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Application of Decision Support System in Determining the Best Physics Learning Media Aids Using VIKOR, EDAS, and EXPROM II Methods

Yono Cahyono[1], Perani Rosyani[2*], Resti Amalia[3], Sewaka[4], Alfitri Rizka Rinanda[5], Muhammad Rizki[6], Okvrilllia Reony Ondri[7]
Pamulang University
Corresponding Author: Perani Rosyani dosen00837@unpam.ac.id

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A B S T R A C T

The development of effective physics learning media is a major challenge in supporting an innovative and result-oriented learning process. This research aims to implement a Decision Support System (DSS) in the selection of physics learning media aids by using the EDAS, VIKOR, and EXPROM II methods. The EDAS method is used to evaluate alternative learning media tools based on tiered preferences, while VIKOR provides an optimal solution by considering the best and worst values. In addition, EXPROM II provides an explicit assessment of complexity and risk in the context of physics learning media selection. The practical implications of these findings can help decision makers in the field of education to improve the quality of physics learning media used in the educational process

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INTRODUCTION

In the era of increasingly advanced education, the use of learning media in physics learning is very important. Effective learning media can help improve students' understanding of complex physics concepts. However, the main problem that often arises is identifying the best physics learning media tools to meet student needs. In this case, a Decision Support System (DSS) is needed that can provide objective guidance in the selection of the most appropriate physics learning media tools.

A key issue in determining the best physics learning media tool is the subjectivity of decision-making. Decisions are often based on qualitative assessments that rely heavily on personal experience and preferences. Therefore, a method is needed that can provide an objective basis in selecting the most suitable physics learning media tools. In this research, the methods chosen are VIKOR (VIšekriterijumsko KOmpromisno Rangiranje), EDAS (Evaluation based on Distance from Average Solution) and EXPROM II (Extended Promethee II).

Therefore, this research is expected to make a major contribution in improving the quality of physics learning by providing an objective basis in the selection of effective learning media aids. This allows educators to make the right decision in choosing learning media that suits the needs of students, which ultimately increases students' understanding and interest in physics education.

LITERATURE REVIEW

In determining the best physics learning media tools to facilitate students in choosing the best physics learning media tools so that the learning process can be more effective. In order to determine the right choice the author applies the VIKOR (VIšekriterijumsko KOmpromisno Rangiranje), EDAS (Evaluation based on Distance from Average Solution) and EXPROM II (Extended Promethee II) methods to obtain rankings so as to produce precise and accurate assessments. There are 6 alternative data of physics learning media aids shown in table 1.

Table 1. Alternative Data for Physics Learning Media Aids

Code	Alternative
F1	Physics Question Bank
F2	Learn Physics Easy
F3	Physics Formula
F4	PhyWiz
F5	Pocket Physics
F6	Complete Physics Formula & Materials

In determining physics learning media aids, criteria that support decision making are also needed. There are 6 criteria including can be seen in table 2.

Table 2. Criteria Data

Code	Criteria	Weights	Attribute
C1	Storage Capacity	2	Cost
C2	App Features	3,5	Benefit
C3	Number of Materials	1,5	Benefit
C4	Number of Language Options	1	Benefit
C5	Number of Users	1	Benefit
C6	Review Rating	1	Benefit

The following table 3 is an alternative table of several applications that will be selected as alternatives to the best physics learning media aids.

Table 3. Alternative Physics Learning Media Aids

Alternative	C1	C2	C3	C4	C5	C6
Physics Question Bank	3.8	Question Bank	0	1	50000	4.6
Learn Physics Easy	11	Materials, Videos, Question Bank	11	1	10000	4.6
Physics Formula	7.1	Materials	48	1	1000000	5.0
PhyWiz	6.4	Materials, Question Bank	35	10	1000000	4.5
Pocket Physics	10	Materials	27	3	1000000	4.7
Complete Physics Formula & Materials	12	Materials	55	1	50000	4.6

In criterion 2, there are several features of the application offered, this feature is linguistic data so it must be weighted simply. The weighting model can be seen in table 4.

Table 4. Weighting of Application Feature Criteria

Description	Value
Materials	1
Videos	1
Question Bank	1

From table 4, the weighting of the criteria above can produce match rating data as shown in table 5 below:

Table 5. Suitability Rating Data

Alternative	C1	C2	C3	C4	C5	C6
F1	3.8	1	0	1	50000	4.6
F2	11	3	11	1	10000	4.6
F3	7.1	1	48	1	1000000	5.0
F4	6.4	2	35	10	1000000	4.5
F5	10	1	27	3	1000000	4.7
F6	12	1	55	1	50000	4.6
Max	12	3	55	10	1000000	5.0
Min	3.8	1	0	1	10000	4.5

METHODOLOGY

VIKOR (VIšekriterijumsko KOmpromisno Rangiranje) Method

VIKOR (VIšekriterijumsko KOmpromisno Rangiranje) is one of the methods used in Multi Attribute Decision Making (MADM). The ranking considers the closest solution or alternative as an approximate ideal solution. The VIKOR method is a MADM method with complex linear normalization calculations that can guarantee against existing alternatives/solutions. The processing steps of the VIKOR method are as follows:

a. Perform the Decision matrix of alternatives with size $X_{n\times c}$,with the following formula:

$$X = \begin{matrix} A_1 \\ A_2 \\ A_3 \\ \vdots \\ A_n \end{matrix} \begin{bmatrix} X_{11} & X_{12} & X_{13} & \cdots & X_{1n} \\ X_{21} & X_{22} & X_{23} & \cdots & X_{2c} \\ X_{31} & X_{32} & X_{33} & \cdots & X_{3c} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ X_{n1} & X_{n2} & X_{n3} & \cdots & X_{nc} \end{bmatrix} \quad (1)$$

Where A_1 is the i-th alternative, $i = 1,2,\dots,n$ is the j-th criterion and x_{ij} is the element of the matrix that shows the performance of the i-th alternative.

b. Calculate positive and negative values as ideal solutions, with the formula.

$$f_j^* = \{\min f_{ij} | j = 1,2 \dots, c\}$$
$$= \{f_1^*, f_2^*, \dots, f_j^*, \dots, f_c^*\} \quad (2)$$
$$f_j^- = \{\max f_{ij} | j = 1,2 \dots, c\}$$
$$= \{f_1^-, f_2^-, \dots, f_j^-, \dots, f_c^-\} \quad (3)$$

c. Perform normalization to produce a new decision matrix with size $N_{n\times c}$, with the formula.

$$N_{ij} = \frac{f_{ij}^* - X_{ij}}{f_{ij}^* - f_{ij}^-} \quad (4)$$

d. Calculating the normalization matrix with weights, with the formula.

$$F_{ij} = N_{ij} \times BK_i \quad (5)$$

B_{Ki} is the weight calculated using AHP with the number of calculations $F_{n\times c}$.

e. Calculate the utility measure, with the formula.

$$S_i = \sum_{j=1}^{6} F_{ij} \quad (6)$$

$R_i = \max(F_{i1}, F_{i2}, \dots, F_{i6})$ (7)

$S^- = \max(S_1, S_2, S_3 \dots, S_{55})$ (8)

$S^* = \min(S_1, S_2, S_3 \dots, S_{55})$

$R^- = \max(R_1, R_2, R_3 \dots, R_{55})$ (9)

$R^* = \min(R_1, R_2, R_3 \dots, R_{55})$

f. Calculate the VIKOR index (Q), with the following formula:

$$Q_1 = \left[v \frac{(S_1 - S^*)}{(S^- - S^*)}\right] + \left[(1 - v) \frac{(R_1 - R^*)}{(R^- - R^*)}\right] \quad (10)$$

where v is the maximum weight of group utility which is usually set to 0.5.

g. Ranking alternatives from VIKOR Value.
The VIKOR index value obtained in the ranking step to determine the best alternative choice is determined on the small VIKOR value that indicates better quality.

h. Perform a compromise solution with two solutions with the difference between the first and second VIKOR index or Acceptable advantage condition.

EDAS Method (Evaluation based on Distance from Average Solution)

The EDAS (Evaluation Distance to Average Solution) method is one of the methods developed to support the SPK process. The characteristic of this method is that it uses a calculation function to analyze and solve problems by analyzing positive and negative ideal distances and averaging them to get the final result, achieving accurate and precise final results.

i. Form a Decision Matrix

$$X = \left[X_{ij}\right]_{nxm} = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1m} \\ X_{21} & X_{22} & \cdots & X_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ X_{n1} & X_{n2} & \cdots & X_{nm} \end{bmatrix} \quad (1)$$

With X_{ij} representing the performance value of the i-th alternative on the *j*-th criterion.

j. Make provisions regarding the average value for all criteria.

$$AV_j = \frac{\sum_{i=m}^{n} X_{ij}}{n} \quad (2)$$

k. Finding the average value of positive and negative distances according to the type of criteria.
if the criterion type is benefit, the formula used is as follows:

$$PDA_{ij} = \frac{max\left(0, (X_{ij} - AV_j)\right)}{AV_j} \quad (3)$$

$$NDA_{ij} = \frac{max\left(0, (AV_j - X_{ij})\right)}{AV_j} \quad (4)$$

If the criterion type is cost, the formula used is as follows:

$$PDA_{ij} = \frac{max\left(0, (AV_j - X_{ij})\right)}{AV_j} \quad (5)$$

$$NDA_{ij} = \frac{max\left(0, (X_{ij} - AV_j)\right)}{AV_j} \quad (6)$$

l. Calculation of positive and negative distances for all alternatives.

$SP_i = \sum_{j=1}^{m} PDA_{ij}.wj$ (7)

$SN_i = \sum_{j=1}^{m} NDA_{ij}.wj$ (8)

Where wj is the *j*-th criterion weight.

m. Normalization of SP and SN values for all alternatives.

$NSP_i = \frac{SP_i}{max_i(SP_i)}$ (9)

$NSN_i = \frac{max\left(0,\left(X_{ij}-AV_j\right)\right)}{AV_j}$ (10)

n. Calculating scores on all alternatives.

$AS_i = \frac{1}{2}(NSP_i + NSN_i)$ (11)

EXPROM II (Extended Promethee II) Method

Extended Promethee II (EXPROM II) is an extension or expansion of the modified version of the Promethee II method, or similar to Promethee II. Pairwise alternative comparison takes into account the deviation of each criterion used in the Extended Promethee II (EXPROM II) method. Practically speaking, ideal and anti-ideal alternatives represent only the extreme performance limits determined by the boundary conditions of the problem under consideration. The steps of Extended Promethee II (EXPROM II) are as follows:

a. Creating a Decision Matrix.
   The Decision Matrix is a matrix consisting of alternative values i for each criterion j.
b. Normalize the Decision Matrix.
   For benefit criteria:

   $r_{ij} = \frac{[X_{ij}-\min(X_{ij})]}{[\max(X_{ij})-\min(X_{ij})]} (i = 1,2, \dots, m; j = 1,2, \dots, n)$ (1)

   For cost criteria:

   $r_{ij} = \frac{[\max(X_{ij})-X_{ij}]}{[\max(X_{ij})-\min(X_{ij})]}$ (2)

   where:

   r_{ij} = normalized matrix.
   i = alternative.
   j = criteria.
c. Determination of Preference Function $P_j(i, i')$.
   The Preference Function Equation $P_j(i, i')$ is given below:

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

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

   Where:

   P_{ij} = Preference Function.
   i = alternative.
   i' = alternative that will be paired.
d. Calculating Weak Preference (WP) Value.
   Calculating the Weak Preference Index and considering criteria with different weights for each criterion the equation is as follows:

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

   Where:

   WP = Weak Preference.

n = number of criteria.
W_j = weight of criterion j.

e. Calculating the Value of $SP_j(i, i')$.
Determine the strong preference function value $SP_j(i, i')$ as follows:
$$SP_j(i, i') = [\max(0, d_j - L_j)]/[dm_j - L_j] \quad (6)$$
Where:
SP_j = Strict Preference of criterion j. dm_j = 1
d_j = rij-ri′j. L_j = 0

f. Calculating Strict Preference (SP) Value.
$$SP_j(i, i') = [\sum_{j=1}^{n} W_j \, xSP_j(i, i)] \sum_{j=1}^{n} W_j \quad (7)$$
Where:
SP = Weak Preference.
n = number of criteria.
W_j = weight of criterion j.

g. Calculating the total value of Total Preferences or $TP(i, i')$.
$$TP(i, i') = \text{Min}\,[1, \text{WP}(i, i') + SP(i, i')] \quad (8)$$

h. Calculate the Entering flow and Leaving flow using the equation:
For the outgoing (positive) direction in alternative *i*:
$$\varphi^+(i) = \frac{1}{m-1} \sum_{j=1}^{n} TP(i, i')(i \neq i') \quad (9)$$
For the incoming (negative) direction in alternative *i*:
$$\varphi^-(i) = \frac{1}{m-1} \sum_{j=1}^{n} TP(i, i')(i \neq i') \quad (10)$$
Where:
i = alternative. m = number of alternatives.
i' = paired alternative. n = number of criteria.
Outflow means how many alternatives dominate other alternatives, while outflow is how many alternatives are dominated by other alternatives.

i. Calculating Net Flow.
From the calculation of ranking φ(i) for other alternatives:
$$\varphi(i) = \varphi^+(i) - \varphi^-(i) \quad (11)$$

j. Ranking alternatives based on the highest φ(i). The ranking of all considered alternatives depends on the values of φ(i). The higher the value of φ(i), the better the alternative. Thus, the best alternative is the one with the highest φ(i) value.

RESULTS

Manual calculations using the VIKOR (VIšekriterijumsko KOmpromisno Rangiranje), EDAS (Evaluation based on Distance from Average Solution) and EXPROM II (Extended Promethee II) methods obtained rankings and produced precise and accurate evaluations. This manual calculation process is explained in more detail below.

VIKOR Method (VIšekriterijumsko KOmpromisno Rangiranje)

- Create a decision matrix of alternatives with size $X_{36\times 6}$.

$$X_{36\times6} = \begin{bmatrix} 3{,}8 & 1 & 0 & 1 & 50.000 & 4{,}6 \\ 11 & 3 & 11 & 1 & 10.000 & 4{,}6 \\ 7{,}1 & 1 & 48 & 1 & 1.000.000 & 5{,}0 \\ 6{,}4 & 2 & 35 & 10 & 1.000.000 & 4{,}5 \\ 10 & 1 & 27 & 3 & 1.000.000 & 4{,}7 \\ 12 & 1 & 55 & 1 & 50.000 & 4{,}6 \end{bmatrix}$$

- Calculate positive and negative values as the ideal solution of each criterion.

The positive ideal solution is the minimum value of each criterion of all alternatives. While the negative ideal value is the maximum value of each criterion of all alternatives.

$$f_1^* = \max(X_{11}, X_{12}, X_{13}, X_{14}, \dots, X_{66})$$
$$f_1^* = \max(12{,}3{,}55{,}10{,}1.000.000, (5{,}0))$$
$$f_1^* = \max(1.000.000)$$

$$f_1^- = \min(X_{11}, X_{12}, X_{13}, X_{14}, \dots, X_{66})$$
$$f_1^- = \min\big((3{,}8), 1{,}0{,}1{,}10.000, (4{,}5)\big)$$
$$f_1^- = \max(3{,}8)$$

The ideal solution calculations of f_6^+ and f_6^- are presented in Table, below:

Table 6. PDA Value Data

f^*	12	3	55	10	1000.000	5,0
f^-	3,8	1	0	1	10.000	4,5

- Calculating the normalization matrix.

Calculation of the normalization matrix as follows:

$$n_{11} = \frac{12-3{,}8}{12-3{,}8} = 1 \qquad n_{14} = \frac{10-1}{10-1} = 1$$

$$n_{12} = \frac{3-1}{3-1} = 1 \qquad n_{15} = \frac{1.000.000-50.000}{1.000.000-10.000} = 0{,}9596$$

$$n_{13} = \frac{55-0}{55-0} = 1 \qquad n_{16} = \frac{5{,}0-4{,}6}{5{,}0-4{,}5} = 0{,}8$$

and so on until $\boldsymbol{N_{66}}$, so that the normalization matrix N is obtained as follows:

$$N_{36\times 6} = \begin{bmatrix} 1 & 1 & 1 & 1 & 0,9596 & 0,8 \\ 0,1213 & 0 & 0,8 & 1 & 1 & 0,8 \\ 0,5978 & 1 & 0,1273 & 1 & 0 & 0 \\ 0,6087 & 0,5 & 0,3637 & 0 & 0 & 1 \\ 0,2439 & 1 & 0,5090 & 0,7778 & 0 & 0,6 \\ 0 & 1 & 0 & 1 & 0,9596 & 0,8 \end{bmatrix}$$

- Calculating normalization weights.

Before calculating the normalization weight, first find the weight of the criteria and measure the consistency of each criterion.

- Finding the weight of the criteria.

$PR_1 = \frac{1+1+1+1+0,9596+0,8}{6} = \frac{5,7596}{6} = 0,9599$

This calculation is done as many times as the criteria used, namely six criteria, so that up to PR_6.

- Finding the weight of the criteria.

$K_{11} = 3,8 \times 0,9599 = 3,648$ $K_{14} = 1 \times 0,4121 = 0,4121$

$K_{12} = 1 \times 0,6203 = 3,6203$ $K_{15} = 50.000 \times 0,5218 = 26,090$

$K_{13} = 0 \times 0,4542 = 0$ $K_{16} = 4,6 \times 0,6266 = 2,882$

This calculation is up to $\boldsymbol{K_{66}}$. resulting in the following K matrix:

$$K = \begin{bmatrix} 3,648 & 0,6203 & 0 & 0,4121 & 26.090 & 2,883 \\ 10,559 & 1,861 & 4,996 & 0,4121 & 5.218 & 2,883 \\ 6,816 & 0,6203 & 21,802 & 0,4121 & 521.800 & 3,133 \\ 6,144 & 1,241 & 15,897 & 4,121 & 521.800 & 2,819 \\ 9,599 & 0,6203 & 12,264 & 1,237 & 521.800 & 2,946 \\ 11,519 & 0,6203 & 24,981 & 0,4121 & 26.090 & 2,883 \end{bmatrix}$$

Sum the K matrix values by row.

$BK_1 = 3,648 + 0,6203 + 0 + 0,4121 + 26.090 + 2,883 = 26.097,563$

This calculation is up to BK6.

Furthermore, the normalized decision matrix is multiplied by the weight of the criteria, as follows:

$F_{11} = 1 \times 0,9599 = 0,9599$ $F_{14} = 1 \times 0,4121 = 0,4121$

$F_{12} = 1 \times 0,6203 = 0,6203$ $F_{15} = 0,9596 \times 0,5218 = 0,5008$

$F_{13} = 1 \times 0,4542 = 0,4542$ $F_{16} = 0,8 \times 0,6266 = 0,5013$

and so on until the calculation of $\boldsymbol{F_{66}}$.

$$f = \begin{bmatrix} 0,9599 & 0,6203 & 0,4542 & 0,4121 & 0,5008 & 0,5013 \\ 0,1165 & 0 & 0,3634 & 0,4121 & 0,5218 & 0,5013 \\ 0,5739 & 0,6203 & 0,0579 & 0,4121 & 0 & 0 \\ 0,5843 & 0,3101 & 0,1651 & 0 & 0 & 0,6266 \\ 0,2341 & 0,6203 & 0,2311 & 0,3206 & 0 & 0,3759 \\ 0 & 0,6203 & 0 & 0,4121 & 0,5008 & 0,5012 \end{bmatrix}$$

- Calculating the utility measure of each alternative.

Calculation of the utility measure of each alternative, namely the S and R values:

$S_1 = 0,9599 + 0,6203 + 0,4542 + 0,4121 + 0,5008 + 0,5013 = 3,4486$

Calculation of utility measure S up to S_{66}.
$R_1 = \max(0{,}9599 + 0{,}6203 + 0{,}4542 + 0{,}4121 + 0{,}5008 + 0{,}5013 = 3{,}4486$
Calculation of utility measure R up to $\boldsymbol{R_{66}}$.

- Calculating VIKOR index (Q).

Calculation of the VIKOR index (Q), where the VIKOR value selected as the ideal solution is the smallest VIKOR value. The following is an example of calculating the VIKOR index with a weight (v) that has been set to 0.5.

$S^- = \max(S1, S2, S3, \dots \dots \dots, S66)$
$S^- = \max(0.9599\ , 0{,}6203\ , 0{,}4542\ , 0{,}4121\ , 0{,}5008\ , \dots, 0{,}5012\ ) = 0{,}9599$
$S^* = \min(S1, S2, S3, \dots \dots \dots, S66)$
$S^* = \min(0.9599\ , 0{,}6203\ , 0{,}4542\ , 0{,}4121\ , 0{,}5008\ , \dots, 0{,}5012) = 0$
$R^- = \max(R1, R2, R3, \dots \dots \dots, R66)$
$R^- = \max(0{,}9599\ , 0{,}6203\ , 0{,}4542\ , 0{,}4121\ , 0{,}5008\ , \dots, 0{,}5012) = 0{,}9599$
$R^* = \min(R1, R2, R3, \dots \dots \dots, R66)$
$R^* = \min(0{,}9599\ , 0{,}6203\ , 0{,}4542\ , 0{,}4121\ , 0{,}5008\ , \dots, 0{,}5012) = 0$
So the VIKOR index is as follows:
$Q_1 \left[0{,}5\ \frac{(3{,}4486-\ 0)}{(0{,}9599-0)}\right] + \left[(1-0{,}5)\frac{(3{,}4486-\ 0)}{(0{,}9599-0)}\right] = 1{,}7964 + 1{,}7964 = 3{,}5928$
Further calculation until VIKOR index $\boldsymbol{Q_{66}}$..

- Ranking alternatives by sorting starting from the smallest Q_i value.

The results of the ranking of physics learning media aids with the VIKOR method, can be presented in table 7.

Table 7. PDA Value Data

Code	Alternative	Value	Rangking
F1	Physics Question Bank	3,5928	6
F2	Learn Physics Easy	1,995	4
F3	Physics Formula	1,7336	1
F4	PhyWiz	1,7564	2
F5	Pocket Physics	1,8564	3
F6	Complete Physics Formula & Materials	2,1192	5

Calculations that have been carried out from 6 alternatives produce the best alternative which can be seen in the table, namely alternative **F3** with the application name **Physics Formula** with a value of **1,7336** as the highest score.

- Perform a compromise solution of two solutions, with the following calculations:

The first solution compares the DQ value with the difference between the first VIKOR index and the second or Acceptable advantage condition.

$DQ = \frac{1}{(J-1)} = \frac{1}{(36-1)} = -0{,}9714$
$Q\left(A^{(2)}\right) - Q\left(A^{(1)}\right) = 1{,}995 - 3{,}5928 = -1{,}5978$
The resulting difference value of -1.5978 is smaller than the DQ value = -0.9714 so that the acceptable advantage is met.

EDAS Method (Evaluation based on Distance from Average Solution)

a. Define a Decision Matrix.

$$X = \left[X_{ij}\right]_{nxm} = \begin{bmatrix} 3{,}8 & 11 & 7{,}1 & 6{,}4 & 10 & 12 \\ 1 & 3 & 1 & 2 & 1 & 1 \\ 0 & 11 & 48 & 35 & 27 & 55 \\ 1 & 1 & 1 & 10 & 3 & 1 \\ 50.0000 & 10.000 & 1.000.000 & 1.000.000 & 1.000.000 & 50.000 \\ 4{,}6 & 4{,}6 & 5 & 4{,}5 & 4{,}7 & 4{,}6 \end{bmatrix}$$

b. Make provisions for the average value for all criteria.

$$AV_1 = \frac{3{,}8+1+0+1+50.000+4{,}6}{6} = \frac{50.010{,}4}{6} = 8.335$$
$$AV_2 = \frac{11+3+11+1+10.000+4{,}6}{6} = \frac{10.030{,}6}{6} = 1.671{,}76667$$
$$AV_3 = \frac{7{,}1+1+48+1+1.000.000+5}{6} = \frac{1.000.062{,}1}{6} = 166.677{,}017$$
$$AV_4 = \frac{6{,}4+2+35+10+1.000.000+4{,}5}{6} = \frac{1.000.057{,}9}{6} = 166.676{,}317$$
$$AV_5 = \frac{10+1+27+3+1.000.000+4{,}7}{6} = \frac{1.000.045{,}7}{6} = 166.674{,}283$$
$$AV_6 = \frac{12+1+55+1+50.000+4{,}6}{6} = \frac{50.073{,}6}{6} = 8.345{,}6$$

c. Finds the average value of the positive or negative distance according to the type of criteria.

- PDA

  If the criterion type is cost the formula used is as follows:

  - Average positive distance F1

$$PDA_{11} = \frac{8.335-3{,}8}{8.335} = 0{,}9995 \qquad PDA_{14} = \frac{166.676-6{,}4}{166.676} = 0{,}9999$$
$$PDA_{12} = \frac{1.671-11}{1.671} = 0{,}0909 \qquad PDA_{15} = \frac{166.674-10}{166.674} = 0{,}9999$$
$$PDA_{13} = \frac{166.677-7{,}1}{166.677} = 0{,}9999 \qquad PDA_{16} = \frac{8.345-12}{8.345} = 0{,}9986$$

  If the criterion type is benefit, the formula used is as follows:

  - Average positive distance F2

$$PDA_{21} = \frac{1-8.335}{8.335} = -0{,}9998 \qquad PDA_{24} = \frac{2-166.676}{166.676} = -0{,}9999$$
$$PDA_{22} = \frac{3-1.671}{1.671} = -0{,}9982 \qquad PDA_{25} = \frac{1-166.674}{166.674} = -0{,}9999$$
$$PDA_{23} = \frac{1-166.677}{166.677} = -0{,}9999 \qquad PDA_{26} = \frac{1-8.345}{8.345} = -0{,}9998$$

  In calculating the average value of positive distance for the next alternative, it is the same as **the steps to calculate the average positive distance of F2**. Based on the above calculations, the results of the PDA value data can be seen in table 8.

Table 8. PDA Value Data

Alternative	C1	C2	C3	C4	C5	C6
F1	0,9995	0,0909	0,9999	0,9999	0,9999	0,9986
F2	-0,9998	-0,9982	-0,9999	-0,9999	-0,9999	-0,9998
F3	-1	-0,9934	-0,9997	-0,9997	-0,9998	-0,9934
F4	-0,9998	-0,9994	-0,9999	-0,9999	-0,9999	-0,9999
F5	4,9988	4,9844	4,9996	4,9996	4,9997	4,9916
F6	-0,9994	-0,9972	-0,9999	-0,9999	-0,9999	-0,9994

- NDA

  if the cost criterion type is used, the formula is as follows:

  - Average negative distance F1

$$PDA_{11} = \frac{8.335-3,8}{8.335} = 0,9995 \qquad PDA_{14} = \frac{166.676-6,4}{166.676} = 0,9999$$
$$PDA_{12} = \frac{1.671-11}{1.671} = 0,0909 \qquad PDA_{15} = \frac{166.674-10}{166.674} = 0,9999$$
$$PDA_{13} = \frac{166.677-7,1}{166.677} = 0,9999 \qquad PDA_{16} = \frac{8.345-12}{8.345} = 0,9986$$

  If the criteria type is benefit, the formula used is as follows:

  - Average negative distance F2

$$PDA_{21} = \frac{1-8.335}{8.335} = -0,9998 \qquad PDA_{24} = \frac{2-166.676}{166.676} = -0,9999$$
$$PDA_{22} = \frac{3-1.671}{1.671} = -0,9982 \qquad PDA_{25} = \frac{1-166.674}{166.674} = -0,9999$$
$$PDA_{23} = \frac{1-166.677}{166.677} = -0,9999 \qquad PDA_{26} = \frac{1-8.345}{8.345} = -0,9998$$

In calculating the average value of negative distance for the next alternative, it is the same as **the steps to calculate the average negative distance of F2**. Based on the above calculations, the results of the NDA value data can be seen in table 9.

Table 9. NDA Value Data

Alternative	C1	C2	C3	C4	C5	C6
F1	-0,9995	-0,0909	-0,9999	-0,9999	-0,9999	-0,9986
F2	0,9998	0,9982	0,9999	0,9999	0,9999	0,9998
F3	1	0,9934	0,9997	0,9997	0,9998	0,9934
F4	0,9998	0,9994	0,9999	0,9999	0,9999	0,9999
F5	-4,9988	-4,9844	-4,9996	-4,9996	-4,9997	-4,9916
F6	0,9994	0,9972	0,9999	0,9999	0,9999	0,9994

d. Calculation of positive and negative distances for all alternatives.

- SP
  - F1 positive distance calculation

$$PDA_{11} = \frac{8.335-3,8}{8.335} = 0,9995 \qquad PDA_{14} = \frac{166.676-6,4}{166.676} = 0,9999$$
$$PDA_{12} = \frac{1.671-11}{1.671} = 0,0909 \qquad PDA_{15} = \frac{166.674-10}{166.674} = 0,9999$$
$$PDA_{13} = \frac{166.677-7,1}{166.677} = 0,9999 \qquad PDA_{16} = \frac{8.345-12}{8.345} = 0,9986$$

In calculating the positive distance assessment for the next alternative, it is the same as **the steps to calculate the F1 positive distance assessment**. Based on the above calculations, the results of the SP value data can be seen in table 10.

Table 10. SP Value Data

Alternative	C1	C2	C3	C4	C5	C6
F1	1,999	0,31815	1,49985	0,9999	0,9999	0,9986
F2	-1,9996	-3,4937	-1,49985	-0,9999	-0,9999	-0,9998
F3	-2	-3,4769	-1,49955	-0,9997	-0,9998	-0,9934
F4	-1,9996	-3,4979	-1,49985	-0,9999	-0,9999	-0,9999
F5	9,9976	17,4454	7,4994	4,9996	4,9997	4,9916
F6	-1,9988	-3,4902	-1,49985	-0,9999	-0,9999	-0,9994

- SN
  - F1 negative distance calculation

$$SN_{11} = -0{,}9995 \times 2 = -1{,}999$$
$$SN_{12} = -0{,}0909 \times 3{,}5 = -0{,}31815$$
$$SN_{13} = -0{,}9999 \times 1{,}5 = -1{,}49985$$
$$SN_{14} = -0{,}9999 \times 1 = -0{,}9999$$
$$SN_{15} = -0{,}9999 \times 1 = -0{,}9999$$
$$SN_{16} = -0{,}9986 \times 1 = -0{,}9986$$

In calculating the negative distance assessment for the next alternative, it is the same as **the steps to calculate the F1 negative distance assessment**. Based on the above calculations, the results of the SN value data can be seen in table 11.

Table 11. SN Value Data

Alternatif	C1	C2	C3	C4	C5	C6
F1	-1,999	-0,31815	-1,49985	-0,9999	-0,9999	-0,9986
F2	1,9996	3,4937	1,49985	0,9999	0,9999	0,9998
F3	2	3,4769	1,49955	0,9997	0,9998	0,9934
F4	1,9976	3,4979	1,49985	0,9999	0,9999	0,9999
F5	-9,9976	-17,4454	-7,4994	-4,9996	-4,9997	-4,9916
F6	1,9988	3,4902	1,49985	0,9999	0,9999	0,9994

e. Normalization of SP and SN values for all alternatives.

- Normalization of SP values

$$NSP_1 = \frac{6{,}8154}{49{,}9333} = 0{,}1365 \qquad NSP_4 = \frac{-9{,}99705}{49{,}9333} = -0{,}2003$$
$$NSP_2 = \frac{-9{,}99275}{49{,}9333} = -0{,}2001 \qquad NSP_5 = \frac{49{,}9333}{49{,}9333} = 1$$
$$NSP_3 = \frac{-9{,}96935}{49{,}9333} = -0{,}1997 \qquad NSP_6 = \frac{-9{,}98805}{49{,}9333} = -0{,}2000$$

- Normalization of SN values

$$NSN_1 = \frac{-6{,}8154}{9{,}99705} = -0{,}6817 \qquad NSN_4 = \frac{9{,}99705}{9{,}99705} = 1$$
$$NSN_2 = \frac{9{,}99275}{9{,}99705} = 0{,}9996 \qquad NSN_5 = \frac{-49{,}9333}{9{,}99705} = -4{,}9948$$
$$NSN_3 = \frac{9{,}96935}{9{,}99705} = 0{,}9972 \qquad NSN_6 = \frac{9{,}98805}{9{,}99705} = 0{,}9991$$

f. Calculating scores on all alternatives.

$$AS_1 = \frac{1}{2}\left(0{,}1365 + (-0{,}6817)\right) = -0{,}2726 \qquad AS_4 = \frac{1}{2}(-0{,}2003 + 1) = 0{,}39985$$
$$AS_2 = \frac{1}{2}(-0{,}2001 + 0{,}9996) = 0{,}39975 \qquad AS_5 = \frac{1}{2}\left(1 + (-4{,}9948)\right) = -1{,}9974$$

$AS_3 = \frac{1}{2}(-0{,}1997 + 0{,}9972) = 0{,}39875$ $AS_6 = \frac{1}{2}(-0{,}2000 + 0{,}9991) = 0{,}39955$

From the calculations that have been carried out above with the application of the EDAS method, a ranking can be generated which can be seen in the table 12.

Table 12. Score Calculation Data

Code	Alternative	Value	Ranking
F1	Physics Question Bank	-0,2726	5
F2	Learn Physics Easy	0,39975	2
F3	Physics Formula	0,39875	4
F4	PhyWiz	0,39985	1
F5	Pocket Physics	-1,9974	6
F6	Complete Physics Formula & Materials	0,39955	3

Calculations that have been carried out from 6 alternatives produce the best alternative which can be seen in the table, namely alternative **F4** with the application name **PhyWiz** with a value of **0.39985** as the highest score.

EXPROM II (Extended Promethee II) Method

The following are the weights generated using the Rank Order Centroid (ROC) method as below:

$$W_1 = \frac{1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}}{6} = 0{,}41 \qquad W_4 = \frac{0+0+0+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}}{6} = 0{,}10$$

$$W_2 = \frac{0+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}}{6} = 0{,}24 \qquad W_5 = \frac{0+0+0+0+\frac{1}{5}+\frac{1}{6}}{6} = 0{,}06$$

$$W_3 = \frac{0+0+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}}{6} = 0{,}16 \qquad W_6 = \frac{0+0+0+0+0+\frac{1}{6}}{6} = 0{,}03$$

The criteria assessment data used is obtained from research results. Completion using The Extended Promothee II (EXPROM II) method, as follows:

a. Decision Matrix Generation

$$\begin{bmatrix} 3.8 & 1 & 0 & 1 & 50000 & 4.6 \\ 11 & 3 & 11 & 1 & 10000 & 4.6 \\ 7.1 & 1 & 48 & 1 & 1000000 & 5.0 \\ 6.4 & 2 & 35 & 10 & 1000000 & 4.5 \\ 10 & 1 & 27 & 3 & 1000000 & 4.7 \\ 12 & 1 & 55 & 1 & 50000 & 4.6 \end{bmatrix}$$

Where:

Max (Xij) = C1=12, C2=3, C3=55, C4=10, C5=1000000, C6=5.0

Min (Xij) = C1=3.8, C2=1, C3=0, C4=1, C5=10000, C6=4.5

b. Normalization of Decision Matrix

C1 = Storage Capacity

$$R_{11} = \frac{[12 - 3.8]}{[12 - 3.8]} = 1 \qquad R_{14} = \frac{[12 - 6.4]}{[12 - 3.8]} = 0.68$$

$$R_{12} = \frac{[12 - 11]}{[12 - 3.8]} = 0.12 \qquad R_{15} = \frac{[12 - 10]}{[12 - 3.8]} = 0$$

$R_{13} = \frac{[12 - 7.1]}{[12 - 3.8]} = 0.59$ $\qquad$ $R_{16} = \frac{[12 - 12]}{[12 - 3.8]} = 0$

Furthermore, the completion of calculations **C2, C3, C4, C5, and C6** are the same as the completion of calculation **C1** above. From the above calculations, a normalized decision matrix can be obtained, which is as follows:

$$X = \begin{bmatrix} 1 & 0 & 0 & 0 & 0.04 & 0.2 \\ 0.12 & 1 & 0.2 & 0 & 0 & 0.2 \\ 0.59 & 0 & 0.8 & 0 & 1 & 1 \\ 0.68 & 0.5 & 0.6 & 1 & 1 & 0 \\ 0.24 & 0 & 0.4 & 0.2 & 1 & 0.4 \\ 0 & 0 & 1 & 0 & 0.04 & 0.2 \end{bmatrix}$$

c. Determine the Preference value $P_j(i, i')$

C1 = Storage Capacity

If 1 ≤ 0.12 false, else if 1 > 0.12 true, then P1(1,2) = 1 – 0.12 = 0.88
If 1 ≤ 0.59 false, else if 1 > 0.59 true, then P1(1,3) = 1 – 0.59 = 0.41
If 1 ≤ 0.68 false, else if 1 > 0.68 true, then P1(1,4) = 1 – 0.68 = 0.32
If 1 ≤ 0.24 false, else if 1 > 0.24 true, then P1(1,5) = 1 – 0.24 = 0.76
If 1 ≤ 0 false, else if 1 > 0 true, then P1(1,6) = 1 – 0 = 1
If 0.12 ≤ 1 true, then P1(2,1) = 0
If 0.12 ≤ 0.59 true, then P1(2,3) = 0
If 0.12 ≤ 0.68 true, then P1(2,4) = 0
If 0.12 ≤ 0.24 true, then P1(2,5) = 0
If 0.12 ≤ 0 false, else if 0.12 > 0 true, then P1(2,6) = 0.12 - 0 = 0.12
If 0.59 ≤ 1 true, then P1(3,1) = 0
If 0.59 ≤ 0.12 false, else if 0.59 > 0.12 true, then P1(3,2) = 0.59 – 0.12 = 0.47
If 0.59 ≤ 0.68 true then P1(3,4) = 0
If 0.59 ≤ 0.24 false, else if 0.59 > 0.24 true, then P1(3,5) = 0.59 – 0.24 = 0.35
If 0.59 ≤ 0 false, else if 0.59 > 0 true then P1(3,6) = 0.59 - 0 = 0.59
If 0.68 ≤ 1 true then P1(4,1) = 0
If 0.68 ≤ 0.12 false, else if 0.68 > 0.12 true, then P1(4,2) = 0.68 – 0.12 = 0.56
If 0.68 ≤ 0.59 false, else if 0.68 > 0.59 true, then P1(4,3) = 0.68 – 0.59 = 0.09
If 0.68 ≤ 0.24 false, else if 0.68 > 0.24 true, then P1(4,5) = 0.68 – 0.24 = 0.44
If 0.68 ≤ 0 false, else if 0.68 > 0 true then P1(4,6) = 0.68 - 0 = 0.68
If 0.24 ≤ 1 true then P1(5,1) = 0
If 0.24 ≤ 0.12 false, else if 0.24 > 0.12 true, then P1(5,2) = 0.24 – 0.12 = 0.12
If 0.24 ≤ 0.59 true then P1(5,3) = 0
If 0.24 ≤ 0.68 true then P1(5,4) = 0
If 0.24 ≤ 0 false, else if 0.24 > 0 true then P1(5,6) = 0.24 - 0 = 0.24
If 0 ≤ 1 true, then P1(6,1) = 0
If 0 ≤ 0.12 true, then P1(6,2) = 0
If 0 ≤ 0.59 true, then P1(6,3) = 0
If 0 ≤ 0.68 true, then P1(6,4) = 0
If 0 ≤ 0.24 true, then P1(6,5) = 0

Furthermore, the completion of **C2, C3, C4, C5, and C6** is the same as the completion of **C1** above. After that, the results of the preference value are obtained, then the preference value is made into data in tabular form as follows:

Table 13. Preference Value

Alternative	C1	C2	C3	C4	C5	C6
Pj(1,2)	0.88	0	0	0	0.4	0
Pj(1,3)	0.41	0	0	0	0	0
Pj(1,4)	0.32	0	0	0	0	0.2
Pj(1,5)	0.76	0	0	0	0	0
Pj(1,6)	1	0	0	0	0	0
Pj(2,1)	0	1	0.2	0	0	0
Pj(2,3)	0	1	0	0	0	0
Pj(2,4)	0	0.95	0	0	0	0.2
Pj(2,5)	0	1	0	0	0	0
Pj(2,6)	0.12	1	0	0	0	0
Pj(3,1)	0	0	0.8	0	0.96	0.8
Pj(3,2)	0.47	0	0.6	0	1	0.8
Pj(3,4)	0	0	0.2	0	0	1
Pj(3,5)	0.35	0	0.4	0	0	0.6
Pj(3,6)	0.59	0	0	0	0.96	0.8
Pj(4,1)	0	0.05	0.6	1	0.96	0
Pj(4,2)	0.56	0	0.4	1	1	0
Pj(4,3)	0.09	0.05	0	1	0	0
Pj(4,5)	0.44	0.05	0.2	0.8	0	0
Pj(4,6)	0.68	0.05	0	1	0.96	0
Pj(5,1)	0	0	0.4	0.2	0.96	0.2
Pj(5,2)	0.12	0	0.2	0.2	1	0.2
Pj(5,3)	0	0	0	0.2	1	0
Pj(5,4)	0	0	0	0	1	0.4
Pj(5,6)	0.24	0	0	0.2	0.96	0.2
Pj(6,1)	0	0	1	0	0	0
Pj(6,2)	0	0	0.8	0	0.04	0
Pj(6,3)	0	0	0.2	0	0	0
Pj(6,4)	0	0	0.4	0	0	0.2
Pj(6,5)	0	0	0.6	0	0	0

d. Calculating the value of WP(i,i^')

$$= \frac{[(W1\ X\ P1\ (1,2))+(W2\ X\ P2\ (1,2))+(W3\ X\ P3(1,2))+(W4\ X\ P4\ (1,2))+(W5\ X\ P5(1,2))+(W6\ X\ P6(1,2))]}{1}$$

$$= \frac{[(0{,}41\ X\ 0{,}88)+ (0{,}24\ X\ 0)+ (0{,}16\ X\ 0)+ (0{,}10\ X\ 0)+ (0{,}06\ X\ 0{,}4\ )+ (0{,}03\ X\ 0\ )]}{1}$$

$$= \frac{0{,}36+0+0+0+0.02+0}{1}$$

WP (1,2) = 0,56

$$= \frac{[(W1\ X\ P1\ (1,3))+(W2\ X\ P2\ (1,3))+(W3\ X\ P3(1,3))+(W4\ X\ P4\ (1,3))+(W5\ X\ P5(1,3))+(W6\ X\ P6(1,3))\ ]}{1}$$

$$= \frac{[(0{,}41\ X\ 0{,}41)+ (0{,}24\ X\ 0)+ (0{,}16\ X\ 0)+ (0{,}10\ X\ 0)+ (0{,}06\ X\ 0\ )+ (0{,}03\ X\ 0\ )]}{1}$$

$$= \frac{0,168+0+0+0+0+0}{1}$$

Perform calculations up to **WP (6.5)**. After that, the results of the WP (Weak Preferential) value are then made into data in the form of table 15.

e. Calculating the Value of Strict Preferences J or $SP_j(i,i')$
C1 = Storage Capacity

$$SPj\ (1,2) = \left[\frac{\max(0,(1-0.12)-0)}{1-0}\right] = \left[\frac{\max(0,88)}{1}\right] = 0,88$$

$$SPj\ (1,3) = \left[\frac{\max(0,(1-0.59)-0)}{1-0}\right] = \left[\frac{\max(0,41)}{1}\right] = 0,41$$

$$SPj\ (1,4) = \left[\frac{\max(0,(1-0.68)-0\ )}{1-0}\right] = \left[\frac{\max(0,32)}{1}\right] = 0,32$$

$$SPj\ (1,5) = \left[\frac{\max(0,(1-0.24)-0\ )}{1-0}\right] = \left[\frac{\max(0,76)}{1}\right] = 0,76$$

$$SPj\ (1,6) = \left[\frac{\max(0,(1-0)-0\ )}{1-0}\right] = \left[\frac{\max(1)}{1}\right] = 1$$

Calculate up to $\boldsymbol{SP_j}$ **(6,5)** and solve **C2, C3, C4, C5, and C6** just like solving **C1** above. After that, the results of the value of strict preferences J or $SP_j(i,i')$ are obtained, then made into data in the form of a table 14.

Table 14. Strict Preferences J value or $SP_j(i,i')$

Alternative	C1	C2	C3	C4	C5	C6
SPj(1,2)	0,88	1	-0,2	0	0,04	0
SPj(1,3)	0,41	0	-0,8	0	-0,96	-0,8
SPj(1,4)	0,32	-0,5	-0,6	-1	-0,96	0,2
SPj(1,5)	0,76	0	-0,4	-0,2	0	-0,2
SPj(1,6)	1	0	-1	0	0	0
SPj(2,1)	-0,88	1	0,2	0	-0,04	0
SPj(2,3)	-0,47	1	-0,6	0	-1	-0,8
SPj(2,4)	-0,56	0,5	-0,4	-1	-1	0,2
SPj(2,5)	-0,12	1	-0,2	-0,2	-1	-0,2
SPj(2,6)	0,12	1	-0,8	0	-0,04	0
SPj(3,1)	-0,41	0	0,8	0	0,96	0,8
SPj(3,2)	0,47	-1	0,6	0	1	0,8
SPj(3,4)	-0,09	-0,5	0,2	-1	0	1
SPj(3,5)	0,35	0	0,4	-0,2	0	0,6
SPj(3,6)	0,59	0	-0,2	0	0,96	0,8
SPj(4,1)	-0,32	0,5	0,6	1	0,96	-0,2
SPj(4,2)	0,56	-0,5	0,4	1	1	-0,2
SPj(4,3)	0,09	0,5	-0,2	1	0	-1
SPj(4,5)	0,44	0,5	0,2	0,8	0	-0,4
SPj(4,6)	0,68	0,5	0,4	1	0,96	-0,2
SPj(5,1)	-0,76	0	0,4	0,2	0,96	0,2
SPj(5,2)	0,12	-1	0,2	0,2	1	0,2
SPj(5,3)	-0,35	0	-0,4	0,2	0	-0,6
SPj(5,4)	-0,44	-0,5	-0,2	0,8	0	0,4
SPj(5,6)	-0,24	0	-0,6	0,2	0,96	0,2

SPj(6,1)	-1	0	1	0	0	0
SPj(6,2)	-0,12	-1	0,8	0	0,04	0
SPj(6,3)	-0,59	0	0,2	0	-0,96	-0,8
SPj(6,4)	-0,68	-0,5	0,4	-1	-0,96	0,2
SPj(6,5)	-0,24	0	0,6	-0,2	-0,96	-0,2

f. Calculating the Strict Preferences Value or $SP(i,i')$

$$= \frac{[(W1\ X\ SP1\ (1,2))+(W2\ X\ SP2\ (1,2))+(W3\ X\ SP3\ (1,2))+(W4\ X\ SP4\ (1,2))+(W5\ X\ SP5\ (1,2))+(W6\ X\ SP6\ (1,2))]}{1}$$

$$= \frac{[(0{,}41\ X\ 0{,}88)+\ (0{,}24\ X\ 1)+\ (0{,}16\ X\ (-0{,}2))+\ (0{,}10\ X\ 0)+\ (0{,}06\ X\ 0{,}04)+(0{,}03\ X\ 0)]}{1}$$

$$= \frac{0{,}36+0{,}24-0{,}3+0+0{,}002+0}{1} = \frac{0{,}30}{1}$$

SP(1,2) = 0,30

$$= \frac{[(W1\ X\ SP1\ (1,3))+(W2\ X\ SP2\ (1,3))+(W3\ X\ SP3\ (1,3))+(W4\ X\ SP4\ (1,3))+(W5\ X\ SP5\ (1,3))+(W6\ X\ SP6\ (1,3))]}{1}$$

$$= \frac{[(0{,}41\ X\ 0{,}41)+\ (0{,}24\ X\ 0)+\ (0{,}16\ X\ (-0{,}8))+\ (0{,}10\ X\ 0)+\ (0{,}06\ X\ (-0{,}96))+\ (0{,}03\ X\ (-0{,}8))]}{1}$$

$$= \frac{0{,}17+0-0{,}13+0-0{,}16-0{,}02}{1} = \frac{-\ 0{,}14}{1}$$

Perform calculations up to **SP (6.5)**. After that, the results of the value of strict preferences $SP(i,i')$are then made into data in the form of table 15.

g. Calculating the Total Preference Value or $TP(i,i')$

TP (1,2) = Min[1, 0,56 + 0,30] = Min [1, 0,86] = 0,86
TP (1,3) = Min[1, 0,168 + (−0,14)] = Min [1, 0,03] = 0,03
TP (1,4) = Min[1, 0,137 + (−0,33)] = Min [1, -0,19] = −0,19
TP (1,5) = Min[1, 0,311 + 0,23] = Min [1, 0,54] = 0,54
TP (1,6) = Min[1, 0,41 + 0,25] = Min [1, 0,66] = 0,66

Perform calculations up to **SP (6.5)**. After that, the results of the value of strict preferences $SP(i,i')$ are obtained, then made into data in the form of a table.

Table 15. $WP(i,i')$, $SP(i,i')$, and $TP(i,i')$values

Alternatif	WP	SP	TP
(1,2)	0,56	0,30	0,86
(1,3)	0,168	-0,14	0,03
(1,4)	0,137	-0,33	-0,19
(1,5)	0,311	0,23	0,54
(1,6)	0,41	0,25	0,66
(2,1)	0,56	0,10	0,66
(2,3)	0,24	-0.06	0,18
(2,4)	0,234	-0,32	-0,09
(2,5)	0,24	0,07	0,31
(2,6)	0,289	0,16	0,45
(3,1)	0,21	0,14	0,35
(3,2)	0,373	0,12	0,49
(3,4)	0,062	-0,2	-0,14
(3,5)	0,387	0,2	0,59
(3,6)	0,324	0,29	0,61
(4,1)	0,265	0,23	0,49

(4,2)	0,453	0,32	0,77
(4,3)	0,149	0,09	0,24
(4,5)	0,304	0,39	0,69
(4,6)	0,448	1,15	1,59
(5,1)	0,147	0,38	0,53
(5,2)	0,225	-0,7	0,47
(5,3)	0,08	-0,19	-0,11
(5,4)	0,072	-0,27	-0,19
(5,6)	0,181	-0,91	-0,73
(6,1)	0,16	-0,25	-0,09
(6,2)	0,130	0,04	0,17
(6,3)	0,032	-0,29	-0,26
(6,4)	0,07	-0,49	-0,42
(6,5)	0,096	-0,09	0,006

h. Calculating Leaving Flow and Entering Flow
- Calculating the incoming flow (Leaving Flow)

$\varphi^{+} = \frac{1}{6-1}$ X 1,9 = 0,38 $\qquad \varphi^{+} = \frac{1}{6-1}$ X 3,78 = 0,756

$\varphi^{+} = \frac{1}{6-1}$ X 1,51 = 0,302 $\qquad \varphi^{+} = \frac{1}{6-1}$ X (− 18,84) = − 3,768

$\varphi^{+} = \frac{1}{6-1}$ X 1,9 = 0,38 $\qquad \varphi^{+} = \frac{1}{6-1}$ X (−0,594) = − 0,119

- Calculating the outgoing flow (Entering)

$\varphi^{-} = \frac{1}{6-1}$ X 1,94 = 0,388 $\qquad \varphi^{-} = \frac{1}{6-1}$ X (-1,03) = − 0,206

$\varphi^{-} = \frac{1}{6-1}$ X 2,76 = 0,552 $\qquad \varphi^{-} = \frac{1}{6-1}$ X 2,14 = 0,428

$\varphi^{-} = \frac{1}{6-1}$ X 0,08 = 0,016 $\qquad \varphi^{-} = \frac{1}{6-1}$ X 2,58 = 0,516

i. Calculating Net Flow

$\varphi(i) = \varphi^{+}(i) - \varphi^{-}(i)$
$= 0,38 - 0,388 = -0,008$
$= 0,302 - 0,552 = -0,172$
$= 0,38 - 0,016 = 0,364$
$= 0,756 + 0,206 = 0,962$
$= -3,768 - 0,428 = -4,196$
$= -0,119 - 0,516 = -0,635$

j. Ranking alternatives

From the calculation stage in this ranking, the highest φ(i) value can be taken to show the feasibility of a decision to determine the best physics learning media aids can be seen below:

Table 16. Suitability Rating Data

Code	Alternative	Value	Rangking
F1	Physics Question Bank	-0,008	3
F2	Learn Physics Easy	-0,172	4
F3	Physics Formula	0,364	2
F4	PhyWiz	0,962	1

F5	Pocket Physics	-4,196	6
F6	Complete Physics Formula & Materials	-0,635	5

Calculations that have been carried out from 6 alternatives produce the best alternative which can be seen in the table, namely alternative **F4** with the application name **PhyWiz** with a value of **0.962** as the highest score.

DISCUSSION

After calculating the three methods to determine the best physics learning media tools, the calculations carried out based on the six alternatives resulted in various optimal alternatives, which can be seen in the **VIKOR (VIšekriterijumsko KOmpromisno Rangiranje) Method** is alternative **F2** with the application name Physics Formula with a value of **1.7336**, **EDAS (Evaluation based on Distance from Average Solution) Method** is alternative **F4** with the application name **PhyWiz** with a value of **0.39985**, and **EXPROM II (Extended Promethee II) Method** is alternative **F4** with the application name **PhyWiz** with a value of **0.962**. So that the three methods have the highest score respectively.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The application of decision support system with EDAS, VIKOR, and EXPROM II methods can help decision makers in choosing the most suitable physics learning media aids. This research contributes to the development of more sophisticated evaluation methods and provides a foundation for further research in the field of education.

Recommendations

The VIKOR method is used to determine the best solution that achieves the optimal compromise between alternatives and criteria. Furthermore, the EDAS Method is used to rank the alternatives based on their distance from the average solution. Finally, the EXPROM II Method contributes in handling relative preferences and identifying higher preferences.

FURTHER STUDY

This research is limited to EDAS, VIKOR, and EXPROM II methods only; there are other methods that can be explored to increase the diversity and comprehensiveness of the research. In addition, the selection of variables taken into account in this study may not cover the entire spectrum of factors that can influence the selection of physics learning media aids. It is recommended to expand the scope of variables taken into account in the selection of physics learning media aids.

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