Research of Simple Multi-Attribute Rating Technique for Decision Support

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Abstract. One of the roles of decision support system is that it can assist the decision maker in obtaining the appropriate alternative with the desired criteria, one of the methods that could apply for the decision maker is SMART method with multicriteria decision making. This multi-criteria decision-making theory has meaning where every alternative has criteria and has value and weight, and the author uses this approach to facilitate decision making with a compelling case. The problems discussed in this paper are classified into problems of a variety Multiobjective (multiple goals to be accomplished) and multicriteria (many of the decisive criteria in reaching such decisions).

1. Introduction

Decision Support Systems is represented as a system capable of providing the ability to solve problems and communications capabilities for semi-structured problems. In particular [1] [2] [3] [4], Decision Support Systems are defined as a system that supports the work of a leader or decision maker in solving semi-structured problems by providing information or suggestions to a particular decision [4] [5] [6].

Decision support systems utilize private resources in a manner with computer skills to improve decision results, so this is a computer-based support system for decision-making that deals with semi-issues structured [1] [2]. The unstructured problem contains relationships between elements that are not understood by the troubleshooter. While the semi-structured problem is an issue that includes some elements recognized by the problem solvers [1]. Decision-making is always correlated with the uncertainty of the results of decisions taken, to reduce this risk factor, the decision requires valid information about the conditions that have been, and may occur, then processed the information into several alternative problems solving as a material consideration in deciding the steps to be implemented, so that the decision taken is expected to provide maximum benefits [4].

The decision support system that will introduce in this research use SMART method which aims to gather information about all data related to multiple attributes and multiple-criteria [7]. The data in the parameters is the data of the past and the future, from the data, will be generated classification and the relationship between data one and other data so that the final result will get the best results solution,
choosing SMART (Simple Multi Attribute Rating Technique) method because this method can make multi-decision decisions, so it is expected to create an accurate decision-making system and can solve the problem of decision making the best [7] [8] [9] [10].

In previous research conducted Risawandi [1], SMART method completion process is not elaborated in detail and there are no results that can explain how the results of using SMART method with alternatives and dynamic criteria, in this study the author tries to display the calculation of SMART procedure in detail toward alternatives based on criteria and weights; and dynamically differentiate process time with alternatives and criteria.

2. Methodology
SMART (Simple Multi Attribute Rating Technique) is a multi-criteria decision method developed by Edward in 1977 [1] [7]. This multi-criteria decision-making technique is proposed on the theory that each alternative consists of some criteria that have values and each criterion have weights that describe how important compared to other criteria. This weighting is used to assess each alternative to obtain the best choice. SMART is a linear additive model to predict the value of each option. SMART Method is more useful because of its simplicity in responding to the needs of decision makers and how it responds. The analysis involved is transparent so that this approach provides a great understanding of the problem and is acceptable to the decision maker [1] [10]. The multi-linear function model used by SMART is as follows:

\[
\text{Maximize } \sum_{j=1}^{k} W_j \cdot U_{ij}
\]

Explanation:
1. \( W_j \) is the criteria weighted value to j of k criteria.
2. \( U_{ij} \) is an alternative utility value i on criterion j.
3. The decision selection is to identify which of the n alternatives have the greatest practical value. The value of this function can also be used to rank alternatives.

3. Result and Discussion
Below is a test of decision support system using the SMART method, the case used with multi-criteria and multi-attribute concept so that it can be performed in different cases.

1. Known weights of assessment as follows:

| No | Criteria | Weight |
|----|----------|--------|
| 1  | C1       | 100    |
| 2  | C2       | 80     |
| 3  | C3       | 50     |
| j  |          | 230    |

2. From the above weights are made into relative weights, as follows:

| No | Criteria | Weight | Relative Weights |
|----|----------|--------|------------------|
| 1  | C1       | 100/230| 0.434            |
| 2  | C2       | 80/230 | 0.347            |
| 3  | C3       | 50/230 | 0.217            |
3. Alternative and weight value

| Table 3. Alternative and weight value |
|--------------------------------------|
| Alternative | Criteria |
|             | C1 | C2 | C3 |
| A1          | 77 | 79 | 78 |
| A2          | 80 | 85 | 80 |
| A3          | 85 | 85 | 74 |
| A4          | 77 | 85 | 88 |
| A5          | 77 | 88 | 75 |
| A6          | 72 | 89 | 90 |
| A7          | 72 | 70 | 89 |
| A8          | 90 | 90 | 88 |
| A9          | 74 | 90 | 78 |
| A10         | 77 | 89 | 89 |

4. The next stage is to determine the alternative value based on each criterion, in this case, it is estimated the alternative value on the scale between 0-100, for C1 value 77 as the minimum value and 90 as the maximum value, as example below:

a. Weight C1 for A1

\[
\text{Weight the value of C1.A1} = \left(\frac{90 - 77}{90 - 77}\right) = 100
\]

b. Weight C2 for A1

\[
\text{Weight the value of C2.A1} = \left(\frac{90 - 85}{90 - 80}\right) = 50
\]

c. Weight C3 for A1

\[
\text{Weight the value of C3.A1} = \left(\frac{90 - 78}{90 - 74}\right) = 75
\]

Based on the above process obtained value evaluation factor as follows:

| Table 4. Evaluation Factor |
|---------------------------|
| Criteria | Alternative |
|          | A1 | A2 | A3 | A4 |
| C1       | 100| 62.5| 38.4| 100|
| C2       | 55 | 100| 50 | 50 |
| C3       | 75 | 93 | 100| 31,25|
In the next stage determined the total evaluation value for each alternative, the total value of its assessment as follows:

**Table 5. Evaluation Factor for A1**

| Criteria | Evaluation Factor A1 | Factor Weight | Weight Evaluation |
|----------|----------------------|---------------|-------------------|
| C1       | 100                  | 0.434         | 43.4              |
| C2       | 55                   | 0.347         | 19.085            |
| C3       | 75                   | 0.217         | 16.275            |
| Total    | 234                  | 0.998         | 78.76             |

**Table 6. Evaluation Factor for A2**

| Criteria | Evaluation Factor A2 | Factor Weight | Weight Evaluation |
|----------|----------------------|---------------|-------------------|
| C1       | 62.5                 | 0.434         | 27.25             |
| C2       | 100                  | 0.347         | 34.7              |
| C3       | 93                   | 0.217         | 20.181            |
| Total    | 230                  | 0.998         | 82.006            |

**Table 7. Evaluation Factor for A3**

| Criteria | Evaluation Factor A3 | Factor Weight | Weight Evaluation |
|----------|----------------------|---------------|-------------------|
| C1       | 38.4                 | 0.434         | 16.66             |
| C2       | 50                   | 0.347         | 17.35             |
| C3       | 100                  | 0.217         | 21.7              |
| Total    | 188.4                | 0.998         | 55.71             |

**Table 8. Evaluation Factor for A4**

| Criteria | Evaluation Factor A4 | Factor Weight | Weight Evaluation |
|----------|----------------------|---------------|-------------------|
| C1       | 100                  | 0.434         | 43.4              |
| C2       | 50                   | 0.347         | 17.35             |
| C3       | 31.25                | 0.217         | 6.78              |
| Total    | 218                  | 0.998         | 67.53             |

Based on the above table, the highest total weight value is an A3 alternative; and the following is a table of calculation results using the SMART method:

**Table 9. Evaluation Factor for A4**

| Criteria | A1 | A2 | A3 | A4 |
|----------|----|----|----|----|
| C1       | 100| 62.5| 38.4| 100|
| W<sub>C1</sub> | 0.434| 0.434| 0.434| 0.434|
| C2       | 55 | 100| 50 | 50 |
| W<sub>C2</sub> | 0.347| 0.347| 0.347| 0.347|
| C3       | 75 | 93 | 100| 31.25|
| W<sub>C3</sub> | 0.217| 0.217| 0.217| 0.217|
| Total Value | 78.76| 75.06| 55.71| 67.53|
The results of the experiment based the number of alternatives to the number of predefined criteria (3 criteria) get a processing time of not more than 20 seconds, where the addition of the number of alternatives does not increase the processing time significantly, with 50 alternatives and 3 criteria only takes 12 seconds, The next process tests 50 alternatives to the number of criteria at random, see table below:

| Table 10. Testing with many criteria |
|------------------------------------|
| Alternative | 50 | 50 | 50 | 50 | 50 |
| Criteria    | 3  | 6  | 9  | 12 | 15 |
| Time(Second)| 13 | 40 | 65 | 90 | 197|

From the value of the table above can be seen in the graph below:

![Figure 1. Result alternative and Many Criteria](image)

Testing 50 alternatives with the varying number of criteria get a significant processing time and take a long time.

4. Conclusion
Based on the results of tests conducted with the number of dynamic alternatives and use three criteria then the process of calculation using the SMART method does not require a long time, but different if the alternatively added dynamically with the number of constant alternatives then the process of calculating the SMART method will require process time which is longer.

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