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SELECTION OF THE BEST LECTURER USING FUZZY TAHANI

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Abstracts
This quantitative descriptive study seeks to provide an overview of the Fuzzy Tahani use to aid in selecting the best lecturers in the Mathematics Education Study Program based on EDOM. Four areas of lecturer competency will be measured: pedagogical, professional, personality, and social. Compiling domains and membership functions, establishing membership degrees, compiling Fuzzy rules, compiling Fuzzy Queries, assessing fire strength, and assembling recommendations for the best lecturer candidates are the six parts of this research. The study's findings indicate that Fuzzy Tahani can aid in selecting the finest lecturers based on EDOM. Based on calculations, DTM06 is the best lecturer in the Mathematics Education Study Program.

Keyword:
Fuzzy Tahani, Best Lecturer, EDOM

Introduction

Education is a means to improve the quality of human resources so that they have competitiveness in facing an era of change (Has et al., 2020). Lecturers are one of the essential components in the education system in higher education. Lecturers play an important role in educating students to become adaptive people. Article 5 of Law Number 14 on Teachers and Lecturers (2005) states that the part of lecturers as professionals serve to enhance their dignity and function as agents of learning, development of science, technology, and art, and to perform community service which aims to improve the quality of national education.

Lecturer performance is one of the determining factors for the success of the teaching and learning process in the classroom. Improving the performance of lecturers can enhance the performance of study programs and higher education institutions (Nuryanto et al., 2020). Lecturer performance is one of the aspects assessed in the accreditation instrument compiled by LAMDIK (Lembaga Akreditasi Mandiri Kependidikan/ Independent Accreditation Institute

for Education). Therefore, an effective strategy is needed to control and improve the performance of lecturers in study programs.

To achieve optimal lecturer performance in the field of learning, LPM IAIN Kediri developed a lecturer performance assessment instrument with measurable and objective performance indicators in the form of an EDOM (Evaluasi Dosen Oleh Mahasiswa/ Evaluation for Lecturers by Students) questionnaire. The EDOM instrument assesses four aspects of lecturer competence in teaching: educational, professional, personality, and social. These four aspects are interrelated and reinforce one another so that they have the same level of importance in the context of the success of a lecturer. However, it is essential to note that the emphasis on each competency can differ depending on the particular context and perspective.

As a follow-up to the EDOM results, the Mathematics Education Study Program appropriately recognizes lecturers who achieve the best EDOM scores and warns lecturers who score below the minimum standard. The study program must do this to realize the commitment to good study program governance. So far, decision makers choose the best lecturers in the Mathematics Education Study Program based on the highest average score of the four competencies assessed in the EDOM. This average grade-based assessment strategy becomes ineffective if the decision maker determines the criteria for the best lecturer as a lecturer with high scores in all competencies. This method cannot guarantee that lecturers with the highest average scores have high scores in all aspects of competency. Therefore, it is necessary to apply the DSS (Decision Support System) based method to obtain more valid lecturer selection results based on the preference weights set by the decision maker.

Decision-making is a critical process in management where good decisions can lead to good results and vice versa. Many studies have discussed the implementation of DSS-based methods to facilitate the selection of the best lecturers. The intended plans include the Simple Additive Weighting (SAW) Method (Alfiando et al., 2021; Asnawi & Muwafiq, 2019; Gemawaty & Yuliani, 2023; Hasugian, 2019; Ramadani & Heltiani, 2020; Romindo, 2020), Elimination and Choice Translating Reality (ELECTRE) Method (Simangunsong, Pandi Barita Nauli & Sinaga, 2019; Siregar et al., 2022), Vikor Method (Kusuma et al., 2019), Profile Matching Method (Ermawita & Fauzi, 2020; Fauzan & Yuhandri, 2019), Technique For Order Performance By Similarity To Ideal Solution (TOPSIS) Method (Simanjorang, 2019), Analytical Hierarchy Process (AHP) Method (Wibowo & Nisaa, 2020), Weighted Product (WP) Method (Djufri et al., 2020; Fernandez et al., 2021; Sitorus & Tambun, 2020; Tri et al., 2020), Multi Objective Optimization On The Basic Of Ratio (MOORA) Method (Arista, 2020), Multi Attribute Utility Theory (MAUT) Method (Adam et al., 2020; Putra et al., 2020), Simple Multi Attribute Rating Technique (SMART) Method (Maryaningsih & Suranti, 2021; Putra & Djasmayena, 2020), dan Simple Multi-Attribute Rating Technique Exploiting Ranks (SMARTER) Method (Silalahi, 2020).

Traditional decision-making methods based on Boolean logic or statistical analysis may be less effective in complex and uncertain situations. It is where the concept of Fuzzy Logic emerged. Fuzzy logic is part of artificial intelligence (AI) (Amalia et al., 2020). Fuzzy logic is a paradigm in decision-making theory that allows the representation and manipulation of indecisive and graded concepts. In Fuzzy Logic, variables and conditions have membership levels from 0 to 1. In other words, Fuzzy Logic can express ideas partially or ambiguously, which are more in line with the complex and uncertain real world.

Some of the advantages of Fuzzy Logic compared to other methods in DSS include (1) being able to handle uncertainty by considering all possibilities and minimizing risk, (2) being able to model the relationship between complex variables, (3) enabling decision-makers to describe their preferences in the appropriate membership level, (4) enabling the integration of knowledge that is unstructured or difficult to express explicitly, (5) being able to represent human thought (Klir & Yuan, 1995; Zadeh, 1975; Zimmermann, 1996).

Fuzzy Tahani is a model used in the data search process that bases its performance on operations in Fuzzy Sets. Fuzzy Tahani works to find data with mutually compatible information to obtain accurate data (Hidayat & Gernowo, 2015; Setiawan et al., 2017). This study aims to provide an overview of the implementation of Fuzzy Tahani in supporting the selection of the best lecturers in the Mathematics Education Study Program based on the results of the EDOM. By implementing Fuzzy Tahani, the study program is hoped to get the best lecturer candidates as expected.

Methods

This research is of a qualitative descriptive type. It discusses the steps for implementing Fuzzy Tahani in facilitating the selection of the best lecturers in the Mathematics Education Study Program at IAIN Kediri. The instrument used is the EDOM questionnaire, which measures four aspects of lecturer competency: educational, professional, personality, and social. We use the average value of each aspect as the input variable and express its membership function in a combination of triangular and trapezoidal curves. We categorize the output variables in this study into three types: low, medium, and high.

LPM IAIN Kediri distributes EDOM instruments to students at the end of each semester. In this study, the data used were the average EDOM scores for the even semesters of 2020-2021 and the odd semesters of 2021-2022 from 13 Mathematics Education Study Program lecturers. We state the names of each lecturer in the DTM01 to DTM13 codes. Table 1 is the result of the recapitulation of the average values of the four competency aspects for each lecturer:

Table 1. The Average Values of the Four Competency Aspects

Lecturer Code	Educational	Professional	Personality	Social
DTM01	4,2077	4,2045	4,2280	4,2476
DTM02	4,0795	4,1187	4,1407	4,1283
DTM03	4,2483	4,2511	4,2404	4,2096
DTM04	4,2898	4,2938	4,2951	4,2828
DTM05	4,3605	4,3640	4,3606	4,3597
DTM06	4,5028	4,4943	4,4993	4,4993
DTM07	4,3451	4,2782	4,3086	4,2817
DTM08	4,1926	4,1849	4,1620	4,1563
DTM09	4,4012	4,4433	4,4391	4,4305
DTM10	4,2206	4,2596	4,2379	4,2384
DTM11	4,3855	4,3568	4,3445	4,3729
DTM12	4,3049	4,2805	4,3034	4,2922
DTM13	4,5224	4,5005	4,4996	4,4637

Source: Author Documentation

This research procedure consists of six stages, namely (1) compiling domain and membership functions, (2) determining the degree of membership, (3) compiling possible Fuzzy rules, (4) compiling Fuzzy Queries, (5) determining fire strength, and (6) compiling recommendations for the best lecturer candidates. We calculate and process data using Microsoft Excel.

Results and Discussion

Compiling Domain and Membership Functions

The EDOM instrument consists of 40 statement items assessed using a Likert Scale from 1 to 5. Score 1 indicates the lecturer's competence is not very good, value 2 indicates the lecturer's competence is not good, value 3 indicates the lecturer's competence is quite good, value 4 indicates the lecturer's competency is good, and value 5 indicates the lecturer's competency is excellent. We state the domain of the membership function for each variable in Table 2:

Table 2. Input and Output Variable Domains

No.	Input Variable	Output Variable	Domain
1.	Educational Aspect	Low	[0, 3]
		Medium	[1.5, 4.5]
		High	[3, 5]
2.	Professional Aspect	Low	[0, 3]
		Medium	[1.5, 4.5]
		High	[3, 5]
3.	Personality Aspect	Low	[0, 3]
		Medium	[1.5, 4.5]
		High	[3, 5]
4.	Social Aspect	Low	[0, 3]
		Medium	[1.5, 4.5]
		High	[3, 5]

Source: Author Documentation

Through Table 2, we can arrange the membership function for each variable as follows:

$$\mu_{low}(x_i) = \begin{cases} 1 & x_i \leq 1{,}5 \\ \dfrac{3 - x_i}{3 - 1{,}5} & 1{,}5 < x_i < 3 \\ 0 & x_i \geq 3 \end{cases} \quad (1)$$

$$\mu_{medium}(x_i) = \begin{cases} 0 & x_i \leq 1{,}5 \text{ or } x_i \geq 4{,}5 \\ \dfrac{x_i - 1{,}5}{3 - 1{,}5} & 1{,}5 < x_i < 3 \\ \dfrac{4{,}5 - x_i}{4{,}5 - 3} & 3 < x_i < 4{,}5 \\ 1 & x_i = 3 \end{cases} \quad (2)$$

$$\mu_{high}(x_i) = \begin{cases} 0 & x_i \leq 3 \\ \dfrac{x_i - 3}{4{,}5 - 3} & 3 < x_i < 4{,}5 \\ 1 & x_i \geq 4{,}5 \end{cases} \quad (3)$$

where

x_i = the value of the i-th input variable
i = 1, 2, 3, 4
x_1 = the average value of the educational aspect
x_2 = the average value of the professional aspect
x_3 = the average value of the personality aspect
x_4 = the average value of the social aspect

We illustrate the membership function graph of the four variables in Figure 1:

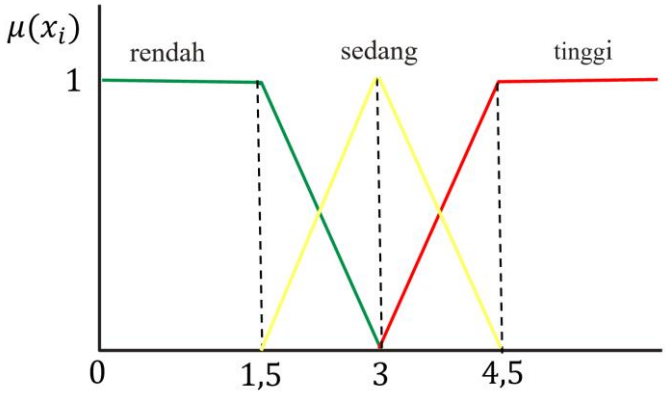

Figure 1. Membership Function Representation of the Four Input Variables

Determining the Degree of Membership

We calculate the membership degree of each aspect for each candidate using equations (1), (2), and (3). Table 3, Table 4, Table 5, and Table 6 contains the results:

Table 3. Membership Degree of Educational Aspect

Lecturer Code	Input Value	Low	Medium	High
DTM01	4,2077	0	0,194883892	0,805116108
DTM02	4,0795	0	0,280305891	0,719694109
DTM03	4,2483	0	0,167769068	0,832230932
DTM04	4,2898	0	0,140131457	0,859868543
DTM05	4,3605	0	0,093016817	0,906983183
DTM06	4,5028	0	0	1
DTM07	4,3451	0	0,10328612	0,89671388
DTM08	4,1926	0	0,204902018	0,795097982
DTM09	4,4012	0	0,065880536	0,934119464
DTM10	4,2206	0	0,18627503	0,81372497
DTM11	4,3855	0	0,076300741	0,923699259
DTM12	4,3049	0	0,130065009	0,869934991
DTM13	4,5224	0	0	1

Source: Author Documentation

Table 4. Membership Degree of Professional Aspect

Lecturer Code	Input Value	Low	Medium	High
DTM01	4,2045	0	0,196977094	0,803022906
DTM02	4,1187	0	0,254178576	0,745821424

Lecturer Code	Input Value	Low	Medium	High
DTM03	4,2511	0	0,165936674	0,834063326
DTM04	4,2938	0	0,137470504	0,862529496
DTM05	4,3640	0	0,090671258	0,909328742
DTM06	4,4943	0	0,003827982	0,996172018
DTM07	4,2782	0	0,147856158	0,852143842
DTM08	4,1849	0	0,210060571	0,789939429
DTM09	4,4433	0	0,03779872	0,96220128
DTM10	4,2596	0	0,160275599	0,839724401
DTM11	4,3568	0	0,095438765	0,904561235
DTM12	4,2805	0	0,146339297	0,853660703
DTM13	4,5005	0	0	1

Source: Author Documentation

Table 5. Membership Degree of Personality Aspect

Lecturer Code	Input Value	Low	Medium	High
DTM01	4,2280	0	0,181323902	0,818676098
DTM02	4,1407	0	0,239541602	0,760458398
DTM03	4,2404	0	0,173086611	0,826913389
DTM04	4,2951	0	0,136600329	0,863399671
DTM05	4,3606	0	0,092920472	0,907079528
DTM06	4,4993	0	0,000447339	0,999552661
DTM07	4,3086	0	0,127607904	0,872392096
DTM08	4,1620	0	0,225303058	0,774696942
DTM09	4,4391	0	0,040628308	0,959371692
DTM10	4,2379	0	0,174704865	0,825295135
DTM11	4,3445	0	0,1037	0,8963
DTM12	4,3034	0	0,131069327	0,868930673
DTM13	4,4996	0	0,000260273	0,999739727

Source: Author Documentation

Table 6. Membership Degree of Social Aspect

Lecturer Code	Input Value	Low	Medium	High
DTM01	4,2476	0	0,168233567	0,831766433
DTM02	4,1283	0	0,24777399	0,75222601
DTM03	4,2096	0	0,193621687	0,806378313
DTM04	4,2828	0	0,144782344	0,855217656
DTM05	4,3597	0	0,093534817	0,906465183
DTM06	4,4993	0	0,000470694	0,999529306
DTM07	4,2817	0	0,145514089	0,854485911
DTM08	4,1563	0	0,229166055	0,770833945
DTM09	4,4305	0	0,046360595	0,953639405
DTM10	4,2384	0	0,174382544	0,825617456
DTM11	4,3729	0	0,084727778	0,915272222

DTM12	4,2922	0	0,138552465	0,861447535
DTM13	4,4637	0	0,024219497	0,975780503

Source: Author Documentation

Compiling Possible Fuzzy Rules

To compute the fire-strength value of the implications, the fuzzy rules in this system use a monotone implication function with dynamic input sets and operators. The dynamic nature in this context forms fuzzy rules based on the user's intended combination. The AND rule is the operator utilized in this work to compile Fuzzy rules. Table 7 lists all conceivable Fuzzy rules:

Table 7. Fuzzy Rules

Rules	Variable				Decision
	Educational	Professional	Personality	Social	
Rule Number 01	Low	Low	Low	Low	No
Rule Number 02	Low	Low	Low	Medium	No
Rule Number 03	Low	Low	Low	High	No
Rule Number 04	Low	Low	Medium	Low	No
Rule Number 05	Low	Low	Medium	Medium	No
Rule Number 06	Low	Low	Medium	High	No
Rule Number 07	Low	Low	High	Low	No
Rule Number 08	Low	Low	High	Medium	No
Rule Number 09	Low	Low	High	High	No
Rule Number 10	Low	Medium	Low	Low	No
Rule Number 11	Low	Medium	Low	Medium	No
Rule Number 12	Low	Medium	Low	High	No
Rule Number 13	Low	Medium	Medium	Low	No
Rule Number 14	Low	Medium	Medium	Medium	No
Rule Number 15	Low	Medium	Medium	High	No
Rule Number 16	Low	Medium	High	Low	No
Rule Number 17	Low	Medium	High	Medium	No
Rule Number 18	Low	Medium	High	High	No
Rule Number 19	Low	High	Low	Low	No
Rule Number 20	Low	High	Low	Medium	No
Rule Number 21	Low	High	Low	High	No
Rule Number 22	Low	High	Medium	Low	No
Rule Number 23	Low	High	Medium	Medium	No
Rule Number 24	Low	High	Medium	High	No
Rule Number 25	Low	High	High	Low	No
Rule Number 26	Low	High	High	Medium	No
Rule Number 27	Low	High	High	High	No
Rule Number 28	Medium	Low	Low	Low	No
Rule Number 29	Medium	Low	Low	Medium	No
Rule Number 30	Medium	Low	Low	High	No

Rules	Variable				Decision
	Educational	Professional	Personality	Social	
Rule Number 31	Medium	Low	Medium	Low	No
Rule Number 32	Medium	Low	Medium	Medium	No
Rule Number 33	Medium	Low	Medium	High	No
Rule Number 34	Medium	Low	High	Low	No
Rule Number 35	Medium	Low	High	Medium	No
Rule Number 36	Medium	Low	High	High	No
Rule Number 37	Medium	Medium	Low	Low	No
Rule Number 38	Medium	Medium	Low	Medium	No
Rule Number 39	Medium	Medium	Low	High	No
Rule Number 40	Medium	Medium	Medium	Low	No
Rule Number 41	Medium	Medium	Medium	Medium	No
Rule Number 42	Medium	Medium	Medium	High	No
Rule Number 43	Medium	Medium	High	Low	No
Rule Number 44	Medium	Medium	High	Medium	No
Rule Number 45	Medium	Medium	High	High	No
Rule Number 46	Medium	High	Low	Low	No
Rule Number 47	Medium	High	Low	Medium	No
Rule Number 48	Medium	High	Low	High	No
Rule Number 49	Medium	High	Medium	Low	No
Rule Number 50	Medium	High	Medium	Medium	No
Rule Number 51	Medium	High	Medium	High	No
Rule Number 52	Medium	High	High	Low	No
Rule Number 53	Medium	High	High	Medium	No
Rule Number 54	Medium	High	High	High	No
Rule Number 55	High	Low	Low	Low	No
Rule Number 56	High	Low	Low	Medium	No
Rule Number 57	High	Low	Low	High	No
Rule Number 58	High	Low	Medium	Low	No
Rule Number 59	High	Low	Medium	Medium	No
Rule Number 60	High	Low	Medium	High	No
Rule Number 61	High	Low	High	Low	No
Rule Number 62	High	Low	High	Medium	No
Rule Number 63	High	Low	High	High	No
Rule Number 64	High	Medium	Low	Low	No
Rule Number 65	High	Medium	Low	Medium	No
Rule Number 66	High	Medium	Low	High	No
Rule Number 67	High	Medium	Medium	Low	No
Rule Number 68	High	Medium	Medium	Medium	No
Rule Number 69	High	Medium	Medium	High	No
Rule Number 70	High	Medium	High	Low	No
Rule Number 71	High	Medium	High	Medium	No
Rule Number 72	High	Medium	High	High	No

Rules	Variable				Decision
	Educational	Professional	Personality	Social	
Rule Number 73	High	High	Low	Low	No
Rule Number 74	High	High	Low	Medium	No
Rule Number 75	High	High	Low	High	No
Rule Number 76	High	High	Medium	Low	No
Rule Number 77	High	High	Medium	Medium	No
Rule Number 78	High	High	Medium	High	No
Rule Number 79	High	High	High	Low	No
Rule Number 80	High	High	High	Medium	No
Rule Number 81	High	High	High	High	Yes

Source: Author Documentation

Table 7 describes the 81 possible combinations of values in choosing the best lecturer. However, in this study, we will only use the 81st rule. In selecting the best lecturer, candidates must have high scores in four aspects of competence. It is the distinction between the Fuzzy Tahani and the average value method implementation. The average value approach cannot guarantee that the chosen candidates will receive high scores in all categories of lecturer competency.

Compiling Fuzzy Queries

Based on the 81st rule, we construct a Fuzzy Query as follows. This query guarantees that the system will only recommend lecturers who meet the criteria with a membership degree of more than 0.

SELECT Lecturer Code
FROM Lecturer Code List
WHERE his educational aspect is HIGH
AND his professional aspect is HIGH
AND his personality aspect is HIGH
AND his social aspect is HIGH

Determining Fire Strength

At this point, using the provided Fuzzy Query, we determine the fire strength value of each candidate. That is, fire strength is the smallest value of the four aspects' degrees of membership. Table 8 shows the fire strength values for each candidate:

Table 8. Fire Strength Value

Lecturer Code	High Membership Degree				Fire Strength
	Educational	Professional	Personality	Social	
DTM01	0,805116108	0,803022906	0,818676098	0,831766433	0,803022906
DTM02	0,719694109	0,745821424	0,760458398	0,75222601	0,719694109
DTM03	0,832230932	0,834063326	0,826913389	0,806378313	0,806378313
DTM04	0,859868543	0,862529496	0,863399671	0,855217656	0,855217656
DTM05	0,906983183	0,909328742	0,907079528	0,906465183	0,906465183
DTM06	1	0,996172018	0,999552661	0,999529306	0,996172018

DTM07	0,89671388	0,852143842	0,872392096	0,854485911	0,852143842
DTM08	0,795097982	0,789939429	0,774696942	0,770833945	0,770833945
DTM09	0,934119464	0,96220128	0,959371692	0,953639405	0,934119464
DTM10	0,81372497	0,839724401	0,825295135	0,825617456	0,81372497
DTM11	0,923699259	0,904561235	0,8963	0,915272222	0,8963
DTM12	0,869934991	0,853660703	0,868930673	0,861447535	0,853660703
DTM13	1	1	0,999739727	0,975780503	0,975780503

Source: Author Documentation

Compiling Recommendations for the Best Lecturer Candidates

The candidate with the highest fire strength score is the best lecturer. According to the data in Table 8, applicant DTM06 got the best lecturer title with a fire strength value of 0.996172018.

Analysis

The data in Table 1 shows that all Mathematics Education Study Program lecturers get an average score of above 4 in all aspects of lecturer competency. In the educational part, the lowest average score is 4.0795, while the highest is 4.5224. In the professional aspect, the lowest average score is 4.1187, while the highest is 4.5005. Regarding personality, the lowest average score was 4.1407, while the highest was 4.4996. In the social aspect, the lowest average score is 4.1283, while the highest is 4.4993. The information in Table 2 concludes that the output variables of each lecturer are in the 'medium' and 'high' domains. Therefore, in Table 3, Table 4, Table 5, and Table 6, the degree of membership for the 'low' output variable is 0.

Because all lecturers in the Mathematics Education Study Program get an average score of above 4, and the output variable domain 'high' is [3, 5], the chance for a lecturer to get a high score is more significant than a medium score. We can observe this through the membership degree values of each input variable in Table 3, Table 4, Table 5, and Table 6. The 'high' column value is much greater than the 'medium'. It means that all lecturers have the potential to become the best lecturer candidates because they have achieved high scores in all aspects.

When constructing the Fuzzy Query, we use the AND operator to provide a limit to the candidates. The system automatically eliminates lecturers who do not get high scores in one or more aspects. Table 8 contains high membership degrees for each competency aspect. In the educational part, the highest score was achieved by DTM06 and DTM13. Regarding professionalism and personality, the highest score was achieved by DTM13, followed by DTM06. On the social aspect, the highest score was achieved by DTM06, followed by DTM13.

DTM13 excels in 3 aspects, while DTM06 in 2 aspects. However, the system chose DTM06 as the best lecturer. It happens because operator AND will select the slightest membership degree of the four aspects as fire strength. The fire strength of DTM13 is 0.975780503, while DTM06 is 0.996172018. Because DTM06 has the greatest fire strength, he was chosen by the system as the best lecturer. We argue that these results are excellent. The system can select lecturers with the fewest weaknesses.

Conclusion

The application of Fuzzy Tahani in selecting the best lecturers can provide candidate recommendations according to predetermined criteria. This method can appoint any lecturer

who meets the requirements. It can be observed from the membership degree value of each competency aspect the lecturer possesses. All lecturers of the Mathematics Education Study Program were declared eligible to become candidates because they had high scores in all aspects of lecturer competency. Based on the calculations and data processing results, the system selects DTM06 as the best lecturer.

The input variables included in the decision support system for selecting the best lecturers are limited to the four lecturer competencies in implementing classroom learning. The task of lecturers is not only to teach in class but also to conduct research and community service. Performance in research and community service by lecturers also deserves to be assessed. Therefore, future researchers must develop a system by adding value to research performance, community service performance, lecturer achievement, and recognition as input variables. In addition, future researchers also can add assessors from colleagues and lecturer superiors.

This study's calculation and data processing was carried out using Microsoft Excel. It is suggested that further researchers develop an application that can integrate data retrieval systems with decision support systems. With an integrated application, it is hoped that selecting the best lecturers can be done more quickly and effectively.

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