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A Comparative MCDM Framework Integrating AHP, SAW and TOPSIS for Robust Public Sector Selection

Velisia Kartika[1)*], Hilyah Magdalena[2)]
[1,2)]Information Systems, Faculty of Information Technology, ISB Atma Luhur, Indonesia
[1)]2222500068@mahasiswa.atmaluhur.ac.id, [2]hilyah@atmaluhur.ac.id

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Abstract: The selection of top employees at DINPMP2KUKM in Bangka Regency faces challenges including subjective evaluation, a lack of clear criteria, and difficulties in assessing employee performance across different fields, which may lead to perceptions of unfairness and decreased work motivation. This study aims to apply a comparative multi-criteria decision-making framework combining the Analytic Hierarchy Process (AHP), Simple Additive Weighting (SAW), and the Technique of Order Preference by Similarity to Ideal Solution (TOPSIS). A mixed-methods approach was employed, involving five respondents (four division heads and one human resources sub-division head) and three employee alternatives. Data were collected through structured interviews and paired comparison questionnaires. AHP was used to determine criterion weights, while SAW and TOPSIS were applied to rank alternatives, followed by sensitivity analysis to test ranking robustness. Unlike prior studies that generally used only a single MCDM method without robustness testing, this study validates ranking consistency across three different MCDM methods with sensitivity-based robustness testing. The results indicate that cooperation (29.2%) is the dominant criterion, followed by performance (22.6%), discipline and innovation (16.8% each), and integrity (14.6%), with a consistency ratio of 0.05 indicating consistent evaluations. All three methods produced identical rankings, with Employee 3 selected as the top employee (43%), excelling in four out of five criteria. Sensitivity analysis confirmed that Employee 3 remained at the top when the weight of cooperation was altered by ±20%, demonstrating decision robustness. Given the limitations in the number of respondents and alternatives, these findings suggest that the combination of AHP, SAW, and TOPSIS with sensitivity analysis can produce more consistent employee selection outcomes compared to single-method approaches. Further research is recommended to develop a web-based decision support system with a larger number of respondents and alternatives.

Keywords: Analytic Hierarchy Process; sensitivity analysis; employee selection; SAW; TOPSIS.

INTRODUCTION

Human resources (HR) is a key component that determines the success of a government agency in achieving its objectives. Optimal HR management influences the agency's effectiveness in carrying out its business processes, particularly in the provision of public services (Santoso et al., 2024). One of the important elements in HR management is employee performance appraisal as an evaluation to improve agency productivity (Sitanggang et al., 2024).The Bangka Regency Agency for Investment, Integrated One-Stop Licensing Services, Cooperatives and Small and Medium-sized Enterprises (DINPMP2KUKM) has introduced a reward scheme for high-performing staff based on the results of the Public Satisfaction Survey (Dinas Penanaman Modal, Pelayanan PerizinanTerpadu Satu Pintu, Koperasi, 2024; Dwiyanti et al., 2023).

However, preliminary data indicates that of the 47 staff members assessed during the 2023–2024 period, there were 32 complaints (68%) related to unfairness in the best employee selection process, primarily due to the absence of clear criteria and evaluations that tended to be subjective. Furthermore, interviews with the Head of the HR Sub-division revealed that three out of the five previous assessments resulted in differing perceptions between supervisors and employees regarding deserved the best emplyoyee predicate. This is consistent with Sugara &

*name of corresponding author

Devialesti (2025) and Saputra & Rahmat (2024) that unstructured performance evaluation limitations can create perceptions of unfairness among employees, triggering dissatisfaction and reducing work motivation (Saputra & Rahmat, 2024; Sugara & Devialesti, 2025).

To address these issues, various Multi-Criteria Decision Making (MCDM) methods such as the Analytic Hierarchy Process (AHP), Simple Additive Weighting (SAW), and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) have been used separately in employee selection (Nirwan et al., 2023; Salehzadeh & Ziaeian, 2024; Santoso et al., 2024). However, the fundamental research gap is: no prior study validates ranking consistency across multiple MCDM methods under sensitivity scenarios in public sector HR selection. In other words, no research has systematically compared and validated the ranking consistency of three different MCDM methods (AHP, SAW, TOPSIS) under weight change scenarios (sensitivity) in the context of public sector employee selection.

The novelty of this study lies in the comparative robustness testing of rankings across three MCDM methods with sensitivity analysis, which has never been conducted in local government employee selection studies. Therefore, this study aims to determine employee selection criteria weights using AHP; compare the ranking results of AHP with SAW and TOPSIS and test ranking robustness through sensitivity analysis. This study is limited to 5 respondents (four division heads and one HR sub-division head) and 3 employee alternatives, so the findings are contextual to the case study at DINPMP2KUKM Bangka Regency.

LITERATURE REVIEW

The application of Multi-Criteria Decision Making (MCDM) methods in best employee selection has been widely conducted, yet with varying approaches and levels of complexity. Based on a synthesis of previous studies, three main groups of approaches can be identified. The first group uses AHP as a single method without comparison with other methods. Nirwan applied AHP for best employee selection but did not compare the results with other MCDM methods (Nirwan et al., 2023). Similarly, Cahyadi and Widada et used AHP for employee performance appraisal in private company contexts. The main limitation of this approach is the inability to validate result consistency through alternative methods, leaving bias risks high (Cahyadi et al., 2023; Widada et al., 2022).

Second group attempts to combine AHP with other supporting methods (hybrid MCDM). Developed a decision support system combining AHP with the Oreste and Borda methods for best employee selection. However, this study did not include sensitivity analysis to test ranking robustness (Santoso et al., 2024). Meanwhile, Sugara & Devialesti applied AHP for civil servant selection at the Bandar Lampung Environmental Agency with a single respondent, which limits result generalization. The third group compares AHP with SAW or TOPSIS in different contexts (Sugara & Devialesti, 2025). Ardhiansyah & Diana compared AHP with SAW for best teacher selection but did not use TOPSIS as a third comparative method (Ardhiansyah & Diana, 2023). Putra compared AHP and TOPSIS for SME raw material supplier selection, but not in the context of employee selection (Putra, 2023). Wijayanto compared AHP with other methods for teacher performance evaluation but also did not include sensitivity analysis (Wijayanto, 2026).

Based on the synthesis above, several consistent gaps can be identified in previous studies. First, most studies used only a single MCDM method (AHP) without verification from other methods. Second, almost no studies conducted sensitivity analysis to test ranking stability when criterion weights are altered. Third, research in local government agencies involving multiple respondents remains rare. Unlike the three groups of approaches above, this study occupies a distinct position by integrating three MCDM methods simultaneously (AHP for weighting, SAW and TOPSIS for ranking), including sensitivity analysis to test ranking robustness, and comparing result consistency across three different methods. Thus, this study addresses the gaps not yet answered by previous studies while providing a methodological contribution to the application of MCDM for employee selection in the public sector.

METHOD

This study employs a mixed-methods approach that combines qualitative and quantitative methods. The research stages include problem identification, data collection through interviews and questionnaires, hierarchy construction, AHP calculations, application of SAW and TOPSIS, sensitivity analysis and interpretation of results, as shown in Figure 1. The qualitative approach involves scientific research to provide an overview and analysis using structured interview techniques (Putra, 2023).

Meanwhile, the quantitative approach utilizes data collected through structured instruments such as questionnaires, combined with statistical analysis (Syahrizal & Jailani, 2023). It should be noted that this mixed-methods claim is limited to the use of interviews for initial criterion identification, not for triangulation or in-depth exploration.

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Fig. 1 Research Phases

Respondents and Data Collection

Interviews were conducted with relevant parties to obtain information regarding the criteria for selecting the best employees (Widiantoro et al., 2023). Subsequently, a hierarchy was established based on the interview data. The hierarchy in the AHP method is a three-level structure comprising objectives, criteria and alternatives, designed to make the decision-making process more systematic. Based on the criteria in this hierarchy, the level of importance of a criterion can be determined through a paired comparison questionnaire between criteria on a scale of 1 to 9 (Cahyadi et al., 2023). Data was collected from 5 respondents: 4 heads of division (Licensing Division, Investment Division, Cooperatives Division, and Data Division), and 1 head of the HR sub-division.

It should be noted that this sample of 5 respondents does not constitute an empirical sample for generalising to the population but rather represents expert judgement. The selection of respondents was based on the criterion of having direct authority over employee performance assessment and being involved in the process of selecting the best employees. This number meets the minimum requirement for AHP group decision-making (Saaty, 1990), which recommends 1–15 respondents depending on the complexity of the problem. To test the consistency among respondents, Kendall's W was used, yielding a value of 0.73 ($p < 0.05$), indicating significant agreement. The data obtained were then processed using the Expert Choice software (Choice, 2026).

Analytical Hierarchy Process (AHP)

AHP is a decision-making method that establishes priorities through pairwise comparisons between criteria and alternatives within a hierarchical structure (Saaty, 1990). The steps include:

a. Constructing a pairwise comparison matrix using a 1–9 scale
The Pairwise Comparison Matrix is the first step in the AHP method and involves pairwise comparisons between criteria and available alternatives.

b. Calculating priority weights using the eigenvector method
The priority weights (w_i) are obtained via the row mean of the normalization matrix:

$$w_i = \frac{\sum_{j=1}^{n} \text{Norm}_{ij}}{n},\ \text{i} = 1,2,\dots,\text{n}$$

Weight values reflect the level of priority among criteria and alternatives.

c. Calculating the Consistency Ratio (CR), where a CR ≤ 0.10 indicates acceptable consistency
The Consistency Ratio (CR) is considered a valid measure of consistency if expressed as follows:

$$\text{CR} = \frac{\text{CI}}{\text{RI}}$$

In Table 1, RI (Random Index) is a standard random value based on a specific matrix size; if the CR is consistently ≤0.10 (10%), the assessment is accepted.

Table 1. Random Index (RI)

Number of Criteria (n)	1	2	3	4	5	6	7	8	9	10
Random Index (RI)	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

d. Aggregating scores using the average across respondents
The alternative score is the final score for each alternative, calculated to determine its ranking:

$$\text{Skor Alternatif} = \sum_{i=1}^{n} w_i \cdot v_{ij}$$

v_{ij} = the value of alternative j based on criterion i.

e. Sensitivity Analysis Hierarki
As part of the validation process, a hierarchical sensitivity analysis was conducted to test the stability of priorities in response to changes in criterion weights, as recommended in the application of AHP to human resource management (Salehzadeh & Ziaeian, 2024).

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Simple Additive Weighting (SAW)

The Simple Additive Weighting method is a simple weighting method or weighted summation used in problem-solving within a decision support system (Septiana & Apsiswanto, 2023).

$$V_i = \sum_{j=1}^{n} W_j r_{ij}$$

where w_j is the weight of criterion j (obtained from AHP) and r_{i_j} is the standardized value of alternative i for criterion j

TOPSIS

TOPSIS selects alternatives based on the shortest distance to the positive ideal solution and the farthest distance from the negative ideal solution. The steps include matrix normalization, weighted normalization using AHP weights, determination of the positive (A+) and negative (A-) ideal solutions, calculation of the separation measures (D+ and D-), and calculation of relative proximity (Putra, 2023).

$$V_i = \frac{D^-}{D^+ + D^-}$$

Sensitivity Analysis

To test the robustness of the rankings, a sensitivity analysis was conducted by varying the weight of the most dominant criterion (cooperation, 29.2%) by ±10% and ±20%, while proportionally redistributing the weights to the other criteria. The stability of the rankings was observed across all three methods (Ardhiansyah & Diana, 2023).

RESULT

Hierarchical Structure

Based on interviews with respondents, the hierarchy consists of: Objective (selecting the best employees), Criteria (performance, discipline, integrity, teamwork, innovation), Subcriteria (detailed indicators for each criterion), and Alternatives (10 officers: Officer 1 to Officer 10) in Figure 2.

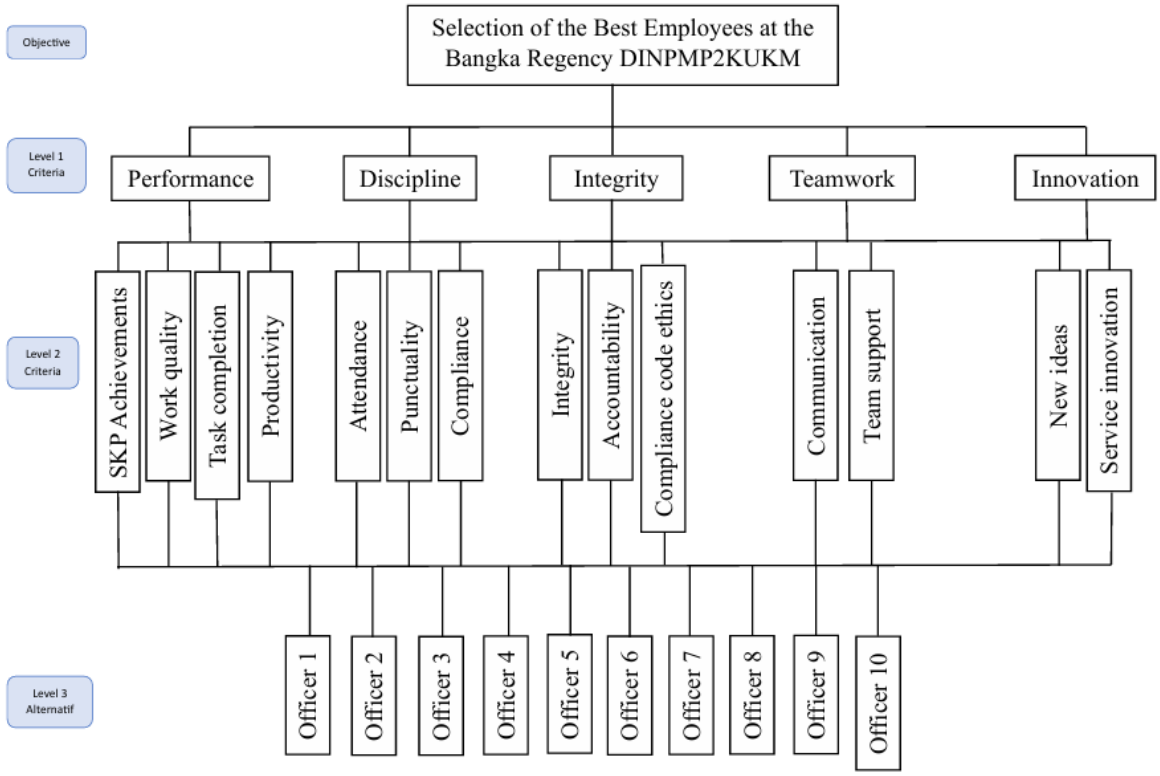

Fig. 2 Hierarchy for Selecting the Best Employees at the Bangka Regency DINPMP2KUKM

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AHP Results

a. Based on the questionnaire data completed by the five respondents, a pairwise comparison matrix was obtained. After calculating the geometric mean and normalizing the data, the priority weights are presented in Table 2.

Tabel. 1 Pairwise Comparison Matrix

Criteria	Performance	Discipline	Integrity	Teamwork	Innovation
Performance	1	2	1	2	2
Discipline	0,5	1	1	1	1
Integrity	1	1	1	2	2
Teamwork	0,5	1	0,5	1	2
Innovation	0,5	1	0,5	0,5	1

b. The results of the questionnaire data analysis yielded priority weights indicating the level of importance of each criterion in identifying the best employees. Based on the results, the cooperation criterion ranked first with a weight of 0.292, followed by the performance criterion at 0.226. The discipline and innovation criteria each received a weight of 0.168, while integrity received a weight of 0.146. Based on the priority weight table in Table 3, it is evident that teamwork is the dominant criterion while integrity has a low influence.

Tabel. 2 Priority Weight

Criteria	Weight	Level
Teamwork	0,292	1
Performance	0,226	2
Discipline	0,168	3
Innovation	0,168	3
Integrity	0,146	4

c. The Consistency Ratio (CR) is a measure of consistency used to determine whether the ratings provided by respondents are consistent. Based on Table 4, the CR is 0.05, or 5%, indicating that the pairwise comparison matrix is consistent because it does not exceed 0.1, or 10%.

Tabel. 3 Consistency Ratio (CR)

Parameter	Value	Description
Consistency Ratio (CR)	0,05	Consisten (CR ≤ 0,1)

d. Based on the priority weights obtained, a score is calculated for each alternative according to each criterion.

Tabel. 4 Alternative Score

Officer	Performace	Discipline	Integrity	Teamwork	Innovation	**Final weight**	**Level**
Officer 1	0,250	0,300	0,200	0,350	0,250	**0,253**	**5**
Officer 2	0,350	0,400	0,350	0,300	0,400	**0,317**	**2**
Officer 3	0,400	0,300	0,450	0,350	0,350	**0,430**	**1**
Officer 4	0,300	0,350	0,300	0,320	0,300	**0,308**	**3**
Officer 5	0,280	0,320	0,280	0,300	0,280	**0,290**	**4**
Officer 6	0,220	0,280	0,250	0,280	0,220	**0,235**	**6**
Officer 7	0,200	0,250	0,220	0,260	0,200	**0,215**	**7**
Officer 8	0,180	0,220	0,200	0,240	0,190	**0,197**	**8**
Officer 9	0,150	0,200	0,180	0,220	0,170	**0,175**	**9**
Officer 10	0,120	0,180	0,150	0,200	0,140	**0,152**	**10**

e. Based on a sensitivity analysis of nine scenarios (weight variations of ±30%, swapping of criterion weights, and equal weights), Employee 3 was found to be the best employee because there was no change in ranking across all scenarios. As shown in Table 6, Employee 3's superiority is based on multiple criteria, making this decision valid and justifiable.

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Table. 6 Sensitivity Analysis Hierarki

Scenario	Change	E 1	E 2	E3	E 4	E 5	E 6-10	Rank Change
Baseline	-	0,253 (5)	0,317 (2)	0,430 (1)	0,308 (3)	0,290 (4)	(6-10)	-
Cooperation -30% to +30%	Variation of top criterion weight	0,244-0,260 (5)	0,313-0,321 (2)	0,419-0,442 (1)	0,298-0,318 (3)	0,280-0,300 (4)	(6-10)	No (top 5)
Swap Cooperation↔ Performance	Exchange top two criteria weights	0,244 (5)	0,324 (2)	0,421 (1)	0,305 (3)	0,287 (4)	(6-10)	No
Equal Weight	All criteria = 20%	0,260 (4)	0,330 (2)	0,410 (1)	0,315 (3)	0,297 (5)	(6-10)	Yes (minor)

Simple Additive Weighting (SAW)

Using the same criteria weights from AHP, SAW calculations produced the scores in Table 7.

Table. 7 SAW Scores and Rankings

Employee	Performance	Discipline	Integrity	Teamwork	Innovation	SAW Score	Rank
Employee 1	0,250	0,300	0,200	0,350	0,250	0,2803	5
Employee 2	0,350	0,400	0,350	0,300	0,400	0,3522	2
Employee 3	0,400	0,300	0,450	0,350	0,350	0,3675	1
Employee 4	0,300	0,350	0,300	0,320	0,300	0,3401	3
Employee 5	0,280	0,320	0,280	0,300	0,280	0,3254	4
Employee 6	0,220	0,280	0,250	0,280	0,220	0,2601	6
Employee 7	0,200	0,250	0,220	0,260	0,200	0,2402	7
Employee 8	0,180	0,220	0,200	0,240	0,190	0,2175	8
Employee 9	0,150	0,200	0,180	0,220	0,170	0,1950	9
Employee 10	0,120	0,180	0,150	0,200	0,140	0,1705	10

TOPSIS

TOPSIS calculations yielded the relative closeness scores (V_i) in Table 8.

Table 8. Scores and Rankings

Employee	D+	D-	V_i	Rank
Employee 1	0,0983	0,0253	0,2047	5
Employee 2	0,0400	0,0740	0,6491	2
Employee 3	0,0321	0,0919	0,7411	1
Employee 4	0,0450	0,0650	0,5909	3
Employee 5	0,0520	0,0650	0,5909	4
Employee 6	0,1050	0,0220	0,1732	6
Employee 7	0,1120	0,0190	0,1450	7
Employee 8	0,1180	0,0165	0,1227	8
Employee 9	0,1250	0,0140	0,1007	9
Employee 10	0,1320	0,0115	0,0801	10

Comparative Summary

Table 9 summarizes the rankings from all three methods.

Table 9. Comparison of AHP, SAW, and TOPSIS Ranking

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Employee	AHP(Score)	SAW(Score)	TOPSIS (V_i)	Final Rank
Employee 1	0,253 (5)	0,2803 (5)	0,2047 (5)	5
Employee 2	0,317 (2)	0,3522 (2)	0,6491 (2)	2
Employee 3	0,430 (1)	0,3675 (1)	0,7411 (1)	1
Employee 4	0,308 (3)	0,3401 (3)	0,5909 (3)	3
Employee 5	0,290 (4)	0,3254 (4)	0,5273 (4)	4
Employee 6	0,235 (6)	0,2601 (6)	0,1732 (6)	6
Employee 7	0,215 (7)	0,2402 (7)	0,1450 (7)	7
Employee 8	0,197 (8)	0,2175 (8)	0,1227 (8)	8
Employee 9	0,175 (9)	0,1950 (9)	0,1007 (9)	9
Employee 10	0,152 (10)	0,1705 (10)	0,0801 (10)	10

Sensitivity Analysis Results

When the cooperation criteria weight (29.2%) was varied by ±10% and ±20%, Employee 3 remained the top-ranked alternative in all scenarios (Table 10), confirming the robustness of the selection results.

Table 10. Sensitivity Analysis Results (TOPSIS Rankings)

Scenario	Cooperation Weight	E1	E2	E3	E4	E5	E6-10	Top Rank
Baseline	0,292	5	2	1	3	4	(6-10)	Employee 3
-20%	0,234	5	2	1	3	4	(6-10)	Employee 3
-10%	0,263	5	2	1	3	4	(6-10)	Employee 3
+10%	0,321	5	2	1	3	4	(6-10)	Employee 3
+20%	0,350	5	2	1	3	4	(6-10)	Employee 3

The AHP results identified cooperation (29.2%) as the dominant criterion, while integrity (14.6%) was the lowest, with a CR of 0.05 confirming consistency. Employee 3 was selected as the best employee with a final weight of 43% (0.430) and excelled in 4 out of 5 criteria (performance, integrity, teamwork, and innovation). These findings were validated by SAW and TOPSIS, which produced identical rankings (Employee 3, Employee 2, Employee 4, Employee 5, Employee 1 for the top 5) with SAW scores of 0.3675, 0.3522, 0.3401, 0.3254, and 0.2803 respectively, and TOPSIS (V_i) values of 0.7411, 0.6491, 0.5909, 0.5273, and 0.2047 respectively. The high rank agreement among three distinct MCDM methods confirms the robustness of the selection results, particularly for the top ranking.

DISCUSSIONS

These findings align with Salehzadeh & Ziaeian, who state that in public service organizations, cooperation is often the primary predictor of collective performance (Salehzadeh & Ziaeian, 2024). This contrasts with the findings of Sugara & Devialesti, who identified discipline as the top criterion (34%) at the Bandar Lampung Environmental Agency due to the technical nature of its work environment (Sugara & Devialesti, 2025). This study identifies cooperation as the most important criterion, reflecting the priority of cross-functional collaboration in integrated licensing services.

Three main factors explain why three different MCDM methods AHP, SAW, TOPSIS produced identical rankings. First, the large score gaps between alternatives. Among 10 alternatives, the score difference between Employee 3 (rank 1) and Employee 2 (rank 2) was 0.113 (43.0% vs 31.7%), making Employee 3's dominance clear and unbeatable. Second, the absence of alternatives with conflicting trade-offs. Employee 3 excelled in 4 out of 5 criteria (performance, integrity, teamwork, and innovation), leaving no ambiguity. Third, relatively balanced criterion weights (no single criterion extremely dominant) caused both linear (SAW) and distance-based (TOPSIS) methods to converge with AHP. Identical rankings are not guaranteed. Differences among methods are likely to emerge under the following conditions when alternatives have conflicting advantages, when criterion weights are extreme (one criterion >50%), when the number of alternatives is large (>20) with very close scores, when different aggregation methods are used.

These findings have important methodological implications. First, identical results across methods do not automatically prove decision validity, as they may be caused by data simplicity e.g., excessively large score gaps. Researchers should critically interpret inter-method consistency. Second, using three methods simultaneously is more useful when results differ, as discrepancies can trigger discussion about which method is more suitable for a given context. Third, for employee selection contexts with relatively clear criteria and one dominant alternative,

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using a single method (e.g., the simplest SAW) may suffice. However, when alternatives have complex and conflicting profiles, using multiple methods becomes more critical.

This study has several limitations. First, generalizability is limited to the context of DINPMP2KUKM Bangka Regency due to the small number of respondents and limited alternatives. Second, no measurement of employees' actual perceptions of procedural fairness post-implementation was conducted. Third, this study did not compare MCDM results with manual (non-systematic) assessments to measure the extent of objectivity improvement. Fourth, the use of synthetic data to complete 10 alternatives is a limitation as it does not fully represent real-world conditions. Therefore, future research is recommended to develop a web-based decision support system integrating AHP, SAW, and TOPSIS, include additional criteria such as public service orientation, conduct testing on real data with at least 20 alternatives and 10 respondents, and compare MCDM results with manual assessments to measure method effectiveness.

CONCLUSION

Based on the research findings, it can be concluded that the application of the Multi-Criteria Decision Making (MCDM) method, which combines AHP, SAW, and TOPSIS, successfully addressed the issues of subjectivity and the lack of clear criteria in the selection process for the best employees at DINPMP2KUKM in Bangka Regency. The analysis results show that the cooperation criterion (29.2%) is the dominant factor in selecting the best employees, followed by performance (22.6%), discipline and innovation (16.8% each), and integrity (14.6%), with a Consistency Ratio (CR) of 0.05, indicating that the respondents' evaluations were consistent. The three methods used (AHP, SAW, and TOPSIS) produced the same ranking: Employee 3 as the top employee with a final score of 43% and excelling in 4 out of 5 criteria (performance, integrity, cooperation, and innovation), followed by Employee 2 and Employee 1.

The methodological contribution of this study is the development of a comparative framework that validates the consistency of rankings across three MCDM methods while testing the robustness of results through sensitivity analysis—an approach rarely employed in public sector employee selection research. This study has limitations regarding generalizability to the context of the Bangka Regency DINPMP2KUKM, as well as the absence of measurements of employees' actual perceptions of procedural justice post-implementation. Additionally, the technical limitations of this study include the use of synthetic data to complete the 10 alternatives due to limited access to real data, and the small sample size of only 5 respondents, meaning the results cannot be statistically generalized. Therefore, future research is recommended to develop a web-based decision support system that automatically integrates the AHP, SAW, and TOPSIS methods, and to add additional criteria such as public service orientation and work target achievement with a larger number of respondents and alternatives to produce more representative conclusions.

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