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Developing Fuzzy-Promethee Method by using AHP Method on Student Achieving Selection

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Abstract

The achievements are the result of person doing. Achievement can be achieved by relying on the intellectual ability, emotional, and spiritual as well as the resilience in the face of situations all aspects of life. Student achievement award can be either scholarships or involve the student in the national and international mathematics Olympiad. In UINSU, determining the best students in each majors still use manual procedures. Promethee is a method to resolve the cases of decision making which belong to the MCDM with outranking principle. This research developed a decision support system that involves AHP and Fuzzy-Promethee. The result show the model that integrating AHP and Fuzzy-Promethee which criteria in achievement selected by AHP then the value of each criteria enter fuzzyfication then select the best student by Promethee method.

Keywords: *Achievement Student, AHP, Fuzzy-Promethee.*

1. Introduction

Awards for outstanding students can be given in the form of scholarships or enrolling these students in local, national and international mathematics olympiads. This award is given to motivate students to always be active and have appreciation. Scholarships are educational assistance aimed at reducing the cost of education while helping to improve the nation's education level. Currently, many scholarships are offered to underprivileged students and high-achieving students. As stated in the 1945 Constitution Article 31 paragraph 1 which reads "that every citizen has the right to receive instruction". So that the central government and local governments are obliged to make it easy for citizens to get quality education. To get a quality education requires a lot of money. Therefore, students whose parents are less fortunate and students who excel are entitled to tuition fees which are usually called scholarships.

Anticipating that the scholarship for tuition assistance (BBP) and Academic Achievement Improvement (PPA) is distributed to those who are entitled, a decision-making system is needed based on four main criteria, namely parents' income, SPP or UKT bills, Grade Point Average (GPA) at least 3 semesters and a maximum of 7 semesters. The selection process for receiving BBP and PPA scholarships is one of the problems that is often raised because it is worried that the distribution will not be on target [3]. The best student can choose by using Decision Support System (DSS).

In its development, the Decision Support System (DSS) which is used in determining the order of ranking, choice and detection related to alternative decision parameters that efficiently meet certain conditions [1] is the Preference Ranking Organization Method For Enrichment Evaluation (Promethee). Promethee is a method for solving a decision-making case that is included in the MCDM (Multi-criteria Decision Making) category with outranking principles. This research used a combination of AHP, Fuzzy and

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Promethee methods. This system has proven to be effective in providing recommendations for the best solution.

2. Research Methodology

This research used research and development method. [6] states that research and development (R&D) is a research approach to produce a new product or improve an existing product. The resulting product can be in the form of hardware or software.

First step in this research is problem analysis with the AHP method. In the analysis of this problem, a description of the process of selecting good criteria is carried out in the process of selecting outstanding students using the AHP method. In decision making, there are three steps taken, namely: intelligent, modeling, and choice (Simon, 1977).

The intelligent stage is to collect the data we need and develop selection criteria. The criteria for determining outstanding students are:

Criterion 1 : C1: Semester Achievement Index (IPS)
Criterion 2 : C2: Grade Point Average (IPK)
Criterion 3 : C3: Number of Lecture Books
Criterion 4 : C4: Allowance
Criterion 5 : C5: Organizational Participation
Criterion 6 : C6: House Distance
Criterion 7 : C7: Use of Gadgets
Criterion 8 : C8: Study Hours

System Algorithm: In the AHP method, a problem is broken down into several criteria arranged in a hierarchy. Each criterion is weighted by making a pairwise comparison between the criteria. Each alternative weight selection performs pairwise comparisons. This step with AHP theory will produce the final value for each alternative. The alternative with the greatest final value is best.

Table 1. Pair Comparison Rating Scale

Intensity of Interest	Information
1	The two elements are equally important
3	One element is slightly more important than the other
5	One element is more important than the other
7	One element is clearly more important than the other
9	One element is absolutely more important than any other
2,4,6,8	The values between two adjacent consideration values
Inverse	If activity *i* gets one point compared to activity *i*, then *i* has the opposite value compared to *i*

3. Result and Discussion

After analyzing the criterion by using AHP Method, then fuzzy and Promethee implemented.

Table 2. Matrix of Criteria Comparison

	IPS	IPS	Jlh Buku	Uang Saku	Organisasi	Jarak rumah	Pengg Gadget	Jam Belajar
IPS	1	3	9	9	7	9	3	3
IPK	0,33	1	5	7	5	9	3	3
Jlh Buku	0,11	0,2	1	3	3	7	3	0,33
Uang Saku	0,11	0,14	0,3	1	0,2	3	0,33	0,2
Organisasi	0,14	0,2	0,33	5	1	5	0,33	0,33
Jarak rumah	0,11	0,14	0,14	0,33	0,33	1	0,33	0,2
Pengg Gadget	0,33	0,33	0,33	3	3	3	1	1
Jam Belajar	0,33	0,33	3	5	3	5	1	1

With the criteria in each column divided by the number of columns concerned, the following matrix is obtained:

Table 3. Addition of Element Values for Each Matrix Column

	IPS	IPS	Jlh Buku	Uang Saku	Organisasi	Jarak Rumah	Pengg Gadget	Jam Belajar
IPS	1	3	9	9	7	9	3	3
IPK	0,33	1	5	7	5	9	3	3
Jlh Buku	0,11	0,2	1	3	3	7	3	0,33
Uang Saku	0,11	0,14	0,3	1	0,2	3	0,33	0,2
Organisasi	0,14	0,2	0,33	5	1	5	0,33	0,33
Jarak rumah	0,11	0,14	0,14	0,33	0,33	1	0,33	0,2
Pengg Gadget	0,33	0,33	0,33	3	3	3	1	1
Jam Belajar	0,33	0,33	3	5	3	5	1	1
$\sum kolom$	**2,46**	**5,34**	**19,1**	**33,33**	**22,53**	**42**	**11,99**	**9,06**
$\sum total$	**145,81**							

This column vector is then multiplied by the original matrix, resulting in a value for each row where each value is further divided by the corresponding vector value. The average value of the results of this division is the maximum principal eigen value (λ_{max}).

Table 4. Criteria Priority Weight Matrix

	IPS	IPS	Jlh Buku	Uang Saku	Organisasi	Jarak rumah	Pengg Gadget	Jam Belajar	Nilai Rata-rata
IPS	0,4065	0,5618	0,4712	0,270027	0,31069685	0,21428571	0,250208507	0,33112583	0,351981238
IPK	0,13415	0,18727	0,26178	0,210021	0,22192632	0,21428571	0,250208507	0,33112583	0,226344967
Jlh Buku	0,04472	0,03745	0,05236	0,090009	0,13315579	0,16666667	0,250208507	0,03642384	0,101373557
Uang Saku	0,04472	0,02622	0,01571	0,030003	0,00887705	0,07142857	0,027522936	0,02207506	0,030818262
Organisasi	0,05691	0,03745	0,01728	0,150015	0,04438526	0,11904762	0,027522936	0,03642384	0,061129488
Jarak rumah	0,13415	0,0618	0,01728	0,090009	0,13315579	0,07142857	0,083402836	0,11037528	0,087699132
Pengg Gadget	0,13415	0,0618	0,15707	0,150015	0,13315579	0,11904762	0,083402836	0,11037528	0,118626085
Jam Belajar	0,13415	0,0618	0,15707	0,150015	0,13315579	0,11904762	0,083402836	0,11037528	0,118626085

Criteria value matrix, this matrix is obtained by the formula: New column row value = Old column row value / the number of each old column. The next step, the number of the criteria priority matrix is divided by the number of predefined criteria (in this case there are 8 criteria) so that the results of the priority weights can be found.

Table 5. Distribution of Total Element Value

	IPS	IPS	Jlh Buku	Uang Saku	Organisasi	Jarak rumah	Pengg Gadget	Jam Belajar	Jumlah	Prioritas
IPS	0,4065	0,5618	0,4712	0,270027	0,31069685	0,21428571	0,250208507	0,33112583	2,815849907	0,35198
IPK	0,13415	0,18727	0,26178	0,210021	0,22192632	0,21428571	0,250208507	0,33112583	1,810759735	0,22634
Jlh Buku	0,04472	0,03745	0,05236	0,090009	0,13315579	0,16666667	0,250208507	0,03642384	0,81098846	0,10137
Uang Saku	0,04472	0,02622	0,01571	0,030003	0,00887705	0,07142857	0,027522936	0,02207506	0,246546096	0,03082
Organisasi	0,05691	0,03745	0,01728	0,150015	0,04438526	0,11904762	0,027522936	0,03642384	0,489035902	0,06113
Jarak rumah	0,13415	0,0618	0,01728	0,090009	0,13315579	0,07142857	0,083402836	0,11037528	0,701593057	0,0877
Pengg Gadget	0,13415	0,0618	0,15707	0,150015	0,13315579	0,11904762	0,083402836	0,11037528	0,949008682	0,11863
Jam Belajar	0,13415	0,0618	0,15707	0,150015	0,13315579	0,11904762	0,083402836	0,11037528	0,949008682	0,11863

Checking the ratio of the consistency matrix of the comparison between the criteria by multiplying all the sum of the element values for each column of the matrix (Table 3) by the priority weighting criteria (Table 5).

Table 6. Multiplication Result for Each Row of the Consistency Matrix Criteria

	IPS	IPS	Jlh Buku	Uang Saku	Organisasi	Jarak rumah	Pengg Gadget	Jam Belajar	Jumlah
IPS	0,35198	0,67903	0,91236	0,27736436	0,42790641	0,78929219	0,355878256	0,35587826	4,149697629
IPK	0,07469	0,10137	0,15409	0,42790641	0,30564744	1,06763477	0,355878256	0,35587826	2,843103838
Jlh Buku	0,01115	0,00616	0,06113	0,2630974	0,18338846	0,8303826	0,101373558	0,03345327	1,490139519
Uang Saku	0,00339	0,00856	0,02631	0,11862609	0,01753983	0,03081826	0,009245479	0,00616365	0,220651181
Organisasi	0,00856	0,01754	0,03915	0,59313043	0,11862609	0,30564744	0,020172731	0,02017273	1,122993975
Jarak rumah	0,00965	0,01661	0,01661	0,02894071	0,03914661	0,02894071	0,012277878	0,01753983	0,169707949
Pengg Gadget	0,03915	0,03915	0,03915	0,35587826	0,35587826	0,35587826	0,039146608	0,11862609	1,342847285
Jam Belajar	0,03915	0,03915	0,35588	0,59313043	0,35587826	0,59313043	0,355878256	0,11862609	2,450814921

Table 7. Consistency Ratio Calculation

	Jumlah	Prioritas	Hasil
IPS	4,1497	0,35198	4,50168
IPK	2,8431	0,22634	3,06945
Jlh Buku	1,49014	0,10137	1,59151
Uang Saku	0,22065	0,03082	0,25147
Organisasi	1,12299	0,06113	1,18412
Jarak rumah	0,16971	0,0877	0,25741
Pengg Gadget	1,34285	0,11863	1,46147
Jam Belajar	2,45081	0,11863	2,56944
		Jlh Hasil	14,8866

$$\lambda_{maks} = \frac{Jumlah\ Hasil}{Jumlah\ Aspek} = 1,860819$$

$$CI = \frac{\lambda_{maks} - n}{n-1} = -0,87703$$

Since n = 8, RI = 1,41 then $CR = \frac{CI}{RI} = -0,622$. Since CR < 0,1 then Consistency Ratio.

The final result is that the priority score of the criteria is the best criteria as the criteria for selecting outstanding students.

Table 8. Priority Table

	IPS	IPS	Jlh Buku	Uang Saku	Organisasi	Jarak rumah	Pengg Gadget	Jam Belajar	Skala Prioritas	Rangking
IPS	1	3	9	9	7	9	3	3	4,501678867	1
IPK	0,33	1	5	7	5	9	3	3	3,069448805	2
Jlh Buku	0,11	0,2	1	3	3	7	3	0,33	1,591513077	4
Uang Saku	0,11	0,14	0,3	1	0,2	3	0,33	0,2	0,251469443	8
Organisasi	0,14	0,2	0,33	5	1	5	0,33	0,33	1,184123463	6
Jarak rumah	0,11	0,14	0,14	0,33	0,33	1	0,33	0,2	0,257407081	7
Pengg Gadget	0,33	0,33	0,33	3	3	3	1	1	1,46147337	5
Jam Belajar	0,33	0,33	3	5	3	5	1	1	2,569441006	3

From Table 8. it can be concluded that the best criteria that can be used in selecting outstanding students are criteria 1: Semester IP, criterion 2: GPA (IPK), criterion 8: Study Hours, criterion 3: Number of Books, and criterion 7: Use of Gadgets. Because the GPA and IPS criteria are the same parameters, the researchers decided on the GPA criteria to use. Meanwhile, Study Hours and Gadget Usage are criteria for the use of time, so the researcher proposes criteria 5: Organization to be the criteria for selecting outstanding students.

Problem Analysis with Fuzzy-Promethee

In this study, we use linguistic weight values which are divided into five parts, namely not important, less important, quite important, important and very important. The weight value is represented in the form of a trapezium interval fuzzy number. This weight value is used to measure the intensity of the importance of a criterion. The value information on each weight is in Table 9.

Table 9. Weighting Value Information

Weighting Name	$W_k\ (m_l, m_w, \alpha,)_{LR}$
Not Important (NI)	(0,25; 0,25; 0,25; 0,25)
Less Important (NTI)	(0,50; 0,50; 0,25; 0,25)
Enough Important (EI)	(0,75; 0,75; 0,25; 0,25)
Important (I)	(1,00; 1,00; 0,25; 0,25)
Very Important (VI)	(1,25; 1,25; 0,25; 0,25)

To support the method used, the criteria used also have the following value information:

1. Grade Point Average / GPA (f_1)

Distribution of the value of the GPA criteria, for the Fuzzy-Promethee evaluation value where the input is a nominal value of x at intervals of 0-4. The requirement for outstanding students is a minimum GPA of 2.75 and GPA> 3.5 to get the cum laude predicate so that the value of $m_l = x - 2.75$, $m_u = x + 1.25$, $\alpha = 2.75$, $\beta = 1.25$. Because Semester IP is not negative, this criterion uses a linear preference function and an area that does not differ.

2. Study Hours (f_2)

The division of the criteria for learning hours is divided into 5 parts, namely 0 - 5 hours, 5 - 10 hours = 1, and 10 - 15 hours. Range from 0 to 3 with the division of the value scale as 0 - 5 hours = 1, 5 - 10 hours = 2 and 10 - 15 hours = 3. The higher the value, the greater the time used for learning. The Fuzzy-Promethee evaluation value where the input is a nominal value of x has a range for the value of m_l and m_u is x, $\alpha = 1. = 1$. In this criterion the level preference function is used.

3. Number of Lecture Books (f_3)

The distribution of the criteria for the number of lecture books, for the Fuzzy-Promethee evaluation value where the input is the nominal value x (unit of fruit) has a range for the value of $m_l = x$, $m_u = x + (10\% * x)$, $\alpha = 25\% * m_l$, and $\beta = 25\% * m_u$, if it is known that ml - α <0 then the value of $\alpha = 0$, because the number of books cannot possibly have a negative value. In this criterion, the linear preference function is used.

4. Organizational Participation (f_4)

The distribution of the criteria for organizational participation is divided into 2 parts, namely following an organization and not being organized. The value range from 0 to 5 with the distribution of scale values, organized = 1 and not organized = 0. Fuzzy-Promethee evaluation value where the input is the value of x has a range for values $m_l = x$, $m_u = x + 1$, $\alpha = \beta = 1$. At this criterion is used, a function of usual preference.

4. Conclusion

This study proposes a new method in the selection system for outstanding students which contains many qualitative variables. The method proposed is to integrate the Analytical Hierarchical Process method which produces the best criteria in the process of selecting outstanding students, which is then continued using the fuzzy-promethee method to choose the alternative of high achieving students. To the next research, can be done how to make an effective program of best student selection

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