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Implementation of AHP and TOPSIS: Selection of Medical Equipment Distributors at the Ministry of Health of the Republic of Indonesia

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ABSTRACT

This research aims to develop a Decision Support System (DSS) using the Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to assist the Ministry of Health in selecting the most suitable medical equipment distributor. The AHP method is employed to determine the weight of multiple evaluation criteria, including Quality Management System, Human Resources Management, Infrastructure, Inventory Handling, Traceability, Complaint Handling, FSCA, Returns, Disposal, Illegal Access, Internal Audit, Management Review, and Third-Party Activities. Once the weights are established, the TOPSIS method is applied to evaluate and rank the distributor alternatives based on their relative proximity to the ideal and anti-ideal solutions. The integration of AHP and TOPSIS ensures a more structured, objective, and data-driven decision-making process. The results show that the distributor labeled D4 has the highest preference value (0.64632), indicating the best performance among all alternatives evaluated. This combined method enhances decision-making accuracy, reduces subjectivity, and aligns selection outcomes with operational and regulatory standards. The study concludes that implementing a DSS using AHP and TOPSIS can significantly improve the efficiency, transparency, and effectiveness of medical equipment distributor selection within the healthcare logistics system.

1. Introduction

In the healthcare industry, selecting the right medical equipment distributor is a critical aspect in ensuring the availability and quality of products that meet established standards. The Ministry of Health of the Republic of Indonesia sets specific criteria for evaluating distributors, including Quality Management System, Human Resource (HR) Management, Facilities and Infrastructure, Inventory Handling and Storage, and Traceability, to ensure safe and efficient distribution procedures. Additionally, other factors such as Complaint Handling, Field Safety Corrective Actions (FSCA), Returns, Disposal, Illegal Access, Internal Audit, Management Review, and Third-Party Activities are vital in evaluating distributor compliance with regulations.

However, the selection process often faces challenges in assessing these various criteria systematically and objectively. Therefore, a Decision Support System (DSS) is needed to assist in more accurate and transparent evaluations. The Analytical Hierarchy Process (AHP) method is applied to determine the importance weight of each criterion, while the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is used to rank the distributors according to how closely they match the standards. This combined approach is expected to improve effectiveness and efficiency in selecting distributors that align with the Ministry's regulations. Choosing the right distributor is vital in the medical equipment supply chain to ensure both product quality and safety. Medical devices used in hospitals, clinics, and other healthcare institutions require strict oversight, both in terms of product quality and distribution management. Hence, the Ministry of Health, as the regulatory body, must adopt an efficient and accurate system to identify suitable distributors. Without a systematic approach, selection becomes subjective and inefficient [1].

In practice, distributor selection is often experience-based and subjective, risking the neglect of critical factors affecting distribution success. Therefore, a data-driven and objective system is needed. One way to achieve this is by implementing a DSS that can recommend the best distributor based on relevant criteria. Prior research has shown that DSS can reduce bias and improve operational efficiency in supplier selection [2].

This study adopts a combination of AHP and TOPSIS methods. AHP helps determine the relative importance of each criterion, while TOPSIS ranks alternatives based on their distance to the ideal solution. This hybrid method is expected to produce more objective and measurable decisions [3].

The criteria used to evaluate medical equipment distributors are diverse, covering important aspects such as quality management systems, HR management, complaint handling, and product returns. Additionally, storage, traceability, and internal audits are also major considerations to ensure trustworthy distributors that comply with existing regulations and standards [4].

The implementation of a DSS based on AHP-TOPSIS is expected to improve the efficiency and effectiveness of distributor selection, ensuring that distributed medical equipment complies with strict quality and safety standards. Thus, this research aims to contribute to improving Indonesia's medical equipment distribution system, particularly under the Ministry of Health's authority [5].

Lestari *et al.* [6] conducted research on the selection of alternative suppliers for medical equipment using AHP and TOPSIS approaches. Their study focused on face shield products and emphasized the importance of prioritizing suppliers to ensure product availability during the pandemic. This study is relevant as it demonstrates the application of AHP-TOPSIS in a real medical logistics context. Nuraini [7] developed a Decision Support System for selecting medical equipment distributors using the Profile Matching method. Although a different method was used, the study is relevant to the current research in terms of its focus on objective and criteria-based distributor selection. Utami [8] used AHP to analyze the use of single-use medical equipment. While the context differs, the methodological approach offers insights into structuring decision-making processes in the healthcare sector. Suryana *et al.* [9] designed a Decision Support System using SAW, AHP, and TOPSIS to evaluate employee performance. Although the object of assessment differs (employees rather than distributors), the combination of decision-making methods demonstrates flexibility and reliability in multi-criteria decision-making scenarios.

Decision Support System (DSS): A Decision Support System (DSS) is a computer-based system designed to assist decision-makers in processing information and analyzing alternatives in complex situations [10]. DSS integrates data, analytical models, and an interactive user interface to support more effective and efficient decision-making [11].

Core Components of DSS: According to Marakas and O'Brien [12], DSS comprises three main components:

1. Database Management System (DBMS): Stores and manages data used in decision analysis.
2. Model-Based Management System (MBMS): Analyzes data using various methods, including AHP and TOPSIS [13][14].
3. User Interface (UI): Facilitates interaction between the user and the system for input and result presentation.

AHP Method: Developed by Saaty and Vargas [13], the Analytic Hierarchy Process (AHP) allows decision-makers to decompose a problem into a hierarchy and assign weights to criteria through pairwise comparisons.

TOPSIS Method: Introduced by Hwang and Yoon [14], TOPSIS evaluates alternatives based on their proximity to the ideal positive and negative solutions. The closer an alternative is to the ideal solution, the better it is considered.

Applications of DSS: DSS has been implemented across various sectors, including supplier selection [15], workforce recruitment [16], and organizational performance evaluation [10]. Integrating AHP and TOPSIS into DSS enhances objectivity and accuracy in multi-criteria decision-making [14].

Benefits of this research is, Improves decision-making efficiency, enables data-driven objectivity, and reduces reliance on intuition. This research had challenge to relies heavily on high-quality data, requires careful design and implementation, and may face user adoption barriers.

In conclusion, DSS plays a vital role in improving decision-making effectiveness. The integration of AHP and TOPSIS has been proven to enhance accuracy in alternative selection across multiple disciplines.

2. Methods

2.1 Research Method

Analytic Hierarchy Process (AHP) is utilized to determine the criteria weights in selecting medical equipment distributors. The steps include Determining the Criteria, Constructing the Pairwise Comparison Matrix, Normalizing the Matrix, Calculating Priority Weights, Consistency Ratio (CR) Calculation.

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is applied to rank distributor alternatives based on their proximity to the ideal solution. The steps are Constructing the Decision Matrix, Normalizing the Decision Matrix, Creating the Weighted Normalized Matrix, Determining Positive Ideal and Negative Ideal Solutions, Calculating the Distance to Ideal Solutions, Calculating Relative Closeness (Ci).

2.1 Research Design

This study adopts a quasi-experimental design to test the DSS in a real-world environment. The following steps are included:

1. Problem Identification: Define system needs and alternative evaluation criteria.
2. Data Collection: Gather data from respondents regarding influencing factors.
3. Modeling and System Development: Apply AHP to determine weights and TOPSIS to rank alternatives.
4. Implementation and Testing: Conduct system trials and evaluate decision support performance.
5. Analysis and Evaluation: Analyze test results and assess the accuracy of system recommendations.
6. Conclusion Drawing: Summarize research findings.

3. Result and Discussions

3.1 AHP and TOPSIS Calculation

The following table 1 displays the 13 evaluation criteria, their assigned weights, descriptions, and whether they are benefit or cost types.

Table 1. Determining Criteria and Weights

No	*Criteria*	*Weight*	*Description*	*Type*
1	Quality Management System	20	Better quality systems enhance distributor performance	Benefit
2	Human Resources Management	5	Effective HR improves compliance and efficiency	Benefit
3	Buildings and Facilities	10	Better infrastructure supports medical equipment logistics	Benefit
4	Inventory Storage and Handling	10	Proper storage reduces damage risk	Benefit
5	Traceability	5	Trackability improves safety and accountability	Benefit
6	Complaint Handling	5	Fewer complaints indicate higher service quality	Cost
7	Field Safety Corrective Action (FSCA)	5	Fewer corrective actions reflect better product quality	Cost
8	Return Handling	5	Lower return rates signal effective distribution	Cost
9	Disposal Management	5	Lower disposal volume indicates better inventory control	Cost
10	Illegal Access and TMS Handling	5	Fewer illegal or nonconforming product cases reflect higher integrity	Cost
11	Internal Audit	10	Transparent audits reflect regulatory compliance	Benefit
12	Management Review	10	Regular reviews improve quality assurance	Benefit
13	Third-Party Activities	5	Support from external partners enhances distribution efficiency	Benefit

The pairwise comparison was constructed using Saaty's scale [17], comparing each criterion's weight with the others to form a matrix.

Kriteria	Sistem Manajemen Mutu	Bangunan dan Fasilitas	Penyimpanan dan Penanganan Persediaan	Audit Internal	Tinjauan Manajemen	Pengelolaan SDM	Mampu Telusur	Penanganan Keluhan	FSCA	Penanganan Retur	Penanganan Pemusnahan	Penanganan Alkes Illegal & TMS	Aktivitas Pihak Ketiga
Sistem Manajemen Mutu	1.00	2.00	2.00	2.00	2.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Bangunan dan Fasilitas	0.50	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Penyimpanan dan Penanganan Persediaan	0.50	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Audit Internal	0.50	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Tinjauan Manajemen	0.50	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Pengelolaan SDM	0.25	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mampu Telusur	0.25	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Penanganan Keluhan	0.25	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
FSCA	0.25	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Penanganan Retur	0.25	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Penanganan Pemusnahan	0.25	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Penanganan Alkes Illegal & TMS	0.25	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Aktivitas Pihak Ketiga	0.25	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Figure 1. Pairwise Comparison Matrix

Matrix Normalization and Priority Calculation. Each matrix value is divided by the total column value. Each row is averaged to determine the priority vector (weight for each criterion).

	C1-SMM	C10 - PAITMS	C11 - AI	C12 - TM	C13 - APK	C2 - SDM	C3 - BF	C4 - PPP	C5 - MT	C6 - PK	C7 - FSCA	C8 - PR	C9 - PP	Bobot Prioritas
C1-SMM	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
C10 - PAITMS	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
C11 - AI	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
C12 - TM	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
C13 - APK	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
C2 - SDM	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
C3 - BF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
C4 - PPP	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
C5 - MT	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
C6 - PK	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
C7 - FSCA	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
C8 - PR	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
C9 - PP	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Figure 2. Calculating the Priority Weight of Criteria

The Consistency Ratio (CR) was computed and confirmed to be less than 0.1, indicating acceptable consistency in judgment.

The performance of each distributor (D1–D5) for all 13 criteria was compiled into a decision matrix. The matrix was normalized using vector normalization.

Nilai Bobot Alternatif

Pencarian Refresh

Kode	Nama Alternatif	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	Aksi
D1	PT. SNIBE DIAGNOSTIC INDONESIA	80	50	85	75	60	60	70	85	50	60	70	55	65	Ubah
D2	PT. KARUNIA LENTERA ABADI	75	55	80	70	65	65	75	80	55	65	75	50	60	Ubah
D3	PT. DWI CAHAYA MULIA	85	60	90	80	55	70	80	90	60	55	80	60	70	Ubah
D4	PT. VASHA BIOTECH INDONESIA	90	65	95	85	50	55	85	95	65	50	85	65	75	Ubah
D5	PT. GEMAHRIPAH ANUGRAH LESTARI	70	45	75	65	70	75	65	75	45	70	60	45	55	Ubah

Figure 3. Alternate Value

Normalisasi

	C1-SMM	C10 - PAITMS	C11 - AI	C12 - TM	C13 - APK	C2 - SDM	C3 - BF	C4 - PPP	C5 - MT	C6 - PK	C7 - FSCA	C8 - PR	C9 - PP
A1	0.44548	0.40324	0.44567	0.44524	0.44414	0.41039	0.41556	0.44567	0.40324	0.44414	0.42021	0.44356	0.44459
A2	0.41763	0.44356	0.41946	0.41556	0.48115	0.44459	0.44524	0.41946	0.44356	0.48115	0.45023	0.40324	0.41039
A3	0.47332	0.48389	0.47189	0.47492	0.40713	0.47879	0.47492	0.47189	0.48389	0.40713	0.48024	0.48389	0.47879
A4	0.50116	0.52421	0.49811	0.5046	0.37012	0.37619	0.5046	0.49811	0.52421	0.37012	0.51026	0.52421	0.51299
A5	0.38979	0.36292	0.39324	0.38587	0.51816	0.51299	0.38587	0.39324	0.36292	0.51816	0.36018	0.36292	0.37619

Figure 4. Decision matrix normalization

Normalisasi Terbobot

	C1-SMM	C10 - PAITMS	C11 - AI	C12 - TM	C13 - APK	C2 - SDM	C3 - BF	C4 - PPP	C5 - MT	C6 - PK	C7 - FSCA	C8 - PR	C9 - PP
D1	0.0891	0.02016	0.04457	0.04452	0.02221	0.02052	0.04156	0.04457	0.02016	0.02221	0.02101	0.02218	0.02223
D2	0.08353	0.02218	0.04195	0.04156	0.02406	0.02223	0.04452	0.04195	0.02218	0.02406	0.02251	0.02016	0.02052
D3	0.09466	0.02419	0.04719	0.04749	0.02036	0.02394	0.04749	0.04719	0.02419	0.02036	0.02401	0.02419	0.02394
D4	0.10023	0.02621	0.04981	0.05046	0.01851	0.01881	0.05046	0.04981	0.02621	0.01851	0.02551	0.02621	0.02565
D5	0.07796	0.01815	0.03932	0.03859	0.02591	0.02565	0.03859	0.03932	0.01815	0.02591	0.01801	0.01815	0.01881

Figure 5. Forming a Weighted Normalization Matrix

Each normalized value was multiplied by the respective AHP criterion weight to form the weighted normalized matrix.

a. Positive Ideal Solution (A^+): Best values for benefit criteria and lowest for cost criteria.
b. Negative Ideal Solution (A^-): Worst values for benefit criteria and highest for cost criteria.

Matriks Solusi Ideal

	C1-SMM	C10 - PAITMS	C11 - AI	C12 - TM	C13 - APK	C2 - SDM	C3 - BF	C4 - PPP	C5 - MT	C6 - PK	C7 - FSCA	C8 - PR	C9 - PP
positif	0.10023	0.01815	0.04981	0.05046	0.02591	0.02565	0.05046	0.04981	0.02621	0.01851	0.01801	0.01815	0.01881
negatif	0.07796	0.02621	0.03932	0.03859	0.01851	0.01881	0.03859	0.03932	0.01815	0.02591	0.02551	0.02621	0.02565

Figure 6. Positive and Negative Ideal Solution

For each distributor, the Euclidean distance to both ideal and anti-ideal solutions was calculated:

a. Di+ (distance to positive ideal)

b. Di−D_i^-Di− (distance to negative ideal)

Relative Closeness (Ci)

$$Ci = \frac{D_i^-}{D_i^+ + D_i^-} \quad (1)$$

Jarak Solusi & Nilai Preferensi

	Positif	Negatif	Preferensi
D1	0.02061	0.0185	0.473
D2	0.02496	0.01547	0.38256
D3	0.01546	0.02592	0.62633
D4	0.0183	0.03343	0.64632
D5	0.03343	0.0183	0.35368

Figure 7. Distance of Positive and Negative Ideal Solutions and Preference Values (Ci)

The higher the Ci value (closer to 1), the better the distributor's ranking.

Table 2. Distributor Ranking

Distributor	Ci Value	Rank
D4	0.64632	1
D1	—	—
D2	—	—
D3	—	—
D5	0.35368	5

Distributor D4 is the best alternative, with the highest Ci value of 0.64632, while D5 ranked lowest.

Perangkingan

	Total	Rank
D1 - PT. SNIBE DIAGNOSTIC INDONESIA	0.473	3
D2 - PT. KARUNIA LENTERA ABADI	0.383	4
D3 - PT. DWI CAHAYA MULIA	0.626	2
D4 - PT. VASHA BIOTECH INDONESIA	0.646	1
D5 - PT. GEMAHRIPAH ANUGRAH LESTARI	0.354	5

Figure 8. Distributor Rank

4.2 Discussion

The implementation of the AHP-TOPSIS method proves effective in objectively evaluating complex multi-criteria distributor selection decisions. AHP provided clear prioritization of evaluation factors, while TOPSIS ranked alternatives based on calculated proximity to an ideal distributor profile.

This approach supports the findings of previous studies that showed AHP-TOPSIS integration enhances decision-making transparency and reliability in public procurement and logistics contexts [18].

Moreover, the results align with findings by Kumar *et al.* [15], demonstrating that this method is adaptable to public-sector needs such as health equipment logistics. The combination of cost and benefit criteria also provides a more comprehensive evaluation framework.

4. Conclusion

4.1 Conclusion

This study successfully applied the AHP and TOPSIS methods to support decision-making in selecting the best medical equipment distributor for the Ministry of Health. The calculation results indicate that Alternative D4 achieved the highest preference value of 0.64632, making it the most suitable option based on the established criteria.

AHP effectively determined the relative weights of each criterion with strong consistency, while TOPSIS ranked the distributor alternatives based on their proximity to an ideal solution.

These findings support previous research by Saaty [17] and Hwang and Yoon [14], which demonstrated the effectiveness of combining AHP and TOPSIS in multi-criteria decision-making. Moreover, this aligns with Kumar *et al.* [15], who emphasized the practical benefits of this integration in logistics and public procurement settings.

4.2 Recommendations

1. Optimization of Distributor Selection System: The Ministry of Health is encouraged to digitize and institutionalize the AHP-TOPSIS model into its logistics management system to accelerate and improve the accuracy of distributor selection.
2. Development of Additional Criteria: Future research may consider adding criteria such as *sustainability* and *technological innovation* to provide a more comprehensive distributor evaluation.
3. Periodic Reevaluation: Regular evaluations of both the criteria and distributor alternatives are recommended to align with evolving health sector needs and regulatory updates.

4.3 Research Implications

1. Theoretical:
   This study enriches the literature on AHP-TOPSIS implementation for public-sector distributor selection. The results confirm the method's potential to enhance objectivity and consistency in decision-making [13], [14].
2. Practical:
   The resulting model provides a structured decision-making tool for the Ministry of Health to select high-performing distributors, potentially improving the nationwide availability and distribution of medical devices.
3. Managerial:
   Decision-makers can use this approach to ensure transparency, efficiency, and accountability in selecting distributors, aligning with national health service goals [15].

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