

Optimization of coas doctor selection using PROMETHEE-based decision support system

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ABSTRACT

The selection process of co-assistant (COAS) doctors in hospitals is a critical stage in ensuring the quality of healthcare services. However, in practice, this process is often conducted subjectively and lacks integration with a structured criteria-based system, which may lead to inconsistent and less accurate decision-making. However, existing studies still lack the implementation of integrated web-based decision support systems with validated ranking results, particularly in the context of COAS doctor selection. This study aims to optimize the selection process of COAS doctors by implementing a decision support system based on the Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE). The method is used to rank alternatives through a multi-criteria decision-making approach involving seven criteria, namely medical knowledge, service attitude, productivity, teamwork, discipline, honesty, and responsibility. The results show that the developed system is capable of generating objective candidate rankings, where the highest net flow value of 0.95 is achieved by the best candidate, indicating strong dominance over other alternatives. Furthermore, the implementation of the PROMETHEE method improves transparency and consistency in decision-making while reducing subjectivity compared to manual approaches. The web-based system also enhances efficiency through automated calculations and real-time data processing. Therefore, this study contributes to the development of multi-criteria decision support systems in the healthcare sector, particularly in providing a more objective, systematic, and efficient approach to COAS doctor selection.

Keywords: Decision Support System, PROMETHEE, COAS Doctor Selection, Multi-Criteria Decision Making, Decision Optimization

ABSTRAK

Proses seleksi dokter co-assistant (COAS) di rumah sakit merupakan tahapan krusial dalam menjamin kualitas pelayanan kesehatan. Namun dalam praktiknya, proses ini masih sering dilakukan secara subjektif dan belum terintegrasi dengan sistem berbasis kriteria yang terstruktur, sehingga berpotensi menghasilkan keputusan yang kurang akurat dan tidak konsisten. Namun, penelitian sebelumnya masih belum banyak mengimplementasikan sistem pendukung keputusan berbasis web yang terintegrasi dengan validasi hasil pemeringkatan, khususnya dalam konteks seleksi dokter COAS. Penelitian ini bertujuan untuk mengoptimalkan proses seleksi dokter COAS melalui penerapan sistem pendukung keputusan berbasis metode Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE). Metode ini digunakan untuk melakukan pemeringkatan alternatif berdasarkan pendekatan pengambilan keputusan multikriteria yang melibatkan tujuh kriteria, yaitu pengetahuan medis, sikap pelayanan, produktivitas, kerja sama, disiplin, kejujuran, dan tanggung jawab. Hasil penelitian menunjukkan bahwa sistem yang dikembangkan mampu menghasilkan pemeringkatan kandidat secara objektif, di mana nilai net flow tertinggi sebesar 0,95 diperoleh oleh kandidat terbaik yang menunjukkan dominasi yang kuat dibandingkan alternatif lainnya. Selain itu, penerapan metode PROMETHEE mampu meningkatkan transparansi dan konsistensi dalam pengambilan keputusan serta mengurangi subjektivitas dibandingkan metode manual. Sistem berbasis web yang dikembangkan juga meningkatkan efisiensi proses seleksi melalui otomatisasi perhitungan dan pengolahan data secara real-time. Dengan demikian, penelitian ini memberikan kontribusi dalam pengembangan sistem pendukung keputusan berbasis multikriteria di bidang kesehatan, khususnya dalam menyediakan pendekatan seleksi dokter COAS yang lebih objektif, sistematis, dan efisien.

Kata kunci: Sistem Pendukung Keputusan, PROMETHEE, Seleksi Dokter COAS, Pengambilan Keputusan Multikriteria, Optimasi Keputusan

Manuscript received 15 Oct. 2021; revised 29 Jan. 2022; accepted 2 May. 2022. Date of publication 17 May. 2022. Journal Geuthee of Engineering and Energy is licensed under a Creative Commons Attribution-Share Alike 4.0 International License.



1. INTRODUCTION

The recruitment process of medical personnel, especially co-assistant (COAS) doctors, is a crucial aspect in maintaining the quality of healthcare services in hospitals. A well-structured selection process ensures that selected candidates possess not only adequate medical knowledge but also strong professional attitudes such as discipline, responsibility, and teamwork. However, in practice, the selection process for COAS doctors is still often conducted manually and tends to be subjective, which may lead to inconsistencies and inaccuracies in decision-making. This condition can negatively affect both the efficiency of the selection process and the overall quality of healthcare services.

Along with the advancement of information technology, Decision Support Systems (DSS) have been widely adopted to assist complex and multi-criteria decision-making processes [1], [2]. DSS are capable of integrating various criteria and data sources to produce decisions that are more objective, consistent, and transparent [3]. In the healthcare sector, DSS applications have also evolved by utilizing data-driven approaches to improve the accuracy of both clinical and managerial decisions [4]. Furthermore, Multi-Criteria Decision Making (MCDM) methods such as PROMETHEE are commonly used due to their ability to rank alternatives based on multiple conflicting criteria in a systematic manner [5], [6], [7].

Several previous studies have demonstrated the effectiveness of the PROMETHEE method in decision-making contexts. Bangun et al. [8] developed a decision support system for employee recruitment using a combination of profile matching and PROMETHEE, which successfully reduced subjectivity and improved ranking consistency. Similarly, Rosmala et al. [9] showed that PROMETHEE can enhance efficiency and accuracy in partner selection processes. In another study, da Costa Fátima et al. [10] applied PROMETHEE in lecturer performance evaluation and produced more objective ranking results compared to manual methods.

Despite these advancements, several limitations still exist. A systematic literature review by Riyadi [11] indicates that many DSS implementations in recruitment processes still rely on static weighting schemes, limited evaluation criteria, and lack comprehensive validation of decision outcomes. In addition, Pohl and Geldermann [12] highlight that although PROMETHEE has been widely applied, its integration into real-time web-based systems with proper validation mechanisms remains a challenge in practical implementation.

Therefore, there is still a research gap in the development of an integrated web-based decision support system that not only applies the PROMETHEE method but also provides validated and transparent ranking results, particularly in the context of COAS doctor selection.

Based on this gap, this study aims to develop a web-based decision support system for the selection of COAS doctors using the PROMETHEE method. The proposed system is designed to provide objective, systematic, and transparent recommendations based on multiple evaluation criteria. In addition, this study contributes by integrating automated ranking calculations with validation processes to ensure the reliability of decision outcomes. It is expected that the developed system can improve the efficiency and accuracy of the selection process while supporting better decision-making in healthcare institutions.

2. RESEARCH METHOD

This study uses a Decision Support System (DSS) approach based on the Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) method to support the decision-making process in the recruitment of COAS doctors. The research stages are systematically arranged to ensure that the process of analysis, design, implementation, and evaluation of the system runs in a structured manner and produces optimal outputs [13], [14], [15].

The stages of research carried out can be explained as follows [16]:

1. Problem Identification

The initial stage of the research was carried out by identifying problems that occurred in the process of recruiting COAS doctors in hospitals, namely the existence of subjectivity in the assessment of candidates and the absence of a system that was able to manage various criteria in an integrated manner.

2. Data Collection

Data was collected through observation and interviews with hospitals to obtain information related to the criteria used in the COAS doctor selection process. The criteria used in this study include: medical knowledge, service attitude, productivity, cooperation, discipline, honesty, and responsibility [17].

3. Determination of Criteria and Weights

Each criterion is given weight according to its level of importance to the selection process. The determination of weights is carried out based on the results of discussions with experts (expert judgment) so that it reflects real needs in the field.

4. System Planning

At this stage, a web-based system design is carried out which includes the design of *flowcharts*, *databases*, and *user interfaces*. The system is designed to be able to manage candidate data, criterion data, and the calculation process of the PROMETHEE method automatically.

5. Application of the PROMETHEE Method

The PROMETHEE method is used to rank candidates based on preference scores [18]. The stages in this method include:

- Compilation of the result matrix
- Calculation of the preference function
- Calculation of values *leaving flow* (φ^+)
- Calculation of values *entering flow* (φ^-)
- Calculation of values *net flow* (φ)
- Determination of alternative rankings

6. System Implementation

The system is implemented using web-based technology with the PHP programming language and MySQL database [19]. The implementation is carried out to ensure that the system can be used directly by users in the selection process.

7. System Testing

The test was carried out using the [20]:

- Blackbox Testing* to test system functionality
- Whitebox Testing* to test program logic
- Validation of the results of the PROMETHEE method to ensure the accuracy of the ranking

8. Analysis and Evaluation

The results obtained from the system were analyzed to see the level of effectiveness and accuracy in supporting the decision-making process compared to manual methods.

In general, the stages of research can be described in the flowchart as follows:

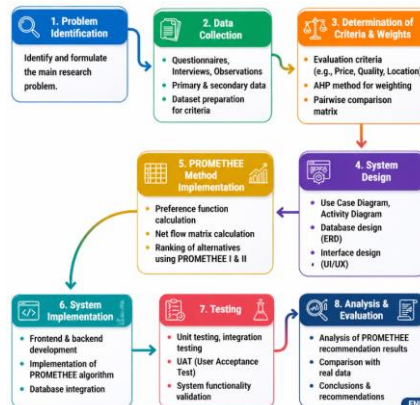


Figure 1. Research Stage Flow

2.1 The PROMETHEE Method

The PROMETHEE method is one of the methods in the *Multi-Criteria Decision Making* (MCDM) approach that is used to determine alternative rankings based on several conflicting criteria. This method works by comparing each alternative pair based on the preference function [6], [21].

a. Results Matrix

The decision matrix is used to represent the value of each alternative against each of the criteria, which are expressed as follows:

$$X = [x_{ij}] \quad (1)$$

where:

x_{ij} is the second alternative value to the criterion to-j

b. Preferences Function

The preference function is used to calculate the level of preference between two alternatives:

$$P_j(a, b) = f(d) \quad (2)$$

with:

$$d = f_j(a) - f_j(b) \quad (3)$$

c. Preference Index

$$\pi(a, b) = \sum_{j=1}^n w_j \cdot P_j(a, b) \quad (4)$$

where:

(w_j) = Weighting criteria to-j

d. Leaving Flow (ϕ^+)

$$\phi^+(a) = \frac{1}{n-1} \sum_{b \in A} \pi(a, b) \quad (5)$$

Leaving flow shows how much an alternative is better than another.

e. Entering Flow (ϕ^-)

$$\phi^-(a) = \frac{1}{n-1} \sum_{b \in A} \pi(b, a) \quad (6)$$

Entering flow indicates how much an alternative is outnumbered by another.

f. Net Flow (ϕ)

$$\phi(a) = \phi^+(a) - \phi^-(a) \quad (7)$$

Net flow values are used as the basis for determining the final ranking of alternatives.

2.2 Research Data Structure

The following table shows the data structure used in the study:

Table 1. COAS Doctor Assessment Criteria

No	Kriteria	Tipe
1	Medical Knowledge	Benefit
2	Service Attitude	Benefit
3	Productivity	Benefit
4	Teamwork	Benefit
5	Discipline	Benefit

6	Honesty	Benefit
7	Responsibility	Benefit

2.3 System Testing

System testing is carried out to ensure that the developed system runs in accordance with the research objectives. The test is carried out with the following approach:

1. **Blackbox Testing**

Used to test system functionality based on the inputs and outputs generated.

2. **Whitebox Testing**

Used to test the logical structure of programs and process flows in systems.

3. **Method Validation**

It is carried out by comparing the results of the system calculation with the manual calculation of the PROMETHEE method to ensure the accuracy of the ranking results.

3. RESULTS AND DISCUSSION

3.1 Datasets and Assessment Criteria

In this study, sample data was used in the form of 5 COAS doctor candidates who will be selected based on 7 predetermined criteria. All criteria are *benefits*, meaning that the higher the value, the better.

Table 2. Alternative Data for COAS Doctor Candidates

Alternatif	Knowledge	Attitude	Productivity	TeamWork	Discipline	Honesty	Responsibilities
A1	80	85	78	82	88	90	85
A2	75	80	85	80	85	88	80
A3	85	88	80	85	90	92	88
A4	78	82	82	78	84	85	82
A5	82	86	79	84	87	89	86

3.2 Determination of Weighting Criteria

The weighting of each criterion is determined based on expert judgment involving medical practitioners and hospital management who are directly involved in the COAS doctor selection process. This approach is commonly used in multi-criteria decision-making problems where domain expertise plays a critical role in assessing the relative importance of evaluation criteria.

The determination process is conducted through structured discussions and interviews to identify the significance of each criterion in reflecting the competencies required for COAS doctors. Criteria such as medical knowledge and discipline are assigned higher weights due to their direct impact on clinical performance and patient safety. Meanwhile, criteria such as teamwork and responsibility are also considered important, but with relatively lower weights as they support collaborative aspects of healthcare services.

This approach is consistent with previous studies that utilize expert-based weighting in decision support systems, such as Bangun et al. [8] and Rosmala et al. [9], where expert judgment is applied to ensure that the weighting scheme reflects real-world decision-making conditions. However, it is important to note that this method may introduce subjectivity, as highlighted by Riyadi[11], who identified static and subjective weighting as a common limitation in DSS-based recruitment systems.

Table 3. Criteria Weighting

Criteria	Weight
Medical Knowledge	0.20
Service Attitude	0.15
Productivity	0.15
Teamwork	0.10

Discipline	0.15
Honesty	0.15
Responsibility	0.10

Total weight = 1.00

3.3 Calculation of the PROMETHEE Method

3.3.1 Calculation of Value Difference (d)

A comparison between alternatives A1 and A2:

$$d = f(A1) - f(A2)$$

Examples on the Knowledge criteria:

$$d = 80 - 75 = 5$$

Since all criteria are *of the benefit* type, a simple preference function is used:

$$P(d) = \begin{cases} 1, & d > 0 \\ 0, & d \leq 0 \end{cases}$$

3.3.2 Preference Index

Calculation of the preference index between A1 and A2:

$$\pi(A1,A2) = (0.20 \times 1) + (0.15 \times 1) + (0.15 \times 0) + (0.10 \times 1) + (0.15 \times 1) + (0.15 \times 1) + (0.10 \times 1)$$

$$\pi(A1,A2) = 0.85$$

3.3.3 Preference Matrix

Table 4. Matriks Preferensi $\pi(a,b)$

	A1	A2	A3	A4	A5
A1	-	0.85	0.00	0.70	0.20
A2	0.15	-	0.00	0.65	0.10
A3	1.00	1.00	-	1.00	0.90
A4	0.30	0.35	0.00	-	0.20
A5	0.80	0.90	0.10	0.80	-

3.3.4 Leaving Flow (ϕ^+)

$$\phi^+(a) = \frac{1}{n-1} \sum_{b \in A} \pi(a,b)$$

Calculation results

Alternatif	ϕ^+
A1	0.44
A2	0.23
A3	0.98
A4	0.21
A5	0.65

3.3.5 Entering Flow (ϕ^-)

$$\phi^-(a) = \frac{1}{n-1} \sum_{b \in A} \pi(b, a)$$

Alternatif	ϕ^-
A1	0.56
A2	0.77
A3	0.03
A4	0.63
A5	0.52

3.3.6 Net Flow (ϕ)

$$\phi(a) = \phi^+(a) - \phi^-(a)$$

Alternatif	ϕ (Net Flow)
A1	-0.12
A2	-0.54
A3	0.95
A4	-0.42
A5	0.13

3.4 Ranking Results

Table 5. Ranking Candidate

Ranking	Alternatif	Nilai ϕ
1	A3	0.95
2	A5	0.13
3	A1	-0.12
4	A4	-0.42
5	A2	-0.54

3.5 Results Analysis

Based on the results of the calculation of the PROMETHEE method, the A3 alternative has the *highest net flow* value of 0.95. This shows that A3 has the strongest dominance over other alternatives in all the criteria used. A3 candidates excel in almost all aspects, especially on the criteria of medical knowledge, discipline, and honesty, which are important factors in health care.

The A5 alternative takes second place with a value of 0.13, which indicates that the candidate also performs well although not as strong as A3. Meanwhile, alternative A1 came in third place with a relatively small negative value, which suggests that the candidate is still quite competitive.

In contrast, alternatives A2 and A4 had greater negative values, indicating that the two candidates were more likely to be "beaten" by the other candidates in paired comparisons. This indicates that the candidate does not meet the criteria that have been set optimally.

The developed system is capable of:

1. Input candidate data
2. Manage criteria and weights

3. Perform PROMETHEE calculations automatically
4. Display ranking results

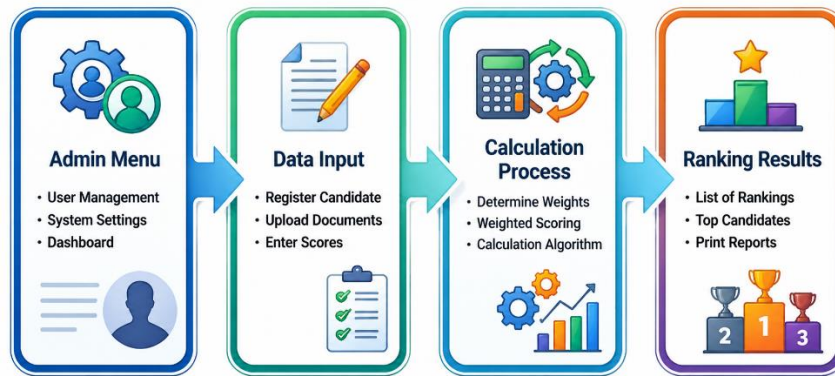


Figure 2. COAS Selection System Flow View

Inteface App View

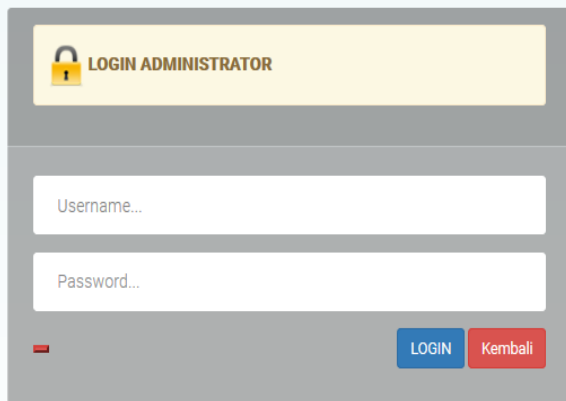


Figure 3 (a) SPK login view

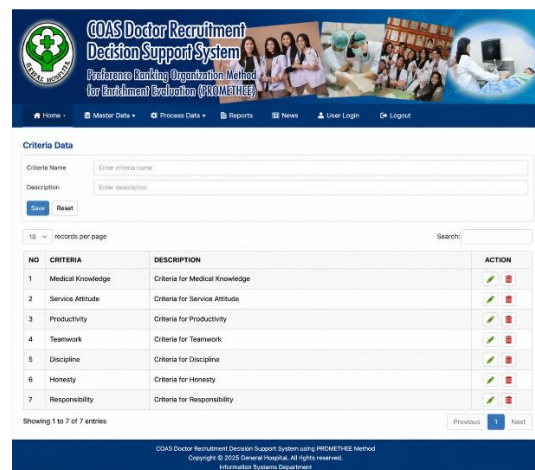


Figure 3(b) Input Criteria

3.6 System Testing Results

System testing is conducted to evaluate the functionality, logical correctness, and computational accuracy of the developed decision support system. This evaluation consists of three main approaches, namely Blackbox Testing, Whitebox Testing, and PROMETHEE Method Validation, as described in the research methodology.

3.6.1 Blackbox Testing

Blackbox testing is performed to verify that each function in the system operates correctly based on user input and expected output. This testing focuses on system functionality without considering internal code structure.

Table 6. Blackbox Testing Results

No	Test Scenario	Input	Expected Output	Result
1	Login system	Valid username & password	Dashboard displayed	Valid
2	Input candidate data	Complete candidate data	Data stored successfully	Valid
3	Input criteria & weights	Criteria and weight values	Data saved correctly	Valid
4	PROMETHEE	Candidate dataset	Ranking results generated	Valid

	calculation			
5	Display ranking	Processed data	Ranking displayed correctly	Valid

The test results show that all the main functions of the system are running as expected. This indicates that the system has met the *functional suitability* aspect in software development, where all features can be used without errors in the given test scenario.

3.6.2 Whitebox Testing

Whitebox testing is conducted to evaluate the internal logic and program flow of the system, particularly in the PROMETHEE calculation process.

The testing focuses on:

1. Logical flow of preference calculation
2. Iteration over alternatives
3. Accuracy of flow computation (leaving, entering, net flow)

Test results:

1. All logical paths in the PROMETHEE calculation module execute correctly
2. No logical errors found in looping and decision structures
3. Each calculation step produces consistent intermediate results

Whitebox testing shows that the program's logical structure has been running systematically without any flow errors. This is important because the PROMETHEE method relies heavily on gradual calculations that are sensitive to logical errors, so the validity of the algorithm can be guaranteed.

3.6.3 PROMETHEE Method Validation

Validation is performed by comparing the results generated by the system with manual calculations using the PROMETHEE method.

Table 7. Validation Results

Alternative	Manual Calculation (ϕ)	System Result (ϕ)	Difference
A1	-0.12	-0.12	0.00
A2	-0.54	-0.54	0.00
A3	0.95	0.95	0.00
A4	-0.42	-0.42	0.00
A5	0.13	0.13	0.00

The validation results showed that there was no difference between the manual calculation and the system results, with a difference value of 0.00 for all alternatives. This proves that the implementation of the PROMETHEE method in the system has been carried out very accurately. This validation is important proof that the system is not only technically functional, but also mathematically correct.

3.7 Discussion

The results of this study indicate that the PROMETHEE method is capable of producing objective and systematic ranking outcomes in the selection of COAS doctors. The highest net flow value obtained by alternative A3 demonstrates that the method can effectively identify candidates with the strongest overall performance across multiple criteria. This finding confirms that the PROMETHEE approach is suitable for handling complex decision-making problems involving multiple evaluation aspects.

When compared to previous studies, the findings of this research are consistent with the results reported by Bangun et al. [8], who showed that the integration of PROMETHEE in a decision support system can significantly reduce subjectivity in employee recruitment. Similarly, Rosmala et al. [9] found that the PROMETHEE method improves decision accuracy and efficiency in partner selection. In line with these studies, the current research also demonstrates that PROMETHEE provides a structured and transparent ranking mechanism.

However, this study extends previous work by implementing the PROMETHEE method within a web-based decision support system that supports automated calculations and real-time data processing. In addition, this research incorporates a validation process by comparing system-generated results with manual calculations, which ensures the correctness and reliability of the ranking outcomes. This aspect is often not explicitly addressed in earlier studies, where the focus is primarily on method application rather than system validation.

From a practical perspective, the developed system offers several advantages. First, it enhances decision objectivity by minimizing human bias through mathematical computation. Second, it improves transparency since each stage of the calculation can be clearly traced. Third, it supports multi-criteria evaluation in a structured manner, allowing decision-makers to consider various important aspects simultaneously. Finally, the automation provided by the web-based system significantly reduces the time and effort required in the selection process.

Despite these advantages, this study still has several limitations. The determination of criteria weights relies on expert judgment, which may introduce a certain level of subjectivity. In addition, sensitivity analysis has not been conducted to evaluate the stability of the ranking results under different weighting scenarios. The dataset used in this study is also relatively limited, which may affect the generalizability of the results. Therefore, future research is recommended to integrate more objective weighting methods such as the Analytical Hierarchy Process (AHP), perform sensitivity analysis, and utilize larger datasets to improve the robustness of the system.

4. CONCLUSION

This study demonstrates that the implementation of the PROMETHEE method in a web-based decision support system is effective in producing objective and systematic rankings for COAS doctor selection. The results indicate that the system is able to reduce subjectivity and improve the consistency of decision-making through multi-criteria evaluation. This research contributes by developing an integrated system that combines automated PROMETHEE calculations with validation of ranking results, ensuring both computational accuracy and practical usability in real-world decision-making processes. The system also enhances transparency and efficiency compared to conventional manual methods.

However, this study has several limitations, including the use of subjective weighting based on expert judgment, the absence of sensitivity analysis, and a limited dataset. Therefore, future research is recommended to incorporate objective weighting methods such as the Analytical Hierarchy Process (AHP), perform sensitivity analysis, and utilize larger datasets to improve the robustness and generalizability of the system.

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