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Simple Additive Weighting Method to Determine the Location of Fuel Station

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ABSTRACT

Decision-making is always associated with the uncertainty of the outcome of the decision taken. Decision Support System was developed to reduce the uncertainty factor by processing information into an alternative solution to a problem. The method that can be applied in decision support system is Simple Additive Weighting (SAW). To know the information processing process of decision support system using SAW method the writer use case study of fuel refueling location with criteria of population density, the number of dictionaries, offices, competitors and the price of land. After all criterion values are entered then the result of processing with SAW method will be ranked and the highest ranking will be selected.

Keyword: Decision Support System, SAW Method, Simple Additive Weighting

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 fuel refilling election which has several criteria such as population density, the number of dictionaries, offices, competitors and the price of land.

The use of SAW methods in determining refueling locations 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	Property	Weight Value
C1	Total Population	Benefit	20
C2	Total Campus	Benefit	20
C3	Total Offices	Benefit	20
C4	Competitor	Benefit	20
C5	Land Prices	Cost	20

TABLE 2. Values and Weights for criteria

Value	Weight	Criteria Value	Description
80-100	50	5	Very Good
60-79	45	4	Good
45-59	40	3	Enough
20-39	35	2	Bad
0-19	30	1	Very Bad

2. Record the value of the component criteria

The value data of the criterion component is the value data of each alternative based on the existing criteria. Once the criteria component value is entered it will get the component table of each alternative criterion

TABLE 3. Component Criteria

Alternative	C1	C2	C3	C4	C5
A1	5320	2	1	10000	2
A2	4027	6	0	5000	5
A3	3012	5	2	15000	5

3. Perform normalization

If j is a benefit attribute then it is calculated by using the formula:

$$N_{ij} = (X_{ij} / \text{Max} X_{ij}) \quad (5)$$

If j is a cost attribute then calculated by using the formula:

$$N_{ij} = (\text{Min } X_{ij} / X_{ij}) \quad (6)$$

a. C1 Criteria

$$A1 = \frac{5320}{\max\{5320;4027;3012\}} = \frac{5320}{5320} = 1$$

$$A2 = \frac{4027}{\max\{5320;4027;3012\}} = \frac{4027}{5320} = 0.756$$

$$A3 = \frac{3012}{\max\{5320;4027;3012\}} = \frac{3012}{5320} = 0.566$$

b. C2 Criteria

$$A1 = \frac{2}{\max\{2;6;4\}} = \frac{2}{6} = 0.333$$

$$A2 = \frac{6}{\max\{2;6;4\}} = \frac{6}{6} = 1$$

$$A3 = \frac{4}{\max\{2;6;4\}} = \frac{4}{6} = 0.667$$

c. C3 Criteria

$$A1 = \frac{1}{\max\{1;0;2\}} = \frac{1}{2} = 0.5$$

$$A2 = \frac{0}{\max\{1;0;2\}} = \frac{0}{2} = 0$$

$$A3 = \frac{2}{\max\{1;0;2\}} = \frac{2}{2} = 1$$

d. C4 Criteria

$$A1 = \frac{min(10000;5000;15000)}{10000} = \frac{5000}{10000} = 0.5$$

$$A2 = \frac{min(10000;5000;15000)}{5000} = \frac{5000}{5000} = 1$$

$$A3 = \frac{min(10000;5000;15000)}{15000} = \frac{5000}{15000} = 0.33$$

e. C5 Criteria

$$A1 = \frac{2}{\max\{2;5;1\}} = \frac{2}{5} = 0.4$$

$$A2 = \frac{5}{\max\{2;5;1\}} = \frac{5}{5} = 1$$

$$A3 = \frac{1}{\max\{2;5;1\}} = \frac{1}{5} = 0.2$$

From the above calculation obtained normalized matrix as follows:

$$R = \begin{bmatrix} 1.00 & 0.33 & 0.50 & 0.50 & 0.40 \\ 0.75 & 1.00 & 0 & 1.00 & 1.00 \\ 0.56 & 0.66 & 1.00 & 0.33 & 0.20 \end{bmatrix}$$

4. Give the importance value on each of the following criteria:
   W1= 20%, W2= 20%, W3= 20%, W4= 20% W5= 20%

   W = [0,20 0,20 0,20 0,20 0,20]

5. Furthermore, the ranking or preference value for each alternative (Vi) can be calculated using the formula

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

The results obtained are as follows:

A1=(0,20)(1.00)+(0,20)(0.33)+(0,20)(0.50)+(0,20)(0.50)+(0.20)(0.40)= 0.546
A2=(0,20)(0.75)+(0,20)(1.00)+(0,20)(0)+(0,20)(1.00)+(0.20)(1.00)= 0.553
A3=(0.20)(0.67)+(0.20)(0.57)+(0.20)(1.00)+(0.20)(0.33)+(0.20)(0.20)= 0.751

6. Based on the calculations performed, alternative A3 is selected.

IV. CONCUSION

The use of the SAW method to determine the best location to build an oil refueling station can assist the managerial in making decisions, on tests conducted using 5 criteria and 3 alternatives quite successfully select the best location, for testing with many alternatives and many criteria can also well done as well, the next development of SAW method includes a simple method in the process and not good for many criteria, especially with sub-criteria that influence collective assessment, the method suggested for development is the method of Analytical Hierarchy Process.

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