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Decision Support System Analysis of School Promotion Media Selection using MABAC, OCRA And CODAS Methods

Ajib Bahauddin[1*], Aang Suryana[2], Muhammad Arrasyid[3], Perani Rosyani[4], Saprudin[5]
Universitas Pamulang
Corresponding Author: Ajib Bahauddin ajibbahauddin90@gmail.com

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A B S T R A C T

School promotion is an activity to communicate educational products to consumers or prospective students. Promotional activities require strategic policies in order to maximize promotional results, therefore analysis of the selection of appropriate promotional media needs to be done. Multi-Attributive Border Approximation area Comparison, Operational Competitiveness Rating Analysis, COmbinative Distance-based Assessment in decision support system with case study at SMK Airlangga Balikpapan. MABAC, OCRA and CODAS are used in the calculation process that produces output in the form of promotional media ranking to be recommended to the school promotion team as a consideration for selecting the right promotional media. Alternative promotional media used in this research are brochures, posters, billboards, banners and newspaper advertisements. Based on the results of the research, the MABAC, OCRA and CODAS methods can be applied to the school promotion media selection decision support system and can produce output in the form of a priority ranking of school promotion media

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INTRODUCTION

Public satisfaction is measured based on four aspects, including teaching staff, infrastructure, management, and content standards. If the process and assessment as well as the level of achievement of development are still weak in fighting power and marketing, of course it will still experience setbacks and even go out of business. Schools must of course also participate in socializing all programs, developments, and achievements to the community in this case as users of educational services. To do a marketing, one of the strategies that can be done is by increasing the promotion strategy. Promotion really prioritizes quality which is of course in accordance with customer needs so that good promotion will certainly strive for a good program too, not just mediocre.

Strategic policies in order to maximize the results of school promotion are needed in school promotion activities. However, determining the policy is not an easy thing. The problem that is often experienced by the promotion team is the lack of maximizing the results of promotion because the selection of promotional media is still done without careful consideration of the strategy. This results in large promotional costs with few prospective students. Therefore, a system is needed that can support the decision-making process in determining school promotion strategy policies.

Computer-based decision support systems (SPK) are quite widely applied in determining policies in various fields, such as in economics, industry, education and others, including in the selection of promotional media. In general, SPK is a computer-based system that utilizes data and models to solve structured problems. In particular, SPK is a system that supports the work of decision makers in solving semi-structured problems by providing information and alternative decisions on certain problems.(Rosita, Gunawan, and Apriani 2020)

Multi-Attributive Border Approximation area Comparison (MABAC), Operational Competitiveness Rating Analysis (OCRA), COmbinative Distance-based Assessment (CODAS) is one of the methods that can be used to help the decision-making process in SPK.

This research aims to determine the priority ranking of school promotion media by implementing the Multi-Attributive Border Approximation area Comparison (MABAC), Operational Competitiveness Rating Analysis (OCRA), COmbinative Distance-based Assessment (CODAS) methods into a decision support system with schools in Indonesia. MABAC, OCRA, CODAS are used in the calculation process that produces outputs in the form of promotional media ratings to be recommended to the school promotion team as a consideration for choosing the right promotional media.

LITERATURE REVIEW

School promotion is a crucial aspect in developing the image and increasing the attractiveness of educational institutions. In this context, the selection of promotional media plays an important role in ensuring an effective message is delivered to the target audience. In several previous studies, the MOORA (Multi-Objective Optimization by Ratio Analysis) method has been used to assist decision-making related to the selection of promotional media. However, recent research has introduced alternative approaches, namely the MABAC (Multi-Attributive Border Approximation Area Comparison), OCRA (Organizational Criteria Analysis), and CODAS (Complex Proportional Assessment) methods. A number of previous studies have integrated the MOORA method to select the promotional media that best suits the objectives and characteristics of a particular school. MOORA allows decision-makers to evaluate and compare promotional media alternatives based on a number of pre-defined criteria. Some of the frequently applied criteria include cost, reach, and message effectiveness.

In further development, recent studies have begun to explore the potential of alternative methods such as MABAC, OCRA, and CODAS. The MABAC method offers an innovative approach by using modeling techniques to determine the relative boundaries between alternatives. Meanwhile, OCRA highlights the role of organizational criteria in promotional media selection and presents a more holistic approach. CODAS, with its complex approach, contributes to an in-depth understanding of the impact of promotional media on school image. It is important to compare the strengths and weaknesses of each method in the context of school promotional media selection. Comparative analysis can help in understanding situations where one method is superior to another. In addition, integration of methods can also be an attractive alternative, combining the advantages of each approach.

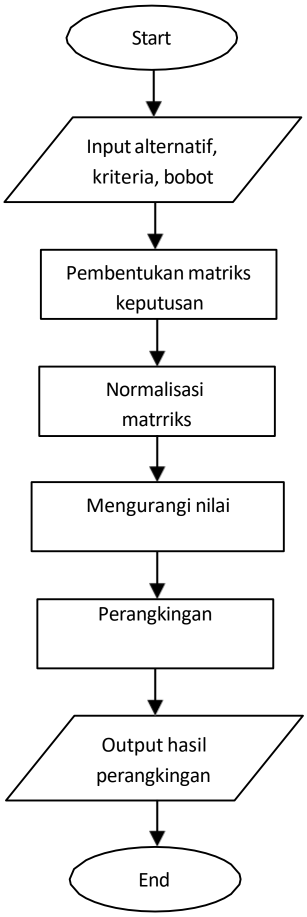

Figure 1. Conceptual Framework

METHODOLOGY

Decision Support System

Michael Scott Morton was the first person to create the idea of a Decision Support System (DSS), previously known as a Management Decision Support System in the early 1970s. This system is a computer-based interactive system that aims to assist in decision making by solving unstructured problems using certain models and data. The processing of data and information carried out during the decision-making process aims to produce various options that can be selected. SPK, an information system implementation, is intended only as a decision-making tool (Primaniyar 2020). Furthermore, during the 2000s, decision support systems began to use web, mobile, and cloud technologies. DSS were also increasingly used in various fields. Major advances in information technology and artificial intelligence during the current big data era further changed the current model of decision support systems. With machine learning and highly advanced data analytics, the latest generation of DSS enables the processing of very large and complex data.

Multi-Attributive Approximation Area Comparison Method (MABAC)

MABAC was developed in 2015 by Pamucar and Cirovic and is well known for providing decision-making solutions. In the MABAC method, the distance between the Border Approximation Area (BAA) and alternatives can determine the best alternative (Handayani, Muhsidi, and Khomalia 2021). As explained in Indic D. & Lukovic's journal, this method was chosen because with other multicriteria decision-making methods such as SAW, COPRAS, MOORA, TOPSIS, and VI-KOR, the MABAC method produces a (consistent) solution ranking and is considered a reliable method for rational decision making. The MABAC method is used for ranking alternatives in this paper. The definition of the criterion function distance of each observed alternative from the border approximation area shows the basic assumptions of the MABAC method. The procedure for applying the MABAC (Multi-Attributive Border Approximation Area Comparison) method, which is a mathematical formulation, is presented in the following section (Ndruru et al., 2020). MABAC is gradually being accepted and used in various industries such as manufacturing, transportation, engineering, and management. Some researchers have even created variants of the existing MABAC method. MABAC continues to evolve and is now one of the alternative choices for multi-criteria decision-making for various purposes. There are many academic studies that continue to investigate it. In performing calculations with the MABAC method, the following steps can be followed (KALEM and AKPINAR 2022), (Baydaş 2022):

a. Form an initial decision matrix (X).

$$X = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array}$$

b. Normalize the initial matrix (X).

$$N = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} n_{11} & n_{12} & \cdots & n_{1n} \\ n_{21} & n_{22} & \cdots & n_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ n_{m1} & n_{m2} & \cdots & n_{mn} \end{bmatrix} \end{array}$$

The value of the normalized matrix (N) is determined using the formula:

$$n_{ij} = \frac{xij - x_1{}^-}{x_1{}^+ - x_1{}^-} (for\ benefit\ criteria)$$

$$n_{ij} = \frac{xij - x_1{}^+}{x_1{}^- - x_1{}^+} (for\ cost\ criteria)$$

c. Calculate the weighted matrix where the formula can be seen as follows:

$v_{ij=w_j.(n_{ij}+1)}$

$$V = \begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & \cdots & v_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ v_{m1} & v_{m2} & \cdots & v_{mn} \end{bmatrix} = \begin{bmatrix} w_1.(n_{11}+1) & w_2.(n_{12}+1) & \cdots & w_n.(n_{1n}+1) \\ w_1.(n_{21}+1) & w_2.(n_{22}+1) & \cdots & w_n.(n_{2n}+1) \\ \vdots & \vdots & \ddots & \vdots \\ w_1.(n_{m1}+1) & w_2.(n_{m2}+1) & \cdots & w_n.(n_{mn}+1) \end{bmatrix}$$

d. Determination of the border approximation area matrix (G).

$$g_i = \left(\prod_{j=1}^{m} v_{ij}\right)^{\frac{1}{m}}$$

After calculating the gi value for each criterion, the border approach of the area matrix G is formed with an n x 1 format (n is the number of criteria on which the selection of alternatives is based).

$$G = \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} g_1 & g_1 & \cdots & g_n \end{bmatrix} \end{array}$$

e. Calculation of alternative distances from the border approximation region for matrix element (Q).

$$Q = \begin{bmatrix} q_{11} & q_{12} & \cdots & q_{1n} \\ q_{21} & q_{22} & \cdots & q_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ q_{m1} & q_{m2} & \cdots & q_{mn} \end{bmatrix} = \begin{bmatrix} v_{11} - g_1 & v_{12} - g_2 & \cdots & v_{1n} - g_n \\ v_{21} - g_1 & v_{22} - g_2 & \cdots & v_{2n} - g_n \\ \vdots & \vdots & \ddots & \vdots \\ v_{m1} - g_1 & v_{m1} - g_2 & \cdots & v_{mn} - g_n \end{bmatrix}$$

f. Ranking alternatives

The calculation of the criterion function value for alternatives is obtained from the sum of the alternative distances from the border approximation area (Q). The greater the value of Si, the better the alternative.

$$S_i = \sum_{j=1}^{n} q_{ij}$$

Operational Competitiveness Rating Analysis (OCRA) Method

The Operational Competitiveness Rating Analysis (OCRA) method is a relative performance measurement approach based on a nonparametric model. This method was first developed by Parkan in 1994 and is a very useful and simple method to analyze various sectors and compare different decision units. Moreover, the ability to compare and monitor the performance of decision units over time is another important feature of this method. Operational Competitiveness Rating Analysis (OCRA) is a non-parametric efficiency measurement technique and was first proposed to solve the problem of performance measurement and productivity analysis (Nasyuha et al. 2022). This method was developed as a framework to evaluate and improve the operational competitiveness of companies by considering a number of relevant performance perspectives. The Performance Prism framework, also introduced by Professor Neely, is the basis of OCRA. The OCRA method includes the evaluation of critical operational performance based on five perspectives: strategy, procedures, capabilities, stakeholders, and contribution. The OCRA method has been gradually used in corporate management practice since its launch to evaluate operational competitiveness. The method has proven to provide a complete basis. OCRA and its developments continue to be used, especially for operational management studies and corporate performance measurement. The Combinative Distance-Based Assessment Method (CODAS) is an assessment method that combines various assessment methods: distance-based assessment, content-based assessment, and learning-based assessment. In 2010, Dr. Andreas C. Schmidt from the University of Tübingen, Germany, developed this method.The following is a summary of the steps used in the operational competitiveness assessment (OCRA) method:

1. In the first step, form decision matrix Xij

$$xij = \begin{bmatrix} X_{11} & X_{12} & \dots & X_{1n} \\ X_{21} & X_{22} & \dots & X_{2n} \\ \cdots & \cdots & \dots & \cdots \\ X_{m1} & X_{m2} & \dots & X_{mn} \end{bmatrix}$$

2. In the second step, the preference ranking with respect to the non-beneficial criteria (cost criteria) is determined. Here, the working values of the alternatives for the criteria to be minimized are calculated only from the beneficial criteria are not considered.

$$\bar{I}_1 = \sum_j^g = 1\ Wj\ \frac{\max(xij)}{\min(xij)}\ (i = 1{,}2 \ldots, m\ j = 1{,}2{,}..g)$$

3. In the third step, the linear preference ranking of each alternative for unfavorable criteria is calculated by the formula below.

$$\bar{\bar{I}}_1 = \bar{I}_1 - min(\bar{I}_1)$$

4. In the fourth step, the preference ranking with respect to the benefit criteria is determined. For beneficial criteria, the alternative that has a higher value is preferred. The total performance rating of alternative i for all the beneficial criteria is calculated by the formula below.

$$\bar{\bar{O}}_i = \sum_j^n = g + 1\ \ Wj \frac{xij - \max(xij)}{\min(\ xij)} (i = \ 1{,}2, \ldots., m\ j = \ g + l, g + 2 \ldots, n)$$

5. In the fifth step, the linear preference ranking is calculated for the useful criteria using the formula.

$$\bar{\bar{O}}_I = \bar{\bar{O}}_I\ - \min(\bar{\bar{O}}_i)$$

6. In the sixth step, the total preference value for each alternative is calculated using the formula below.

$$P1 = \left(\bar{\bar{I}}_i + \bar{\bar{O}}_i\right) - \min\left(\bar{\bar{I}} + \bar{\bar{O}}\right) i = 1,2, \ldots . m$$

Combinative Distance-Based Assessment (CODAS)

Combinative Distance-Based Assessment (CODAS) is one of the methods used to solve decision-making problems that have multiple criteria (Kesharvarz et al. 2016). At Vilnius University of Technology, Lithuania, the CODAS method was first used to solve the problem of selecting students for scholarships. It is considered to be more efficient, consistent with other methods, and has high stability of results. In this method, alternatives are selected through two gauges. The primary measure relates to the alternative's Euclidean distance from the negative-ideal. Using this type of distance requires a standard neglect space I2 for the criteria. The second measure is the Taxicab distance which corresponds to the standard neglect space I1 . The alternative that has a greater distance from the negative-ideal solution is the preferred alternative. In this method, if there are two or more alternatives that have the same Euclidean distance, the Taxicab distance is used as the second measure. Although the standard I2 ignoring space is preferred in CODAS, both ignoring spaces can be taken into account in the process. In conducting the ranking process, the CODAS method has seven stages, which are as follows :

a. Formation of Decision Matrix (X), can be calculated by Equation 1.

$$x = [xij]_{nxm} \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{1m} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix}$$

Description :
m : Number of criteria
n : Number of alternatives
xij : performance value of alternative i against criterion j

b. Normalization of the Decision Matrix for all criteria. Linear normalization is used for performance values with Equation 2.

$$\begin{cases} \dfrac{xij}{\underset{i}{max_{xij}}} \; jika\; j \;\in\; N_b \\ \dfrac{\underset{i}{min_{xij}}}{xij} \; jika\; j \;\in\; Nc \end{cases}$$

Description:
nij : Normalized performance value of alternative i against criterion j
Nbb : Benefit type criteria
Nc : Cost type criteria

c. Calculating the normalized and weighted decision-making matrix. The normalized and weighted performance value of alternative i against criterion j (rij) can be calculated using Equation 3.

$$r_{ij} = w_j \,.\, n_{ij}$$

Description:
wj: Normalized weight of criterion j

$$0 < w_j < 1$$
$$\sum_{j=1}^{m} w_j = 1.$$

d. Determine the ideal-negative solution point of each criterion (nsj) using Equation 4 and Equation 5.

$$ns = \left[ns_j\right]_{1xm}$$
$$ns_j = \min_i r_{ij}$$

e. Calculate the Euclidean distance (Ei) and Taxicab distance (Ti) of alternatives from the negative-ideal solution, using Equation 6 and Equation 7.

$$E_i = \sqrt{\sum_{j=1}^{m}(r_{ij} - ns_j)^2}$$

$$T_i = \sum_{j=1}^{m}\left|r_{ij} - ns_j\right|$$

f. Create a Relative Assessment (Ra) matrix and its matrix components (hik), using Equation 8 and Equation 9.

$$Ra = [h_{ik}]_{n\times n}$$
$$h_{ik} = (E_i - E_k) + (\varphi(E_i - E_k) \times (T_i - T_k))$$

Where $k \in \{1,2, \cdots , n\}$, and ψ (read: miu) is a threshold function to recognize the Euclidean distances of two alternatives, and is defined by Equation 10.

$$\varphi(x) = \begin{cases} 1\ jika\ |x| \geq \tau \\ 0\ jika\ |x| < \tau \end{cases}$$

Where τ (read: tau) is a threshold parameter that can be determined by the decision maker. It is recommended to specify this parameter with a value between 0.01 and 0.05. If the difference between the Euclidean distances of two alternatives is less than τ, these two alternatives are also compared using Taxicab distance.

g. Calculating the assessment results of each alternative (Hi), can be calculated with Equation 11.

$$H_i = \sum_{k=1}^{n} h_{ik}$$

Ranking alternatives based on the results of alternative assessment i (Hi). The alternative with the highest assessment result (Hi) is the best choice among the existing alternatives.

RESULTS AND DUSCISSIONS

The decision support system built in this research is implemented using MABAC, OCRA, CODAS methods as calculation methods for determining priority ranking. Criteria, alternatives and criteria weight values are obtained from interviews with the school promotion team as a decission maker. The weight value of criteria and its types and the scale of alternative value assessment can be seen in Tables 1 and 2.

Table 1. Weight Value and Criteria Type

Weight	Type	Criterion Name	Criteria
0.35	Cost	Cost	C1
0.15	Benefit	Time	C2
0.25	Benefit	Reach	C3
0.15	Benefit	Completeness	C4
0.10	Benefit	Flexibility	C5

Table 2. Rating Scale

	Not Important	Less Imprortant	Imprortant	Very important
Cost	1	2	3	4

Furthermore, it will carry out the ranking process with the MABAC, OCRA, CODAS methods. In this study, the system was tested using input data as shown in Table 3. In Table 3, alternatives are coded with the provisions of numbers 1 representing Brochures, 2 representing Posters, 3 representing Billboards, 4 representing Banners, and 5 representing Newspaper advertisements.

Table 3. Data Input

Alternatif	Kriteria				
	C1	C2	C3	C4	C5
A1	4	3	3	3	3
A2	4	3	3	2	2
A3	1	2	2	1	2
A4	3	3	2	3	2
A5	4	3	2	1	2

Application of the MABAC Method

The MABAC method steps are as follows:

1. Create a decision matrix

$$X = \begin{bmatrix} 3 & 3 & 3 & 3 & 4 \\ 3 & 3 & 2 & 2 & 4 \\ 2 & 2 & 1 & 2 & 1 \\ 3 & 2 & 3 & 2 & 3 \\ 3 & 2 & 1 & 2 & 4 \end{bmatrix}$$

2. Normalization of the initial decision matrix
   a. Benefit Criteria

C1

$n_{11} = \frac{3-2}{3-2} = \frac{1}{1} = 1{,}00$

$n_{21} = \frac{3-2}{3-2} = \frac{1}{1} = 1{,}00$

$n_{31} = \frac{2-2}{3-2} = \frac{0}{1} = 0$

$n_{41} = \frac{3-2}{3-2} = \frac{1}{1} = 1{,}00$

$n_{51} = \frac{3-2}{3-2} = \frac{1}{1} = 1{,}00$

C2

$n_{12} = \frac{3-2}{3-2} = \frac{1}{1} = 1{,}00$

$n_{22} = \frac{3-2}{3-2} = \frac{1}{1} = 1{,}00$

$n_{32} = \frac{2-2}{3-2} = \frac{0}{1} = 0$

$n_{42} = \frac{2-2}{3-2} = \frac{0}{1} = 0$

$n_{52} = \frac{2-2}{3-2} = \frac{0}{1} = 0$

C3

$n_{13} = \frac{3-1}{3-1} = \frac{2}{2} = 1{,}00$

$n_{23} = \frac{2-1}{3-1} = \frac{1}{2} = 0{,}5$

$n_{33} = \frac{1-1}{3-1} = \frac{0}{2} = 0$

$n_{43} = \frac{3-1}{3-1} = \frac{2}{2} = 1{,}00$

$n_{53} = \frac{1-1}{3-1} = \frac{0}{2} = 0$

C4

$n_{14} = \frac{3-2}{3-2} = \frac{1}{1} = 1{,}00$

$n_{24} = \frac{3-2}{3-2} = \frac{0}{1} = 0$

$n_{34} = \frac{2-2}{3-2} = \frac{0}{1} = 0$

$n_{44} = \frac{2-2}{3-2} = \frac{0}{1} = 0$

$n_{54} = \frac{2-2}{3-2} = \frac{0}{1} = 0$

   b. Cost Criteria

C5

$n_{15} = \frac{4-4}{1-4} = \frac{0}{-3} = 0$

$n_{25} = \frac{4-4}{1-4} = \frac{0}{-3} = 0$
$n_{35} = \frac{1-4}{1-4} = \frac{-3}{-3} = 1{,}00$
$n_{45} = \frac{3-4}{1-4} = \frac{-1}{-3} = 0{,}333$
$n_{55} = \frac{4-4}{1-4} = \frac{0}{-3} = 0$

Table 4. Initial Decision Matrix Normalized Data

ALTERNATIF	C1	C2	C3	C4	C5
A1	1,00	1,00	1,00	1,00	0
A2	1,00	1,00	0,50	0	0
A3	0	0	0	0	1,00
A4	1,00	0	1,00	0	0,333
A5	1,00	0	0	0	0

3. Calculating the weighted matrix
A1
v_{11} = 0,15 x (1,00 + 1) = 0,3
v_{12} = 0,25 x (1,00 + 1) = 0,5
v_{13} = 0,15 x (1,00 + 1) = 0,3
v_{14} = 0,10 x (1,00 + 1) = 0,2
v_{15} = 0,35 x (0 + 1) = 0,35
A2
v_{21}= 0,15 x (1,00 + 1) = 0,3
v_{22} = 0,25 x (1,00 + 1) = 0,5
v_{23} = 0,15 x (0,5 + 1) = 0,225
v_{24} = 0,10 x (0 + 1) = 0,10
v_{25} = 0,35 x (0 + 1) = 0,35
A3
v_{31} = 0,15 x (0 + 1) = 0,15
v_{32} = 0,25 x (0 + 1) = 0,25
v_{33} = 0,15 x (0 + 1) = 0,15
v_{34} = 0,10 x (0 + 1) = 0,10
v_{35} = 0,35 x (1,00 + 1) = 0,7
A4
v_{41} = 0,15 x (1,00 + 1) = 0,3
v_{42} = 0,25 x (0 + 1) = 0,25
v_{43} = 0,15 x (1,00 + 1) = ,0,3
v_{44} = 0,10 x (0 + 1) = 0,10
v_{45} = 0,35 x (0,333 + 1) = 0,466
A5
v_{51} = 0,15 x (1,00 + 1) = 0,3
v_{52} = 0,25 x (0 + 1) = 0,25
v_{53} = 0,15 x (0 + 1) = 0,15
v_{54} = 0,10 x (0 + 1) = 0,10
v_{55} = 0,35 x (0 + 1) = 0,35

Table 5. Weighted Data Matrix

ALTERNATIF	C1	C2	C3	C4	C5
A1	0,3	0,5	0,3	0,2	0,35
A2	0,3	0,5	0,225	0,10	0,35
A3	0,15	0,25	0,15	0,10	0,7
A4	0,3	0,25	0,3	0,10	0,466
A5	0,3	0,25	0,15	0,10	0,35

4. Determination of Border Approximation Area Matrix

   G1 =$(0{,}3\ x\ 0{,}3\ x\ 0{,}15\ x\ 0{,}3\ x\ 0{,}3)^{\frac{1}{5}}$ = 0,000243

   G2 = $(0{,}5 \text{ x } 0{,}5 \text{ x } 0{,}25 \text{ x } 0{,}25 \text{ x } 0{,}25)^{\frac{1}{5}}$ = 0,000781

   G3 = $(0{,}3 \text{ x } 0{,}225 \text{ x } 0{,}15 \text{ x } 0{,}3 \text{ x } 0{,}15)^{\frac{1}{5}}$ = 0,000091

   G4 = $(0{,}2 \text{ x } 0{,}10 \text{ x } 0{,}10 \text{ x } 0{,}10 \text{ x } 0{,}10)^{\frac{1}{5}}$ = 0,000004

   G5 = $(0{,}35 \text{ x } 0{,}35 \text{ x } 0{,}7 \text{ x } 0{,}466 \text{ x } 0{,}35)^{\frac{1}{5}}$ = 0,002797

   Border Approach G area matrix is formed with the format of n x 1

   [0,000243 0,000781 0,000091 0,000004 0,002797]

5. Calculating alternative distances

   A1
   q_{11} = (0,3 - 0,000243) = 0,29975
   q_{12} = (0,5 - 0,000781) = 0,49921
   q_{13} = (0,3 - 0,000091) = 0,29990
   q_{14} = (0,2 - 0,000004) = 0,19999
   q_{15} = (0,35 - 0,002797) = 0,34720
   A2
   q_{21} = (0,3 - 0,000243) = 0,29975
   q_{22} = (0,5 - 0,000781) = 0,49921
   q_{23} = (0,225 - 0,000091) = 0,22490
   q_{24} = (0,10 - 0,000004) = 0,09999
   q_{25} = (0,35 - 0,002797) = 0,34720
   A3
   q_{31} = (0,15 - 0,000243) = 0,14957
   q_{32} = (0,25 - 0,000781) = 0,24921
   q_{33} = (0,15 - 0,000091) = 0,14990
   q_{34} = (0,10 - 0,000004) = 0,09999
   q_{35} = (0,7 - 0,002797) = 0,69720
   A4
   q_{41} = (0,3 - 0,000243) = 0,29975
   q_{42} = (0,25 - 0,000781) = 0,24921
   q_{43} = (0,3 - 0,000091) = 0,29990
   q_{44} = (0,10 - 0,000004) = 0,09999
   q_{45} = (0,466 - 0,002797) = 0,46320
   A5
   q_{51} = (0,3 - 0,000243) = 0,29975

q_{52} = (0,25 - 0,000781) = 0,24921
q_{53} = (0,15 - 0,000091) = 0,14990
q_{54} = (0,10 - 0,000004) = 0,09999
q_{55} = (0,35 - 0,002797) = 0,34720

Table 6. Alternative Distance Value Data

ALTERNATIF	C1	C2	C3	C4	C5
A1	0,29975	0,49921	0,29990	0,19999	0,34720
A2	0,29975	0,49921	0,22490	0,09999	0,34720
A3	0,14957	0,24921	0,14990	0,09999	0,69720
A4	0,29975	0,24921	0,29990	0,09999	0,46320
A5	0,29975	0,24921	0,14990	0,09999	0,34720

6. Alternative Ranking
   S1= (0,29975 + 0,49921 + 0,29990 + 0,19999 + 0,34720) = 1,64605
   S2 = (0,29975 + 0,49921 + 0,22490 + 0,09999 + 0,34720) = 1,47105
   S3 = (0,14957 + 0,24921 + 0,14990 + 0,09999 + 0,69720) = 1,34587
   S4 = (0,29975 + 0,24921 + 0,29990 + 0,09999 + 0,46320) = 1,41205
   S5 = (0,29975 + 0,24921 + 0,14990 + 0,09999 + 0,34720) = 1,14605

Table 7. Alternatives Ranking Data

ALTERNATIF	NILAI	PERINGKAT
A1	1,64605	1
A2	1,47105	2
A3	1,34587	4
A4	1,41205	3
A5	1,14605	5

3.1 Application of OCRA Method

1. Form a decision matrix

$$\begin{bmatrix} 3 & 3 & 3 & 3 & 4 \\ 3 & 3 & 2 & 2 & 4 \\ 2 & 2 & 1 & 2 & 1 \\ 3 & 2 & 3 & 2 & 3 \\ 3 & 2 & 1 & 2 & 4 \end{bmatrix}$$

2. Calculate the preference ranking for the criteria to be minimized (cost) for criteria C4 and C5

$$\bar{I}_1 = (0{,}35\ \frac{4-4}{1}) = 0{,}35$$

$$\bar{I}_2 = (0{,}35\ \frac{4-4}{1}) = 0{,}35$$

$$\bar{I}_3 = (0{,}35\ \frac{4-1}{1}) = 0{,}525$$

$$\bar{I}_4 = (0{,}35\ \frac{4-3}{1}) = 0{,}35$$

$$\bar{I}_5 = (0{,}35\ \frac{4-4}{1}) = 0{,}35$$

3. Calculating the linear preference ranking of each unfavorable alternative (Cost).
$\bar{\bar{I}}1 = 0{,}35 - 0{,}35 = 0$

$\bar{\bar{I}}2 = 0{,}35 - 0{,}35 = 0$

$\bar{\bar{I}}3 = 0{,}525 - 0{,}35 = 0{,}275$

$\bar{\bar{I}}4 = 0{,}35 - 0{,}35 = 0$

$\bar{\bar{I}}5 = 0{,}35 - 0{,}35 = 0$

4. Calculate the preference ranking for the maximized criteria.

$$\bar{O}_1 = \sum (0{,}15\ \left(\frac{3-2}{2}\right) + \left(0{,}25\ \frac{3-2}{2}\right) + \left(0{,}15\frac{3-1}{1}\right) + (0{,}10\ \frac{3-2}{2}) = \sum\ 0{,}15 + 0{,}125 + 0{,}3 + 0{,}05 = 0{,}625$$

$$\bar{O}_2 = \sum (0{,}15\ \left(\frac{3-2}{2}\right) + \left(0{,}25\ \frac{3-2}{2}\right) + \left(0{,}15\frac{1-1}{1}\right) + (0{,}10\ \frac{2-2}{2}) = \sum\ 0{,}15 + 0{,}125 + 0 + 0{,}1 = 0{,}375$$

$$\bar{O}_3 = \sum (0{,}15\ \left(\frac{2-2}{2}\right) + \left(0{,}25\ \frac{2-2}{2}\right) + \left(0{,}15\frac{1-1}{1}\right) + (0{,}10\ \frac{2-2}{2}) = \sum\ 0 + 0 + 0{,}075 + 0 = 0{,}075$$

$$\bar{O}_3 = \sum (0{,}15\ \left(\frac{3-2}{2}\right) + \left(0{,}25\ \frac{2-2}{2}\right) + \left(0{,}15\frac{3-1}{1}\right) + (0{,}10\ \frac{2-2}{2}) = \sum\ 0{,}15 + 0 + 0{,}3 + 0 = 0{,}45$$

$$\bar{O}_5 = \sum (0{,}15\ \left(\frac{3-2}{2}\right) + \left(0{,}25\ \frac{2-2}{2}\right) + \left(0{,}15\frac{1-1}{1}\right) + (0{,}10\ \frac{2-2}{2}) = \sum\ 0{,}15 + 0 + 0{,}075 + 0 = 0{,}225$$

5. Calculating linear preference sets

$\bar{\bar{O}}1 = 0{,}625 - 0{,}45 = 0{,}175$

$\bar{O}2 = 0{,}375 - 0{,}45 = -0{,}075$

$\bar{O}3 = 0{,}075 - 0{,}45 = 0{,}375$

$\bar{O}4 = 0{,}45 - 0{,}45 = 0$

$\bar{O}5 = 0{,}225 - 0{,}45 = 0{,}225$

6. Calculating the total preference value for each alternative

$P_1 = (0 + 0{,}175) - 0{,}35 = 0{,}225$

$P_2 = (0 + 0{,}075) - 0{,}35 = 0{,}225$

$P_3 = (0{,}275 + -0{,}375) - 0{,}35 = 0{,}225$

$P_4 = (0 + 0) - 0{,}35 = 0{,}225$

$P_5 = (0 + -0{,}225) - 0{,}35 = 0{,}225$

Tabel 8. Preference Result Values

ALTERNATIF	Promotion media	Mark Preference	Rating
A1	Brochure	− 0,175	2
A2	Poster	− 0,275	4
A3	billboard	− 0,45	1
A4	Banner	− 0,35	3
A5	Newspaper Advertisement	− 0,575	5

Application of Codas Method

a. Step 1: Forming the decision matrix.
   The first stage forms a matrix, The decision matrix represents all available information for each attribute in matrix form. The matrix is created using Equation 1.

$$X = \begin{bmatrix} 3 & 3 & 3 & 3 & 4 \\ 3 & 3 & 2 & 2 & 4 \\ 2 & 2 & 1 & 2 & 1 \\ 3 & 2 & 3 & 2 & 3 \\ 3 & 2 & 1 & 2 & 4 \end{bmatrix}$$

b. Step 2: Perform normalization of the decision matrix.
   The second stage forms a normalization matrix (N) by determining which sub-criteria are included in the benefit or cost type using Equation 2. If the sub-criteria has a benefit type, it can be found using the benefit formula, while sub-criteria that have a cost type can be found using the cost formula.

$n_{11} = \frac{3}{3} = 1$

$n_{12} = \frac{3}{3} = 1$

$n_{13} = \frac{2}{3} = 0.666667$

$n_{14} = \frac{3}{3} = 1$

$n_{15} = \frac{3}{3} = 1$

$n_{21} = \frac{3}{3} = 1$

$n_{22} = \frac{3}{3} = 1$

$n_{23} = \frac{2}{3} = 0.666667$

$n_{24} = \frac{2}{3} = 0.666667$

$n_{25} = \frac{2}{3} = 0.666667$

Table 9. Normalized Matrix (N)

	C1	C2	C3	C4	C5
A1	1	1	1	1	0.25
A2	1	1	0.666667	0.666667	0.25
A3	0.666667	0.666667	0.333333	0.666667	1
A4	1	0.666667	1	0.666667	0.333333
A5	1	0.666667	0.333333	0.666667	0.25

c. Step 3: Form a normalized and weighted matrix.
The third stage calculates the normalized and weighted matrix value using Equation 3. The weight is multiplied by the result of the normalized matrix value, so that the rij value will be obtained. Table 10 is a normalized matrix based on the weight of each sub-criteria.

$r_{11} = 0.15 * 1 = 0.15$

$r_{12} = 0.15 * 1 = 0.15$

$r_{13} = 0.15 * 0.666667 = 0.1$

$r_{14} = 0.15 * 1 = 0.15$

$r_{15} = 0.15 * 1 = 0.15$

$r_{21} = 0.25 * 1 = 0.25$

r_{22}= 0.25 * 1 = 0.25

r_{23}= 0.25 * 0.666667 = 0.166667

r_{24}= 0.25 * 0.666667 = 0.166667

r_{25}= 0.25 * 0.666667 = 0.166667

Table 10. Weighted Normalized Matrix (R)

	C1	C2	C3	C4	C5
A1	0.15	0.25	0.15	0.1	0.0875
A2	0.15	0.25	0.1	0.066667	0.0875
A3	0.1	0.166667	0.05	0.066667	0.35
A4	0.15	0.166667	0.15	0.066667	0.116667
A5	0.15	0.166667	0.05	0.066667	0.0875

d. Step 4: Determining the negative ideal value (NS)
The fourth stage is to find the negative ideal value using Equation 5. The negative ideal value is taken from the smallest value on the criteria used. Table 11 is a negative ideal value taken based on the lowest value of the normalized and weighted matrix value.

ns_{c1} = 0.1

ns_{c2} = 0.166667

ns_{c3} = 0.05

ns_{c4} = 0.066667

Table 11. Negative Ideal Values (NS)

C1	C2	C3	C4	C5
0.1	0.166667	0.05	0.066667	0.0875

e. Step 5 : Calculating Euclidian and Taxicab (E/T) distance values
The fifth stage calculates the euclidian and taxicab distance (E/T) using Equation 6 and Equation 7. The euclidian distance is calculated by subtracting the weighted normalized matrix value (R) with the negative ideal value (NS) which is raised by 2 and summed, then rooted. Table 12 shows the euclidian and taxicab distance values. Euclidian distance.

$$E_{A1} = \sqrt{\begin{matrix}(0.15-0.1)^2+(0.25-0.166667)^2+(0.15-0.05)^2+\\(0.1-0.066667)^2+(0.0875-0.0875)^2\end{matrix}}$$

$$= 0.14337209$$

$$E_{A2} = \sqrt{\begin{matrix}(0.15-0.1)^2+(0.25-0.166667)^2+(0.1-0.05)^2+\\(0.066667-0.066667)^2+(0.0875-0.0875)^2\end{matrix}}$$

= 0.10929064

$$E_{A3} = \sqrt{\begin{matrix}(0.1-0.1)^2+(0.166667-0.166667)^2+(0.05-0.05)^2+\\(0.066667-0.066667)^2+(0.35-0.0875)^2\end{matrix}}$$

= 0.2625

$$E_{A4} = \sqrt{\begin{matrix}(0.15-0.1)^2+(0.166667-0.166667)^2+(0.15-0.05)^2+\\(0.066667-0.066667)^2+(0.116667-0.0875)^2\end{matrix}}$$

= 0.11554521

$$E_{A5} = \sqrt{\begin{matrix}(0.15-0.1)^2+(0.166667-0.166667)^2+(0.05-0.05)^2+\\(0.066667-0.066667)^2+(0.0875-0.0875)^2\end{matrix}}$$

= 0.05

$$T_{A1} = \left|\begin{matrix}(0.15-0.1)^2+(0.25-0.166667)^2+(0.15-0.05)^2+\\(0.1-0.066667)^2+(0.0875-0.0875)^2\end{matrix}\right|$$

= 0.266666667

$$T_{A2} = \left|\begin{matrix}(0.15-0.1)^2+(0.25-0.166667)^2+(0.1-0.05)^2+\\(0.066667-0.066667)^2+(0.0875-0.0875)^2\end{matrix}\right|$$

= 0.183333333

$$T_{A3} = \left|\begin{matrix}(0.1-0.1)^2+(0.166667-0.166667)^2+(0.05-0.05)^2+\\(0.066667-0.066667)^2+(0.35-0.0875)^2\end{matrix}\right|$$

= 0.2625

$$T_{A4} = \left|\begin{matrix}(0.15-0.1)^2+(0.166667-0.166667)^2+(0.15-0.05)^2+\\(0.066667-0.066667)^2+(0.116667-0.0875)^2\end{matrix}\right|$$

= 0.179166667

$$T_{A5} = \left|\begin{matrix}(0.15-0.1)^2+(0.166667-0.166667)^2+(0.05-0.05)^2+\\(0.066667-0.066667)^2+(0.0875-0.0875)^2\end{matrix}\right|$$

= 0.05

Table 12. Euclidian/Taxicab Distance Value (E/T)

f. Step 6 : Forming a Relative Assessment (RA) matrix

The sixth stage forms a Relative Assessment (RA) matrix with a threshold value parameter of 0.02 using Equation 9. The value of the relative assessment matrix is obtained by subtracting the value of euclidian i and constant euclidian, then the results are compared with the threshold, if it is smaller then the result is zero, or vice versa then the value becomes one. then multiplied by the reduction in the value of taxicab i and constant taxicab. Table 13 is the relative assessment matrix.

Table 13. Matriks Relative Assessment (RA)

EUCLIDIAN AND TAXICAB DISTANCE			
Ei		Ti	
A1	0.14337209	A1	0.266666667
A2	0.10929064	A2	0.183333333
A3	0.2625	A3	0.2625
A4	0.11554521	A4	0.179166667
A5	0.05	A5	0.05

MATRIKS RA t=0.05					
	A1	A2	A3	A4	A5
A1	0	0.034081	-0.11913	0.027827	0.093372
A2	-0.03408	0	-0.15321	-0.00625	0.059291
A3	0.119128	0.153209	0	0.146955	0.2125
A4	-0.02783	0.006255	-0.14695	0	0.065545
A5	-0.09337	-0.05929	-0.2125	-0.06555	0

g. Step 7 : Calculating the assessment score value (H)

The seventh stage calculates the assessment score (H) value using Equation 11. Summing the assessment matrix values that have been obtained previously in one row. Table 14 is the assessment score value which is the total of the assessment matrix values.

$$H_{A1} = 0 + 0.034081446 + (-0.119127) + 0.027827 + 0.93372 = 0.036153$$

$$H_{A1} = -0.03408 + 0 + (-0.15321) + -0.00625 + 0.059291 = -0.13425$$

$$H_{A1} = 0.119128 + 0.153209 + 0 + 0.146955 + 0.2125 = 0.631792$$

$$H_{A1} = -0.02783 + 0.006255 + (-0.14695) + 0 + 0.065545 = -0.10298$$

$$H_{A1} = -0.09337 + (-0.05929) + (-0.2125) + (-0.06555) + 0 = -0.43071$$

Table 14. Assessment Score (H)

Alternatif	H
A1	0.036153
A2	-0.13425
A3	0.631792
A4	-0.10298
A5	-0.43071

h. Step 8 : Performing ranking

The eighth stage performs ranking of the assessment score (H) which is then sorted based on the highest to lowest value. The table is the assessment score value that has been sorted based on its value.

Table 15. Ranking

Alternatif	H	Ranking
A1	0.036152504	2
A2	-0.134254725	4
A3	0.631792065	1
A4	-0.102981909	3
A5	-0.430707935	5

So alternative 3 is the best alternative for school promotional media.

CONCLUSIONS AND RECOMMENDATIONS

(MABAC) The MABAC method can be concluded and implemented in finding the best alternative ranking of the criteria for selecting promotional media for vocational schools, so that the media Brochures, Posters, Billboards, Newspaper Advertising Banners, so as to determine promotional media recommendations with the highest final results obtained, namely in alternative A1 which uses brochure media with a value of 1,64605. So that the alternative that has the highest priority ranking is A1.

(OCRA) Based on the results of the research that has been done, it can be concluded that the Operational Competitiveness Rating Analysis (OCRA) method has been successfully implemented in the decision support system for selecting school promotion media at this SMK. From the results of system calculations according to the weight of criteria and input alternatives obtained from the school promotion team, it is found that brochure media is the alternative that has the highest priority ranking. From the results of testing the accuracy of system calculations so as to obtain an optimization value of - 0.175 on alternative A1 as an alternative that is entitled as the first rank.

(CODAS) In the selection of school promotional media, the use of the CODAS (Complex Proportional Assessment) method can provide significant support in decision-making. This method allows for a comprehensive evaluation by considering a wide range of relevant criteria. The results of the analysis using the CODAS method enable the identification of the most effective promotional media based on various aspects, such as target audience, budget, reach and impact. The use of this method helps prioritize based on the relative importance and weight of each criterion. From the results of testing the accuracy of system calculations to obtain an optimization value of 0.631792065 on alternative A3 as an alternative that is entitled as the first rank.

FURTHER STUDY

Conduct further research to analyze the performance comparison of the MABAC, OCRA, and CODAS methods in the context of selecting promotional media. Comparative analysis can provide a more in-depth picture of the strengths and weaknesses of each method. Recommend the development of an integrative model that combines the best elements of the three methods. This model can provide a more comprehensive and adaptive approach to school promotion media selection. Evaluate the social and economic impacts of implementing the proposed method. This research can provide insight into the concrete benefits provided by the use of decision support systems in school promotion media selection.

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REFERENCES

Baydaş, Mahmut. 2022. "The Effect of Pandemic Conditions on Financial Success Rankings of BIST SME Industrial Companies: A Different Evaluation with the Help of Comparison of Special Capabilities of MOORA, MABAC and FUCA Methods." *Business & Management Studies: An International Journal* 10(1):245–60. doi: 10.15295/bmij.v10i1.1997.

Handayani, Cucu-, Adi Muhamad Muhsidi, and Nur Isti Khomalia. 2021. "Metode Multi Attributive Border Approximation Area Comparison (MABAC) Untuk Penilaian Kinerja Dalam Pengelolaan Alokasi Dana Desa (ADD)." *Jurnal ICT : Information Communication & Technology* 20(2):303–9. doi: 10.36054/jict-ikmi.v20i2.377.

KALEM, Rabia Nur, and Muhammet Enes AKPINAR. 2022. "Personnel Performance Assessment Using Entropy Based MABAC Method: An Application in the Food Sector." *Equinox Journal of Economics Business and Political Studies* 9(1):89–106. doi: 10.48064/equinox.1063776.

Kesharvarz, Mehdi, Edmundas Zavadskas, Zenonas Turskis, and Jurgita Antucheviciene. 2016. "A_new_combinative_distance-Based_assessm." *Economic Computation and Economic Cybernetics Studies and Research* 50(1):39–68.

Ndruru, N. et al. (2020) 'Penerapan Metode MABAC Untuk Mendukung Pengambilan Keputusan Pemilihan Kepala Cabang Pada PT. Cefa Indonesia Sejahtera Lestari', Resolusi : Rekayasa Teknik Informatika dan Informasi, 1(1), pp. 36–49. Available at: https://doi.org/10.30865/resolusi.v1i1.11.

Rosita, Isa, Gunawan, and Desi Apriani. 2020. "55 Metik Volume. 4 Nomor." *Penerapan Metode Moora Pada Sistem Pendukung Keputusan Pemilihan Media Promosi Sekolah (Studi Kasus: SMK Airlangga Balikpapan) Isa* 4:2020.

Sidabutar, A. and Kristini Purba, R. (2022) 'Sistem Pendukung Keputusan Pemberian Bantuan UMKM pada Dinas Koperasi Menerapkan Metode OCRA', Proceedings Economic, Social Science, Computer, Agriculture And Fisheries (Escaf 1st), 1(1), pp. 1–11.

Suriati, N., Midyanti, D.M. and Ristian, U. (2022) 'Implementasi Metode Combinative Distance-Based Assessment (CODAS) Untuk Rekomendasi Rekanan Jasa Konsultansi Berbasis Website', 9(5), pp. 1632–1642. Available at: https://doi.org/10.30865/jurikom.v9i5.5012.

Vinet, L. and Zhedanov, A. (2011) 'A "missing" family of classical orthogonal polynomials', Journal of Physics A: Mathematical and Theoretical, 44(8), pp. 1689–1699. Available at: https://doi.org/10.1088/1751-8113/44/8/085201.

Zega, M. and Syahrizal, M. (2022) 'Sistem Pendukung Keputusan Rekomendasi Penerimaan Bantuan Beasiswa Kurang Mampu Dengan Menerapkan Metode Ocra Dan Pembobotan Roc Pada Sekolah YapimMedan', KOMIK (Konferensi …, 6(November), pp. 550–558. Available at: https://doi.org/10.30865/komik.v6i1.5731.