Multi-Attribute Decision Making with VIKOR Method for Any Purpose Decision

Dodi Siregar¹, Heri Nurdiyanto², S Sriadhi³, Diana Suita⁴, Ummul Khair¹, Robbi Rahim⁵, Darmawan Napitupulu⁶, Achmad Fauzi⁷, Abdurrozzaq Hasibuan⁸, M Mesran⁹ and Andysah Putera Utama Siahaan⁴

¹Department of Informatics, Universitas Harapan Medan, Indonesia
²Department of Informatics, STMIK Dharma Wacana, Indonesia
³Department of Electrical Engineering, Universitas Negeri Medan, Indonesia
⁴Department of Civil Engineering, Universitas Harapan Medan, Indonesia
⁵School of Computer and Communication Engineering, Universiti Malaysia Perlis, Malaysia
⁶Research Center for Quality System and Testing Technology, Indonesian Institute of Sciences, Indonesia
⁷Department of Computer Engineering, STMIK Kaputama, Indonesia
⁸Department of Industrial Engineering, Universitas Islam Sumatera Utara, Indonesia
⁹Department of Informatics, STMIK Budi Darma, Indonesia

*usurobbi85@zoho.com

Abstract. Implementation of Decision Support System for various purposes now can facilitate policy makers to get the best alternative from a variety of predefined criteria, one of the methods used in the implementation of Decision Support System is VIKOR (Vise Kriterijumska Optimizacija I Kompromisno Resenje). VIKOR method in this research got the best results with an efficient and easily understood process computationally, it is expected that the results of this study facilitate various parties to develop a model any solutions.

1. Introduction

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]. Decision-making is always correlated with the uncertainty of the results of decisions taken, to reduce this uncertainty 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 [3].

The decision support system that will present in this research uses VIKOR method which aims to gather information about all data related to multiple attributes and multiple-criteria [4]. The use of VIKOR method is used because the method it can choose highly effective and efficient criteria for determining decision outcomes with multiple attributes and multiple-criteria [4] [5] [6]. VIKOR is a multiple attribute decision-making method used to solve problems in discrete space [7]. Therefore, in MADM is usually used to perform assessment or selection of several alternatives in a limited number,
the process of multiple attribute decision making in this paper shows the calculation of VIKOR method gradually with 25 alternatives and five criteria to determine the accuracy of the process of VIKOR.

2. Methodology

Some previous studies which discussed the VIKOR method is Papathanasiou [7], Papathanasiou makes web-based application of TOPSIS and VIKOR MCDM, the policy makers can choose 2 (two) different decision result from application, and also another researcher Nisel [8] analyzed the application of VIKOR method to determine the rank of graduation from business program students, and many other studies discussing experimental results with VIKOR and its combination, from several types of research it was observed that VIKOR could arrange for many alternatives, so it can be assumed that the VIKOR algorithm is still relevant to use and in this research VIKOR method is calculated gradually to facilitate the calculation process for many criteria, many attributes and many alternatives.

The VIKOR method focuses on ranking and chooses from a set of samples with different criteria, which can help decision makers to get a final determination [4].

VIKOR is a method for optimizing multiple criteria in a complex system. VIKOR’s basic concept is to rank the current samples by looking at the results of the corresponding values or regrets (R) of each sample. The VIKOR method has applied by some researchers in the case of MCDM [7].

The formula of the VIKOR method is as follows:

1) Normalization of the matrix

\[ R_{ij} = \frac{(x_{ij} - x_j^*)}{(x_j^* - x_{ij}^*)} \]

Information:

- \( x_{ij} \) = Value of sample i data criteria j
- \( (I = A, B, C, D, E) \)
- \( (J = 5 \text{ criteria}) \)
- \( x_j^* \) = Best value in one criterion
- \( x_j^* \) = the worst value in one criterion

2) Calculating the S and R-Value

\[ S_i = \sum_{j=1}^{n} w_j \times (R_{ij}) \]

\( w_j \) = weighting criteria

The value of S is achieved from the sum of the result of the multiplication of the criteria weights by the data in each sample

\[ R_i = \max_j \ [w_j \times R_{ij}], \text{ largest value from } [w_j \times R_{ij}] \]

The value of R is the largest value of the multiplication of the weight of the criteria with the normalized data of each sample

3) Calculates the VIKOR index

\[ \text{Formula} = \left[ \frac{S_i - S_{i'}}{S_{i'} - S_{i}} \right] \times V + \left[ \frac{R_i - R_{i'}}{R_{i'} - R_i} \right] \times (1-V) \]

- \( S = \text{smallest } S \text{ value (the best value)} \)
- \( S^* = \text{the largest } S \text{ value} \)
- \( R = \text{the smallest } R \text{ value} \)
- \( R^* = \text{the largest } R \text{ value} \)

3. Result and Discussion

The analysis of the VIKOR method can be seen gradually in the following test process gradually, for the first step is to determine the criteria to be given the weight value for VIKOR calculation process, Table 1 below are the criteria that are used in this paper:
Table 1. Criteria and Weight

| No | Criteria | Weight (%) |
|----|----------|------------|
| 1  | C1       | 30         |
| 2  | C2       | 25         |
| 3  | C3       | 17         |
| 4  | C4       | 20         |
| 5  | C5       | 8          |

The next process is to determine alternatives with values for each criterion:

Table 2. Alternative and Criteria Value

| No | Alternative | Criteria |
|----|-------------|----------|
|    |             | C1       | C2       | C3       | C4       | C5       |
| 1  | A1          | 0        | 21       | 0        | 15       | 0        |
| 2  | A2          | 11       | 23       | 5        | 13       | 3        |
| 3  | A3          | 12       | 10       | 0        | 12       | 0        |
| 4  | A4          | 10       | 15       | 0        | 12       | 0        |
| 5  | A5          | 5        | 9        | 16       | 8        | 0        |
| 6  | A6          | 9        | 8        | 13       | 5        | 0        |
| 7  | A7          | 15       | 14       | 0        | 7        | 0        |
| 8  | A8          | 24       | 12       | 0        | 18       | 0        |
| 9  | A9          | 17       | 17       | 16       | 20       | 0        |
| 10 | A10         | 5        | 8        | 17       | 5        | 6        |
| 11 | A11         | 9        | 7        | 17       | 12       | 8        |
| 12 | A12         | 10       | 10       | 5        | 20       | 0        |
| 13 | A13         | 17       | 22       | 0        | 11       | 0        |
| 14 | A14         | 0        | 12       | 0        | 11       | 0        |
| 15 | A15         | 5        | 8        | 10       | 6        | 7        |
| 16 | A16         | 5        | 8        | 7        | 4        | 0        |
| 17 | A17         | 0        | 0        | 9        | 4        | 0        |
| 18 | A18         | 10       | 14       | 0        | 11       | 0        |
| 19 | A19         | 7        | 5        | 0        | 8        | 0        |
| 20 | A20         | 11       | 15       | 0        | 5        | 0        |
| 21 | A21         | 13       | 9        | 0        | 4        | 0        |
| 22 | A22         | 17       | 20       | 0        | 4        | 0        |
| 23 | A23         | 23       | 20       | 0        | 5        | 0        |
| 24 | A24         | 0        | 0        | 0        | 0        | 0        |
| 25 | A25         | 0        | 0        | 0        | 0        | 0        |

From table value of each criterion will be normalized data, the result can see as below, with example value Criteria C1

\[ R(A1), C1 = \frac{(24-0)}{(24-0)} = 1 \]

\[ R(A2), C1 = \frac{(24-11)}{(24-0)} = \frac{13}{24} = 0.54 \]

R (A1) and R (A2) are samples of normalization calculation of first criterion matrix with alternative 1 and alternative 2, and matrix normalization process is executed for all criteria and alternatives, the final result of matrix normalization process could be seen in Table 3 below:
Table 3. Normalization Matrix and Weight

| No | Alternative | C1 | C2 | C3 | C4 | C5 |
|----|-------------|----|----|----|----|----|
| 1  | A1          | 1  | 0.08 | 1 | 0.25 | 1 |
| 2  | A2          | 0.54 | 0 | 0.71 | 0.35 | 0.62 |
| 3  | A3          | 0.5 | 0.56 | 1 | 0.4 | 1 |
| 4  | A4          | 0.58 | 0.35 | 1 | 0.4 | 1 |
| 5  | A5          | 0.79 | 0.61 | 0.06 | 0.6 | 1 |
| 6  | A6          | 0.62 | 0.65 | 0.23 | 0.75 | 1 |
| 7  | A7          | 0.37 | 0.39 | 1 | 0.65 | 1 |
| 8  | A8          | 0 | 0.48 | 1 | 0.1 | 1 |
| 9  | A9          | 0.29 | 0.26 | 0.06 | 0 | 1 |
| 10 | A10         | 0.79 | 0.65 | 0 | 0.75 | 0.25 |
| 11 | A11         | 0.62 | 0.69 | 0 | 0.4 | 0 |
| 12 | A12         | 0.58 | 0.56 | 0.71 | 0 | 1 |
| 13 | A13         | 0.29 | 0.04 | 1 | 0.45 | 1 |
| 14 | A14         | 1 | 0.48 | 1 | 0.45 | 1 |
| 15 | A15         | 0.79 | 0.65 | 0.41 | 0.7 | 0.12 |
| 16 | A16         | 0.79 | 0.65 | 0.58 | 0.8 | 1 |
| 17 | A17         | 1 | 1 | 0.47 | 0.8 | 1 |
| 18 | A18         | 0.58 | 0.39 | 1 | 0.45 | 1 |
| 19 | A19         | 0.71 | 0.78 | 1 | 0.6 | 1 |
| 20 | A20         | 0.54 | 0.35 | 1 | 0.75 | 1 |
| 21 | A21         | 0.46 | 0.61 | 1 | 0.8 | 1 |
| 22 | A22         | 0.29 | 0.13 | 1 | 0.8 | 1 |
| 23 | A23         | 0.04 | 0.13 | 1 | 0.75 | 1 |
| 24 | A24         | 1 | 1 | 1 | 1 | 1 |
| 25 | A25         | 1 | 1 | 1 | 1 | 1 |

After the results obtained from the normalization of criteria and alternatives, the next is to multiply the value of normalization and weight so that the performance as table 4 below:

Table 4. Result Normalization x Weight

| No | Alternative | C1 | C2 | C3 | C4 | C5 |
|----|-------------|----|----|----|----|----|
| 1  | A1          | 30 | 2  | 17 | 5  | 8  |
| 2  | A2          | 16.2 | 0 | 12.07 | 7 | 4.96 |
| 3  | A3          | 15 | 14 | 17 | 8  | 8  |
| 4  | A4          | 17.4 | 8.75 | 17 | 8 | 8 |
| 5  | A5          | 23.7 | 15.25 | 1.02 | 12 | 8 |
| 6  | A6          | 18.6 | 16.25 | 3.91 | 15 | 8 |
| 7  | A7          | 11.1 | 9.75 | 17 | 13 | 8 |
| 8  | A8          | 0 | 12 | 17 | 2 | 8 |
| 9  | A9          | 8.7 | 6.5 | 1.02 | 0 | 8 |
| 10 | A10         | 23.7 | 16.25 | 0 | 15 | 2 |
| 11 | A11         | 18.6 | 17.25 | 0 | 8 | 0 |
| 12 | A12         | 17.4 | 14 | 12.07 | 0 | 8 |
| 13 | A13         | 8.7 | 1 | 17 | 9 | 8 |
| 14 | A14         | 30 | 12 | 17 | 9 | 8 |
| 15 | A15         | 23.7 | 9.75 | 6.97 | 14 | 0.96 |
| 16 | A16         | 23.7 | 16.25 | 9.86 | 16 | 8 |
| 17 | A17         | 30 | 25 | 7.99 | 16 | 8 |
Based on the formula VIKOR method that has been described and from the value of table 3 and table 4 and got the value of Q (VIKOR index) by using formula 3 of VIKOR, the results index value in  

| No | Alternative | Q Value |
|----|-------------|---------|
| 1  | A1          | 0.9325  |
| 2  | A2          | 0.8135  |
| 3  | A3          | 0.4435  |
| 4  | A4          | 0.4347  |
| 5  | A5          | 0.5879  |
| 6  | A6          | 0.4799  |
| 7  | A7          | 0.4229  |
| 8  | A8          | 0.292   |
| 9  | A9          | 0     |
| 10 | A10         | 0.78    |
| 11 | A11         | 0.3595  |
| 12 | A12         | 0.8211  |
| 13 | A13         | 0.323   |
| 14 | A14         | 0.8416  |
| 15 | A15         | 0.5576  |
| 16 | A16         | 0.6792  |
| 17 | A17         | 0.707   |
| 18 | A18         | 0.4478  |
| 19 | A19         | 0.6492  |
| 20 | A20         | 0.4632  |
| 21 | A21         | 0.4968  |
| 22 | A22         | 0.384   |
| 23 | A23         | 0.3279  |
| 24 | A24         | 1       |
| 25 | A25         | 1       |

From the table above obtained the data that the sample (A9) has the smallest index value, and A9 is the best ranking, from the data table 5 above obtained graph of the process of using the VIKOR method for each criterion and alternatives that exist.
Based on the above graph shows the results of calculations VIKOR method meet proper distribution with a uniform process.

4. Conclusion
The experiment of the VIKOR method can help to complete effective decision-making because the concept is straightforward and easy to understand and the computation process is efficient and can measure the relative performance of various decision alternatives.

5. References
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Figure 1. VIKOR Result