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Simple Additive Weighting Method to Determining Employee Salary Increase Rate

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ABSTRACT

Employees are seen as one of the important company assets and need to be managed and developed to support the survival and achievement of corporate goals. One form of employee organization that can be done by the company is to provide appropriate salary payments for employees. Increase in salary greatly affects the motivation and productivity of employees in implementing and completing the work. To determine the magnitude of the salary increase, a system is needed that can support the decision making done by the manager. Utilization of decision support system using Simple Additive Weighting (SAW) method helps managers to make quicker and more accurate decision making. The basic concept of the SAW method is to find the weighted sum of performance ratings on each alternative and on all attributes that require the process of normalizing the decision matrix (X) to a scale comparable to all existing alternative ratings. This method is chosen because it is able to select the best alternative from a number of alternatives that exist based on the criteria specified. The research is done by finding the weight value for each attribute then done ranking which will determine the optimal alternative.

Keywords : Decision Support System, SAW Method, Simple Additive Weighting, Employee Salary Rate

I. INTRODUCTION

Decision-making [1] [2] is always associated with the uncertainty of the outcome of the decision taken. To reduce the uncertainty factor, the decision requires valid information about the conditions that have been and may occur and then process the information into several alternative problem-solving as a balance to take a decision [1] [3] [4]. Therefore, developed a decision support system that can process the information into an alternative problem solving [1] [4].

Decision Support System (DSS) is an information system that provides information, modeling and data manipulation [5] [6]. Another opinion of DSS is similar to traditional management information system because both of them depend on database as data source. Some DSS objectives include helping managers make decisions on semi-structured issues, increasing the effectiveness of decisions taken by managers rather than improving efficiency, computing speed, increasing productivity and improving quality [1] [5].

The method that can be applied to the DSS is Simple Additive Weighting (SAW) [7] which is one method to solve multi-attribute decision making problem [7], to know the process of processing information with SAW method for case study of salary rate which has several criteria such as Achievement, Discipline, Attitude, Work Period.
The use of SAW methods in determining employee salary increase rate can help decision makers to get recommendations before decisions are made.

II. THEORY

Decision Support System

Decision support system is an interactive information support system that provides information and modeling [1] [5] [8]. The system is used to assist decision making in semi-structured situations and unstructured situations, where no one knows exactly how decisions should be made.

Decision support systems are usually built to support a solution to a problem or to evacuate an opportunity [1] [4] [9]. Such decision support systems are called application decision support systems. Application of decision support system used in decision making in a problem. The application of decision support system using CBIS (computer based information system) is flexible, interactive and can be adapted and developed in support of solution to the problem of unstructured specification management [7] [10].

Decision-making involving multiple criteria is called multiple criteria decision making [1]. Multiple criteria decision making is part of a relatively complex decision-making problem that involves one or more decision-makers, with a number of diverse criteria to be considered, and each criterion has a specific weighting value, with the aim of obtaining an optimal solution to a source problems [1] [8].

Simple Additive Weighting (SAW)

The Simple Additive Weighthing method is the best known and most widely used method of dealing with MADM (Multiple Attribute Decision Making) situations.

The SAW method is often also known as the weighted summing method. The basic concept of the SAW method is to find the 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 comparable to all existing alternative ratings. The formula used in this method is as follows:

$$r_{ij} = \frac{x_{ij}}{Max(x_{ij})} \quad (1)$$

$$r_{ij} = \frac{Min(x_{ij})}{x_{ij}} \quad (2)$$

If j is an attribute benefit then using the formula number one. If the attribute j cost then using the formula number two:

$$w = \frac{C1}{C1+\cdots+Cn} x\ 100\% \quad (3)$$

$$V_i = \sum_{j-1}^{n} = 1\ w_j\ r_{ij} \quad (4)$$

The weights of all criteria are obtained by using the formula number three. With *rij* is the normalized performance rating of alternatives on attribute Ci Ai; i = 1,2, ..., n and j = 1,2, ..., n. Preference value alternative (vi) using the formula number four.

III. RESULT AND DISCUSSION

The process of calculating alternative values with Simple Additive Weighthing method provides ease in determining the selection of locations in accordance with the criteria desired by the user. If this method is applied then the process is as follows:

1. Define the value rules for each criterion

TABLE 1. Criteria Weight Data

No	Criteria Name	Weight Value
C1	Achievement	35
C2	Discipline	25
C3	Attitude	25
C4	Work Period	15

2. Alternative Value

There are 62 employees who will receive a salary increase. The following data from 62 employees.

TABLE 2. Alternative Value

Alternative	Name
A1	Marlina
A2	Ahmad Syafruddin
A3	Nurhayati
A4	Novi Lolita Sari
A5	Lide Kristanti Silalahi
A6	Saedah Masril Hasan
A7	Rasyid Habibi Sa’ad
A8	Muri Handayani
A9	Abdul Rahman

A10	Erwin Ramadani Pane
A11	Kiki Rezeki Silitonga
A12	M. Agus SaleH Napitupulu
A13	Erik Suganda Lase
A14	Taufik Hidayat
A15	Dewi Purnama Sari
A16	Johannes Sembiring
A17	Efryawan
A18	Endang Tria Marisa
A19	Rika Tirana
A20	Janty Kustio
A21	Timbul JNP Tampubolon
A22	Ilyas
A23	Miftah Fikri Sihombing
A24	Elianus Zalukhu
A25	Erick Noven C. Turnip
A26	Irham
A27	Riki Kurniawan
A28	Rahmat
A29	M. Reza Palawan Dwi P
A30	Kiswoyo Saputra
A31	Muhammad Ryan Athif
A32	Muhammad Fadli Rangkuti
A33	Muhammad Rendi Pranata
A34	Weni Apliyanti
A35	Ahmadsyah Frizal
A36	Rio Fisika
A37	Roby Ardiansyah
A38	Muhammad Syahri
A39	Muhammad Ishaq
A40	Azhar Syahmidun Pasaribu
A41	Budi Kiatno
A42	Sahdam
A43	Frengki Romanto H
A44	Chrystine Tobing
A45	Suryani
A46	Rumita Siagian
A47	Agus Sutikno
A48	Dewi Sekar Ayu
A49	Eko Syahputra
A50	Muhammad Muchsin
A51	Ganda Sanses Silaen
A52	Farida Hanum
A53	Dedi Mahyudi
A54	Iqbal Wilanta Pratama S.
A55	Suhada
A56	Agus Salim
A57	Rizal Efendi Pane
A58	Ade Sanjaya
A59	Tengku Zainuddin
A60	Sri Widarti
A61	Faisal Husni
A62	Tri Yudha Armega

3. Weight Value

The weight values for the criteria are arranged in the following table:

TABLE 3. Weight Value

Name	Value
Very Bad	1
Bad	2
Enough	3

Good	4
Very Good	5

4. Determine the match rating of each alternative on each of the criteria

TABLE 4. Rating of Alternative for Each Criteria

Alternative	Result Value			
	A1	A2	A3	A4
A1	4	4	4	4
A2	4	3	4	4
A3	4	4	4	4
A4	3	3	3	4
A5	4	4	4	3
A6	4	2	4	2
A7	3	4	4	2
A8	3	3	3	4
A9	4	2	3	5
A10	4	4	3	5
A11	4	3	3	5
A12	3	4	4	4
A13	4	4	4	5
A14	4	4	4	4
A15	3	4	4	3
A16	4	4	4	3
A17	4	4	4	3
A18	3	3	3	3
A19	3	2	3	2
A20	4	3	3	3
A21	4	3	4	4
A22	4	4	4	4
A23	3	3	3	4
A24	3	3	4	2
A25	3	4	3	4
A26	3	4	4	4
A27	3	3	3	3
A28	4	4	3	3
A29	4	3	3	3
A30	4	4	4	3
A31	4	3	4	3
A32	3	3	3	3
A33	3	4	3	2
A34	3	3	4	2
A35	3	3	3	2
A36	3	3	4	2
A37	4	4	4	2
A38	3	4	3	2
A39	3	3	4	2
A40	3	4	4	2
A41	3	4	3	2
A42	3	3	3	2
A43	3	4	4	2
A44	4	4	4	2
A45	4	4	4	2
A46	4	5	4	2
A47	4	4	4	2
A48	3	3	3	2
A49	4	3	4	2
A50	3	3	3	2
A51	3	3	3	2
A52	4	5	4	2
A53	3	3	3	2
A54	3	4	3	1
A55	3	4	4	1
A56	3	3	3	1
A57	4	4	4	1
A58	4	4	4	1
A59	4	4	4	1

A60	3	4	4	1
A61	3	3	3	1
A62	3	3	3	1

5. Calculate the normalized value of each alternative by using this formula

$$r_{ij} = \frac{x_{ij}}{\underset{i}{Max}\, x_{ij}}$$

The result of normalization is made in the form of a normalization matrix as below.

$$R = \begin{bmatrix} 1 & 0.8 & 1 & 0.8 \\ 1 & 0.6 & 1 & 0.8 \\ 1 & 0.8 & 1 & 0.8 \\ 0.75 & 0.6 & 0.75 & 0.8 \\ 1 & 0.8 & 1 & 0.6 \\ 1 & 0.4 & 1 & 0.4 \\ 0.75 & 0.8 & 1 & 0.4 \\ 0.75 & 0.6 & 0.75 & 0.8 \\ 1 & 0.4 & 0.75 & 1 \\ 1 & 0.8 & 0.75 & 1 \\ 1 & 0.6 & 0.75 & 1 \\ 0.75 & 0.8 & 1 & 0.8 \\ 1 & 0.8 & 1 & 1 \\ 1 & 0.8 & 1 & 0.8 \\ 0.75 & 0.8 & 1 & 0.6 \\ 1 & 0.8 & 1 & 0.6 \\ 1 & 0.8 & 1 & 0.6 \\ 0.75 & 0.6 & 0.75 & 0.6 \\ 0.75 & 0.4 & 0.75 & 0.4 \\ 1 & 0.6 & 0.75 & 0.6 \\ 1 & 0.6 & 1 & 0.8 \\ 1 & 0.8 & 1 & 0.8 \\ 0.75 & 0.6 & 0.75 & 0.8 \\ 0.75 & 0.6 & 1 & 0.6 \\ 0.75 & 0.8 & 0.75 & 0.8 \\ 0.75 & 0.8 & 1 & 0.8 \\ 0.75 & 0.6 & 0.75 & 0.6 \\ 1 & 0.8 & 1 & 0.6 \\ 1 & 0.6 & 0.75 & 0.6 \\ 1 & 0.8 & 1 & 0.6 \\ 1 & 0.6 & 1 & 0.6 \end{bmatrix} \begin{bmatrix} 0.75 & 0.6 & 0.75 & 0.6 \\ 0.75 & 0.8 & 0.75 & 0.4 \\ 0.75 & 0.6 & 1 & 0.4 \\ 0.75 & 0.6 & 0.75 & 0.4 \\ 0.75 & 0.6 & 1 & 0.4 \\ 1 & 0.8 & 1 & 0.4 \\ 0.75 & 0.8 & 0.75 & 0.4 \\ 0.75 & 0.6 & 1 & 0.4 \\ 0.75 & 0.8 & 1 & 0.4 \\ 0.75 & 0.8 & 0.75 & 0.4 \\ 0.75 & 0.6 & 0.75 & 0.4 \\ 0.75 & 0.8 & 1 & 0.4 \\ 1 & 0.8 & 1 & 0.4 \\ 1 & 0.8 & 1 & 0.4 \\ 1 & 1 & 1 & 0.4 \\ 1 & 0.8 & 1 & 0.4 \\ 0.75 & 0.6 & 0.75 & 0.4 \\ 1 & 0.6 & 1 & 0.4 \\ 0.75 & 0.6 & 0.75 & 0.4 \\ 0.75 & 0.6 & 0.75 & 0.4 \\ 1 & 1 & 1 & 0.4 \\ 0.75 & 0.6 & 0.75 & 0.4 \\ 0.75 & 0.8 & 0.75 & 0.2 \\ 0.75 & 0.8 & 0.75 & 0.2 \\ 0.75 & 0.6 & 0.75 & 0.2 \\ 1 & 0.8 & 1 & 0.2 \\ 1 & 0.8 & 1 & 0.2 \\ 1 & 0.8 & 1 & 0.2 \\ 0.75 & 0.8 & 1 & 0.2 \\ 0.75 & 0.6 & 0.75 & 0.2 \\ 0.75 & 0.6 & 0.75 & 0.2 \end{bmatrix}$$

6. Determine the preferences of each alternative by using the formula:

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

W = [0.35 0.25 0.25 0.15]

The preference value for determining the ranking result is as follows:

V_1 = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.8) = 0.92 (15%)

V_2 = (0.35 x 1) + (0.25 x 0.6) + (0.25 x 1) + (0.15 x 0.8) = 0.87 (10%)

V_3 = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.8) = 0.92 (15%)

V_4 = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.8)=0.72 (5%)

V_5 = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.6) = 0.89 (10%)

V_6 = (0.35 x 1) + (0.25 x 0.4) + (0.25 x 1) + (0.15 x 0.4) = 0.76 (5%)

V_7 = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.4) = 0.7725 (5%)

V_8 = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.8) = 0.72 (5%)

V_9 = (0.35 x 1) + (0.25 x 0.4) + (0.25 x 0.75) + (0.15 x 1) = 0.7875 (5%)

V_{10} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 0.75) + (0.15 x 1) = 0.8875 (10%)

V_{11} = (0.35 x 1) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 1) = 0.8375 (10%)

V_{12} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.8) = 0.8325 (10%)

V_{13} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 1) = 0.95 (15%)

V_{14} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.8) = 0.92 (15%)

V_{15} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.6) = 0.8025 (10%)

V_{16} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.6) = 0.89 (10%)

V_{17} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.6) = 0.89 (10%)

V_{18} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.6) = 0.69 (0%)

V_{19} = (0.35 x 0.75) + (0.25 x 0.4) + (0.25 x 0.75) + (0.15 x 0.4) = 0.61 (0%)

V_{20} = (0.35 x 1) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.6) = 0.7775 (5%)

V_{21} = (0.35 x 1) + (0.25 x 0.6) + (0.25 x 1) + (0.15 x 0.8) = 0.87 (10%)

V_{22} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.8) = 0.92 (15%)

V_{23} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.8) = 0.72 (5%)

V_{24} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 1) + (0.15 x 0.6) = 0.7525 (5%)

V_{25} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 0.75) + (0.15 x 0.8) = 0.77 (5%)

V_{26} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.8) = 0.8325 (10%)

V_{27} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.6) = 0.69 (0%)

V_{28} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.6) = 0.8275 (10%)

V_{29} = (0.35 x 1) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.6) = 0.7775 (5%)

V_{30} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.6) = 0.89 (10%)

V_{31} = (0.35 x 1) + (0.25 x 0.6) + (0.25 x 0.1) + (0.15 x 0.6) = 0.84 (10%)

V_{32} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.6) = 0.69 (0%)

V_{33} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 0.75) + (0.15 x 0.4) = 0.71 (5%)

V_{34} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 1) + (0.15 x 0.4) = 0.7225 (5%)

V_{35} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.4) = 0.66 (0%)

V_{36} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 1) + (0.15 x 0.4) = 0.7225 (5%)

V_{37} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.4) = 0.86 (10%)

V_{38} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 0.75) + (0.15 x 0.4) = 0.71 (5%)

V_{39} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 1) + (0.15 x 0.4) = 0.7225 (5%)

V_{40} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.4) = 0.7725 (5%)

V_{41} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 0.75) + (0.15 x 0.4) = 0.71 (5%)

V_{42} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.4) = 0.66 (0%)

V_{43} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.4) = 0.7725 (5%)

V_{44} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.4) = 0.86 (10%)

V_{45} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.4) = 0.86 (10%)

V_{46} = (0.35 x 1) + (0.25 x 1) + (0.25 x 1) + (0.15 x 0.4) = 0.91 (15%)

V_{47} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.4) = 0.86 (10%)

V_{48} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.4) = 0.66 (0%)

V_{49} = (0.35 x 1) + (0.25 x 0.6) + (0.25 x 1) + (0.15 x 0.4) = 0.81 (10%)

V_{50} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.4) = 0.66 (0%)

V_{51} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.4) = 0.66 (0%)

V_{52} = (0.35 x 1) + (0.25 x 1) + (0.25 x 1) + (0.15 x 0.4) = 0.91 (15%)

V_{53} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.4) = 0.66 (0%)

V_{54} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 0.75) + (0.15 x 0.2) = 0.68 (0%)

V_{55} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 0.75) + (0.15 x 0.2) = 0.68 (0%)

V_{56} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.2) = 0.63 (0%)

V_{57} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.2) = 0.83 (10%)

V_{58} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.2) = 0.83 (10%)

V_{59} = (0.35 x 1) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.2) = 0.83 (10%)

V_{60} = (0.35 x 0.75) + (0.25 x 0.8) + (0.25 x 1) + (0.15 x 0.2) = 0.7425 (5%)

V_{61} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.2) = 0.63 (0%)

V_{62} = (0.35 x 0.75) + (0.25 x 0.6) + (0.25 x 0.75) + (0.15 x 0.2) = 0.63 (0%

IV. CONCUSION

Implementation of Simple Additive Weighting (SAW) method in decision making of salary raising level is done by finding weighted sum of criteria on each alternative and at attribute which require normalization of decision matrix, then doing the process of ranking up to value of preference to determine alternative which get increase salary between 5% - 15% or not at all get a raise

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