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Editor-in-Chief

السَّلاَمُ عَلَيْكُمْ وَرَحْمَةُ اللهِ وَبَرَكَاتُهُ

.

Best wishes to all the members of Editorial Board, Reviewers Panel, Authors and Readers of PIKSEL for a very happy, and stay healthy.

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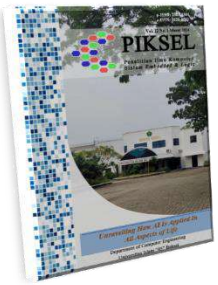

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Integration of Fuzzy AHP and TOPSIS In Decision Support System for Lecturer Academic Promotion

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Abstract

Lecturer academic position or known as functional position is a criterion to measure the quality of higher education lecturers. Functional positions are also a form of performance performance for lecturers to be more measurable. Currently, technology is a tool for universities to measure lecturer performance and monitor applications for lecturer functional position increases to avoid the subjective nature that occurs in many cases. This research proposes to integrate the Fuzzy AHP and TOPSIS methods in providing recommendations to universities regarding the order of lecturers who are eligible to apply for functional promotion. This method assesses the relative importance of each criterion (education, teaching, research, community service, and support) and alternative (worthy and not worthy). The results obtained as many as 8 lecturers were declared worthy of promotion recommendations with lecturer 8 and lecturer 7 being the first and second order recommended for eligibility.

Keywords: *lecturer academic position, functional position, Fuzzy AHP, TOPSIS*

1. Introduction

One measurement of the quality of higher education is seen from the quality of human resources (lecturers) and the quality of lecturers can be proven by the level of education and the level of academic position of lecturers or often called functional positions. Provisions regarding the functional position of lecturers and credit score are regulated in the Regulation of the Minister of Administrative Reform and Bureaucratic Reform Number 17 of 2013 concerning: Functional Position of Lecturer and Credit Score (lldikti kemendikbud, 2019). Functional position rules are usually intended to show more measurable and quality performance, given the competition of lecturers around the world .

A lecturer must have a Master's degree and a minimum functional position of expert Assistant with rank or class III-b. The lecturer must then advance to the position of Head Lecturer or Professor, by continuing his doctoral studies. The requirements for these two positions are a Doctorate and publications in reputable international journals (lldikti kemendikbud, 2019) .

The promotion can be categorized into two classes, namely the promotion of academic positions normally (regular) and jumping positions (Setyowati Lilis et al., 2018). In general, the process of increasing the academic position of lecturers considers the credit score obtained from integrity, ethics, manners and responsibility in education,

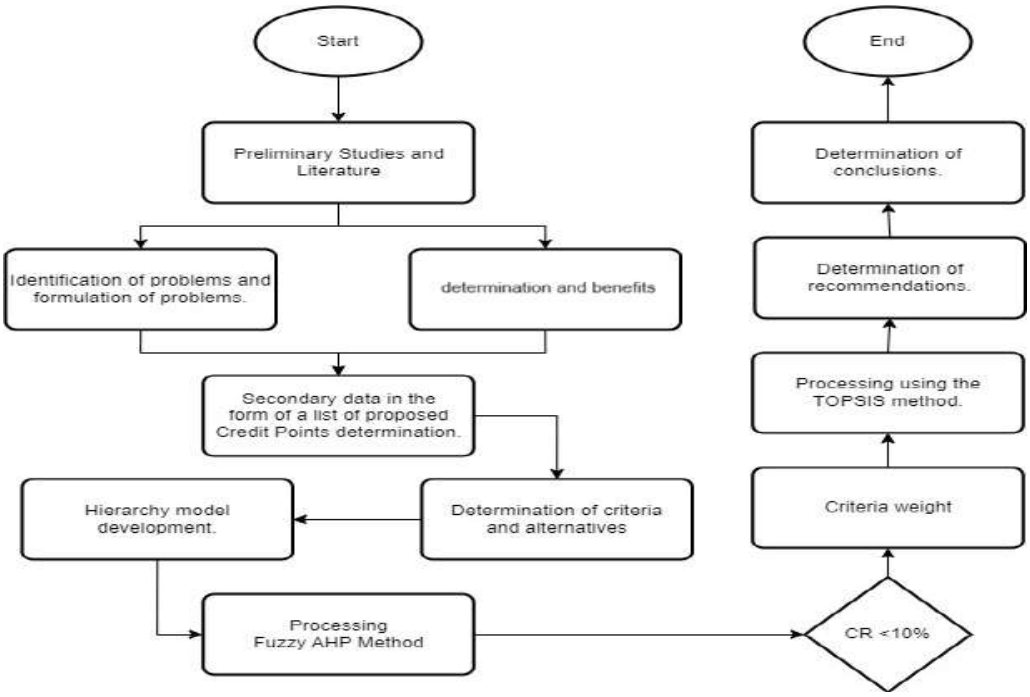
teaching and community service as well as fulfilling the requirements for publication of scientific papers (Afifah, 2018). Currently, technology can help universities to encourage lecturers to regularly manage and apply for lecturer academic promotion in order to avoid the subjective nature that occurs in many cases of recommendations for lecturer academic promotion (Khalida et al., 2019) (Hartini, 2018).

The lecturer academic position recommendation system can be one of the solutions to the problems mentioned so that recommendations for lecturer academic promotion can be made objectively, effectively, and efficiently and produce consistent decisions. The Multiple Criteria Decision Making (MCDM) method can be applied to the recommendation system because the MCDM method functions to determine the best choice from a number of options by considering the reference criteria (Sugiartawan & Suprihanto, 2021). One type of MCDM is the Fuzzy Analytical Hierarchy Process (Fuzzy AHP). This method assesses the relative importance of each criterion. Another MCDM method is Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) which works based on the concept that the selected alternative is calculated from the shortest distance from the positive ideal solution and has the longest distance from the negative ideal solution (Sutinah & Nisa, 2018).

The recommendation process for lecturer academic promotion must have optimal results, because of the limited quota for applying for lecturer academic promotion. This research proposes the integration of Fuzzy AHP algorithm integrated with TOPSIS to determine alternatives that have preferences from each criterion that apply for lecturer academic promotion. The purpose of this research is that the order of lecturers who want to apply for lecturer academic promotion will be recommended by the system.

2. Research Method

This research uses expert respondents from one of the public universities in Bekasi. The data used is primary data, meaning that the data is collected directly from expert sources at the research location. The research method can be found in Figure 1.



Source: Research's Result (2023)

Figure 1. Research Method

Based on the List of Proposed Determination of Credit Score (DUPAK), criteria and alternatives can be determined. The criteria referred to in the Fuzzy AHP and TOPSIS algorithms are measures that are the basis for assessment. An alternative is the result of a final decision or recommendation (Broto & Maharani, 2020) (Rucitra, 2015). There are five criteria determined, namely education (C1), teaching (C2), research (C3), community service (C4) and support (C5) and the alternatives are lecturers who are eligible for promotion or not eligible. The percentage of criteria required for each level of lecturer academic promotion is different. The percentage of criteria for each level is in accordance with PERMENPANRB 17-2013 (Ildikti kemendikbud, 2019). The percentage of criteria for each level of lecturer academic position is described by a hierarchical model that can be seen in Figure 2 and Figure 3.

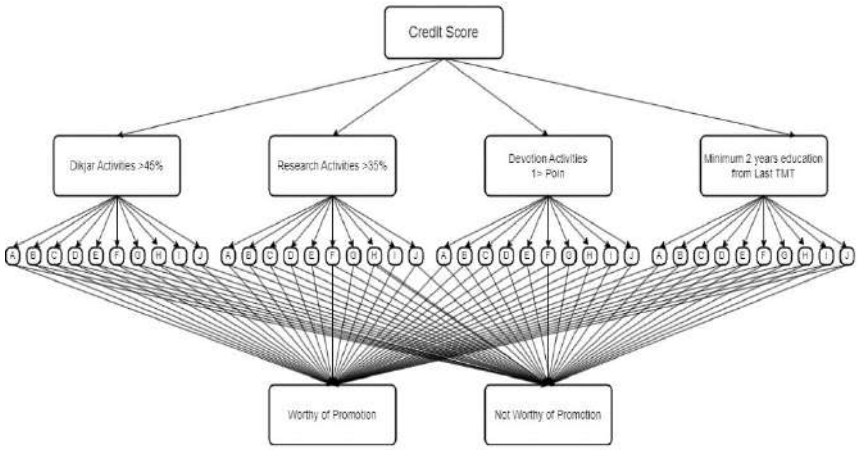


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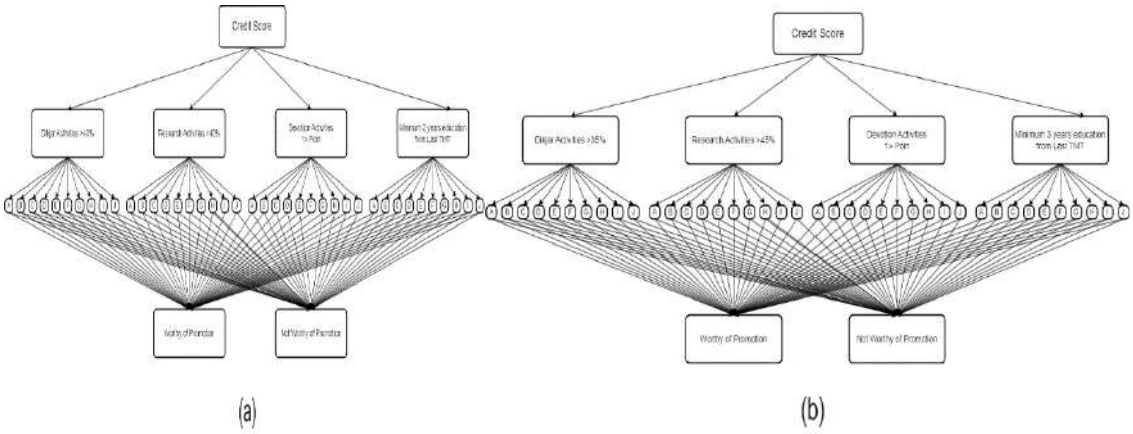
Figure 2. Hierarchy Model for Lectors



Source: Research's Result (2023)

Figure 3. (a) Hierarchy Model for Head Lectors, (b) Hierarchy Model for Professor

The next step is processing using the Fuzzy AHP method and then calculating the consistency of the criteria weights in order to continue the recommendation process. The Fuzzy Analytical Hierarchy Process (AHP) (Chang, 1996) calculation process is as follows:

1. Determining pairwise matrix comparisons between criteria with TFN scale to create a hierarchical structure.
2. Calculating the priority fuzzy synthesis value (S_i)

$$S_i = \sum_{j=1}^{m} M_i^j \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_i^j\right]^{-1} \quad (1)$$

with

$$\sum_{j=1}^{m} M_i^j = \left(\sum_{j=1}^{m} l_j , \sum_{j=1}^{m} m_j , \sum_{j=1}^{m} u_j\right) \quad (2)$$

and

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_i^j = \left(\sum_{i=1}^{n}\sum_{j=1}^{m} l_{ij} , \sum_{i=1}^{n}\sum_{j=1}^{m} m_{ij} , \sum_{i=1}^{n}\sum_{j=1}^{m} u_{ij}\right) \quad (3)$$

$S\_i\ x\text{^}2$

3. Calculating the vector value (V) and the defuzzification ordinate value (d'). Two fuzzy triangular numbers $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ with probability level $M_2 \geq M_1$ can be defined as follows:

$$V(M_2 \geq M_1) = \begin{cases} 1 & if\ m_2 \geq m_1 \\ 0 & if\ \ l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & for\ other\ conditions \end{cases} \quad (4)$$

For a convex fuzzy number M compared to a number k of convex fuzzy numbers M_i can be determinant by:

$$V(M \geq M_1, M_2, \dots, M_k) = \min_{i=1,2,\dots,k} V(M \geq M_i). \quad (5)$$

With assume $d'(A_i) = \min_{\substack{k=1,2,\dots,n \\ k \neq i}} V(S_i \geq S_k)$ (6)

4. Perform normalization of Fuzzy weight values. Vector weights are defined:

$$W' = (d(A_1), d(A_2), \dots, d(A_n))^T$$

After all criteria weights are met, the role of alternatives is carried out. The following steps are used to perform ranking and use the TOPSIS method:

1. Creating a decision matrix

$$X = \begin{array}{c} \\ a_1 \\ a_2 \\ \vdots \\ a_m \end{array} \begin{array}{c} \begin{array}{cccc} c_1 & c_2 & \cdots & c_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{21} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array} \quad (7)$$

Wiith a_i are alternatives $i = 1,2, \dots, m$ and c_j are attributes $j = 1,2, \dots, m$.

2. Perform normalization on the decision matrix (R). The entries of the normalized decision matrix are obtained from

$$r_{ij} = x_{ij}\left(\sum_{i=1}^{m} x_{ij}\right)^{-1}$$

3. Calculating the weights on the normalized decision matrix. The weighted normalization matrix (Y) is a matrix which is the result of the calculation of the matrix r multiplied by the weight value of the criteria w_j. The weight value used is the weight value that refers to the criteria. The weighted normalized decision matrix is formed from the equation.

$$y_{ij} = r_{ij} w_j \quad (8)$$

4. Calculating the value of positive ideal solutions and negative ideal solutions.

$$A^+ = \left(y_1^+, y_2^+, \dots, y_j^+\right) \quad (8)$$

$$A^- = \left(y_1^-, y_2^-, \dots, y_j^-\right) \quad (9)$$

with

$$y_j^+ = \begin{cases} \max\limits_{j=1,2,\dots,n} y_{ij} & \text{, if j of profit atribute in the positive ideal solution} \\ \min\limits_{j=1,2,\dots,n} y_{ij} & \text{, if j of cost atribute in the positive ideal solution} \end{cases}$$

$$y_j^- = \begin{cases} \max\limits_{j=1,2,\dots,n} y_{ij} & \text{, if j of cost atribute in the negative ideal solution} \\ \min\limits_{j=1,2,\dots,n} y_{ij} & \text{, if j of profit atribute in the negative ideal solution} \end{cases}$$

5. Calculating the distance between positive ideal solution values and negative ideal solutions.

$$D_i^+ = \sum_{j=i}^{m} \left(y_j^+ - y_{ij}\right)^2 \quad (10)$$

$$D_i^- = \sum_{j=i}^{m} \left(y_j^- - y_{ij}\right)^2 \quad (11)$$

6. Calculating the preference value

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (12)$$

with $i = 1,2, \dots, m$

3. Result and Analysis

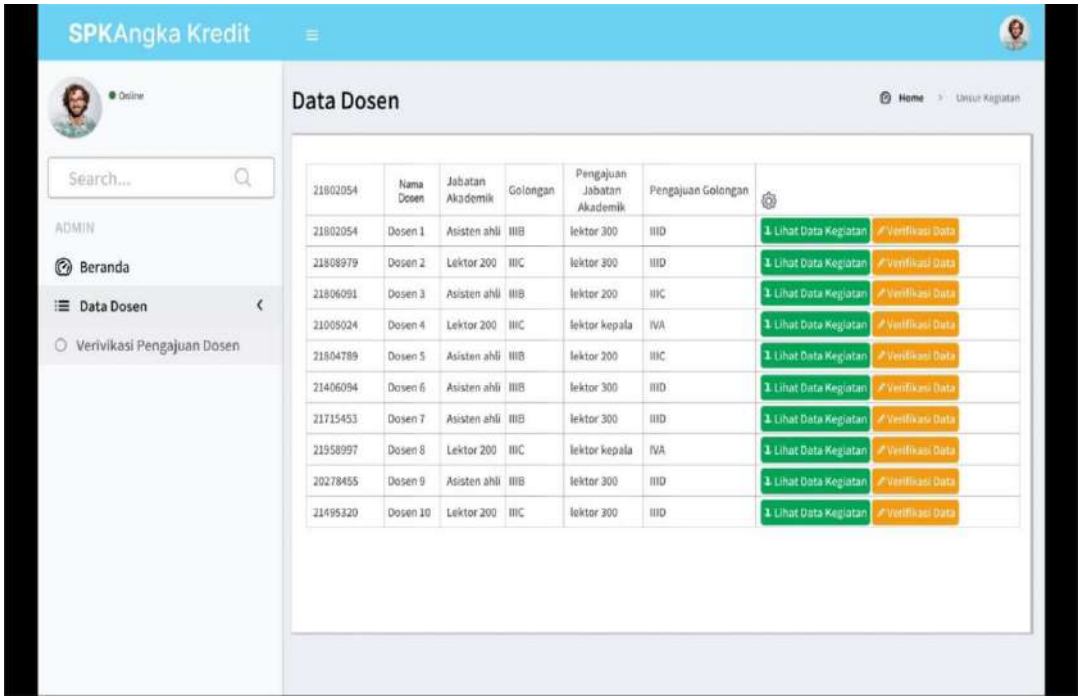
This recommendation system works with each criterion that has been determined by its weight by Fuzzy AHP then continued with ranking using TOPSIS. The number of samples is the result of the Slovin sampling method with an error tolerance of 0.25 and from a total population of 35 lecturers. Ten of these lecturers submitted proposals for academic promotion to the level of lecturer and head lecturer can be seen in Figure 4. The determination of whether or not an alternative is feasible is determined by the need for points that refer to the rules of PERMENPAN-RB 17-2013 can be seen in Table 1 and the calculations are as follows:

$$\frac{Value\ Obtained}{Biggest\ Value} \leq x < \frac{Value\ Obtained}{Biggest\ Value}$$

Tabel 1. Eligibility Point Range

Level	Range Value
Expert Assistant IIIB	$0.1 \leq x < 0.19$
Lector IIIC	$0.19 \leq x < 0.28$
Lector IIID	$0.28 \leq x < 0.38$
Head Lector IVA	$0.38 \leq x < 0.52$
Head Lector IVB	$0.52 \leq x < 0.67$
Head Lector IVC	$0.67 \leq x < 0.80$
Professor IVD	$0.80 \leq x < 1$
Professor IVE	$1 \leq x$

Source: Research's Result (2023)



Source: Research's Result (2023)

Figure 4. Menu Features for Lecturers who Apply for Academic Promotion

3.1. Matriks Perbandingan Berpasangan dan Nilai Kriteria Dosen

Determining each importance intensity of each criterion to avoid CR>0.1 or inconsistent values. Table 2 is a pairwise comparison matrix whose value is between 1-9 according to the AHP rating scale that has been determined based on the assumptions of a master assessor. Table 3 is the ownership of alternative sample points for applying for lecturer academic promotion.

Tabel 2. Pairwise Matrix

	C1	C2	C3	C4	C5
C1	1	3	5	5	7
C2	1/3	1	5	7	9
C3	1/5	1/5	1	9	9
C4	1/5	1/7	1/9	1	3
C5	1/7	1/9	1/9	1/3	1

Source: Research's Result (2023)

Tabel 3. Decision Matrix Structure

		Criteria				
Alternatif	**Recomendation**	**C1**	**C2**	**C3**	**C4**	**C5**
Dosen 1	lector 300 IIID	0.25	1	1	0.5	0.5
Dosen 2	lector 300 IIID	0.25	1	1	0.5	0.5
Dosen 3	lector 200 IIIC	0.25	0.5	0.5	1	1
Dosen 4	lector kepala IVA	0.75	0.5	1	0.5	0.5
Dosen 5	lector 200 IIIC	0.25	1	0.5	0.75	0.75
Dosen 6	lector 300 IIID	0.75	0.75	0.75	1	1
Dosen 7	lector 300 IIID	1	0.75	0.75	0.5	0.5

Alternatif	Recomendation	Criteria				
		C1	C2	C3	C4	C5
Dosen 8	lector kepala IVA	1	0.75	1	0.75	0.75
Dosen 9	lector 300 IIID	0.25	0.5	0.5	0.5	1
Dosen 10	lector 300 IID	0.25	0.5	0.5	0.5	1

Source: Research's Result (2023)

3.2. Transformasi TFN terhadap Skala

The pairwise matrix that has been obtained is then transformed into the form of Fuzzy AHP criteria weights. Table 4 shows the weight value of each criterion with variables l, namely the lower limit, m, namely the middle limit, u, namely the upper limit. The total value of the number of rows and columns is calculated to get the weight of the Fuzzy AHP criteria which can be seen in Table 5.

Tabel 4. Pairwise Matrix In Fuzzy AHP

	C1			C2			C3			C4			C5		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
C1	1	1	1	1	1.5	2	2	2.5	3	2	2.5	3	3	3.5	4
C2	0.5	0.67	1	1	1	1	2	2.5	3	3	3.5	4	4	4.5	4.5
C3	0.3	0.4	0.5	0.33	0.4	0.5	1	1	1	4	4.5	4.5	4	4.5	4.5
C4	0.3	0.4	0.5	0.25	0.29	0.333	0.22	0.22	0.25	1	1	1	1	1.5	2
C5	0.3	0.29	0.333	0.22	0.22	0.25	0.22	0.22	0.25	0.5	0.67	1	1	1	1

Source: Research's Result (2023)

Tabel 5. Total Rows and Columns of Fuzzy AHP Weights

	l	m	u
C1	10	12	13.5
C2	11	12.2	13.5
C3	9.7	10.8	11
C4	2.8	3.41	4.083
C5	2.2	2.33	2.75
Total	**35**	**40.7**	**44.83**

Source: Research's Result (2023)

3.3. Perhitungan Fuzzy AHP

Based on the Fuzzy AHP theory developed (Chang, 1996). The next step is to calculate the Fuzzy AHP synthesis value for each criterion, the results of which can be seen in Table 6.

Tabel 6. Total Rows and Columns of Fuzzy AHP Weights

	l	m	u
C1	0.2	0.3	0.384
C2	0.2	0.3	0.384
C3	0.2	0.27	0.313
C4	0.1	0.08	0.116
C5	0	0.06	0.078

Source: Research's Result (2023)

Tabel 7. Vector Value, Defuzzification, and Weight of the Normalized Vector

V (C1 ≥ C2)	C1	C2	C3	C4	C5	d'(Ci)	Weight
C1	……	0.974	1	1	1	0.974	1.318
C2	1	…….	1	1	1	1	1.353

V (C1 ≥ C2)	C1	C2	C3	C4	C5	d'(Ci)	Weight
C3	1	0.699	…….	1	1	0.699	0.890
C4	0	0	-0.875	…….	1	-0.875	-1
C5	-1.180	0	0	0.357	…….	-1.180	-1.560
			Total each column			0.618	1

Source: Research's Result (2023)

Table 7 above shows the weight of each criterion. The weight of the education criteria is 1.318, the weight of the teaching criteria is 1.353, the weight of the research criteria is 0.890, the weight of the community service criteria is -1 and the weight of the supporting criteria is -1.560. The results of determining the weight of Fuzzy AHP show the order of weight from largest to smallest, namely teaching, education, research, community service, and support criteria.

3.4. Perangkingan Alternatif dengan Perhitungan TOPSIS

The weights that have been obtained based on the Fuzzy AHP calculation in Table 7 are then used as a reference weight by the TOPSIS calculation to get the order of lecturers who are recommended to apply for academic positions. The point ownership value of each alternative based on the submitted DUPAK can be seen in Table 3. The next step is to normalize the decision matrix and calculate the weights on the normalized matrix which can be seen in Table 8.

Tabel 8. Weighted Nomalization Matrix

	Criteria				
Alternatif	C1	C2	C3	C4	C5
Dosen 1	0.100222966	0.419313935	0.404061018	0.116247639	0.058123819
Dosen 2	0.100222966	0.419313935	0.404061018	0.116247639	0.058123819
Dosen 3	0.100222966	0.209656967	0.202030509	0.232495277	0.116247639
Dosen 4	0.300668897	0.209656967	0.404061018	0.116247639	0.058123819
Dosen 5	0.100222966	0.419313935	0.202030509	0.174371458	0.087185729
Dosen 6	0.300668897	0.314485451	0.303045763	0.232495277	0.116247639
Dosen 7	0.400891863	0.314485451	0.303045763	0.116247639	0.058123819
Dosen 8	0.400891863	0.314485451	0.404061018	0.174371458	0.087185729
Dosen 9	0.100222966	0.209656967	0.202030509	0.116247639	0.116247639
Dosen 10	0.100222966	0.209656967	0.202030509	0.116247639	0.116247639

Source: Research's Result (2023)

The next step is to calculate the positive ideal solution matrix (D_i^+) and negative ideal solution matrix (D_i^-), If the benefit attributes (C1, C2 and C3) then (D_i^+) is the maximum value and (D_i^-) is the minimum value in each column. If cost attributes (C4 and C5) then (D_i^+) is the minimum value and (D_i^-) is the maximum value in each column. The positive and negative ideal solution can be seen in Table 9 and the distance between the value of each alternative with the positive ideal solution matrix (D_i^+) and the negative ideal solution matrix (D_i^-) can be seen in Table 10.

Tabel 9. Positive Ideal Solution and Negative Ideal Solution

	Criteria				
	C1	C2	C3	C4	C5
A^+	0.400892	0.419314	0.404061	0.232495	0.116248
A^-	0.100223	0.209657	0.202031	0.116248	0.058124

Source: Research's Result (2023)

Tabel 10. Distance of each alternative with (D_i^+) and (D_i^-)

	(D_i^+)	(D_i^-)
Dosen 1	0.327557	0.291157
Dosen 2	0.327557	0.291157
Dosen 3	0.418538	0.129969
Dosen 4	0.266257	0.284596
Dosen 5	0.368023	0.219497
Dosen 6	0.176742	0.279756
Dosen 7	0.195154	0.334058
Dosen 8	0.123337	0.382662
Dosen 9	0.434382	0.058124
Dosen 10	0.434382	0.058124

Source: Research's Result (2023)

The next step is to rank alternatives by calculating the relative closeness to the ideal solution (V_i) . Alternatives with the largest to smallest (V_i) values become the basis for ranking. The ranking results can be seen in Table 11.

Tabel 11. Rank Alternative V_i

Alternatif	V_i
Dosen 8	0.756251
Dosen 7	0.631237
Dosen 6	0.612831
Dosen 4	0.516646
Dosen 1	0.470584
Dosen 2	0.470584
Dosen 5	0.373599
Dosen 3	0.236950
Dosen 9	0.118017
Dosen 10	0.118017

Source: Research's Result (2023)

Based on the integration of Fuzzy AHP and TOPSIS, the recommendation system for lecturer academic promotion resulted in 8 lecturers being recommended to be eligible to apply for lecturer academic promotion. Lecturer 8 gets the first order of recommendations worthy of academic promotion to lector head IVA, lecturer 7 and lecturer 6 second and third order recommended eligible of academic promotion to lector IIID, lecturer 4 fourth order recommended eligible of academic promotion to lector IVA. Lecturer 1 and lecturer 2, fifth and sixth, are recommended to be promoted to lector IIID. Lecturer 5 and lecturer 3 in the seventh and eighth ranks are recommended to be eligible for academic promotion to lector IIIC. Lecturer 9 and lecturer 10 are not recommended to be promoted applying for an increase in lecturer academic position because the points obtained do not reach the specified range.

4. Conclusion

Ten lecturers who applied for an increase in lecturer academic positions, the recommendation system stated that 8 lecturers were eligible to apply for an increase in lecturer academic positions and 2 lecturers were not eligible to apply. Fuzzy AHP algorithm integrated with TOPSIS in the recommendation system successfully determines the order of alternatives that have preference points that meet each criterion for applying for lecturer academic promotion. Lecturers who do not have points with the specified range are declared not eligible to apply for promotion.

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Author Contributions

Khalida proposed the topic; Khalida and Khairunnisa conceived models and designed the experiments; Khalida conceived the optimisation algorithms; Khalida and Khairunnisa analysed the result.

Conflicts of Interest

The author declare no conflict of interest.

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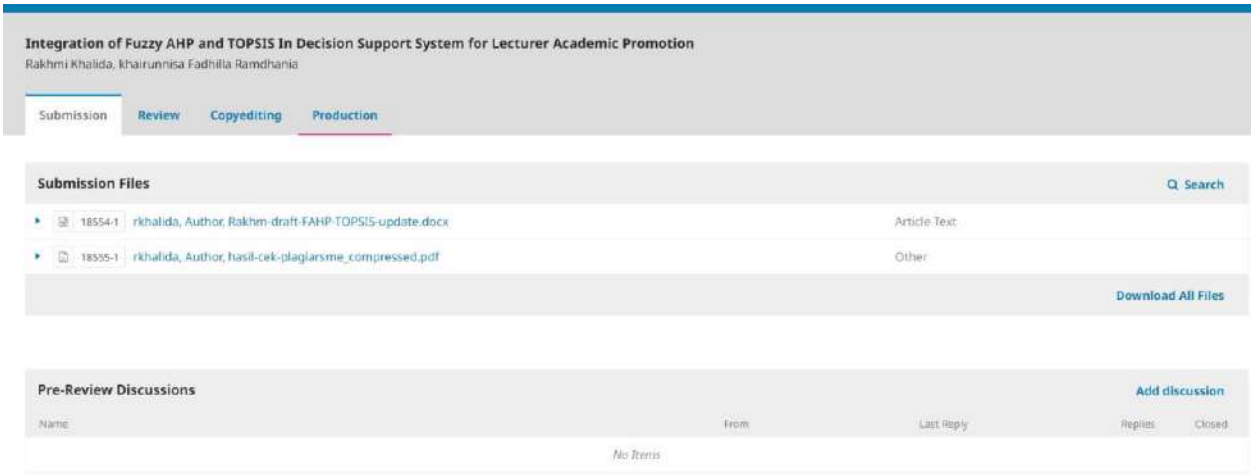
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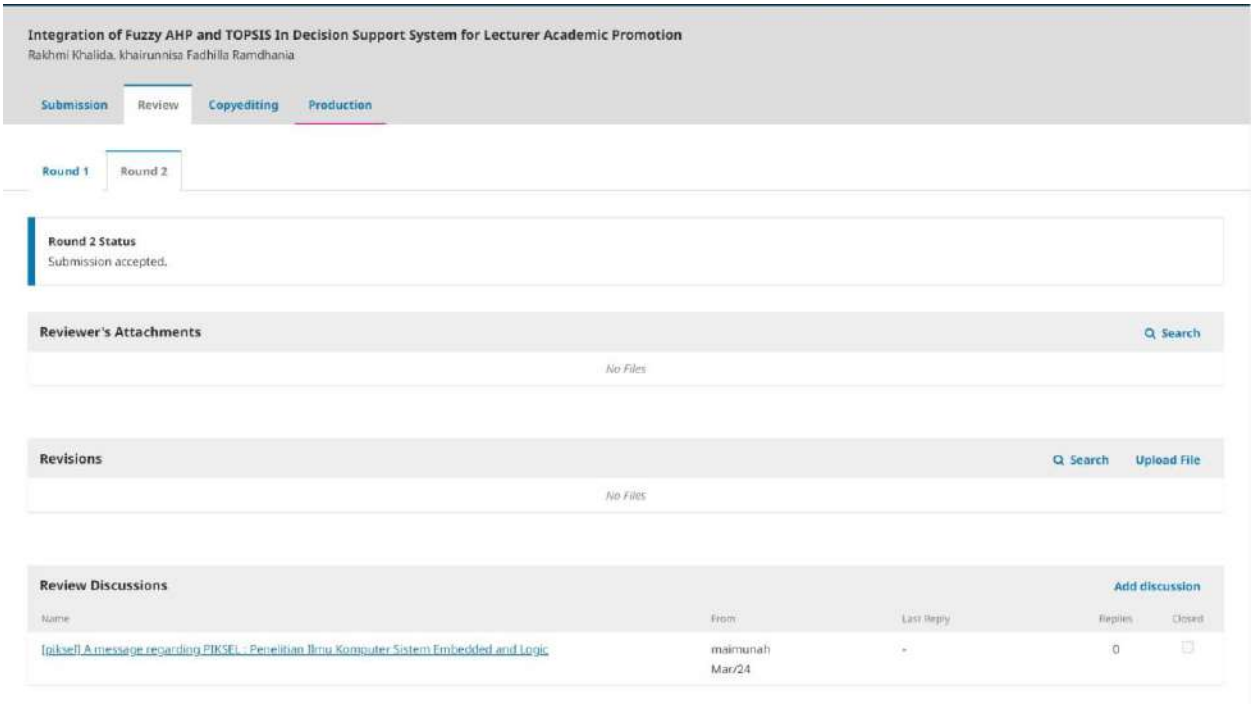
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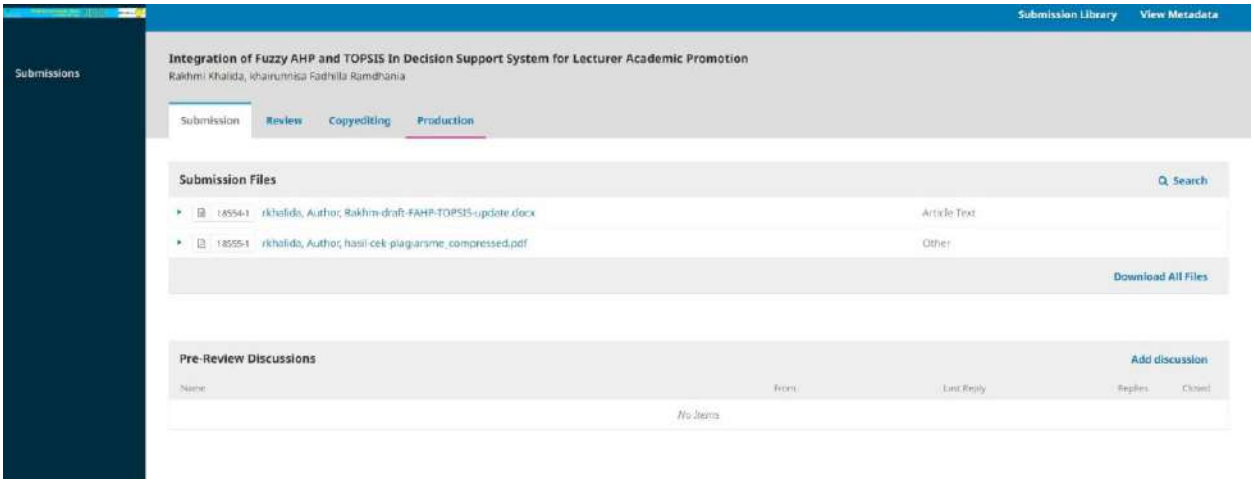
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