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Hybrid Entropy and CRADIS Method Approach in Decision Support System for Selecting the Best Employees

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Abstract−Selecting the right employees is a key factor in improving organizational performance and productivity. However, in many organizations, the employee selection process is still conducted through manual assessments and subjective judgments, which may lead to bias and inconsistent decisions. Therefore, a systematic and objective approach is needed to support the evaluation process. This study integrates the Entropy method and the CRADIS method within a decision support system to determine the best employee candidates. The Entropy method is applied to calculate objective criteria weights based on the variation of information in the data, while the CRADIS method is used to rank candidates according to their proximity to the ideal solution and distance from the anti-ideal solution. The integration of these two methods provides a framework that reduces subjectivity in determining criterion importance and produces more discriminative ranking results. The findings indicate that candidate GF achieved the highest score of 0.6848, followed by EY with 0.6835 and AR with 0.6528, showing that these candidates have performance profiles closest to the defined criteria. In addition, sensitivity analysis using several scenarios of criteria weight changes demonstrates that the proposed model is relatively stable, with an overall ranking consistency of 81.8%, while alternatives AR, DI, and FR show 100% ranking stability. These results indicate that the Entropy–CRADIS approach can improve the accuracy, objectivity, and reliability of employee selection decisions in multi-criteria decision-making environments.

Keywords: CRADIS Method; Hybrid MCDM; Entropy; Employee Selection; Decision Support System

1. INTRODUCTION

In a competitive work environment, selecting the best employees becomes one of the crucial factors determining the success and sustainability of an organization[1]–[3]. Outstanding employees not only can complete tasks effectively but also contribute to the overall achievement of the company's strategic goals. Therefore, the recruitment and assessment process must be conducted carefully, systematically, and based on relevant criteria. However, the selection of the best employees often faces challenges such as subjectivity in assessment, limitations of information, and difficulties in processing complex multi-criteria data. To address this issue, Decision Support Systems (DSS) present an effective solution. DSS is a computer-based system used to assist decision-makers in resolving semi-structured and unstructured problems[4]–[6]. In the context of employee selection, DSS allows evaluation based on various criteria such as performance, skills, discipline, and teamwork ability. With the help of systematic quantitative methods, DSS can enhance objectivity and consistency in the employee selection process. However, most existing studies still present the problem of employee selection in a general manner and do not clearly highlight the specific research gaps related to the limitations of the methods used, particularly in terms of objective weighting and the effectiveness of ranking mechanisms in handling multi-criteria evaluation. Many approaches rely on subjective weighting or apply ranking methods without considering the variability of data across criteria, which can potentially affect the reliability of the final decision. Therefore, it is important to develop an approach that not only supports systematic decision-making but also addresses these methodological gaps by integrating objective weighting and robust ranking techniques in the employee selection process.

The implementation of DSS does not always provide optimal results for all decision-making methods[7], [8]. Many methods rely solely on subjective weighting or have weaknesses in integrating various evaluation aspects. Although Decision Support Systems are widely used to assist decision-makers in complex evaluation processes, many DSS implementations still rely on single decision-making methods that may not adequately capture the complexity of multi-criteria problems. In several cases, DSS models depend heavily on subjective weighting or simple ranking techniques, which can lead to inconsistent results and reduced decision reliability. These limitations indicate that conventional DSS approaches may struggle to balance objectivity in determining criterion importance and robustness in ranking alternatives. This creates a need for a hybrid approach that can combine the strengths of several methods to produce more accurate and reliable decisions. One promising approach is the combination of the Entropy method as an objective weighting and a compromise ranking method based on the distance to the ideal solution. The Entropy method is used to determine the criteria weights objectively based on the level of data variation, thereby reducing the subjective bias of the decision maker. The Entropy Method has several advantages that make it a good choice for determining the weights of criteria objectively in multi-criteria decision-making[9]–[11]. One of its main advantages is its objective nature, as it does not require subjective judgments from decision-makers. The weights of criteria are calculated directly based on data from the decision matrix, making the results free from bias or personal views[12], [13]. This method can also avoid redundancy, as criteria with similar information patterns will be given relatively small weights, thereby emphasizing the truly important criteria in the decision-making process.

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The Entropy weighting method is an objective approach in multi-criteria decision-making used to determine the importance of each criterion based on the information contained in the data[9], [11], [14]. This method evaluates the level of variation among alternatives for each criterion. Criteria with greater variation provide more useful information in distinguishing alternatives and therefore receive higher weights, while criteria with relatively similar values receive lower weights because they contribute less to the differentiation process[15]–[17]. Due to this capability, the Entropy method is effective for handling datasets with varying performance values, such as in employee evaluation, where candidates may have different levels of performance across multiple criteria. By determining weights directly from data distribution, the Entropy method reduces subjective bias and supports a more objective and reliable decision-making process in the selection of the best employees.

The compromise ranking of alternatives from distance to ideal solution (CRADIS) method is a multi-criteria decision-making approach that determines alternative rankings by considering the proximity to the ideal solution and the distance from the anti-ideal solution[18]–[20]. In this method, the best alternative is expected to have the smallest distance from the ideal condition and the largest distance from the worst condition. The CRADIS method calculates a compromise value that reflects the balance between these two distances, and this value is used as the basis for ranking alternatives. Compared with other distance-based approaches, CRADIS offers a more balanced evaluation mechanism because it emphasizes a compromise assessment between ideal and anti-ideal conditions without relying heavily on additional parameters or complex preference strategies. This makes the ranking process more stable and easier to interpret, especially in situations where alternatives show relatively close performance across several criteria. Therefore, CRADIS is considered effective for supporting decision-making problems that require fair and consistent ranking results, such as in employee selection contexts where multiple criteria must be evaluated simultaneously[21]–[23].

The Hybrid Entropy and CRADIS method is a multi-criteria decision-making approach that combines two main techniques, namely the first being the Entropy method for objective criterion weight determination and the second being the CRADIS method for ranking alternatives based on their proximity to the ideal solution. In this method, the process begins with collecting a decision matrix that contains evaluations of various alternatives against a number of criteria. Next, the Entropy method is used to calculate the weight of each criterion based on the degree of variation or uncertainty of information in the data. Criteria with a high level of variation are considered more informative and are given a greater weight, while criteria with low variation are given a smaller weight. This weight is then used in the CRADIS calculation, which involves data normalization, determining the ideal solution (the best value for each criterion) and the anti-ideal solution (the worst value), as well as calculating the distance of each alternative from both solutions. Compared with other multi-criteria decision-making approaches, this hybrid method offers several advantages in terms of objectivity and robustness in the evaluation process. Many existing approaches rely heavily on subjective judgments in determining the importance of criteria or use relatively simple aggregation mechanisms that may reduce the sensitivity of the ranking results when alternatives have similar performance values. In contrast, this hybrid approach emphasizes an objective weighting mechanism based on data variation and combines it with a compromise-based evaluation that considers the relative position of each alternative against both ideal and worst conditions. As a result, the method can provide a more balanced and reliable ranking outcome, especially in decision-making problems that involve complex criteria and multiple alternatives.

The combination of these two methods provides advantages in terms of weighting accuracy and fairness in the ranking process of alternatives. Based on these considerations, this study aims to examine the application of a hybrid approach that integrates the Entropy method and CRADIS within a decision support system for selecting the best employees. In addition, this research seeks to explore how the integration of objective weighting and compromise-based ranking can contribute to improving the decision-making process in employee evaluation. Through this approach, the study is expected to provide insights into the use of hybrid multi-criteria decision-making methods as an alternative framework that can support more systematic and data-driven human resource selection in organizational environments.

2. RESEARCH METHODOLOGY

2.1 Research Stages

The stages of research generally refer to the sequence of systematic steps taken by researchers in formulating, conducting, and completing a scientific study to achieve the research objectives[24]. These stages help maintain the flow of research to be logical, directed, and methodologically accountable. The stages of research conducted are shown in Figure 1.

The stages of the research on the hybrid Entropy and CRADIS approach in the decision support system for selecting the best employees are illustrated in Figure 1. The process begins with data collection, which involves gathering assessment data about candidates based on several relevant criteria such as performance, skills, discipline, and attitude.

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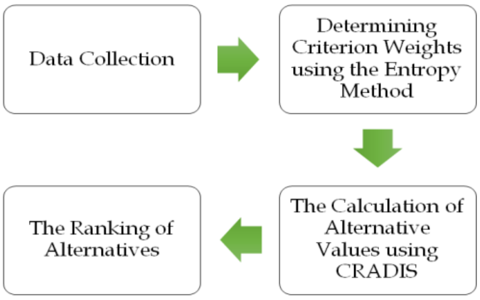

Figure 1. Research Stage

After the data are obtained, the next stage is determining the criterion weights using the Entropy method, which evaluates the level of information variation in the dataset. Criteria that show greater variability among alternatives are assigned higher weights because they provide more discriminative information in the evaluation process. Subsequently, the CRADIS method is applied to calculate the alternative values by measuring the relative closeness of each alternative to the positive ideal solution and its distance from the negative ideal solution. Finally, the ranking of alternatives is determined based on the compromise value produced by the CRADIS calculation, where the alternative with the highest value is considered the best because it is closest to the ideal condition and farthest from the worst condition.

2.2 Entropy Method

The entropy method is an objective approach used to determine the weight or level of importance of each criterion based on the information spread from evaluation data. The greater the data variation of a criterion, the higher the information it contains, and the greater its weight. In this study, the Entropy method is applied to calculate the weights of several employee evaluation criteria based on actual assessment data. The entropy method has five main stages in generating criterion weights, namely.
The first stage begins by assembling evaluation data from several alternatives against a number of criteria into a decision matrix.

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

Symbol X Equation (1) represents the decision matrix used in the multi-criteria evaluation process, where each element x_{ij} indicates the performance value of alternative ith on criterion jth.

The second stage involves the normalization process to equalize the values across criteria that may have different scales. This process aims to convert all values into a uniform scale, allowing for fair comparisons between criteria and alternatives.

$$k_{ij} = \frac{x_{ij}}{\sum_{j=1}^{n} x_{ij}} \quad (2)$$

The symbol k_{ij} represents the normalized value of alternative ith on criterion jth obtained from the normalization process of the decision matrix.

The third stage is to calculate the entropy value of each criterion, which describes the level of uncertainty or diversity of the data for each criterion. Criteria with nearly identical data values across all alternatives will have a high entropy, meaning the information is low. Conversely, if the data for a certain criterion varies greatly, its entropy is low and is considered to have high information.

$$E_j = -\frac{1}{\ln m} \sum_{i=1}^{n} k_{ij} \ln(k_{ij}) \quad (3)$$

The symbol E_j represents the entropy value of criterion j, which reflects the level of information diversity or uncertainty contained in the data for that criterion, $\ln(k_{ij})$ is the natural logarithm used to measure the information content of each normalized value.

The fourth stage determines the degree of variation or diversity for each criterion. This degree of variation describes how much information is contained by a criterion in distinguishing alternatives. The greater the diversity value, the more important the criterion is in the decision-making process.

$$D_j = 1 - E_j \quad (4)$$

The symbol D_j represents the degree of diversification or information utility value of criterion jth.

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The fifth stage is to determine the weight of each criterion based on the obtained degree of variation. This weight is objective because it is entirely determined by the available data, without interference from opinions or subjective preferences of the decision-maker.

$$w_j = \frac{D_j}{\sum_{j=1}^{n} D_j} \quad (5)$$

The symbol w_j represents the final weight of criterion j^{th} obtained from the normalization of the diversification value.

The entropy method assigns weights to criteria based on the distribution of data, rather than subjective opinions. Criteria with more varied and informative data will receive greater weights because they contribute more to distinguishing alternatives. In the context of employee selection in this study, the entropy method helps identify which evaluation criteria provide the most significant differentiation among candidates. Criteria that show greater variation in candidate assessments will be assigned higher weights, indicating that they play a more important role in distinguishing the best employees. As a result, the weighting process becomes more objective and data-driven, enabling the decision support system to evaluate employee candidates more fairly and accurately.

2.2 CRADIS Method

The CRADIS method is an MCDM method that evaluates and ranks alternatives based on a compromise between proximity to the ideal solution and distance from the anti-ideal solution. Here are the stages of the CRADIS method systematically:

The first step of the CRADIS method is to construct a decision matrix, which is a table that contains the performance values of each alternative against each criterion created using equation (1).

The second step of the CRADIS method is normalization so that all data is on a comparable scale. The common normalization techniques used depend on the nature of the criteria (benefit or cost).

$$n_{ij} = \frac{x_{ij}}{x_{max}^{j}} \quad (6)$$

$$n_{ij} = \frac{x_{min}^{j}}{x_{ij}} \quad (7)$$

The symbol n_{ij} represents the normalized value of alternative i^{th} on criterion j^{th} in the CRADIS method, while x_{max}^{j} represents the maximum value among all alternatives for that criterion and x_{min}^{j} indicates the minimum value of criterion j^{th} among all alternatives

The third step of the CRADIS method is to calculate the values in the normalized matrix and then multiply them by the weights of each criterion to obtain the weighted normalized matrix.

$$v_{ij} = n_{ij} * w_j \quad (8)$$

The symbol v_{ij} represents the weighted normalized value of alternative i^{th} on criterion j^{th}.

The fourth step of the CRADIS method is to determine the highest (ideal) and lowest (anti-ideal) values of each criterion from each alternative.

$$t_i^{+} = \max v_{ij} \quad (9)$$

$$t_i^{-} = \min v_{ij} \quad (10)$$

The symbols t_i^{+} in represents the ideal value, while t_i^{-} represents the anti-ideal value.

The fifth step of the CRADIS method is to calculate the deviation values from the ideal and anti-ideal solutions to determine how far each alternative is from the ideal solution (best value) and the anti-ideal solution (worst value) based on the weighted normalized decision matrix values.

$$d_{ij}^{+} = t_i^{+} - v_{ij} \quad (11)$$

$$d_{ij}^{-} = v_{ij} - t_i^{-} \quad (12)$$

The symbol d_{ij}^{+} represents the distance from the ideal value and d_{ij}^{-} represents the distance from the anti-ideal value.

The sixth step of the CRADIS method is calculating the grades of deviation, which is a numerical measure that indicates how close or far an alternative is from the ideal and anti-ideal solutions, which is usually calculated using absolute distance or other deviation functions.

$$s_i^{+} = \sum_{j=1}^{n} d_{ij}^{+} \quad (13)$$

$$s_i^{-} = \sum_{j=1}^{n} d_{ij}^{-} \quad (14)$$

The symbol s_i^{+} indicates the overall distance of alternative i^{th} from the ideal solution, and s_i^{-} indicates the total distance from the anti-ideal solution.

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The seventh step of the CRADIS method is to calculate the utility value that reflects how well the alternative performs overall, taking into account all relevant criteria and their weights.

$$K_i^+ = \frac{s_0^+}{s_i^+} \quad (15)$$

$$K_i^- = \frac{s_i^-}{s_0^-} \quad (16)$$

The symbol K_i^+ and K_i^- representing the reference values of the ideal and anti-ideal distances.

The final step of the CRADIS method is to calculate the final value that indicates the final alternative results based on the overall performance score, which is ready to be used as a basis for decision-making.

$$Q_i = \frac{K_i^+ - K_i^-}{2} \quad (17)$$

The symbol Q_i value indicates that the alternative is closer to the ideal solution and therefore considered more preferable in the decision-making process.

The CRADIS method is a powerful approach for producing alternative rankings in a fair and balanced manner. In the context of selecting the best employees, CRADIS helps provide an objective decision based on an optimal compromise between the expected performance standards and the conditions that must be avoided. In this study, the method evaluates each employee candidate based on several criteria such as performance, discipline, skills, and teamwork ability. By calculating the distance of each candidate from the ideal and anti-ideal solutions, CRADIS can identify candidates whose performance profiles are closest to the expected standards set by the organization. As a result, the decision support system can rank employee candidates more objectively and transparently, ensuring that the selected employees are those who most closely meet the overall evaluation criteria established in this research.

3. RESULT AND DISCUSSION

The implementation of a hybrid approach between the entropy method and CRADIS in a decision support system for selecting the best employees. The use of the entropy method aims to determine the weights of the criteria objectively based on the level of data variation, thus reflecting the significance of each criterion statistically. Meanwhile, the CRADIS method is used to rank alternatives based on their proximity to the ideal solution, considering the balance between the best and worst solutions. The combination of these two methods is expected to improve accuracy and objectivity in decision-making. An analysis was conducted on a number of employee candidates by considering various assessment criteria. The obtained assessment data was then processed using the hybrid approach to produce a ranking order of candidates from the most suitable to the least suitable. The results of this ranking were compared and analyzed to observe the consistency of the system and to identify candidates who have outstanding overall performance.

3.1 Data Collection

The data collection process in this research was carried out to obtain information on the assessment of several employee candidates based on predetermined criteria. Data sources were obtained through questionnaires and structured interviews given to managers or supervisors in each division of the company. Respondents were asked to provide an evaluation of each candidate based on a numerical scale (on a scale of 1–10), in accordance with assessment criteria such as experience (BEP-1), skills (BEP-2), communication (BEP-3), cooperation (BEP-4), and the distance of residence to the workplace (BEP-5). The assessment data for the candidates that have been conducted is displayed in the following Table 1.

Table 1. Assessment Data for the Candidates

Name	BEP-1	BEP-2	BEP-3	BEP-4	BEP-5
AR	8	9	7	9	8
BF	7	8	9	8	7
CR	9	7	8	9	9
DI	6	8	7	7	6
EY	8	9	8	8	7
FR	7	6	7	6	8
GF	9	8	9	9	9

The assessment score for each criterion uses a scale of 1–10, where a score of 1 indicates a very low level of performance and a score of 10 indicates a very high level of performance. As shown in Table 1, the scores represent the evaluation results of each employee candidate across several criteria used in this study. The assessment data were obtained from the company's internal evaluation conducted by management or supervisors based on relevant performance indicators, such as work quality, discipline, skills, work attitude, and teamwork ability. The use of this scale aims to provide a standardized evaluation framework so that each candidate can be compared objectively across

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all criteria involved in the employee selection process. After all the data were collected, the scores were organized into a decision matrix, which serves as the main input for further analysis, including the calculation of objective criterion weights using the Entropy method and the ranking of alternatives using the CRADIS method. Therefore, the data used in this study represent primary data, directly obtained from the company's internal observation and evaluation process.

3.2 Determining Criterion Weights using the Entropy Method

The entropy method focuses on the use of information contained in the variation of assessment data to objectively assign weights to criteria. The entropy method measures the relative diversity of each criterion where the greater the variation in assessments among alternatives, the more valuable the information of that criterion and the higher its weight. The first stage begins by assembling evaluation data from several alternatives against a number of criteria into a decision matrix using (1).

$$X = \begin{bmatrix} x_{11} & x_{12} & x_{13} & x_{14} & x_{15} \\ x_{21} & x_{22} & x_{23} & x_{24} & x_{25} \\ x_{31} & x_{32} & x_{33} & x_{34} & x_{35} \\ x_{41} & x_{42} & x_{43} & x_{44} & x_{45} \\ x_{51} & x_{52} & x_{53} & x_{54} & x_{55} \\ x_{61} & x_{62} & x_{63} & x_{64} & x_{65} \\ x_{71} & x_{72} & x_{73} & x_{74} & x_{75} \end{bmatrix} \quad X = \begin{bmatrix} 8 & 9 & 7 & 9 & 8 \\ 7 & 8 & 9 & 8 & 7 \\ 9 & 7 & 8 & 9 & 9 \\ 6 & 8 & 7 & 7 & 6 \\ 8 & 9 & 8 & 8 & 7 \\ 7 & 6 & 7 & 6 & 8 \\ 9 & 8 & 9 & 9 & 9 \end{bmatrix}$$

The second stage involves a normalization process to equalize values across criteria that may have different scales, calculated using (2).

$$k_{11} = \frac{x_{11}}{\sum_{i=1}^{7} x_{i1}} = \frac{8}{8+7+9+6+8+7+9} = \frac{8}{54} = 0.1481$$

The results of the normalization calculation using the entropy method are displayed in the following table 2.

Table 2. Normalization Results of the Entropy Method

Name	BEP-1	BEP-2	BEP-3	BEP-4	BEP-5
AR	0.1481	0.1636	0.1273	0.1607	0.1481
BF	0.1296	0.1455	0.1636	0.1429	0.1296
CR	0.1667	0.1273	0.1455	0.1607	0.1667
DI	0.1111	0.1455	0.1273	0.1250	0.1111
EY	0.1481	0.1636	0.1455	0.1429	0.1296
FR	0.1296	0.1091	0.1273	0.1071	0.1481
GF	0.1667	0.1455	0.1636	0.1607	0.1667

The third stage is to calculate the entropy value for each criterion, which describes the level of uncertainty or diversity of the data for each criterion calculated using (3).

$$E_1 = -\frac{1}{\ln 7} \sum_{i=1}^{n} k_{i1} \ln(k_{i1})$$

$$E_1 = -\frac{1}{\ln 7} * ((-0.2829) + (-0.2648) + (-0.2986) + (-0.2441) + (-0.2829) + (-0.2648) + (-0.2986))$$

$$E_1 = -0.5139 * (-1.9369) = 0.9954$$

The results of the entropy value calculation using the entropy method are displayed in the following table 3.

Table 3. Entropy Value Results of the Entropy Method

BEP-1	BEP-2	BEP-3	BEP-4	BEP-5
0.9954	0.9958	0.9971	0.9952	0.9954

The fourth stage determines the degree of variation or diversity for each criterion calculated using (4).

$D_1 = 1 - E_1 = 1 - 0.9954 = 0.0046$
$D_2 = 1 - E_2 = 1 - 0.9958 = 0.0042$
$D_3 = 1 - E_3 = 1 - 0.9971 = 0.0029$
$D_4 = 1 - E_4 = 1 - 0.9952 = 0.0048$
$D_5 = 1 - E_5 = 1 - 0.9954 = 0.0046$

The fifth stage is to determine the weight of each criterion based on the degree of variation obtained calculated using (5).

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$$w_1 = \frac{D_1}{\sum_{j=1}^{n} D_j} = \frac{D_1}{D_1 + D_2 + D_3 + D_4 + D_5}$$

$$w_1 = \frac{0.0046}{0.0046 + 0.0042 + 0.0029 + 0.0048 + 0.0046} = \frac{0.0046}{0.0211} = 0.2199$$

The results of the weight of each criterion value calculation using the entropy method are displayed in the following Table 4.

Table 4. Weight of each Criterion Results of the Entropy Method

BEP-1	BEP-2	BEP-3	BEP-4	BEP-5
0.2199	0.1991	0.1357	0.2255	0.2199

The weight of criteria from the Entropy Method calculation shows that BEP-4 has the most dominant role with a weight of 0.2255, followed sequentially by BEP-1 and BEP-5 which both have a value of 0.2199. This indicates that the BEP-4 criterion provides the highest data variation and thus contributes the most significant information in distinguishing employee performance. Meanwhile, BEP-2 occupies the next position with a weight of 0.1991, showing important contributions although slightly lower than BEP-1 and BEP-5. The BEP-3 criterion has the lowest weight of 0.1357, reflecting the smallest variation in assessment among the five criteria. Overall, these differences in weights ensure that criteria with greater assessment variation, especially BEP-4, BEP-1, and BEP-5, receive more attention in the ranking process of outstanding employees.

3.3 The Calculation of Alternative Values using CRADIS Method

The CRADIS method is an approach that assesses alternatives based on how close each alternative's position is to the best conditions (ideal solution) and how far it is from the worst conditions (anti-ideal solution). Each alternative will be evaluated based on its distance from these best and worst benchmarks (the closer the alternative is to the best benchmark and the further it is from the worst benchmark, the higher its position in the ranking). The final result is an objective compromise ranking, where the best alternative is the one that has the optimal balance between proximity to the ideal solution and separation from the anti-ideal solution.

The first step of the CRADIS method is to construct a decision matrix, which is a table that contains the performance values of each alternative against each criterion created using equation (1).
The second step of the CRADIS method is normalization so that all data is on a comparable scale, for the criteria BEP-1, BEP-2, BEP-3, and BEP-4 calculated using (6), and the BEP-5 criterion calculated using (7).

$$n_{11} = \frac{x_{11}}{x_{max}^{1}} = \frac{8}{9} = 0.8889$$

The results of the normalization calculation using the CRADIS method are displayed in the following table 5.

Table 5. Normalization Results of the CRADIS Method

Name	BEP-1	BEP-2	BEP-3	BEP-4	BEP-5
AR	0.8889	1.0000	0.7778	1.0000	0.7500
BF	0.7778	0.8889	1.0000	0.8889	0.8571
CR	1.0000	0.7778	0.8889	1.0000	0.6667
DI	0.6667	0.8889	0.7778	0.7778	1.0000
EY	0.8889	1.0000	0.8889	0.8889	0.8571
FR	0.7778	0.6667	0.7778	0.6667	0.7500
GF	1.0000	0.8889	1.0000	1.0000	0.6667

The third step of the CRADIS method is to calculate the values in the normalized matrix and then multiply them by the weight of each criterion to obtain the weighted normalized matrix calculated using (8) with the criterion weights from the entropy method.
$v_{11} = n_{11} * w_1 = 0.8889 * 0.2199 = 0.1955$

The results of the weighted normalized matrix calculation using the CRADIS method are displayed in the following Table 6.

Table 6. Weighted Normalized Matrix Results of the CRADIS Method

Name	BEP-1	BEP-2	BEP-3	BEP-4	BEP-5
AR	0.1955	0.1991	0.1055	0.2255	0.1649
BF	0.1710	0.1769	0.1357	0.2004	0.1885

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Name	BEP-1	BEP-2	BEP-3	BEP-4	BEP-5
CR	0.2199	0.1548	0.1206	0.2255	0.1466
DI	0.1466	0.1769	0.1055	0.1754	0.2199
EY	0.1955	0.1991	0.1206	0.2004	0.1885
FR	0.1710	0.1327	0.1055	0.1503	0.1649
GF	0.2199	0.1769	0.1357	0.2255	0.1466

The fourth step of the CRADIS method is to determine the highest (ideal) and lowest (anti-ideal) values for each criterion from each alternative, calculated using (9) and (10), the calculation results are displayed in Table 7.

Table 7. Ideal and Anti-ideal Results of the CRADIS Method

Name	Value
Ideal Value (t_i)	0.2255
Anti-ideal Value (t_a)	0.1055

The fifth step of the CRADIS method is to calculate the deviation value from the ideal and anti-ideal solutions to determine how far each alternative is from the ideal solution (best value) and the anti-ideal solution (worst value). The ideal alternative solution is calculated using (11).

$$d_{11}^{+} = t_1^{+} - v_{11} = 0.2255 - 0.1955 = 0.0300$$

The results of the ideal solution for each alternative calculation using the CRADIS method are displayed in the following Table 8.

Table 8. Ideal Solution Alternative Results of the CRADIS Method

Name	BEP-1	BEP-2	BEP-3	BEP-4	BEP-5
AR	0.0300	0.0264	0.1199	0.0000	0.0605
BF	0.0544	0.0485	0.0898	0.0251	0.0370
CR	0.0056	0.0706	0.1049	0.0000	0.0789
DI	0.0789	0.0485	0.1199	0.0501	0.0056
EY	0.0300	0.0264	0.1049	0.0251	0.0370
FR	0.0544	0.0928	0.1199	0.0752	0.0605
GF	0.0056	0.0485	0.0898	0.0000	0.0789
Min	0.0056	0.0264	0.0898	0.0000	0.0056

Next, the calculation of the anti-ideal alternative solution value is carried out using (11).

$$d_{11}^{-} = v_{11} - t_1^{-} = 0.1955 - 0.1055 = 0.09$$

The results of the anti-ideal solution for each alternative calculation using the CRADIS method are displayed in the following Table 9.

Table 9. Anti-ideal Solution Alternative Results of the CRADIS Method

Name	BEP-1	BEP-2	BEP-3	BEP-4	BEP-5
AR	0.090	0.094	0.000	0.120	0.059
BF	0.065	0.071	0.030	0.095	0.083
CR	0.114	0.049	0.015	0.120	0.041
DI	0.041	0.071	0.000	0.070	0.114
EY	0.090	0.094	0.015	0.095	0.083
FR	0.065	0.027	0.000	0.045	0.059
GF	0.114	0.071	0.030	0.120	0.041
Max	0.1144	0.0935	0.0302	0.1199	0.1144

The sixth step of the CRADIS method is to calculate the deviation level, which is a numerical measure that shows how close or far an alternative is from the ideal and anti-ideal solutions, calculated using (13) and (14), with the calculation results in Table 10.

Table 10. Calculate anti-ideal Solution Alternative Results of the CRADIS Method

Name	s_i^{+}	s_i^{-}
AR	0.2369	0.3628
BF	0.2548	0.3449
CR	0.2599	0.3397
DI	0.3030	0.2967
EY	0.2233	0.3764

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Name	s_i^+	s_i^-
FR	0.4028	0.1968
GF	0.2227	0.3769

The seventh step of the CRADIS method is to calculate the utility value that reflects how well the alternative performs overall, taking into account all relevant criteria and their weights calculated using (15) and (16), with the calculation results in Table 11.

Table 11. Utility Value Results of the CRADIS Method

Name	K_i^+	K_i^-
AR	0.5375	0.7680
BF	0.4998	0.7302
CR	0.4898	0.7192
DI	0.4202	0.6281
EY	0.5702	0.7968
FR	0.3161	0.4167
GF	0.5716	0.7980

The final step of the CRADIS method is to calculate the final value that indicates the final alternative results based on the overall performance score, which is ready to be used as a basis for decision-making calculated using (17), with the calculation results in table 12.

Table 12. Utility Value Results of the CRADIS Method

Name	Q_i
AR	0.6528
BF	0.6150
CR	0.6045
DI	0.5242
EY	0.6835
FR	0.3664
GF	0.6848

The CRADIS method is a powerful method for producing alternative rankings fairly and balanced. In the context of selecting the best employees, CRADIS helps provide an objective decision based on an optimal compromise between the expected performance standards and the conditions that must be avoided.

3.4 The Ranking of Alternatives

The ranking results generated by the hybrid Entropy–CRADIS approach present a sequence of employee candidates based on a compromise score between proximity to the ideal condition and separation from the worst condition, where each criterion has been objectively weighed using Entropy. Thus, the top rankings indicate employees whose performance is most balanced and can excel in critical criteria that have a high variance in assessment, while the lower rankings reflect candidates with the greatest gap from the ideal benchmark. This process not only ensures transparency and objectivity in selection but also provides managers with a measurable basis for hiring or employee development decisions. The ranking results of the best employee selections are displayed in Figure 2.

Figure 2. The Ranking Results of the Best Employee Selections

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The ranking results of the employee selection process, as shown in Figure 2, indicate that GF occupies the first position, followed closely by EY and AR in the second and third positions. Although GF and EY have relatively similar final scores, GF shows slightly better overall performance across several criteria, which provides a small advantage in the final ranking. AR also demonstrates strong performance but remains slightly below the top two candidates in terms of overall evaluation. Meanwhile, BF and CR appear in the middle ranks, indicating that their performance is adequate but not as competitive as the top three candidates. On the other hand, DI and FR occupy the lower positions, suggesting that their overall performance across the evaluated criteria is comparatively weaker.

The application of the Entropy and CRADIS methods in the process of selecting the best employees provides a significant contribution to increasing the objectivity and accuracy of decision-making. The Entropy method serves as an objective approach to determining the weights of each criterion based on the level of information variation from the candidates' performance data. By not involving subjective assessments from decision-makers, this method is able to reduce potential biases in weight determination, resulting in a fairer representation of the importance of each criterion. This is crucial in the context of employee selection, where unfair decisions can negatively impact the long-term performance of the organization. Meanwhile, the CRADIS method is used to rank candidates based on their performance values' proximity to the ideal solution and distance from the worst solution. This method takes into account the balance between positive and negative proximity, allowing it to provide ranking results that reflect the best overall compromise. In the context of this research, the application of CRADIS enables a comprehensive assessment of candidates by considering all important aspects that have been normalized and weighted beforehand by the Entropy method. The combination of these two methods not only enhances the quality of the evaluation but also strengthens the legitimacy of the final selection results, as the process is systematic, transparent, and data-driven.

3.5 Sensitivity Analysis

Sensitivity analysis is conducted to evaluate the stability and robustness of the decision-making results obtained from the applied method. This analysis examines how changes in input parameters, particularly the criteria weights, may influence the final ranking of alternatives. In the context of employee selection, sensitivity analysis helps determine whether the ranking results remain consistent when certain parameters are modified. If the ranking of alternatives does not change significantly despite variations in the parameters, the decision model can be considered stable and reliable. Therefore, sensitivity analysis plays an important role in validating the effectiveness of the decision support system and ensuring that the obtained results are not overly dependent on specific parameter values.

Changing the weights of criteria is one of the common approaches used in sensitivity analysis to observe how variations in the importance level of criteria affect the ranking of alternatives. In this process, the original weights obtained from the weighting method are systematically adjusted, either by increasing or decreasing the weight of certain criteria while maintaining the proportional balance among the others. In the context of employee selection in this study, this approach allows the evaluation of how sensitive the ranking results are when the importance of criteria such as performance, discipline, or teamwork is altered. By analyzing the changes in the ranking results after the weight adjustments, researchers can assess the robustness of the proposed decision model and identify whether the final decision remains consistent under different weighting scenarios. Figure 3 is the result of alternative rankings from changes in criteria weights.

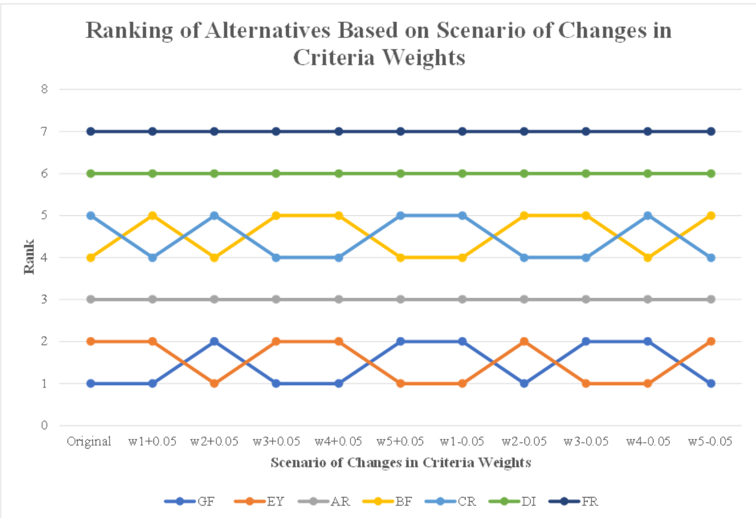

Figure 3. The Ranking Results of Alternatives from Changes in Criteria Weights.

The sensitivity analysis results, as shown in Figure 3, illustrate the ranking stability of alternatives under several scenarios of changes in criteria weights, both increasing and decreasing each weight by 0.05. Overall, the ranking pattern remains relatively stable across all scenarios. The alternative GF consistently occupies the first or second position, indicating strong performance across the evaluated criteria. EY also shows minor fluctuations between the

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first and second ranks, while AR remains consistently in the third position throughout all scenarios, demonstrating high ranking stability. Meanwhile, BF and CR experience slight changes between the fourth and fifth ranks depending on the weight adjustments. In contrast, DI and FR remain constant in the sixth and seventh positions, respectively, indicating relatively lower performance compared to other alternatives. These findings indicate that the proposed decision model produces stable ranking results even when small variations are introduced to the criteria weights, confirming the robustness and reliability of the method in the employee selection evaluation process.

3.6 Discussion

The results obtained from the hybrid Entropy–CRADIS approach demonstrate that objective weighting and compromise-based ranking can effectively identify the most suitable employee candidates. In this study, the Entropy method assigns higher weights to criteria with greater variability, ensuring that more informative criteria contribute more significantly to the decision process. The results show that BEP-4, BEP-1, and BEP-5 play the most important roles in distinguishing candidate performance. This finding supports the argument that objective weighting techniques are useful in reducing subjective bias in decision-making processes, particularly in human resource evaluation where multiple criteria must be considered simultaneously.

These findings are consistent with several previous studies that applied hybrid Multi-Criteria Decision Making (MCDM) approaches in personnel evaluation and selection problems. Previous research has shown that integrating objective weighting methods such as Entropy with ranking methods such as TOPSIS, VIKOR, or CRADIS improves the reliability of decision support systems. Similar to those studies, the current research demonstrates that combining Entropy with CRADIS produces clear ranking results while maintaining transparency in the evaluation process. The ability of the CRADIS method to evaluate alternatives based on proximity to ideal and anti-ideal solutions also aligns with previous research emphasizing the importance of compromise-based evaluation in complex decision environments.

Another important aspect revealed in this study is the stability of ranking results obtained through sensitivity analysis. The analysis indicates that the ranking pattern remains relatively stable even when the criteria weights are adjusted. This suggests that the proposed hybrid model is robust and not overly sensitive to small parameter changes. Previous studies in decision support systems have also highlighted the importance of sensitivity testing to ensure the reliability of MCDM models. Therefore, the stability observed in this research further strengthens the validity of the Entropy–CRADIS integration for practical decision-making applications. Overall, the results of this study are largely consistent with other Hybrid MCDM studies that integrate objective weighting methods with ranking techniques. The findings of this research support the same conclusion is combining Entropy with CRADIS provides a systematic, data-driven approach capable of producing reliable rankings. Thus, rather than contradicting previous research, this study reinforces the effectiveness of hybrid MCDM frameworks for complex decision-making problems such as employee selection.

4. CONCLUSION

The application of the Entropy method and CRADIS in the employee selection process has proven to provide an objective and comprehensive approach in determining the best candidates. The Entropy method allows for the rational determination of criterion weights based on data distribution, without subjective intervention from decision-makers, thereby enhancing fairness in the evaluation process. Meanwhile, the CRADIS method is capable of producing final rankings of candidates by considering proximity to the ideal solution and distance from negative solutions, which reflect the overall best performance. From the final calculations, the candidate with code GF ranked first with a score of 0.6848, followed by EY with a score of 0.6835 and AR with a score of 0.6528, indicating that these three candidates have performance profiles that are closest to the ideal criteria. Thus, the combination of Entropy-CRADIS methods can serve as a reliable tool in the multi-criteria decision-making process for employee selection, especially in contexts that demand objective, transparent, and data-driven evaluations. This research also opens up opportunities for the application of similar methods in other selection contexts, such as promotions, performance evaluations, or partner selections. The application of the Entropy and CRADIS methods in the employee selection process provides a significant contribution to improving the objectivity and accuracy of decision-making. However, this study has a limitation in that the analysis was conducted using a limited number of alternatives and evaluation criteria, which may not fully represent the complexity of employee assessment in larger organizational settings. Therefore, future research is recommended to involve a larger dataset and more diverse criteria to further evaluate the robustness and applicability of the proposed approach in broader decision-making contexts.

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