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Optimization of Data Envelopment Analysis Method with MOORA in the Selection of Research Proposals and PKM

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Abstract

The quality of the selection of research proposals and Community Service (PKM) of lecturers is an important element in supporting the implementation of the Tridarma of Higher Education. However, the selection process that is still carried out manually and tends to be subjective has the potential to cause bias in decision-making. This research aims to develop a decision support system that integrates the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) and Data Envelopment Analysis (DEA) methods to increase objectivity and efficiency in the selection process of research proposals and PKM lecturers at Rokania University. The MOORA method is used to determine a preference score based on the five main criteria for research proposals and six main criteria for PKM proposals, while the DEA method is utilized to evaluate the relative efficiency of each proposal based on the ratio between the MOORA score and the amount of funding submitted. The data used in this study was obtained from the results of the assessment of three reviewers on 14 research proposals and 11 PKM proposals. Each proposal is assessed based on criteria that have been determined by LPPM, then calculations are carried out using both methods. The results show that the combination of MOORA and DEA methods is able to produce more transparent and fair proposal rankings, as well as being able to identify the most efficient proposals in the use of the budget. This study concludes that the integration of MOORA and DEA methods in the lecturer proposal selection system is able to strengthen data-based research and PKM governance, as well as make a real contribution to more rational and measurable decision-making. This system also has the potential to be further developed to support the selection of external grants, recruitment of reviewers, or the allocation of research funds nationally. These findings can be replicated in other higher education institutions that face similar challenges.

Keywords: MOORA, DEA, Research, SPK, PKM.

1. Introduction

The implementation of the Tridarma of Higher Education, which includes education, research, and community service (PKM), is the main foundation in maintaining the quality and relevance of higher education institutions in Indonesia [1] [2]. Regulations regarding the implementation of this program have even been listed in the law, precisely in Law number 12 of 2012 concerning Higher Education. The realization of the tridharma of higher education is a shared responsibility of the entire academic community of higher education, both students, lecturers, and education personnel. In the law, it is written that universities are obliged to organize education, research and community service. In this context, the selection process of research proposals and lecturers' PKM is a crucial element to ensure that the funded activities have scientific quality and strategic benefits. However, until now, many higher education institutions, including Rokania University, still rely on manual and qualitative selection mechanisms, which have the potential to cause subjective bias, lack of transparency, and accountability gaps in recruitment [2], [4].

Rokania University is one of the private universities in Rokan Hulu Regency. As a higher education institution, it seeks to increase transparency and accountability in this selection process through the use of objective data-based decision-making methods. The Institute for Research and Community Service (LPPM) of Rokania University was appointed to be responsible for managing some of these activities, namely research and community service. The Institute for Research and Community Service (LPPM) is required to comply with the protocols set out in the implementation of research and community service activities [5].

AI can help in the decision-making process [6] [7]. AI leverages advanced computing capabilities, such as machine learning, deep learning, and natural language processing, to intelligently collect, analyze, and interpret data, and in support of decision-making [8]. AI can also function as a decision support system, where this technology does not replace the full role of humans, but provides analytical input that can be used by decision-makers to set more rational and evidence-based decision-making. Thus, the integration of AI in the decision-making process not only improves operational efficiency, but also strengthens the

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scientific basis in the process of determining the direction and strategy of an organization or institution [9] [10].

To facilitate the selection of optimal proposals, a computer-based decision support system (DSS) approach is used [11]. Decision support systems (DSS) improve the decision-making process by giving decision-makers the ability to assess value associated with the diverse dimensions of various stakeholders [12] [13]. Decision support system (SPK) can be used in decision-making for decision makers [14]. Decision support system (SPK) can be used in decision-making for decision makers . DSS not only presents information in a systematic manner, but also integrates a variety of relevant assessment criteria, thus aiding in producing more rational, transparent, and accountable decisions.

Various approaches have been proposed to increase objectivity in the selection process, one of which is through the integration of a decision support system based on quantitative methods. The MOORA (Multi-Objective Optimization on the Basis of Ratio Analysis) method has been widely known in multicriteria decision-making because of its ability to handle benefits and costs criteria efficiently and transparently [15] [16]. MOORA is able to provide the results of the selection of the best lecturers objectively by considering various criteria such as teaching quality, research, contribution to the curriculum, and community service [17].

The DEA (Data Envelopment Analysis) method is used to evaluate alternative relative efficiency based on available inputs and outputs, thereby strengthening the justification for resource allocation [18]. Method *Data Envelopment Analysis* (DEA) is a non-parametric evaluation technique that assesses the relative efficiency of comparable decision-making units [19] [20]. The application of DEA in this study provides a strong quantitative foundation for assessing the relative efficiency level of each proposal, as well as helping to ensure that resources are allocated to alternatives that are able to produce maximum output with optimal input utilization.

Several previous studies have applied the MOORA or DEA method separately in the context of research proposal selection, scholarship selection, or educational institution efficiency [21]. However, there is still little research that integrates the two methods in one integrated system for the selection of lecturer proposals as a whole. This gap shows the need for an approach that is able to evaluate quality and efficiency at the same time.

To fill this gap, this study proposes the integration of MOORA and DEA methods in the decision support system for the selection of research proposals and PKM lecturers at Rokania University. The MOORA method is used to calculate preference scores based on specified criteria, while DEA is used to assess efficiency based on the ratio between preference scores and proposed funds. This research aims to build a system that is not only objective in ranking, but also considers the efficiency of resource use.

The main contribution of this research lies in the proposed merger approach, as well as the development of a web-based system that can improve transparency, accountability, and efficiency in decision-making for the selection of lecturer proposals. The results of this research are expected to be replicated in other institutions as best practices in research governance and service in higher education.

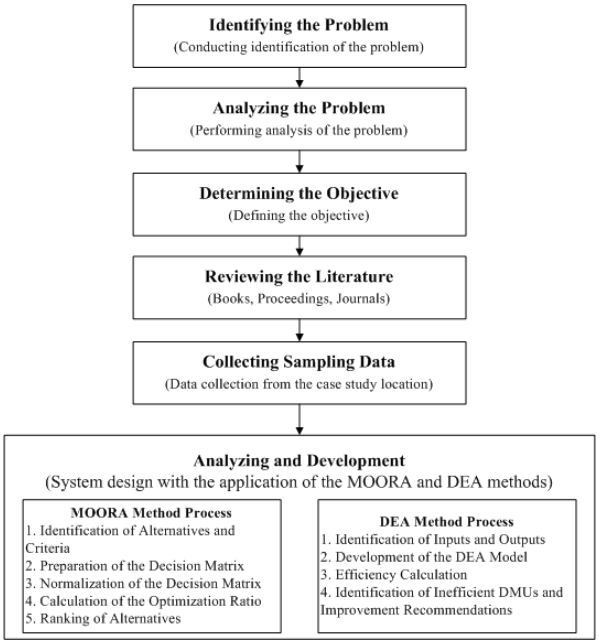
2. Methods

This study uses a quantitative approach with a descriptive-comparative study design based on multicriteria decision-making. The research subjects consisted of 25 proposals from Rokania University lecturers, including 14 research proposals and 11 PKM proposals. The assessment was conducted by three independent reviewers using five main criteria for research proposals and six main criteria for PKM proposals, each of which was graded on a scale of 0–100.

The MOORA method is used to calculate the preference score of each proposal through the process of normalization, weighting, and value aggregation. The results of the MOORA score were then analyzed using the DEA (Data Envelopment Analysis) method of the input-oriented CCR model, with funds submitted as inputs and MOORA scores as outputs, in order to obtain the relative efficiency value of each proposal.

The calculation process is done with the help of Microsoft Excel manually. The final output is in the form of a proposal ranking based on a combination of quality and efficiency scores, as the basis for funding priority recommendations. The methodology of this research displays the research framework to be carried out. Before conducting research, a method or stage is needed that must be carried out to conduct research. This is intended so that the results obtained from this research can be useful to the maximum.

This research methodology is also used to identify the problems found, then make an analysis of the problems which will ultimately find a solution to the problem. In this study, it is necessary to solve problems in the selection of Research Proposals and PKM Lecturers at Rokania University.



Picture 1. Research Framework

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2.1 Problem Identification

This research departs from the problem of the unavailability of a decision support system that can be used effectively for the selection process of research proposals and PKM of lecturers at Rokania University. So far, the selection process has been carried out manually so that it is prone to being influenced by the assessor's subjectivity and lacks measurable evaluation standards. Therefore, a system that is able to accommodate various assessment criteria objectively with a data-driven analytical approach is needed.

2.2 Problem Analysis

The problem analysis was carried out through direct interviews with the Head of LPPM Rokania University to obtain a comprehensive picture of the obstacles faced. The results of the interviews revealed several important issues, such as the complexity of diverse assessment criteria, the lack of standard evaluation standards, and the urgent need for digitization of the selection process. This condition shows that the current manual system is not able to guarantee transparency, efficiency, and accuracy in determining proposals that are worth funding.

2.3 Determination of Research Objectives

The main objective of this research is to design and build a decision support application system based on MOORA and DEA methods for the selection of research proposals and lecturer PKM. The system developed is expected to increase transparency by displaying assessment results openly, efficiency by shortening evaluation time, and accuracy through tested algorithm-based calculations. With this system, the selection process is expected to be more objective, consistent, and scientifically accountable.

2.4 Study Literature

A literature study was conducted to identify and understand in depth the principles, advantages, and weaknesses of the MOORA and DEA methods as the basis for system development. The study focused on previous studies that have applied this method, either separately or in combination, in the context of multi-criteria decision-making. The results of the literature study become the scientific basis for designing the calculation flow, determining the input-output variables, and integrating the two methods in an integrated system.

2.5 Data Collection

The research data was obtained from research proposals and PKM of lecturers at Rokania University who were submitted for funding selection. Each proposal is collected along with its supporting documents, including the assessment criteria that have been set by LPPM and the assessment score from the reviewer. This data is the main source of system testing, from the manual calculation stage to the implementation of MOORA and DEA methods in the application.

2.6 System Analysis and Development

The analysis and development stage of the system includes the design of the application architecture, the design of the user interface, and the preparation of a database in accordance with the needs of the evaluation of the proposal. The system is built using the PHP programming language with the CodeIgniter framework to ensure an organized structure through a Model-View-Controller (MVC) pattern. At this stage, the MOORA

and DEA algorithms are integrated into the system, where the MOORA method is implemented through a series of steps ranging from the identification of alternatives and criteria, data normalization, weighting, to the calculation of the final score for the initial ranking.

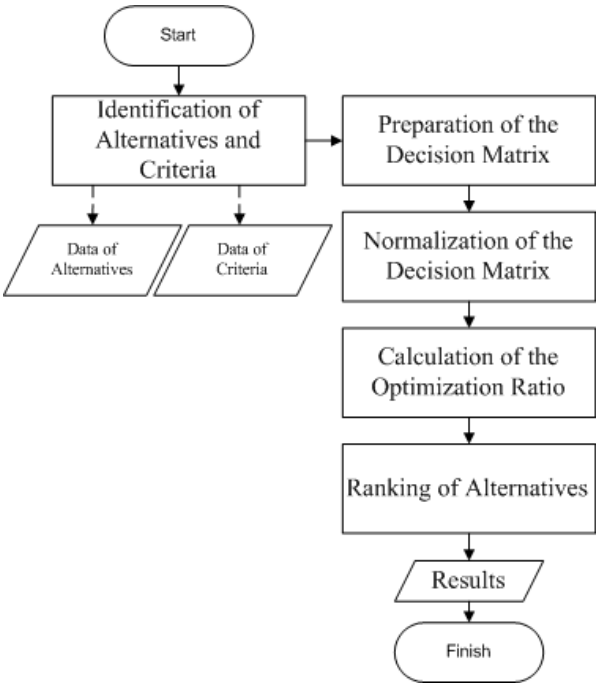


Figure 2. MOORA Steps

The MOORA method begins with the identification stage of alternatives and criteria, namely the process of determining the options to be evaluated along with the assessment parameters. Alternatives can be in the form of research proposals or PKM, while criteria are relevant aspects of assessment, both benefit criteria (the greater the value, the better) and cost criteria (the smaller the value, the better). Furthermore, a decision matrix was prepared that contained the performance value of each alternative against all criteria, with a calculation formula.

$$x'_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}} \quad (1)$$

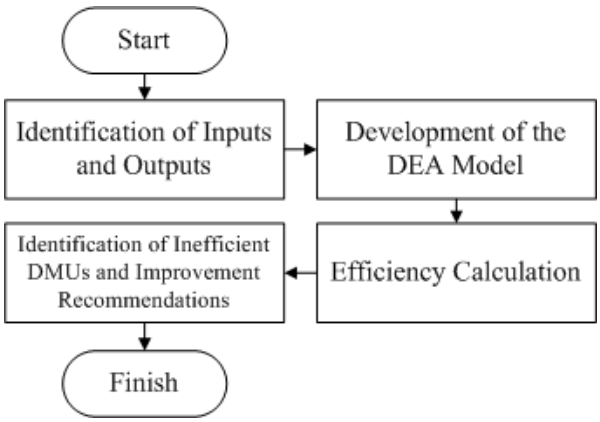
The value can come from quantitative data or the results of expert assessments.

The next stage is the normalization of the decision matrix to equalize the measurement scale between the criteria, so that all values can be compared fairly without bias due to differences in units or ranges of values. Normalization is done by dividing each criterion value by the square root of the square sum of all values in that criterion. After normalization, the optimization ratio is calculated by adding the value to the benefit criterion and subtracting the value from the cost criterion with a formula.

$$y_i = \sum_{j=1}^{g} x'_{ij} - \sum_{j=g+1}^{m} x'_{ij} \quad (2)$$

This calculation results in a score that describes the total performance of each alternative.

The next step is to rank alternatives based on the optimization ratio score that has been obtained. The highest-scoring alternative ranks first and is considered the best option. The final stage is the presentation of results and conclusions in the form of final rankings, which can be used by decision-makers to choose the best alternatives. The results of these calculations can be presented in the form of tables or graphical visualizations to facilitate interpretation and decision-making.



The Data Envelopment Analysis (DEA) method begins with the identification of inputs and outputs that are relevant to the Decision Making Unit (DMU) to be evaluated. Inputs can be resources used, such as cost, amount of labor, or time, while outputs describe outcomes or achievements, such as assessment scores or the number of products produced. This stage is important to ensure that all variables used in the analysis accurately reflect the actual performance of the DMU.

The next step is the development of the DEA model, where the researcher chooses a suitable model, for example the CCR model (Charnes, Cooper, and Rhodes) assuming a constant return to scale or the BCC model (Banker, Charnes, and Cooper) assuming a variable return to scale. This model is formulated in the form of linear optimization to compare the ratio of total output to total input from each DMU.

Once the DEA model is built, efficiency calculations are performed for each DMU. The efficiency value is in the range of 0 to 1, where a value of 1 indicates that the DMU is efficient, while a value below 1 indicates an inefficiency, with the formula

$$\text{Efisiensi Relatif} = \frac{\text{Total } Output \text{ Tertimbang}}{\text{Total } Input \text{ Tertimbang}} \quad (3)$$

Based on these results, inefficient DMU identification and improvement recommendations were made by

comparing inefficient DMU to efficient DMU as a benchmark. These recommendations can include reducing input usage or increasing output to achieve optimal efficiency levels. The final stage is the presentation of results in the form of reports or visualizations that make it easier for decision-makers to formulate strategic steps to improve performance.

3. Results and Discussions

This study integrates MOORA and DEA methods to evaluate 14 research proposals and 11 PKM proposals of lecturers at Rokania University. Data was obtained from the assessment of three independent reviewers. Based on the criteria that have been determined by LPPM, with five criteria for research proposals and six criteria for PKM proposals.

Table 1. Research Proposal Criteria

Code	Criterion	Weight (%)	Kind
K1	Problem Formulation	25	*Benefit*
K2	Research Output Opportunities	25	*Benefit*
K3	Research Methods	25	*Benefit*
K4	Literature Review	15	*Benefit*
K5	Research Feasibility	10	*Benefit*

Table 2. Kriteria Proposal PKM

Code	Criterion	Weight (%)	Kind
K1	Situation Analysis	20	*Benefit*
K2	Partners' priority issues and solutions offered	15	*Benefit*
K3	Target Luaran	15	*Benefit*
K4	Precision Approach Method	10	*Benefit*
K5	PT Qualification	10	*Benefit*
K6	Cost of Work Feasibility Proposed Cost	20	*Benefit*

3.1 Research Proposal Results

The calculation with the MOORA method begins with the normalization of the decision matrix and weighting according to the predetermined assessment criteria. The results of the optimization ratio calculation result in the preference score of each alternative. This score reflects the overall performance of the proposal based on the benefit criteria that have been processed objectively. The final rankings are compiled based on the highest to lowest scores, where the highest-scoring alternatives are seen as the proposals that best meet the assessment criteria. Details of the results of the MOORA calculation are shown in Table 3.

Table 3. MOORA Calculation Results for Research Proposals

Alternatif	Total	Rangking
A1	0,273726	4
A2	0,259727	13
A3	0,270223	6
A4	0,25119	14
A5	0,266938	8
A6	0,274079	2
A7	0,273902	3
A8	0,261369	11
A9	0,266231	9
A10	0,276537	1
A11	0,261241	12
A12	0,271451	5
A13	0,263506	10
A14	0,268703	7

The DEA method is used to measure the relative efficiency level of each proposal by considering the relationship between inputs and outputs. The DEA model used in this study is the input-oriented CCR model, where the amount of funds proposed becomes an input variable, while the proposal assessment score becomes an output variable. The efficiency value is in the range of 0 to 1, with a value of 1 indicating a relatively efficient proposal compared to other proposals. The results of the DEA efficiency calculation are presented in Table 4.

Table 4. DEA Calculation Results for Research Proposals

Alternatif	Relative Efficiency (E)	Rangking
A1	0,987247	2

A2	0,919084	8
A3	0,791991	12
A4	0,845237	11
A5	0,938652	5
A6	1	1
A7	0,93716	6
A8	0,921298	7
A9	0,946943	4
A10	0,88475	9
A11	0,85228	10
A12	0,976565	3
A13	0,771861	13
A14	0,534191	14

After obtaining the calculation results from the MOORA and DEA methods, the next step is to combine the two scores to produce a more comprehensive final ranking. The merger was carried out using a balanced weight, namely 50% for the MOORA score and 50% for the DEA score, so that both aspects-the quality of the multi-criteria assessment and the efficiency of resource use received the same portion of contribution. The results of the merger showed a shift in the ranking of some proposals compared to the initial rankings, indicating a significant difference between the quality of the proposal and its efficiency. The following table 5 presents the final results of the research proposal ranking based on this combined method.

Table 5. Final Results of Research Proposal Ranking

Alternatif	Score MOORA	DEA Efficiency	Combined Score	Final Ranking
A1	0,27373	0,987247	0,630487	2
A2	0,25973	0,919084	0,589406	8
A3	0,27022	0,791991	0,531107	12
A4	0,25119	0,845237	0,548214	11
A5	0,26694	0,938652	0,602795	6
A6	0,27408	1	0,63704	1
A7	0,2739	0,93716	0,605531	5
A8	0,26137	0,921298	0,591334	7
A9	0,26623	0,946943	0,606587	4
A10	0,27654	0,88475	0,580644	9
A11	0,26124	0,85228	0,556761	10
A12	0,27145	0,976565	0,624008	3
A13	0,26351	0,771861	0,517684	13
A14	0,2687	0,534191	0,401447	14

The results of the processing showed that the proposal with the alternative code A6 obtained the highest combined score of 0.63704, thus ranking first on the priority list. The next ranking is consecutively occupied by A1 with a combined score of 0.630487, and A12 with a score of 0.624008. Meanwhile, proposals with the

alternative code A14 obtained the lowest score, at 0.401447, and ranked fourteenth. These findings show that the use of the combined MOORA and DEA methods can provide more objective and accurate evaluation results, and can be used as a strong basis for strategic decision-making related to the selection and funding of research proposals

3.1 PKM Proposal Results

The calculation using the MOORA method for PKM proposals is the same as the calculation in the research proposal. The results of the optimization ratio calculation result in the preference score of each alternative. This score reflects the overall performance of the proposal based on the benefit criteria that have been processed objectively. The final rankings are compiled based on the highest to lowest scores, where the highest-scoring alternatives are seen as the proposals that best meet the assessment criteria. The details of the MOORA calculation results are shown in Table 6

Table 6. MOORA Calculation Results for PKM Proposals

Alternatif	Total	Ranking
A1	0,285812	2
A2	0,266124	8
A3	0,269465	7
A4	0,25052	11
A5	0,280457	3
A6	0,291571	1
A7	0,279575	4
A8	0,270972	6
A9	0,273389	5
A10	0,260447	9
A11	0,261241	12

The DEA model used in this study is the input-oriented CCR model, where the amount of funds proposed becomes an input variable, while the proposal assessment score becomes an output variable. The efficiency value is in the range of 0 to 1, with a value of 1 indicating a relatively efficient proposal compared to other proposals. The results of the DEA efficiency calculation for PKM proposals are as follows.

Table 7. DEA Calculation Results for PKM Proposals

Alternatif	Relative Efficiency (E)	Rangking
A1	0,98025	2
A2	0,912725	4
A3	0,792156	10
A4	0,859207	8
A5	0,57713	11
A6	1	1
A7	0,900056	5
A8	0,929354	3
A9	0,803693	9
A10	0,893253	6
A11	0,860307	7

Table 8. Final Results of PKM Proposal Ranking

Alternatif	Score MOORA	DEA Efficiency	Combined Score	Final Ranking
A1	0,285812	0,98025	0,633031	2
A2	0,266124	0,912725	0,5894245	5
A3	0,269465	0,792156	0,5308105	10
A4	0,25052	0,859207	0,5548635	8
A5	0,280457	0,57713	0,4287935	11
A6	0,291571	1	0,6457855	1

A7	0,279575	0,900056	0,5898155	4
A8	0,270972	0,929354	0,600163	3
A9	0,273389	0,803693	0,538541	9
A10	0,260447	0,893253	0,57685	6
A11	0,25084	0,860307	0,5555735	7

Based on the results of combining the MOORA and DEA methods with a weight of 50% each, a more comprehensive and objective PKM proposal was obtained. Proposals with alternative code A6 occupy the top position with a combined score of 0.6457855, indicating that this proposal has the highest quality of assessment as well as the maximum level of efficiency. The second place is occupied by A1 with a combined score of 0.633031, followed by A8 in third place with a score of 0.600163.

Meanwhile, proposals with the code A5 obtained the lowest combined score of 0.4287935, placing it in eleventh place. These results indicate that while some proposals may have high scores on either method, the combination of MOORA and DEA provides a more balanced evaluation between quality based on assessment criteria and resource use efficiency.

Overall, these findings show that the combined MOORA and DEA methods are effectively used as the basis for PKM proposal selection, as they are able to identify proposals that are not only superior in substance but also efficient in resource utilization, so that they can be a valid reference in funding decision-making.

4. Conclusions

The use of this combined method provides a more comprehensive evaluation because it considers two main aspects, namely the quality of proposals based on assessment criteria (MOORA) and the level of resource use efficiency (DEA).

The test results showed that for the research proposal, A6 ranked highest with a combined score of 0.63704, while A14 ranked lowest with a score of 0.401447. Meanwhile, for the PKM proposal, A6 was also ranked first with a combined score of 0.6457855, and A5 was in last position with a score of 0.4287935. These findings prove that the combined method is able to provide a fairer and more objective ranking than if only one of the methods were used.

Overall, the implementation of MOORA-based decision support systems has been proven to increase transparency, efficiency, and accuracy in the proposal selection process. This system can be used as a reference in strategic decision-making, while minimizing the potential for subjective bias in the assessment process.

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