Best Student Selection Using Extended Promethee II Method

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Abstract - At the end of learning at an educational level, leaders often perceive difficulties in determining the best students at a certain level of education. Cumulative Achievement Index may not be used for decision makers in determining the best students. There are criteria other criteria that influence them are actively organize, have never done a repair value, never follow short semester, never leave. Using these criteria and using Multi-Criteria Decision Making (MCDM) based methods applied to decision support systems can deliver the expected outcomes of higher education leaders. Many methods can be used on decision support systems such as Promethee, Promethee II, Electre, AHP, SAW, or TOPSIS. In this discussion, the author uses Extended Promethee II method in determining the best student at a college.

Keywords: The Best Student, Exprom II, Extended Promethee II

I. INTRODUCTION

Students are learners who are actively studying in formal higher education. Students are believed to have a creative mindset in doing every action. In each learning done on the school unit in the form of semester students will get a final grade known as the Semester Achievement Index (IPS). The accumulation of IPS in each semester becomes a Grade Point Average or known as GPA. In one educational unit, it is often difficult for university leaders to determine who is the best student of some students who follow the education process.

Students who have the highest GPA in each semester are not necessarily the best students that can be determined by the leadership of a college. Many factors determine a student to be the best. Among the factors that can determine the best students in addition to GPA is actively organizing, has never done a repair value, never follow the short semester, never leave. The number of criteria to be considered will make the taker more complex in generating a decision. To overcome this, the use of decision support system becomes the main solution that must be met by policy makers [1].

Implementation of information systems-based decision support system capable of processing alternative data along with criteria as a requirement of a leader to easily determine the best student of several alternative students. Decision Support System is a system that can help the user, in this case, the manager or leader, do some specific process to determine the best solution [2]. For example, the determination of the best employees by applying the TOPSIS method can result in more efficient decisions [3]. The application of SPK using Multi-Criteria Decision Making (MCDM) of them can use TOPSIS method, ELECTRE, AHP, PROMETHEE, SAW, WP [4][5][6]. In this case, the implementation of the Extended Promethee II method can be used to determine the best student based on the criteria specified by several alternatives.

II. METHODS AND MATERIAL

2.1 Extended Promethee II

The method of Extended Promethee II is the development of Promethee II. Abbreviated with EXPROM II, this method steps resembles with the method of Promethee II. Like its predecessor, this method also uses pairwise comparisons against alternative alternatives taking into account changes in changes to each criterion[7][8].

The steps of The Extended Promethee II(EXPROM2)[8], can be seen below:

Step 1: Normalize the decision matrix

Normalize the decision matrix (x_{ij}), for the gain attribute using equation 1 and for the cost attribute using equation 2:

$$R_{ij} = [x_{ij} - \min(x_{ij})] / [\max(x_{ij}) - \min(x_{ij})] \dots \dots \dots (1)$$

$$i=1, 2, \dots, m; j=1, 2, \dots, n$$

$$R_{ij} = [\max(x_{ij}) - x_{ij}] / [\max(x_{ij}) - \min(x_{ij})] \dots \dots \dots (2)$$

Step 2: Calculates evaluative differences from alternative i^{th} with other alternatives.

This step involves calculating the difference in criterion value (d_j) between different alternatives pair-wise.

Step 3: Calculate Preferences $P_j(i, i')$

There are six main types of preference functions, such as ordinary criteria, U-shape criteria, V-form criteria, level criteria, The V-form criteria and Gaussian criteria, but most are common criteria using the following formula:

$$P_j(i, i') = 0 \text{ if } r_{ij} \leq r_{i'j} \dots \dots \dots (3)$$

$$P_j(i, i') = (r_{ij} - r_{i'j}) \text{ if } r_{ij} > r_{i'j} \dots \dots \dots (4)$$

Step 4: Calculate the Weak Preferences Index

The preference index calculation is weak by considering the weighted value criterion with the following equation.

$$WP(i, i') = [\sum_{j=1}^n W_j x P_j(i, i')] / \sum_{j=1}^n W_j \dots \dots \dots (5)$$

Where w_j is the relative importance (weight) of the j criterion.

Step 5: Define the strict preferences

The strict preferences, $SP_j(i, i')$ is based on the ratio of dm_j values to the range of values as defined by the evaluation of all alternative circuits for a criterion.

$$SP_j(i, i') = [\max(0, d_j - L_j)] / [dm_j - L_j] \dots \dots \dots (6)$$

Where L_j is the limit of preference (0 for the usual criterion preferences function and values unimportant for the other five functions of preference) and dm_j differ among other ideal and anti-ideal values of the number of criteria.

Step 6: Compute the strict preferences index

The strict preference index calculation uses the following equation:

$$SP(i, i') = [\sum_{j=1}^n W_j x SP_j(i, i')] / \sum_{j=1}^n W_j \dots\dots\dots(7)$$

Step 7: Calculates the value of total preferences index

$$TP(i, i') = \text{Min}[1, WP(i, i') + SP(i, i')] \dots\dots\dots(8)$$

Step 8: Determining leaving flow and entering Outranking Flow

Determination of Leaving Flow and Entering Outranking Flow using the equation:

Leaving (Positive) Flow

$$\varphi^+(i) = \frac{1}{m-1} \sum_{i'=1}^n TP(i, i') (i \neq i') \dots\dots\dots(9)$$

Entering (Outranking) Flow.

$$\varphi^-(i) = \frac{1}{m-1} \sum_{i'=1}^n TP(i', i) (i \neq i') \dots\dots\dots(10)$$

Step 9: Calculating the net outranking flow

$$\varphi(i) = \varphi^+(i) - \varphi^-(i) \dots\dots\dots(11)$$

Step 10: Determine the ranking

Determining all the priceless alternatives depends on the value of $\varphi(i)$. The better of alternative is the higher value of $\varphi(i)$.

III. RESULTS AND DISCUSSION

Implementation of decision support systems requires alternatives, weights, and criteria in the process of calculation. In table 1 the following criteria have been set:

TABLE I Criteria and Weight

Criateria	Weight	Type
IPK (C1)	0.30	Benefit
Leave Status (C2)	0.20	Benefit
Status of Short Repair / Short Semester (C3)	0.20	Benefit
Active Organizing (C4)	0.30	Benefit

Table II is the value range of the Leave Status criterion.

Tabel II.The Value of Leave Status (C2)

Information	Value
Ever	50
Never	100

Table III show the range of values of the Short Values/Short Recovery criteria.

TABLE III Criteria for Improving Value / Short Semester (C3)

Information	Value
Ever	50
Never	100

Table IV is a range of values from Active Organizing criteria.

TABLE IV Active Organizing (C4)

Information	Value
Inactive	0
Less Active	50
Active	100

Table V, is a list of student alternatives to be selected the best.

TABLE V Student Alternative

Alternative	Criteria			
	C1	C2	C3	C4
A ₁	3.80	Never	Never	Active
A ₂	3.80	Ever	Ever	Inactive
A ₃	3.75	Never	Never	Active
A ₄	3.90	Never	Ever	Less Active

Based on table V and the range of values on each criterion, the results of each alternative are obtained as follows:

TABLE VII The alternative Match Rating Table and Criteria

Alternative	Criteria			
	C1	C2	C3	C4
A ₁	3.80	100	100	100
A ₂	3.80	50	100	0
A ₃	3.75	100	100	100
A ₄	3.90	100	50	50

The first step is to apply the EXPROM II method, which is normalizing the decision matrix using equation 1.

C1 = IPK

$$R_{1,1} = \frac{[3.80 - 3.75]}{[3.90 - 3.75]} = 0.333333$$

$$R_{2,1} = \frac{[3.80 - 3.75]}{[3.90 - 3.75]} = 0.333333$$

$$R_{3,1} = \frac{[3.75 - 3.75]}{[3.90 - 3.75]} = 0$$

$$R_{4,1} = \frac{[3.90 - 3.75]}{[3.90 - 3.75]} = 1$$

C2 = Leave Status

$$R_{1,2} = \frac{[100 - 50]}{[100 - 50]} = 1$$

$$R_{2,2} = \frac{[50 - 50]}{[100 - 50]} = 0$$

$$R_{3,2} = \frac{[100 - 50]}{[100 - 50]} = 1$$

$$R_{3,2} = \frac{[100 - 5]}{[100 - 50]} = 1$$

Do the same for C3 and C4 so the result will be seen in Table VIII.

TABLE VIII The Normalize Matrix

Alternative	C1	C2	C3	C4
A ₁	0.333333	1	1	1
A ₂	0.333333	0	1	0
A ₃	0	1	1	1
A ₄	1	1	0	0.5

The next step is finding for the Preferences $P_j(i, i')$ with equations 3 and 4.

For C1, pairs-wise matrix:

if $0.333333 \leq 0.333333$ *True*, then $P_1(1,2) = 0$

if $0.333333 \leq 0$ *False Else if* $0.333333 > 0$ *True*, then $P_1(1,3) = 0.333333 - 0$
 $= 0.333333$

if $0.333333 \leq 1$ *True*, then $P_1(1,4) = 0$

if $0.333333 \leq 0.333333$ *True*, then $P_1(2,1) = 0$

if $0.333333 \leq 0$ *False Else if* $0.333333 > 0$ *True*, then $P_1(2,3) = 0.333333 - 0 = 0.333333$

if $0.333333 \leq 1$ *True*, then $P_1(2,4) = 0$

if $0 \leq 0.333333$ *True*, then $P_1(3,1) = 0$

if $0 \leq 0.333333$ *True*, then $P_1(3,2) = 0$

if $0 \leq 0.333333$ *True*, then $P_1(3,4) = 0$

if $1 \leq 0.333333$ *False Else if* $1 > 0.333333$ *True*, then $P_1(4,1) = 1 - 0.333333$
 $= 0.666667$

if $1 \leq 0.333333$ *False Else if* $1 > 0.333333$ *True*, then $P_1(4,2) = 1 - 0.333333$
 $= 0.666667$

if $1 \leq 0$ *False Else if* $1 > 0$ *True*, then $P_1(4,3) = 1 - 0 = 1$

For C2, the matrix pairs:

if $1 \leq 0$ *False Else if* $1 > 0$ *True*, then $P_2(1,2) = 1 - 0 = 1$

if $1 \leq 1$ *True*, then $P_2(1,3) = 0$

if $1 \leq 1$ *True*, then $P_2(1,4) = 0$

if $0 \leq 1$ *True*, then $P_2(2,1) = 0$

if $0 \leq 1$ *True*, then $P_2(2,3) = 0$

if $0 \leq 1$ *True*, then $P_2(2,4) = 0$

if $1 \leq 1$ *True*, then $P_2(3,1) = 0$

if $1 \leq 0$ *False Else if* $1 > 0$ *True*, then $P_2(3,2) = 1 - 0 = 1$

if $1 \leq 1$ *True*, then $P_2(4,1) = 0$

if $1 \leq 0$ *False Else if* $1 > 0$ *True*, then $P_2(4,2) = 1 - 0 = 1$

if $1 \leq 1$ *True*, then $P_2(4,3) = 0$

Next, do the same steps for C3 and C4, will get the results as in table IX.

TABLE IX Result of comparison of matrix pairs-wise

Alternative	C1	C2	C3	C4
P ₁ (1,2)	0	1	0	1
P ₁ (1,3)	0.333333	0	0	0
P ₁ (1,4)	0	0	1	0.5
P ₂ (2,1)	0	0	0	0
P ₂ (2,3)	0.333333	0	0	0
P ₂ (2,4)	0	0	1	0
P ₃ (3,1)	0	0	0	0
P ₃ (3,2)	0	1	0	1
P ₃ (3,4)	0	0	1	0.5
P ₄ (4,1)	0.666667	0	0	0
P ₄ (4,2)	0.666667	1	0	0.5
P ₄ (4,3)	1	0	0	0

The next process calculates the Weak Preferential Value using equation 5.

$$WP(1,2) = ((0.3*0) + (0.2*1) + (0.2*0) + (0.3*1)) / 1 = 0.5$$

$$WP(1,3) = ((0.3*0.333333) + (0.2*0) + (0.2*0) + (0.3*0)) / 1 = 0.1$$

$$WP(1,4) = ((0.3*0) + (0.2*0) + (0.2*1) + (0.3*0.5)) / 1 = 0.5$$

$$WP(2,1) = ((0.3*0) + (0.2*0) + (0.2*0) + (0.3*0)) / 1 = 0$$

Calculate up to P₄ (4.3), and the results obtained as in Table

TABLE X Weak Preferences

Alternative	Value
WP(1,2)	0.5
WP(1,3)	0.1
WP(1,4)	0.35
WP(2,1)	0
WP(2,3)	0.1
WP(2,4)	0.2
WP(3,1)	0
WP(3,2)	0.5
WP(3,4)	0.35
WP(4,1)	0.2
WP(4,2)	0.55
WP(4,3)	0.3

Then use equation 6 to find the value of strict preference, the result as in Table XI

TABLE XI Strict Preferences

Alternative	Value
SP(1,2)	0.5
SP(1,3)	0.1
SP(1,4)	0.35
SP(2,1)	0
SP(2,3)	0.1
SP(2,4)	0.2

Alternative	Value
SP (3,1)	0
SP (3,2)	0.5
SP (3,4)	0.35
SP (4,1)	0.2
SP (4,2)	0.55
SP (4,3)	0.3

From WP and SP, calculate the Total Preference value by using an equation to 8.

TABLE XII The Total Preference Value

Alternative	Value
TP(1,2)	$\text{Min}[1, 0.5+0.5] = 1$
TP (1,3)	$\text{Min}[1, 0.1+0.1] = 0.2$
TP (1,4)	$\text{Min}[1, 0.35+0.35] = 0.7$
TP (2,1)	$\text{Min}[1, 0+0] = 0$
TP (2,3)	$\text{Min}[1, 0.1+0.1] = 0.2$
TP (2,4)	$\text{Min}[1, 0.2+0.2] = 0.4$
TP (3,1)	$\text{Min}[1, 0+0] = 0$
TP (3,2)	$\text{Min}[1, 0.5+0.5] = 1$
TP (3,4)	$\text{Min}[1, 0.35+0.35] = 0.7$
TP (4,1)	$\text{Min}[1, 0.2+0.2] = 0.4$
TP (4,2)	$\text{Min}[1, 0.55+0.55] = 1$
TP (4,3)	$\text{Min}[1, 0.3+0.3] = 0.6$

From Table XII will form the dominant aggregate matrix as follows:

$$\begin{bmatrix} - & 1 & 0.2 & 0.7 \\ 0 & - & 0.2 & 0.4 \\ 0 & 1 & - & 0.7 \\ 0.4 & 1 & 0.3 & - \end{bmatrix}$$

The next step calculate Leaving Flow and Entering (Outranking) Flow using equations 9 and 10.

$$\phi 1^+ = \frac{1}{4-1} [1 + 0.2 + 0.7] = \frac{1}{3} \times 1.9 = 0.63333$$

$$\phi 2^+ = \frac{1}{4-1} [0 + 0.2 + 0.4] = \frac{1}{3} \times 0.6 = 0.2$$

$$\phi 3^+ = \frac{1}{4-1} [0 + 1 + 0.7] = \frac{1}{3} \times 1.7 = 0.56667$$

$$\phi 4^+ = \frac{1}{4-1} [0.4 + 1 + 0.3] = \frac{1}{3} \times 1.7 = 0.66667$$

$$\varphi 1^- = \frac{1}{4-1} [0 + 0 + 0.4] = \frac{1}{3} \times 0.4 = 0,13333$$

$$\varphi 2^- = \frac{1}{4-1} [1 + 1 + 1] = \frac{1}{3} \times 3 = 1$$

$$\varphi 3^- = \frac{1}{4-1} [0.2 + 0.2 + 0.6] = \frac{1}{3} \times 1 = 0,33333$$

$$\varphi 4^- = \frac{1}{4-1} [0.7 + 0.4 + 0.7] = \frac{1}{3} \times 1.8 = 0,6$$

The last step calculates the Net (Outranking) Flow using equation 11.

TABLE XIII The Leaving Flow and Entering Flow

Alternative	Leaving Flow	Entering (Outranking) Flow	Net (Outranking) Flow
A ₁	0.63333	0.13333	0.500
A ₂	0.2	1	-0.800
A ₃	0.56667	0.33333	0.233
A ₄	0.66667	0.6	0.067

TABLE XIV Ranking

Alternative	Result	Rank
A ₁	0.500	1
A ₂	-0.800	4
A ₃	0.233	2
A ₄	0.067	3

From the calculation, it is clear that Alternative A₁ is the best alternative of all alternatives.

IV. CONCLUSION

In this paper, the author explores the use of Extended Promethee II method in solving the problem of determining the best students and generate more efficient decisions. The effectiveness of the resulting decisions can motivate students to be more active in learning. In this paper, four criteria in the determination and policy makers can add other criteria such as certificates either from the study organizers, student achievement.

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