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A Comparative Analysis Of Vikor And Topsis For Scholarship Selection

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***Abstract*— Scholarships can be interpreted as financial assistance given to students who have achievements and economic limitations. Selection of scholarship recipients at STMIK Pringsewu still uses manual selection. Manual selection has a weakness in making selections using many criteria, so that it can lead to errors and inconsistent assessments. This study uses the VIKOR method as a ranking method for determining scholarship recipients with criteria set by the leadership, namely: Achievement Index, semester, electric power and home electricity bills. The VIKOR method is a Multi-Criteria Decision Making (MCDM) method that can be used to select more than one criteria. The VIKOR method focuses on ranking by compromising on alternative outcomes and conflicting criteria. The results showed that the VIKOR method can assist the selection process and determine the right scholarship recipient. In addition, the VIKOR method can create a ranking of alternative compromises from a number of existing alternatives**

***Keywords*— Scholarship, VIKOR, MADM, MCDM**

I. INTRODUCTION

Scholarship assistance for students with economic limitations is a form of concern for educational institutions or universities for students who have financial deficiencies, so that these students can continue and complete their education with scholarship assistance for students with economic limitations.

STMIK Pringsewu is one of the universities that has more than 500 students in each class and more and more students are registering as applicants for scholarships. Meanwhile, the system for determining student scholarship receipts is still done conventionally by employees or decision makers in this case the Head of the University Education Bureau which is strongly influenced by factors such as the condition of employees at that time, limited time and many employees who concurrently work with other jobs so that factors Subjectivity in decision making is very large

Based on these problems, it is necessary to build a decision support system to support the process of selecting poor scholarship recipients at STMIK Pringsewu. Decision Support System (DSS) is a computer-based system that presents and processes information that enables decision making to be more productive, dynamic, and innovative [1] . Multiple Criteria Decision Making (MCDM) is the selection of the best alternative from several mutually beneficial exclusive alternatives on the basis of general performance in various criteria or attributes determined by decision makers [2]. MCDM has various methods used to solve problems in the fields of science, business, and government. One of the MCDM methods is the Analytical Hierarchy Process (AHP)[1][2]. This decision support system will be built using the Analytical Hierarchy Process (AHP) method for weighting the criteria, as well as the VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) method and the Technique for Order Preferences by Similarity to an Ideal Solution (TOPSIS) for alternative rankings. The AHP method has advantages in determining the weights and hierarchy of criteria, and can guarantee consistency when determining the weights of the criteria [3]. The VIKOR method has the advantage of compromising existing alternatives, and can complete discrete decision making on conflicting and noncommensurable criteria, namely the difference in units between criteria [4]. The TOPSIS method has several advantages, including the concept is simple and easy to understand, computationally efficient, and has the ability to measure the relative performance of alternative decisions in a simple mathematical form. The compromise solution can be considered as the selection of a solution with the closest Euclidean distance from the positive ideal solution and the farthest Euclidean distance from the negative ideal solution [5]. With the application of this method, it is hoped that the process of selecting students who receive scholarship assistance for underprivileged students can be more objective, accurate, and faster

II. METHOD

The research method used is descriptive analysis method with a quantitative approach, meaning that the research carried out is to emphasize the analysis on numerical data (numbers), which aims to get a clear picture of a situation based on the data obtained by presenting, collecting and analyzing the data. so that it becomes new information that can be used to analyze the problem being studied. Sampling is a process of selecting a portion of the population to be able to represent the population [1]. The research method is a set of rules, activities, and procedures used to organize this research

A. Data Collection

Data collection methods used in this research to obtain data are interview, observation, and documentation.

B. Criteria

The criteria used in this study are:

- GPA
- Semester
- Number of dependents of parents
- Academic and Non-Academic Achievement Data
- Last month's electricity bill
- Land and building tax value last year
- Membership in Campus organizations

C. Vikor Method

- Determine the criteria that will be used as a reference in making decisions, namely the value of report cards, activity values, achievement values, and attitude values.
- Weighting the criteria to distinguish the level of importance between criteria
- Determine positive and negative values as the ideal solution for each criterion
- Calculate the utility measure of each alternative.
- Calculating VIKOR indeks index value
- Alternate Ranking

D. Topsis Method

- Determine the criteria that will be used as a reference in making decisions.
- Doing weighting criteria to distinguish the level of importance between criteria.
- Normalize the decision matrix. The normalization used is vector normalization.
- Perform normalization weighting by multiplying the results of normalization of the decision matrix by the weight of the criteria
- Determine the positive ideal solution and the negative ideal solution for each criterion.
- Calculating the value of relative closeness and sorting alternatives starting from the largest value as a result of ranking students with achievements.
- Calculating the value of relative proximity and sorting alternatives starting from the largest value as a result of ranking students with achievements

III. RESULTS AND DISCUSSION

Document analysis is used to obtain factors that influence the determination of the award of scholarships for economic limitations. In this study there are 7 assessment criteria used, namely: Number of Parent Dependents (C01), Number of Semesters (C02), Student GPA (C03), Academic and Non-Academic Achievement Data (C04), Last Month's Electricity Bill (C05), Value Land and Building Tax last year (C06), Membership in Campus organization (C07). These seven criteria will be analyzed and used as variables to determine the evaluation of scholarships for underprivileged students at STMIK Pringsewu, then these variables are calculated using the prototype that has been designed using the TOPSIS and VIKOR methods. The data inputted into the system is data on scholarship applicants for underprivileged students at STMIK Pringsewu as many as 10 students from all majors which will be used as an alternative for selecting the best students based on the highest calculation value.

TABLE I CRITERIA TABLE

No.	Criteria	Kode
1	Number of Parent Dependents	C01
2	semester	C02
3	GPA	C03
4	Academic and Non-Academic Achievement Data	C04
5	Last Month's Electricity Bill	C05
6	Value Land and Building Tax last year	C06
7	Membership in Campus organization	C07

A. Pairwise Comparison Matrix (PCM)

For each criterion used, a value of X is given which represents the comparison between one criterion and another. So that after a comparison is made between all existing criteria, a pairwise comparison matrix is obtained. Intensity data of the importance of pairwise comparisons between criteria are shown in Table 2

TABLE II PAIRWISE COMPARISON MATRIX

X	C01	C02	C03	C04	C05	C06	C07
C01	1	3	2	1	1	2	1
C02	0.3333	1	2	3	1	1	1
C03	0.5	0.5	1	2	2	1	1
C04	1	0.3333	0.5	1	1	2	1
C05	1	1	0.5	1	1	1	2
C06	0.5	1	1	0.5	1	1	1
C07	1	1	1	1	0.5	1	1

B. Weight normalization matrix

calculate the results by multiplying the pairwise comparison matrix with the priority weight value. The result of the row sum is divided by the corresponding relative priority element then add up the quotient by the number of elements, the result is called λ max. The results can be shown in table 3

TABLE III WEIGHT, CI, CR

Criteria	W	Local W	CI	IR	CR
C01	1.000	0.179	0.1468	1.3	0.111
C02	0.895	0.160			
C03	0.822	0.147			
C04	0.679	0.121			
C05	0.779	0.139			
C06	0.710	0.127			
C07	0.710	0.127			

The CR value obtained is 0.111. This CR value <= 0.20 then the assessment is acceptable, meaning that the preferences given are consistent from the above calculations so that the criteria weights are obtained as shown in Table 4.

TABLE IV W CRITERIA

No.	Criteria	Kode	Weight
1	Number of Parent Dependents	C01	0.179
2	semester	C02	0.160
3	GPA	C03	0.147
4	Academic and Non-Academic Achievement Data	C04	0.121
5	Last Month's Electricity Bill	C05	0.139
6	Value Land and Building Tax last year	C06	0.127
7	Membership in Campus organization	C07	0.127

C. *Alternative ranking with TOPSIS*

The TOPSIS method is used for the alternative ranking process of each criterion by calculating the closeness between the solution and each alternative using the weighted criteria that have been calculated using AHP.

From the normalized weight matrix, the positive ideal solution value and the ideal solution value will be obtained. Then the distance between the alternative candidate and the ideal solution is positive, while the distance between the alternative candidate and the ideal solution is negative. By comparing the distance with the positive and negative ideal solutions, the preference value for each alternative candidate is obtained.

TABLE V TOPSIS RANKING PREFERENCE VALUE

Alternatif	Positif	Negatif	Pref	Rank
A01	0.052	0.073	0.582	4
A02	0.050	0.094	0.651	1
A03	0.052	0.030	0.606	3
A04	0.053	0.087	0.620	2
A05	0.058	0.078	0.574	5
A06	0.064	0.059	0.479	7
A07	0.084	0.070	0.454	9
A08	0.074	0.064	0.463	8
A09	0.061	0.071	0.539	6
A10	0.085	0.058	0.405	10

D. *Alternative ranking with VIKOR*

The next step is to determine the final value which can then be ranked based on the highest final score. VIKOR method ranking results can be seen in the table below

TABLE VI VIKOR RANKING PREFERENCE VALUE

Alternatif	Result Value (Q)	Rangking
A01	0.806717	5
A02	0.919970	1
A03	0.889330	3
A04	0.910903	2
A05	0.758372	8
A06	0.775796	6
A07	0.775256	7
A08	0.600119	10
A09	0.815990	4
A10	0.676881	9

E. *Comparison of VIKOR and TOPSIS Rankings*

The results of TOPSIS and VIKOR rankings for decision-making on granting scholarships to students with economic limitations at STMIK Pringsewu which were tested for accuracy resulted in a comparison of the accuracy values for each method. The TOPSIS algorithm gets the highest accuracy, which is 85.00%. While the VIKOR algorithm gets an accuracy of 80.67%.

TABLE VII DATA SAMPLE

No.	Alternatif	Data	
		Value	Rangking
1.	A01	48,5714	4
2.	A02	52,1429	1
3.	A03	49,2857	3
4.	A04	50,7143	2
5.	A05	45,7143	6
6.	A06	45,0000	7
7.	A07	42,1429	9
8.	ADB	44,2857	8
9.	A09	46,4286	5
10.	A10	41,4286	10

TABLE VIII TOPSIS DATA

TOPSIS DATA		
VALUE	**Rangking**	**Matching**
0,5820	4	Match
0,6510	1	Match
0,6060	3	Match
0,6200	2	Match
0,5740	5	Not Match
0,4790	7	Match
0,4540	9	Match
0,4630	8	Match
0,5390	6	Not Match
0,4050	10	Match

TABLE IX VIKOR DATA

VIKOR DATA		
VALUE	**Rangking**	**Matching**
0,806717	5	Not Match
0,91997	1	Match
0,88933	3	Match
0,910903	2	Match
0,758372	8	Not Match
0,775796	6	Not Match
0,775256	7	Not Match
0,600119	10	Not Match
0,81599	4	Not Match
0,676881	9	Not Match

To calculate the level of accuracy of the performance of the TOPSIS and VIKOR methods, it takes the appropriate amount of data between the results of the ranking system with the two methods, namely the TOPSIS method and the VIKOR method, then will be compared with the amount of existing data. The level of accuracy of system performance will be expressed as a percentage (%).

- The TOPSIS method produces the number of matching data is 8 data from 10 existing data, so the level of accuracy is:

$$Accuracy = \frac{Number\ of\ matching\ data}{Amount\ of\ data}\ x\ 100\%$$

$$Accuracy = \frac{8}{10}\ x\ 100\% = 80\%$$

- The VIKOR method produces the number of matching data is 3 data out of 10 available data, so the level of accuracy is

$$Accuracy = \frac{3}{10}\ x\ 100\% = 30\%$$

Based on the results obtained from manual calculations of sample data, it is proven that the TOPSIS method has a much better level of accuracy than the VIKOR method, which is 50% better, so the TOPSIS method is very appropriate to be used for evaluating the awarding of scholarships.

F. System Design

This application is made using a web-based program with Laravel Framework and Mysql. Based on the results of the analysis of the functional needs of the decision support system for providing scholarship assistance to underprivileged students at STMIK Pringsewu, it can be described in a use case diagram as follows:

Fig. 1. Usecase Diagram

There are needs for a decision support system for providing scholarships for students with economic limitations at STMIK Pringsewu. All of these needs are described in one initial use case, namely login for the User actor and 8 module use cases which are included with the login. In this use case, there is a requirement to do the login process first. The Administrator actor plays more of a role as a user administration manager and existing knowledge on the system

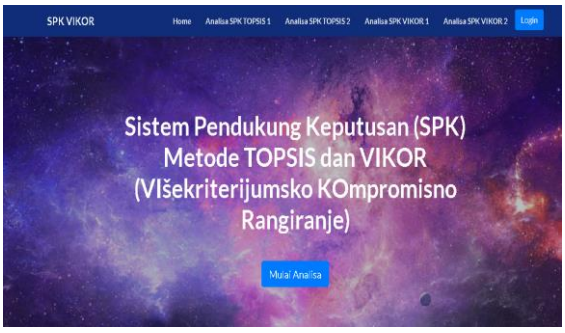

Fig. 2. App Interface

This application is made based on Web-based services intended to make it easier for users to use this application, so that it can be used anywhere and anytime. In the program, a form is given to choose a comparison value between one criterion and another, and a form is also given

to choose the level of criteria for evaluating all available alternative candidates.

G. Accuracy Testing, Analysis, and Validation

The level of accuracy is obtained from the comparison between the results of the TOPSIS and VIKOR ranking methods, the ranking of students receiving scholarship assistance for economic limitations is carried out by the Head of the Academic Section of STMIK Pringsewu. The student data used in this evaluation is student data for the period 2020/2021 semester 1 to semester 7.

Testing the consistency of the degree of importance of the criteria with the AHP method is carried out before this evaluation. The consistency test of the degree of importance of the criteria was carried out 20 times. 12) consistent trials, namely experiments 1, 5, 7, 8, 9, 11, 12, 13, 16, 17, 19, and 20. Experiments that have inconsistent degrees of importance are caused by the resulting Consistency Ratio (CR) value. greater than 0.1 so it cannot be used

TABLE X COMPARISON OF ACCURACY LEVELS

Number Of Trials	Accuracy	
	Topsis	VIKOR
1	0%	10%
2	10%	10%
3	0%	10%
4	50%	10%
5	10%	20%
6	80%	10%
7	70%	40%
8	50%	10%
9	0%	10%
10	80%	20%
11	50%	50%
12	50%	10%
13	40%	10%
14	50%	10%
15	40%	10%
16	40%	10%
17	50%	50%
18	40%	60%
19	50%	10%
20	40%	10%

Based on the table above, it can be seen that the TOPSIS method has the highest accuracy rate of 80% in experiment 12, while the VIKOR method only has the highest accuracy rate of 60% in experiment 17. Based on these results, it can be concluded that the TOPSIS method can be used in the case of student selection. scholarship recipients with economic limitations at STMIK Pringsewu with a degree of importance between criteria adjusted for experiment 12, because the accuracy rate produced is closest to 100%.

The degree of importance between the criteria in experiment 12 is that the criteria for parental dependents are slightly more important than the GPA value, the number of semesters is more important than the GPA value, the electricity account criteria are as important as the PBB, the criteria for organizational activity are slightly more important than the GPA value, the criteria for organizational activity are as important as many academic and non-academic achievements

IV. CONCLUSION

Based on the problems, literature study, research review, research object review and research methodology in decision making using TOPSIS and VIKOR methods, the results of the research that has been carried out can be concluded that VIKOR and TOPSIS methods produce an assessment calculation of effective economic limitations scholarships by entering 7 input criteria and 10 alternatives that have been tested 20 times. From previous studies by comparing the same two methods, the accuracy value in this study is better than theirs, because in the same experiment the accuracy level was 50% better when using the TOPSIS method than the VIKOR method, while the previous study the difference was only 30%.TOPSIS has the highest accuracy rate of 80% in 12 trials, while the VIKOR method only has the highest accuracy rate of 60%. between the adjusted criteria because the resulting accuracy level is closest to 100%. The degree of importance between these criteria is that the criteria for parental dependents are slightly more important than the GPA value, the number of semesters is more important than the GPA value, the electricity account criteria are as important as the PBB, the criteria for organizational activity are slightly more important than the GPA value, the criteria for organizational activity are as important as many academic and non-academic achievements

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