

$$R_{21} = \frac{84}{\text{Max}\ (80,84,85,80,95)} = \frac{84}{95} = 0{,}88$$

$$R_{31} = \frac{85}{\text{Max}\ (80,84,85,80,95)} = \frac{85}{95} = 0{,}89$$

$$R_{41} = \frac{80}{\text{Max}\ (80,84,85,80,95)} = \frac{80}{95} = 0{,}84$$

$$R_{51} = \frac{95}{\text{Max}\ (80,84,85,80,95)} = \frac{95}{95} = 1$$

Alternative 2

$$R_{12} = \frac{95}{\text{Max}\ (95,87,76,83,94)} = \frac{95}{95} = 1$$

$$R_{22} = \frac{87}{\text{Max}\ (95,87,76,83,94)} = \frac{87}{95} = 0{,}92$$

$$R_{32} = \frac{76}{\text{Max } (95,87,76,83,94)} = \frac{76}{95} = 0,8$$

$$R_{42} = \frac{83}{\text{Max } (95,87,76,83,94)} = \frac{83}{95} = 0,87$$

$$R_{52} = \frac{94}{\text{Max } (95,87,76,83,94)} = \frac{94}{95} = 0,99$$

Alternative 3

$$R_{13} = \frac{87}{\text{Max } (87,85,83,88,84)} = \frac{87}{88} = 0,99$$

$$R_{23} = \frac{85}{\text{Max } (87,85,83,88,84)} = \frac{85}{88} = 0,97$$

$$R_{33} = \frac{83}{\text{Max } (87,85,83,88,84)} = \frac{83}{88} = 0,94$$

$$R_{43} = \frac{88}{\text{Max } (87,85,83,88,84)} = \frac{88}{88} = 1$$

$$R_{53} = \frac{84}{\text{Max } (87,85,83,88,84)} = \frac{84}{88} = 0,95$$

Alternative 4

$$R_{14} = \frac{90}{\text{Max } (90,95,80,81,85)} = \frac{90}{95} = 0,95$$

$$R_{24} = \frac{95}{\text{Max } (90,95,80,81,85)} = \frac{95}{95} = 1$$

$$R_{34} = \frac{80}{\text{Max } (90,95,80,81,85)} = \frac{80}{95} = 0,84$$

$$R_{44} = \frac{81}{\text{Max } (90,95,80,81,85)} = \frac{81}{95} = 0,85$$

$$R_{54} = \frac{85}{\text{Max } (90,95,80,81,85)} = \frac{85}{95} = 0,89$$

Alternative 5

$$R_{15} = \frac{80}{} = \frac{80}{} = 0,84$$

$$R_{25} = \frac{95}{\text{Max}(80,95,88,83,80)} = \frac{95}{95} = 1$$

$$R_{35} = \frac{88}{\text{Max}(80,95,88,83,80)} = \frac{88}{95} = 0{,}93$$

$$R_{45} = \frac{83}{\text{Max}(80,95,88,83,80)} = \frac{83}{95} = 0{,}87$$

$$R_{55} = \frac{80}{\text{Max}(80,95,88,83,80)} = \frac{80}{95} = 0{,}84$$

Alternative 6

$$R_{16} = \frac{88}{\text{Max}(88,87,82,83,78)} = \frac{88}{88} = 1$$

$$R_{26} = \frac{87}{\text{Max}(88,87,82,83,78)} = \frac{87}{88} = 0{,}99$$

$$R_{36} = \frac{82}{\text{Max}(88,87,82,83,78)} = \frac{82}{88} = 0{,}93$$

$$R_{46} = \frac{83}{\text{Max}(88,87,82,83,78)} = \frac{83}{88} = 0{,}94$$

$$R_{56} = \frac{78}{\text{Max}(88,87,82,83,78)} = \frac{78}{88} = 0{,}89$$

Normalized matrix (R).

$$R = \begin{pmatrix} 0{,}84 & 1 & 0{,}99 & 0{,}95 & 0{,}84 & 1 \\ 0{,}88 & 0{,}92 & 0{,}97 & 1 & 1 & 0{,}99 \\ 0{,}89 & 0{,}8 & 0{,}94 & 0{,}84 & 0{,}93 & 0{,}93 \\ 0{,}84 & 0{,}87 & 1 & 0{,}85 & 0{,}87 & 0{,}94 \\ 1 & 0{,}99 & 0{,}95 & 0{,}89 & 0{,}84 & 0{,}89 \end{pmatrix}$$

Furthermore, the ranking process by multiplying the normalized matrix (R) with the preference weight value (W) and determining the preference value for each alternative (V1) by adding the product times between the normalized matrix and the preference weight value (W). The following is the weight value of the weight vector preference (W) for each predetermined criterion.

$$\begin{pmatrix} 0{,}6 & 0{,}08 & 0{,}08 & 0{,}08 & 0{,}08 & 0{,}08 \end{pmatrix}$$

The final step in the ranking process is to add each alternative to the normalized matrix (R) for each line, multiply by weight (W), as the formula below.

$$\mathbf{V_n = (R11.W) + (R12.W) + (Rn.W)}$$

V_1= (0,84 x 0,6) + (1 x 0,08) + (0,99 x 0,08) + (0,95 x 0,08) + (0,84 x 0,08) + (1 x 0,08)
= 0.504 + 0.08 + 0.0792 + 0.076 + 0.0672 + 0.08 = 0,8864

V_2= (0,88 x 0,6) + (0,92 x 0,08) + (0,97 x 0,08) + (1 x 0,08) + (1 x 0,08) + (0.99 x 0,08)
=0.528 + 0.0736 + 0.0776 + 0.08+ 0.08 + 0.0792 = 0,9184

V_3= (0,89 x 0,6) + (0,8 x 0,08) + (0,94 x 0,08) + (0,84 x 0,08) + (0,93 x 0,08) + (0,93 x 0,08)
= 0.534 + 0.064 + 0.0752 + 0.0672 + 0.0744 + 0.0744 =0,8892

V_4= (0,84 x 0,6) + (0,87 x 0,08) + (1 x 0,08) + (0,85 x 0,08) + (0,87 x 0,08) + (0,94 x 0,08)
= 0.504 + 0.0696 + 0.08 + 0.068 + 0.0696 + 0.0752 =0,8664

V_5= (1 x 0,6) + (0,99 x 0,08) + (0,95 x 0,08) + (0,89 x 0,08) + (0,84 x 0,08) + (0,89 x 0,08)
= 0.6 + 0.0792 + 0.076 + 0.0712 + 0.0672 + 0.0712 =0,9648

From the above calculations obtained ranking results as in the following table:

Table 10 Preference Values

Alterbative	Preference Values (Vi)	Rank
V1	0,8864	4
V2	0,9184	2
V3	0,8892	3
V4	0,8664	5
V5	0,9648	1

V5 is the first rank because it has a value greater than the other values, V5 is the preference value of the alternative A5, so A5 or in this case Pras. which is an alternative to receiving awards.

4.1. Use Case Diagram of Proposed System

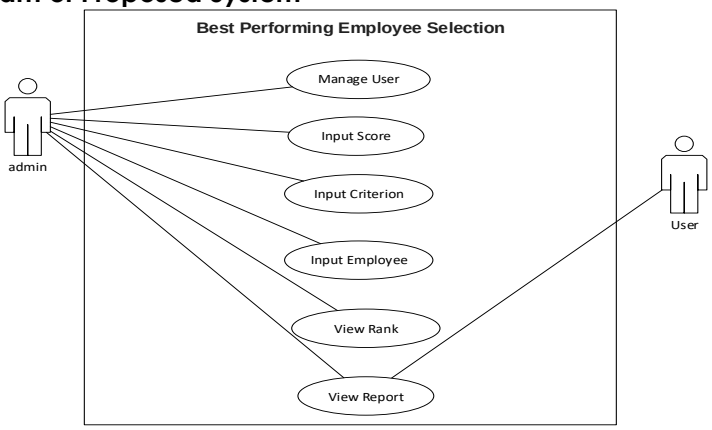

Figure 3 Use Case Diagram

We designed an application based on the analysis that we have done. There are 2 actors who can access the system, namely user and admin. Users in the system can view reports on reports about employees who have the best performance, while the admin is in charge of managing users, inputting values, inputting criteria, inputting employees, viewing ratings, and viewing reports that can later be seen by users.

4.2. User Interface

Alternative Value

After the criteria and the weighting of each criteria has been defined then the following steps to resolve it:

Alternative	Criteria					
	employee work target (benefit)	work behavior - service orientation (benefit)	work behavior - integrity (benefit)	work behavior - commitment (benefit)	work behavior - discipline (benefit)	work behavior - cooperation (benefit)
Indra	80	95	87	90	80	88
Azmi	84	87	85	95	95	87
Pane	85	76	83	80	88	82
Rizky	80	83	88	81	83	83
Pras	95	94	84	85	80	78

Figure 4. Rating Matches on each criterion

Normalization

Normalization equation attribute values to form a normalized matrix (R) and multiplying the weight with the value of each attribute to form a matrix (Y).

Alternative	Criteria						Result
	employee work target	work behavior - service orientation	work behavior - integrity	work behavior - commitment	work behavior - discipline	work behavior - cooperation	
Indra	0.84210526315789	1	0.98863636363636	0.94736842105263	0.84210526315789	1	88.7511961722492
Azmi	0.88421052631579	0.91578947368421	0.96590909090909	1	1	0.98863636363636	92.01531100478431
Pane	0.89473684210526	0.8	0.94318181818182	0.84210526315789	0.92631578947368	0.93181818181818	89.23157894736869
Rizky	0.84210526315789	0.87368421052632	1	0.85263157894737	0.87368421052632	0.94318181818182	86.87177033492839
Pras	1	0.98947368421053	0.95454545454545	0.89473684210526	0.84210526315789	0.88636363636364	96.5377990430622

Figure 5. Normalization

So, the final result of preference value for each alternatives was shown in Table 11

Table 11 preference value

Employee Name	Preference	Rank
Pras	96.5377990430622	1
Azmi	92.01531100478431	2
Pane	89.23157894736869	3
Indra	88.7511961722492	4
Rizky	86.87177033492839	5

4.3. Sytem Testing Methodology

System testing method use the Black Box Testing, where testing only observes the results of execution through test data and functional checks of software. Black-box testing tries to find errors in the following categories [17]:

a. Incorrect or missing functions
b. Interface errors
c. Errors in data structures or external database access
d. Performance errors
e. Initialization and termination errors

5.0 CONCLUSION

Decision Support System can be used to assist users in determining decisions so that information can obtained faster [6]. In this study, we use decision support system using Simple Additive Weighting Method to determine the best performance employee. There are several criteria that are used as assessments in the National Standardization Agency of Indonesia, namely employee work target, work behavior consisting of service orientation, integrity, commitment, discipline, cooperation, and leadership. Because the leadership assessment is only for the level that has subordinates, the criteria used are only service orientation, integrity, commitment, discipline, cooperation. Based on existing criteria at National Standardization Agency of Indonesia, we obtained the value of Rizky = 0.8664 as the employee with the lowest value and the value of Pras = 0.9648 as the best employee. Based on the analysis that have

done, the system developed can determine the employees who have the best performance. Decision Support System using Simple Additive Weighting can help in making decisions to determine the Best Performing Employee

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