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Decision Support System for Ranking the Performance of Beef Cattle Farms Using the Entropy WASPAS Method

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ABSTRACT *– Evaluating beef cattle farming performance requires multiple indicators because the business involves both production and economic aspects, and conditions vary across provinces. When only one indicator is used, the province that appears superior may change depending on the indicator selected, potentially leading to less accurate development and planning decisions. This study aims to applies a Decision Support System (DSS) to rank beef cattle farm performance in ten provinces using the Entropy-WASPAS method. Secondary data for 2024 from Statistics Indonesia (BPS) were analyzed using five criteria: weight gain value, cattle stock, profit/loss, feed cost, and total revenue. Criterion weights were calculated using Entropy, while rankings were determined using WASPAS (λ = 0.50) and compared with MOORA through Spearman's rank correlation. Feed cost received the highest weight (0.255), reflecting the greatest variation among the observed data rather than its actual importance in determining farm performance. Lampung ranked first (Qi = 0.406), while Central Java ranked last (Qi = 0.010). The WASPAS and MOORA rankings showed a strong positive correlation (ρ = 0.867), although they were not identical. The results represent relative rankings among provinces rather than measures of technical efficiency. Since the indicators were not adjusted for production scale, higher criterion values do not necessarily indicate better performance.*

Keywords *- Entropy, WASPAS, Decision Support System, beef cattle farming, Multi-Criteria Decision Making, Performance Ranking.*

Sistem Pendukung Keputusan Pemeringkatan Kinerja Peternakan Sapi Potong Menggunakan Metode Entropy-WASPAS

ABSTRAK *– Evaluasi kinerja usaha peternakan sapi potong memerlukan beberapa indikator karena usaha ini mencakup aspek produksi dan ekonomi, serta memiliki kondisi yang berbeda antarprovinsi. Apabila hanya menggunakan satu indikator, provinsi yang tampak unggul dapat berubah bergantung pada indikator yang dipilih, sehingga berpotensi menyebabkan keputusan pembinaan dan perencanaan menjadi kurang tepat. Penelitian ini bertujuan menerapkan Sistem Pendukung Keputusan (SPK) untuk memeringkat kinerja usaha peternakan sapi potong di sepuluh provinsi menggunakan metode Entropy-WASPAS. Data sekunder tahun 2024 dari Badan Pusat Statistik (BPS) dianalisis menggunakan lima kriteria, yaitu nilai pertambahan bobot, jumlah stok sapi, laba/rugi, nilai pakan, dan total penerimaan. Bobot kriteria dihitung menggunakan metode Entropy, sedangkan pemeringkatan ditentukan menggunakan metode WASPAS (λ = 0,50) dan dibandingkan dengan MOORA melalui korelasi peringkat Spearman. Nilai pakan memperoleh bobot tertinggi (0,255), yang mencerminkan variasi terbesar dalam data yang diamati, bukan tingkat kepentingan aktualnya dalam menentukan kinerja usaha peternakan. Lampung menempati peringkat pertama (Qi = 0,406), sedangkan Jawa Tengah berada di peringkat terakhir (Qi = 0,010). Hasil pemeringkatan WASPAS dan MOORA menunjukkan korelasi positif yang kuat (ρ = 0,867), meskipun keduanya tidak identik. Hasil penelitian menunjukkan peringkat relatif antarprovinsi, bukan ukuran efisiensi teknis. Karena indikator yang digunakan belum disesuaikan dengan skala produksi, nilai kriteria yang lebih tinggi tidak selalu menunjukkan kinerja yang lebih baik.*

Kata Kunci *– Entropy, WASPAS, Sistem Pendukung Keputusan, Peternakan Sapi Potong, Multi Criteria Decision Making, Pemeringkatan Kinerja.*

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1. INTRODUCTION

Beef cattle farming is a livestock activity that has both production and economic aspects [1] . The performance of this business is determined not only by the number of cattle owned, but is also influenced by business management, resource availability, socioeconomic conditions, and the ability to generate income [2], [3] . In addition, ownership scale and labor use are also related to the economic condition of cattle farming businesses [4], [5], [6] .Income is an important indicator for assessing the condition of a business because it can differ according to business characteristics and scale [7], [8] . In cattle farming, income is also influenced by feed expenditure and herd size [9] , while the feasibility of beef cattle farming development involves both financial and non-financial aspects, including technical, managerial, market, and environmental conditions [10], [11] . Therefore, the performance evaluation of beef cattle farming needs to consider production and economic aspects simultaneously.

The problem is that beef cattle farming conditions differ across provinces. This study uses five criteria to compare production and economic performance: weight gain value and cattle stock represent the production aspect, while profit/loss, feed cost, and total revenue represent the economic aspect. Weight gain value reflects production output, cattle stock indicates the scale of livestock resources, profit/loss represents financial outcomes, total revenue reflects business income, and feed cost represents a major production expenditure. These criteria were selected based on the availability of comparable data across the ten provinces in the 2024 Statistics Indonesia (Badan Pusat Statistik, BPS) dataset. Other indicators, such as productivity per animal, feed conversion ratio, operational costs, mortality rates, and profitability relative to investment, could provide additional information but are beyond the scope of this study due to data availability and comparability limitations. Therefore, the five criteria provide a basis for comparing relative production and economic performance, rather than measuring overall technical efficiency. This comparison is important because a province with a large cattle stock does not necessarily generate higher profits or lower feed costs.

This problem can be addressed using a Multi-Criteria Decision Making (MCDM) approach, namely a decision-making method that considers several criteria simultaneously. In this context, a Decision Support System (DSS) can help process various criteria into information that facilitates the evaluation and ranking of alternatives [12], [13] . This study uses the Entropy method to determine the weight of each Criteria based on the variation of information in the data. Thus, the resulting weights reflect the ability of each Criterion to differentiate between alternatives, rather than relying solely on subjective judgment [14], [15], [16] . Next, the Weighted Aggregated Sum Product Assessment (WASPAS) method is used to calculate preference values and determine the ranking of alternatives through a combination of the Weighted Sum Model (WSM) and the Weighted Product Model (WPM) [17] . The combination of Entropy and WASPAS is expected to produce a more systematic evaluation based on the data used.

This study aims to apply a DSS for ranking the relative production and economic performance of beef cattle farming across ten provinces using the Entropy-WASPAS method. The resulting provincial rankings are compared with those obtained using MOORA and examined through Spearman's rank correlation to determine the degree of agreement between the two methods. This study is expected to demonstrate the application of an MCDM-based DSS in ranking beef cattle farming performance and provide information to support regional planning and decision-making. The rankings represent the relative positions of the ten provinces based on the selected criteria and available data, rather than measuring the technical efficiency or managerial performance of individual beef cattle farms.

2. LITERATURE REVIEW

A Decision Support System (DSS) is a computer-based approach that helps decision-makers process data, criteria, and analytical models to generate decision-support information. In this study, the DSS evaluates ten provincial alternatives using several production and economic indicators. The MCDM approach is appropriate because each alternative is assessed simultaneously using criteria with different units and preference directions. Indonesian studies have applied WASPAS to various selection and multicriteria assessment problems, including agricultural pesticide selection [18], [19].

Previous studies have also applied WASPAS in an agricultural context, such as the study by Zunaidi & Wibisono (2022), which developed a DSS for selecting shallot pesticides using four criteria (price, size, coverage area, and expiry date). The calculation results showed that Agrithane obtained the highest Qi value (0.897), supported by the lowest price and the highest weight assigned to the price criterion, so it was recommended as the best pesticide [20] .

Another study on the application of Entropy-WASPAS in performance evaluation was conducted

by Aldisa (2022), who compared the ROC-WASPAS and Entropy-WASPAS methods to support decisions regarding performance awards for hotel employees. The study used the criteria of work performance, integrity, discipline, ethics, and creativity. Alternative A5 received the highest score in both approaches: 2.958 using ROC-WASPAS and 2.968 using Entropy-WASPAS [21] .

Previous research has also compared several MCDM methods, including MAUT, WASPAS, MOORA, Fuzzy AHP, and TOPSIS, for evaluating and ranking alternatives in decision-making problems [22] .

3. RESEARCH METHODS

3.1 Research Stages

This study uses a quantitative approach with secondary data. The research stages include a literature review, data collection, selection of alternatives and criteria, Entropy weighting, normalization, WASPAS ranking, and interpretation of results. The literature review focuses on DSS, MCDM, Entropy, WASPAS, and their applications in Indonesian journals [23] .The main data source is Statistics of Large and Small Livestock Establishments 2024, published by Statistics Indonesia (BPS) in 2025 [1] .

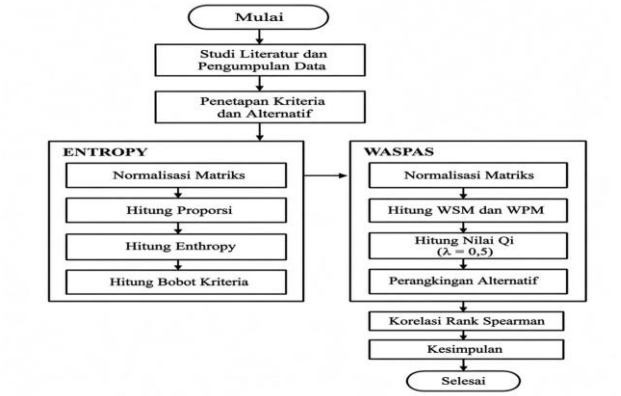


Figure 1. Research Workflow

a) Literature Review and Data Collection

This stage involves collecting relevant references from sources such as official Statistics Indonesia (BPS) publications, national and international scientific journals, and previous studies related to beef cattle farming, Decision Support Systems (DSS), the Entropy method, and the WASPAS method. The literature review establishes the theoretical foundation, clarifies objective weighting using Entropy and ranking using WASPAS, and supports the selection of criteria appropriate to the research objectives. Secondary data were obtained from the official BPS publication for 2024. The data include weight-gain value, cattle stock, profit/loss, feed cost, and total revenue. Data were collected for the selected provincial alternatives using a consistent reference period, and all observations were used to construct the decision matrix.

b) Criteria and Alternatives

The criteria and alternatives were established to construct the decision matrix for ranking beef cattle farming performance. Five criteria related to production performance and business profitability were selected: weight-gain value (C1), cattle stock (C2), profit/loss (C3), feed cost (C4), and total revenue (C5). The criteria were classified as benefit or cost attributes. C1, C2, C3, and C5 were treated as benefit attributes because higher values indicate greater production or profitability, whereas C4 was treated as a cost attribute because lower feed expenditure is preferred. The ten provincial alternatives are North Sumatra, Bengkulu, Lampung, Bangka Belitung Islands, West Java, Central Java, East Java, Banten, West Nusa Tenggara, and East Nusa Tenggara.

c) Entropy-Based Weighting

The Entropy method was used to obtain Criteria weights based on the distribution characteristics of each variable. The process includes constructing the decision matrix, normalizing the data, calculating Entropy values, determining the degree of diversification, and obtaining the final weights. The resulting weights are then used to represent the relative information contribution of each Criteria in evaluating the alternatives.

d) Applying the WASPAS Method

The weights obtained from Entropy are used in the WASPAS ranking process. WASPAS begins by normalizing the decision matrix according to the benefit or cost classification. The normalized values are then processed using two approaches: the Weighted Sum Model (WSM) and the Weighted Product Model (WPM). These values are combined to obtain the final preference score (Qi) using $Qi = \lambda \times QWSM + (1 - \lambda) \times QWPM$. In this study, λ is set to 0.50 so that the two approaches contribute equally to the final score. The alternative with the highest Qi is ranked first.

e) Tools

The tools used in this study are Google Sheets and Google Colab. Google Sheets was used for initial data processing, decision-matrix normalization, Entropy weighting, and WASPAS ranking. Google Colab was used to automate calculations and validate the results using Python and the Pandas and NumPy libraries. It was also used to present the analysis in tables and graphs, supporting a more accurate and efficient workflow.

f) Research Limitations

This study uses secondary data on beef cattle farming companies for 2024 from Statistics Indonesia (BPS), with ten provinces as alternatives and five criteria: weight-gain value, cattle stock, profit/loss, feed cost, and total revenue. Weight-gain value, cattle stock, profit/loss, and total revenue are treated as benefit attributes, while feed cost is treated as a cost attribute. The analysis is limited to one observation period and therefore does not capture performance changes over time. The ranking reflects relative preference based on the selected criteria, rather than comprehensive technical efficiency. Spearman's rank correlation is used as an additional analysis to assess agreement between the WASPAS and MOORA rankings.

3.2 Criteria and Alternatives

The five criteria were selected based on the literature and data availability in Statistics Indonesia (BPS) publications . They represent two dimensions of beef cattle farming: production and economic performance [24] . Weight-gain value (C1) represents production output, while cattle stock (C2) indicates livestock scale. Profit/loss (C3) reflects financial outcomes, feed cost (C4) represents production expenditure, and total revenue (C5) indicates business income. C1, C2, C3, and C5 are classified as benefit criteria, while C4 is classified as a cost criterion. These criteria were selected to enable comparable assessments across provinces, although they do not cover all aspects of farm performance. The ten provincial alternatives were selected based on the availability of complete and consistent data in the BPS publication. The criteria and alternatives are presented in Tables 1 and 2.

Table 1. Criteria

Criteria Code	Description	Type
C1	Weight-Gain Value (per million IDR)	Benefit
C2	Cattle Stock (head)	Benefit
C3	Profit/Loss (million IDR)	Benefit
C4	Feed Cost (million IDR)	Cost
C5	Total Revenue (million IDR)	Benefit

Table 2. Alternatives

Alternative Code	Description
A1	North Sumatra
A2	Bengkulu
A3	Lampung
A4	Bangka Belitung Islands
A5	West Java
A6	Central Java
A7	East Java
A8	Banten
A9	West Nusa Tenggara
A10	East Nusa Tenggara

3.3 Entropy Weighting

The Entropy method is used to determine objective weights based on the information variation in each Criteria. The stages include constructing the proportion matrix, calculating Entropy, determining the degree of diversification, and calculating the final weights [25], [26] . Within a DSS framework, this approach helps reduce dependence on subjective weight assignments.

Entropy Weighting Procedure:

1. Matrix Normalization

Benefit Criteria

$$r_{ij} = \frac{x_{ij}}{\max(x_{ij})} \quad (1)$$

Cost Criteria

$$r_{ij} = \frac{\min(x_{ij})}{x_{ij}}$$

Where:

r_{ij} =normalized value of the element x_{ij} for alternative i and Criteria j

x_{ij} = assessment of alternative A_i on Criteria C_j

$Min\ (x_{ij})$ = minimum value of Criteria j across all alternatives

$Max(x_{ij})$ = maximum value of Criteria j across all alternatives

2. Calculating Proportions

$$p_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} \quad (2)$$

Where:

p_{ij} = proportion of element r_{ij}

r_{ij} = value of the element in the normalized decision matrix

3. Calculating Entropy

$$E_j = \left[\frac{-1}{\ln m}\right] \sum_{i=0}^{n} \left[p_{ij} * \ln(p_{ij})\right] \quad (3)$$

Where:

E_j = Entropy value for Criteria j

m = number of alternatives

n = number of criteria

p_{ij} = value for alternative i, normalized into a proportion

ln = natural logarithm function

4. Calculating Dispersion

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

Where:

d_j = dispersion value for Criteria j

E_j = Entropy value for Criteria j

5. Calculating Criteria Weights

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

Where:
w_j = weight of Criteria j
d_j = dispersion value for Criteria j
n = number of criteria

3.4 WASPAS Ranking

After the Entropy weights are obtained, alternatives are ranked using WASPAS. Normalization is adjusted according to whether each Criteria is a benefit or cost attribute, and the normalized values are combined using WSM and WPM. The final value is calculated as Qi = λQWSM + (1 − λ)QWPM. In this study, λ = 0.50 is used so that WSM and WPM contribute equally.[27], [28]

1. Matrix Normalization

Benefit Criteria

$$r_{ij} = \frac{x_{ij}}{max(x_{ij})} \quad (6)$$

Cost Criteria

$$r_{ij} = \frac{Min(x_{ij})}{x_{ij}}$$

Where:
r_{ij} = normalized value of the element x_{ij} for alternative i and Criteria j
x_{ij} = assessment of alternative A_i on Criteria C_j
$Min\,(x_{ij})$ = minimum value of Criteria j across all alternatives
$Max(x_{ij})$ = maximum value of Criteria j across all alternatives

The WSM and WPM components are calculated as follows:

$$Qi = 0{,}50 \sum_{j=1}^{n} x_{ij}\, w_j + 0{,}50 \prod_{j=1}^{n} (x_{ij})^{wj} \quad (7)$$

Where:
Qi = preference value of alternative i
$x_{ij}w_j$ = multiplication of the value x_{ij} by the weight w_j
$(x_{ij})^{wj}$ = the value x_{ij} raised to the power of the weight w_j
0.50 = value of parameter λ used to combine WSM and WPM

3.5 Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA)

The Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method is used to provide a comparison ranking for WASPAS. The same Entropy weights shown in Table 6 are used, so differences in ranking arise from the aggregation method.

$$y_i = \sum_{j=1}^{g} w_j\, x_{ij} - \sum_{j=g+1}^{n} w_j\, x_{ij} \quad (8)$$

Where:
y_i = optimization value of alternative i
w_j = weight of benefit criteria j
x_{ij} = value of alternative i for criteria j
n = number of criteria
g = number of benefit criteria

4 RESULT

This section presents the results of the Decision Support System (DSS) calculations using Entropy and WASPAS to ranking performance of beef cattle farming across ten Indonesian provinces based on BPS data for 2024 [1] .

4.1 Entropy Weighting

Criteria weights were calculated using Entropy to reflect the distribution characteristics of the data for each Criteria. The process included normalizing the decision matrix, calculating proportions and Entropy values, determining dispersion values, and normalizing the dispersion values to obtain the final weights. The method produces objective weights because they are determined by the variation of information in the dataset. Criteria with greater variation can better distinguish among alternatives and therefore receive relatively higher weights.

4.1.1 Constructing the Decision Matrix

The decision matrix is a table containing the values of every alternative for each Criteria. It provides the basis for the calculations because it contains all initial data to be analyzed using the Entropy method.

$$x_{ij} = \begin{bmatrix} 194.582{,}98 & 9.812 & 7.890{,}06 & 104.242{,}67 & 244.815{,}22 \\ 2.494{,}90 & 2.046 & 1.655{,}95 & 60{,}00 & 2.494{,}90 \\ 1.171.721{,}59 & 80.618 & 383.877{,}95 & 622.721{,}55 & 1.194.417{,}63 \\ 4.934{,}50 & 158 & 3.419{,}03 & 259{,}30 & 4.948{,}40 \\ 569.575{,}36 & 49.681 & 32.689{,}10 & 390.210{,}67 & 584.825{,}04 \\ 7.509{,}88 & 588 & 8.916{,}43 & 34.867{,}17 & 54.935{,}23 \\ 2.311{,}90 & 285 & 38.954{,}28 & 36.352{,}51 & 90.429{,}22 \\ 284.248{,}48 & 11.507 & 17.075{,}86 & 217.708{,}49 & 288.527{,}47 \\ 5.744{,}10 & 1.088 & 3.396{,}04 & 324{,}06 & 6.178{,}15 \\ 1.553{,}39 & 2.187 & 4.072{,}79 & 16{,}00 & 7.616{,}57 \end{bmatrix}$$

4.1.2 Matrix Normalization

Normalization transforms values for each Criteria to a common scale so that the criteria can be compared proportionally. In this stage, the initial value for each alternative is transformed to a range of 0–1 using Equation (1). This reduces the influence of differences in units and scales across variables, preventing a Criteria from dominating the calculation merely because it has larger numerical values. The results are presented in Table 3.

Table 3. Normalized Matrix

Alternative	C1	C2	C3	C4	C5
A1	0,166	0,122	0,021	0,000	0,205
A2	0,002	0,025	0,004	0,267	0,002

Alternative	C1	C2	C3	C4	C5
A3	1,000	1,000	1,000	0,000	1,000
A4	0,004	0,002	0,009	0,062	0,004
A5	0,486	0,616	0,085	0,000	0,490
A6	0,006	0,007	0,023	0,000	0,046
A7	0,002	0,004	0,101	0,000	0,076
A8	0,243	0,143	0,044	0,000	0,242
A9	0,005	0,013	0,009	0,049	0,005
A10	0,001	0,027	0,011	1,000	0,006

4.1.3 Calculating Proportions

The proportion is calculated by dividing each alternative's value by the total value for the corresponding Criteria using Equation (2). The resulting proportion matrix shows the relative contribution of each alternative to each Criteria, as presented in Table 4.

Table 4. Proportion Matrix

Alternative	C1	C2	C3	C4	C5
A1	0,087	0,062	0,016	0,000	0,099
A2	0,001	0,013	0,003	0,193	0,001
A3	0,522	0,510	0,765	0,000	0,482
A4	0,002	0,001	0,007	0,045	0,002
A5	0,254	0,314	0,065	0,000	0,236
A6	0,003	0,004	0,018	0,000	0,022
A7	0,001	0,002	0,078	0,000	0,036
A8	0,127	0,073	0,034	0,000	0,116
A9	0,003	0,007	0,007	0,036	0,002
A10	0,001	0,014	0,008	0,725	0,003

4.1.4 Calculating Entropy and Dispersion

Entropy values indicate the degree of information variation in each Criteria, as calculated using Equation (3). A higher Entropy value indicates lower variation or a more uniform distribution. Conversely, a lower Entropy value indicates greater variation. The dispersion degree describes the variation or information contained in each Criteria using Equation (4). A higher dispersion value indicates greater variation in the dataset, so the Criteria tends to receive a higher Entropy weight. The results are presented in Table 5.

Table 5. Entropy and Dispersion Values

Criteria	Entropy (e_j)	Dispersi (d_j)
C1	0,534	0,466
C2	0,547	0,453
C3	0,416	0,584
C4	0,355	0,645
C5	0,620	0,380

4.1.5 Calculating the Final Weights

The Entropy weighting results in Equation (5) show that C4 (feed cost) has the highest weight, at 0.255, while C5 (total revenue) has the lowest weight, at 0.150. C3 (profit/loss) has a weight of 0.231, C1 (weight-gain value) has a weight of 0.185, and C2 (cattle stock) has a weight of 0.179. The final weights are shown in Table 6.

Table 6. Final Criteria Weights

Criteria	Bobot Akhir
C1	0,185
C2	0,179
C3	0,231
C4	0,255
C5	0,150

4.2 WASPAS Implementation

WASPAS ranks alternatives using the Criteria weights obtained from Entropy. It combines the Weighted Sum Model (WSM) and Weighted Product Model (WPM) to calculate a preference value for each alternative. The 2024 beef cattle company data include weight-gain value, cattle stock, profit/loss, feed cost, and total revenue for the ten provinces. The data are normalized according to the benefit and cost attributes. The normalized values are then multiplied or exponentiated using the Entropy weights and processed through WSM and WPM to obtain the final WASPAS values and alternative rankings.

4.2.1 Constructing the Decision Matrix

The decision matrix is a table containing all alternative values for each Criteria. It forms the basis of the WASPAS calculations because it contains all initial data to be analyzed.

$$x_{ij} = \begin{bmatrix} 194.582,98 & 9.812 & 7.890,06 & 104.242,67 & 244.815,22 \\ 2.494,90 & 2.046 & 1.655,95 & 60,00 & 2.494,90 \\ 1.171.721,59 & 80.618 & 383.877,95 & 622.721,55 & 1.194.417,63 \\ 4.934,50 & 158 & 3.419,03 & 259,30 & 4.948,40 \\ 569.575,36 & 49.681 & 32.689,10 & 390.210,67 & 584.825,04 \\ 7.509,88 & 588 & 8.916,43 & 34.867,17 & 54.935,23 \\ 2.311,90 & 285 & 38.954,28 & 36.352,51 & 90.429,22 \\ 284.248,48 & 11.507 & 17.075,86 & 217.708,49 & 288.527,47 \\ 5.744,10 & 1.088 & 3.396,04 & 324,06 & 6.178,15 \\ 1.553,39 & 2.187 & 4.072,79 & 16,00 & 7.616,57 \end{bmatrix}$$

4.2.2 WASPAS Matrix Normalization

At the WASPAS stage, each alternative's values are normalized using Equation (6), distinguishing between benefit and cost attributes. C1 (weight-gain value), C2 (cattle stock), C3 (profit/loss), and C5 (total revenue) are benefit attributes, whereas C4 (feed cost) is a cost attribute. Differences between provinces reflect trade-offs in performance assessment. The normalized values are then aggregated using WSM and WPM to obtain the final preference value for each alternative. The results are presented in Table 7.

Table 7. WASPAS Normalized Matrix

Alternative	C1	C2	C3	C4	C5
A1	0,166	0,122	0,021	0,000	0,205
A2	0,002	0,025	0,004	0,267	0,002
A3	1,000	1,000	1,000	0,000	1,000
A4	0,004	0,002	0,009	0,062	0,004
A5	0,486	0,616	0,085	0,000	0,490
A6	0,006	0,007	0,023	0,000	0,046
A7	0,002	0,004	0,101	0,000	0,076
A8	0,243	0,143	0,044	0,000	0,242
A9	0,005	0,013	0,009	0,049	0,005
A10	0,001	0,027	0,011	1,000	0,006

4.2.3 WSM and WPM Values

Aggregation using Equation (7) produces WSM and WPM values. Lampung (A3) has the highest WSM value (0.745), and it also has the highest WPM value (0.067). After the two components are combined using $\lambda = 0.50$, Lampung obtains a WASPAS score of 0.406 and ranks first. West Java (A5) ranks second, with a WSM value of 0.293, a WPM value of 0.031, and a WASPAS value of 0.162. These results show how WASPAS combines WSM and WPM to calculate the final preference score for all criteria, as presented in Table 8.

Table 8. WSM and WPM Values

Alternative	WSM	WPM
A1	0,088	0,017
A2	0,074	0,013
A3	0,745	0,067
A4	0,020	0,009
A5	0,293	0,031
A6	0,015	0,006
A7	0,036	0,006
A8	0,117	0,019
A9	0,019	0,012
A10	0,264	0,025

4.2.4 Calculating Qi

WASPAS with $\lambda = 0.50$ produces a preference value for each alternative. The highest Qi indicates the highest-ranked alternative. Lampung has the highest Qi value, at 0.406, while Central Java has the lowest Qi value, at 0.010, as shown in Table 9.

Table 9. Qi Values

Alternative	Province	Qi Value
A1	North Sumatra	0,052
A2	Bengkulu	0,044
A3	Lampung	0,406
A4	Bangka Belitung Islands	0,014
A5	West Java	0,162
A6	Central Java	0,010
A7	East Java	0,021
A8	Banten	0,068
A9	West Nusa Tenggara	0,015
A10	East Nusa Tenggara	0,145

4.2.5 Ranking

The final ranking of the ten provincial alternatives was obtained using the WASPAS method based on the calculated criterion weights. The ranking results are presented in Table 10, with the alternatives ordered from the highest to the lowest preference score.

Table 10. Alternative Ranking

Alternative	Province	Rank
A3	Lampung	1
A5	West Java	2
A10	East Nusa Tenggara	3
A8	Banten	4
A1	North Sumatra	5
A2	Bengkulu	6
A7	East Java	7
A9	West Nusa Tenggara	8
A4	Bangka Belitung Islands	9
A6	Central Java	10

4.3 Spearman's Rank Correlation Test

Spearman's rank correlation is used to measure the association between the WASPAS and MOORA rankings for the ten provincial alternatives using Equation (8) [29], [30]. Because it works with ranked data and does not require a normal distribution, this nonparametric method is often used in MCDM studies to check whether different methods or experts produce similar rankings.

The Spearman rank correlation coefficient between the WASPAS and MOORA rankings for the ten provincial alternatives is $\rho = 0.867$. This indicates a strong positive relationship, meaning that the two methods produce generally similar ranking patterns, although the rankings are not identical. The results are shown in Figure 2.

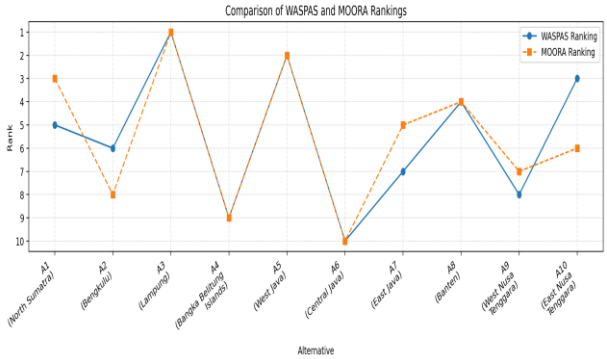


Figure 2. Comparison of WASPAS and MOORA Rankings

5 DISCUSSION

5.1 Interpretation of Entropy Weights and Provincial Rankings

The Entropy results show that feed cost (C4) received the highest weight (0.255), indicating that this criterion had the greatest variation among the ten provincial alternatives. This does not necessarily mean that feed cost is the most important factor in determining actual beef cattle farming performance. Instead, the weight reflects the information contribution of each criterion based on the distribution of the available data.

Lampung obtained the highest WASPAS preference score (0.406), followed by West Java (0.162) and East Nusa Tenggara (0.145). This result indicates that Lampung achieved the highest relative position based on the combined values of the five selected criteria after normalization and weighting. However, this ranking should not be interpreted as direct evidence that beef cattle farming businesses in Lampung are the most efficient or best managed. Therefore, the results represent comparative positions among provinces based on the available indicators, rather than absolute measures of business performance or technical efficiency.

5.2 Future Research

Future research could include additional indicators, such as productivity per animal, feed conversion ratio, mortality rate, operational costs, labor, and capital. The use of multi-year data could also provide insights into changes in provincial performance over time. Furthermore, farm-level data and methods specifically designed to measure technical efficiency could be considered to provide a more comprehensive assessment of beef cattle farming performance.

6 CONCLUSION

This study applied the Entropy-WASPAS method as a decision support system (DSS) approach to rank the relative performance of beef cattle farming across ten provinces of Indonesia using 2024 BPS data. It makes three contributions. First, Entropy provided objective, data-based criterion weights, with feed cost (C4) receiving the highest weight (0.255), followed by profit/loss (0.231), weight gain value (0.185), cattle stock (0.179), and total revenue (0.150); these weights reflect the variation of information in the data, not the normative importance of each criterion. Second, WASPAS (λ = 0.50) produced a provincial ranking from the five criteria simultaneously, with Lampung first (Qi = 0.406) and Central Java last (Qi = 0.010). Third, comparison with the MOORA ranking yielded a Spearman correlation of ρ = 0.867, indicating a strong but not identical agreement between the two methods. This study has three main limitations: it uses agregat provincial data, covers a single observation year, and relies on a limited set of five indicators that excludes productivity per animal, feed conversion, and profitability relative to investment. The results therefore show the relative position of the ten provinces based on the selected indicators, not technical efficiency or the managerial performance of individual farms. Future research could use multi-year data, additional provinces, and efficiency ratio indicators. Overall, Entropy-WASPAS can serve as a DSS approach for ranking the relative production and economic position of beef cattle farming across provinces.

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