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FUZZY LOGIC APPLICATION ON EMPLOYEE ACHIEVEMENT ASSESSMENT (CASE STUDY: EDUCATION QUALITY ASSURANCE INSTITUTE OF MALUKU PROVINCE)

Nurhidayah[1], Yopi Andry Lesnussa[2], Zeth Arthur Leleury[3*]

[1,2,3] *Mathematics Study Program, Faculty of Mathematics and Natural Sciences, Pattimura University*
Jl. Ir. M. Putuhena, Ambon, 97233, Maluku, Indonesia

Corresponding author e-mail: [3*] *zetharthur82@gmail.com*

Abstract. *Employee achievement assessment in an agency is essential for agency planning and evaluation. Therefore, the Employee achievement assessment must be carried out with a good and appropriate method so that it can guarantee fair and satisfactory treatment for the assessed employees. The value of employee achievement is determined by 60% of the target value of employee achievement and 40% of the average employee behavior value consisting of service orientation, integrity, commitment, discipline, and cooperation. The writing and discussion of this research are about the application of the fuzzy logic Mamdani method using MATLAB software in determining the work performance value of the Maluku Education Quality Assurance Institution (LPMP) employees based on the target value of employee achievement and behavioral values. The Mamdani method's calculation level of truth is 94%, so it can be concluded that the fuzzy logic of the Mamdani method can be used to measure the performance value of employees.*

Keywords: *Fuzzy Logic, work performance value, Mamdani method*

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1. INTRODUCTION

Employee achievement assessment in an agency is essential for agency planning and evaluation [1]. Employee achievement assessment must be carried out to determine the achievements to be achieved by each employee. According to [2] the work performance assessment, institutions can also use it to find out the shortcomings and potential of an employee. In determining employee achievement assessment, fuzzy logic can be used as a method of evaluating employee achievement [3], because fuzzy logic can be used in the prediction process [4].

The concept of fuzzy logic was introduced by Lotfi A. Zadef in 1965. Fuzzy logic was introduced as a way to process a series of membership sets inspired by the perception and reasoning processes performed by humans[5]. Fuzzy logic is widely used in various studies because it can be used to measure various phenomena that have ambiguous, disguised, or fuzzy characteristics [6]. One of the studies that use fuzzy logic is research on teacher performance assessment systems using the Tahani method [7]. Several other studies that use fuzzy logic to support this research include research on evaluating the performance of lecturers using the Mamdani method [8] and evaluating employee achievement using the Tsukamoto method [9]. According to [10], fuzzy logic can be considered an approach to splitting an input space into an output space.

Fuzzy logic is often used because of its ability to solve vague problems, in which mathematical models are often made in simple events, such as in the study entitled "Application of Fuzzy Logic Sugeno's Method to Determine the Amount of Bread Production Based on Inventory and Total Demand Data (Case Study: Sarinda Ambon Bread Factory)." The research intends to analyze the determination of the amount of bread production based on inventory data and the number of requests that can be used to assist companies in reaching decisions with the truth value of 86.92165% [11] and the research entitled "Modeling Vocational High School Accreditation in Maluku Province Using Fuzzy Logic Mamdani Method Based on GUI MATLAB" where the research intends to model SMK accreditation by relying on 3 standard aspects as a reference to create the desired model with an accuracy of 90% [12].

Based on the description above, the researcher will conduct a study entitled "Application of Fuzzy Logic on Employee achievement Assessment (Case Study: Maluku Province Education Quality Assurance Institute)".

2. RESEARCH METHODS

This research was made based on a literature review, as well as data analysis using MATLAB software. The inference model used is the Mamdani fuzzy method. The Mamdani method is often known as the min-max method [13]

The data used in this study is secondary data obtained from the Maluku Province Education Quality Assurance Institute (LPMP), namely the data on the nominative list of the Maluku Province LPMP work performance assessments for 2020 – 2021 where the data consists of two input variables and one output variable.

Table 1. *Input* and *Output Variables*

Function	Variable Name	Universe of Conversation
Input	SKP Value	[75 100]
	Behavior Value	[0 100]
Output	Employee achievement Value	[55 100]

The stages of research used in this study are as follows: [14].

1. Fuzzy set formation
   The fuzzy set formation is done by determining the variables and fuzzy sets. The input and output variables are divided into one or more fuzzy sets.
2. Fuzzification
   The process of determining the degree of membership between the fuzzy input data and the fuzzy set that has been defined for each variable.

3. Composition of rules
   If the system consists of several rules, then the inference is obtained from the collection and correlation between the rules. The implication function used by MIN is by using the AND operator. The results of the fuzzy implications of each of these rules are then combined to produce fuzzy inference output, with the output taken being the smallest value of all calculated values.
4. Defuzzification (Affirmation)
   Defuzzification is the last stage that aims to get a firm value on the domain.

3. RESULTS AND DISCUSSION

3.1 Fuzzy Set Formation

In the application of fuzzy logic Mamdani method, the input variables and output variables are divided into one or more fuzzy sets. This study measures the value of employee achievement based on the value of employee work goals (SKP) and behavioral values. The input variable is divided into two, namely the SKP value variable and the employee behavior value variable, and the output variable there is one variable, namely the employee achievement value. The determination of the variables used in this study is in the following Table 2:

Table 2. The domain of *input* and *output variables.*

Variable	Fuzzy set	Universe of talk	Domain
SKP Value	Well	[75 100]	[76 90]
	Very well		[91 100]
Behavior Value	Not enough	[0 100]	[55 60]
	Enough		[61 75]
	Well		[76 90]
	Very good		[91 100]
Employee achievement value	Not enough	[0 100]	[55 60]
	Enough		[61 75]
	Well		[76 90]
	Very good		[91 100]

3.2 Fuzzification

The following is a way to get membership values based on numerical variables and linguistic variables in fuzzy sets and membership functions from SKP value variables and employee behavior values variables.

a. Fuzzy set and membership function of SKP value variable

In a good fuzzy set, the type of membership function curve used is tramph, where the domain of a good fuzzy set is [76 100] and parameters [74.9 75.9 89.9 90.9] The results can be seen in Figure 1.

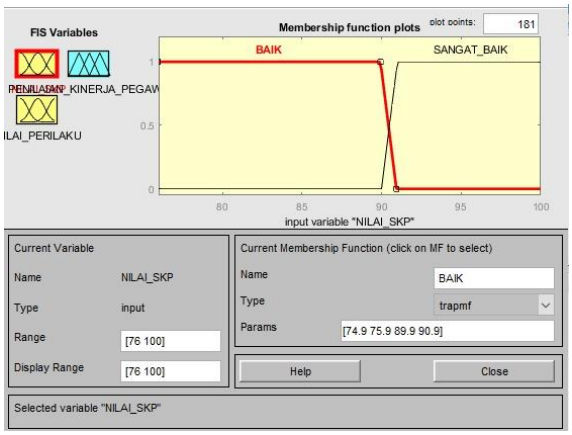

Figure 1. Fuzzy set of SKP values (good)

In very good fuzzy sets, the type of curve used is tramph, where the very good fuzzy set domains are [91-100] and parameters [90 91 100 100]. Then the results can be seen in Figure 2.

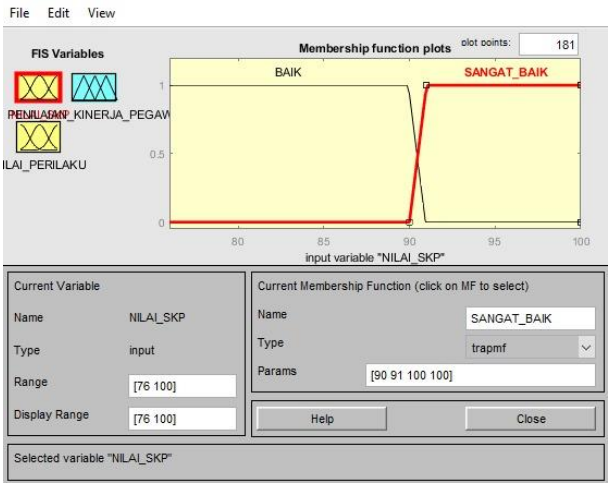

Figure 2. SKP Fuzzy *Set (Very Good)*

Based on Figures 1 and 2, it can be seen that the horizontal axis is the input value of the SKP value variable and the vertical axis is the degree of membership of the input value. With a good and very good fuzzy set membership functions are as follows:

- **Good** membership degree:

$$\mu_{baik}(x) = \begin{cases} 1\ ;\ x < 89{,}9 \\ \dfrac{90{,}9 - x}{90{,}9 - 89{,}9}\ ;\ 89{,}9 \le x \le 90{,}9 \\ 0\ ;\ x > 90{,}9 \end{cases}$$

- **Very good** membership degree:

$$\mu_{sangat\ baik}(x) = \begin{cases} 0\ ;x < 90 \\ \dfrac{x - 90}{91 - 90}\ ;\ 90 \le x \le 91 \\ 1\ ;x > 91 \end{cases}$$

b. Fuzzy set and membership function of behavioral value variables

In less, sufficient, good, and very good fuzzy sets the type of membership function curve is tramph, where the domain of the fuzzy set is less, sufficient, good, and very good, namely: [0 100]. Then the results can be seen in Figure 3 – Figure 6.

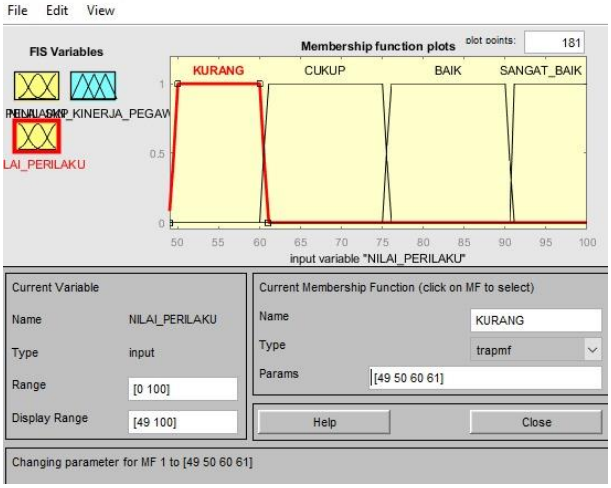

Figure 3. Set fuzzy behavior value (less)

Based on Figure 3, it can be seen that the fuzzy set is lacking the type of membership function curve used in tramph, where the domain in the fuzzy set is lacking, namely [0 100] with parameters [49 50 60 61].

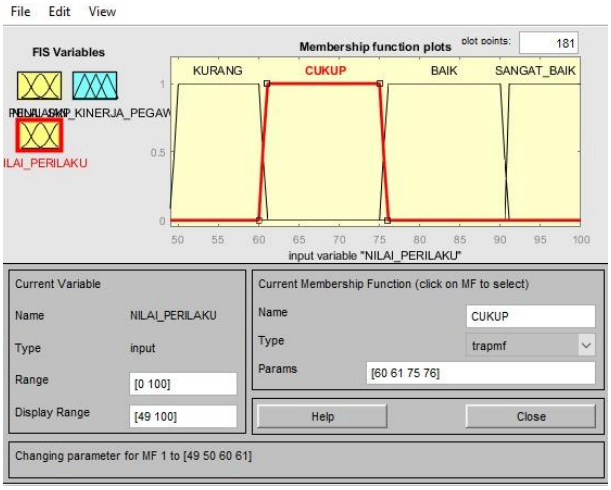

Figure 4. Fuzzy *set* of behavioral values (enough)

Based on Figure 4, it can be seen that the fuzzy set is sufficient. The type of membership function curve used is tramph, where the domain in the fuzzy set is sufficient, namely [0 100] with parameters [60 61 75 76].

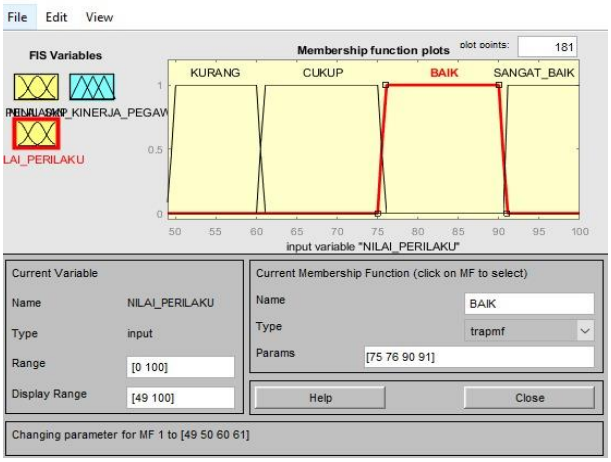

Figure 5. Fuzzy *set* of behavioral values (good)

Based on Figure 5, it can be seen that the fuzzy set of the type of membership function curve used is tramph, where the domain of the good fuzzy set is [0 100] with the parameter [75 76 90 91].

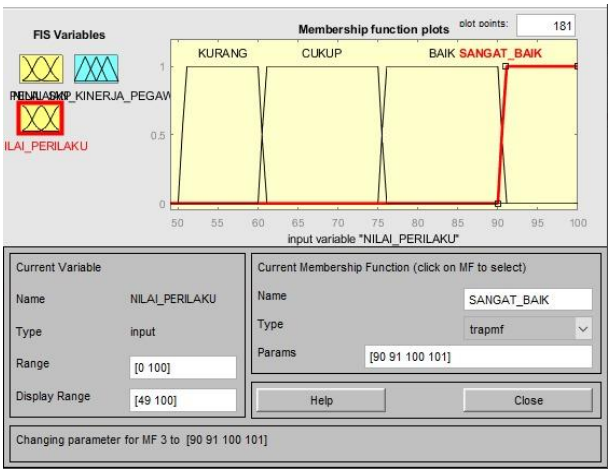

Figure 6. Behavioral fuzzy set (very good)

Based on Figure 6, it can be seen that the fuzzy set is very good. The type of membership function curve used is tramph, where the domain in the fuzzy set is very good, namely [0 100] with parameters [90 91 100 100].

Based on Figure 3 - Figure 6, it can be seen that the horizontal axis is the input value of the behavior value variable and the vertical axis is the degree of membership of the input value. With a good and very good fuzzy set membership functions are as follows:

- **Less** membership degree

$$\mu_{kurang}(x) = \begin{cases} \dfrac{x-49}{50-49}\ ;\ 49 \le x < 50 \\ 1\ ;\ 50 \le x \le 60 \\ \dfrac{61-x}{61-60}; 60 \le x \le 61 \\ 0\ ; x\ > 61 \end{cases}$$

- **Sufficient** membership degree

$$\mu_{cukup}(x) = \begin{cases} 0\ ; x < \ 60 \text{ atau } x\ > 76 \\ \dfrac{x-60}{61-60}; 60 \le x \le 61 \\ 1\ ;\ 61 < x \le 75 \\ \dfrac{76-x}{76-75}; 75 < x \le 76 \end{cases}$$

- **Good** membership degree

$$\mu_{baik}(x) = \begin{cases} 0\ ; x < \ 75 \text{ atau } x\ > 91 \\ \dfrac{x-75}{76-75}; 75 \le x \le 76 \\ 1\ ;\ 76 < x \le 90 \\ \dfrac{76-x}{76-75}; 90 < x \le 91 \end{cases}$$

- **Very good** membership degree

$$\mu_{sangat\ baik}(x) = \begin{cases} 0\ ; x < \ 90 \\ \dfrac{x-90}{91-90}; 90 \le x \le 91 \\ 1\ ;\ x\ > 91 \end{cases}$$

c. Fuzzy set and membership function of employee achievement value variables.
In less, sufficient, good, and very good fuzzy sets the type of membership function curve is tramph, where the domain of the fuzzy set is less, sufficient, good, and very good, namely: [51 100]. Then the results can be seen in Figures 7-Figure 10.

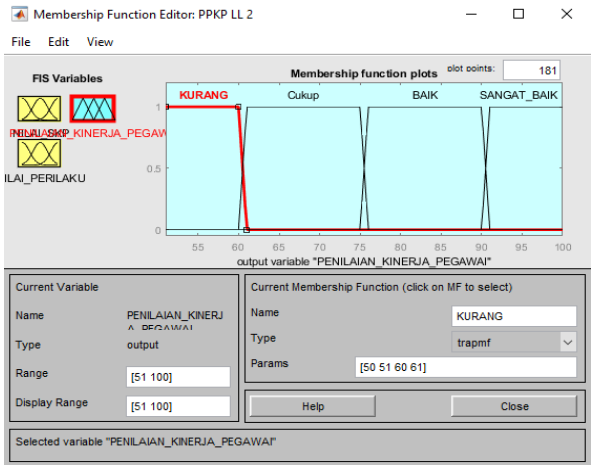

Figure 7. Fuzzy set of employee achievement values (less)

Based on Figure 7, it can be seen that the fuzzy set is lacking the type of membership function curve used in tramph, where the domain in the fuzzy set is lacking, namely [51 100] with parameters [50 51 60 61]

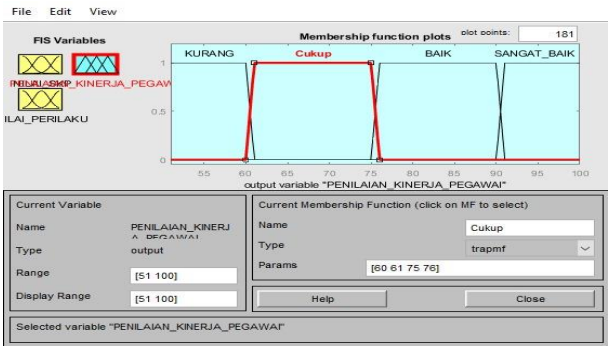

Figure 8. Fuzzy set of employee achievement scores (enough)

Based on Figure 8, it can be seen that the fuzzy set is sufficient. The type of membership function curve used is tramph, where the domain in the fuzzy set is less, namely [51 100] with parameters [60 61 75 76]

Figure 9. Fuzzy set of employee achievement scores (Good)

Based on Figure 9, it can be seen that in the fuzzy set, the type of membership function curve used is tramph, where the domain in the fuzzy set is good, namely [51 100] with parameters [75 76 90 91]

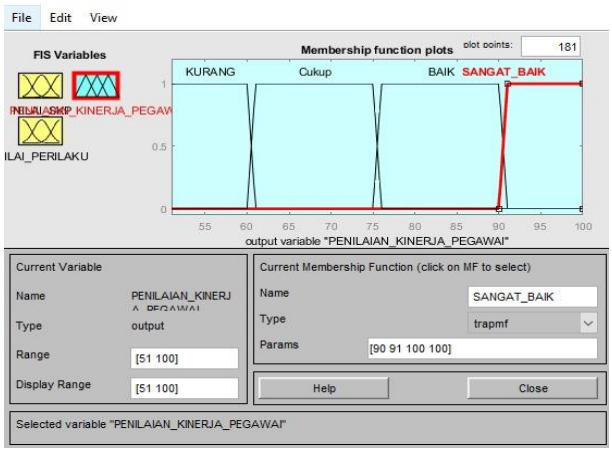

Figure 10. Fuzzy set of employee achievement scores (Very Good)

Based on Figure 10, it can be seen that the fuzzy set is very good. The type of membership function curve used is tramph, where the domain in the fuzzy set is very good, namely [51 100] with parameters [90 91 100 100].

With less, sufficient, good, and very good fuzzy set membership functions from the output variables, namely:

- **Less** membership degree

$$\mu_{kurang}(x) = \begin{cases} 1 ; x < 60 \\ \dfrac{60 - x}{61 - 60} ; 60 \leq x \leq 61 \\ 0 ; x > 61 \end{cases}$$

- **Sufficient** membership degree

$$\mu_{cukup}(x) = \begin{cases} 0 ; x < 60 \text{ atau } x > 76 \\ \dfrac{x - 60}{61 - 60} ; 60 \leq x \leq 61 \\ 1 ; 61 < x \leq 75 \\ \dfrac{76 - x}{76 - 75} ; 75 < x \leq 76 \end{cases}$$

- **Good** membership degree

$$\mu_{baik}(x) = \begin{cases} 0 ; x < 75 \text{ atau } x > 91 \\ \dfrac{x - 75}{76 - 75} ; 75 \leq x \leq 76 \\ 1 ; 76 < x \leq 90 \\ \dfrac{76 - x}{76 - 75} ; 90 < x \leq 91 \end{cases}$$

- **Very good** membership degree

$$\mu_{sangat\ baik}(x) = \begin{cases} 0 ; x < 90 \\ \dfrac{x - 90}{91 - 90} ; 90 \leq x \leq 91 \\ 1 ; x > 91 \end{cases}$$

3.3 Composition Rules

At this stage, the formation of fuzzy rules is carried out with the implication function. The membership value of the set of SKP values and the employee behavior value by taking into consideration the data obtained from LPMP Maluku. The AND operator is an intersection operation on the α-predicate set obtained by taking the smallest membership value between elements in the set (MIN function). By analyzing the data on the boundary of each fuzzy set on each variable, there are 8 fuzzy rules. With the arrangement of IF rules, the value of SKP IS.....AND the value of behavior IS THEN the value of work performance IS....., in the use of the implication function used for each rule is the MIN function. The fuzzy rules in this study are:

1. If (SKP score is Good) and (behavioral value is Less) then (work performance assessment is Enough)
2. If (SKP score is good) and (behavioral value is sufficient) then (work performance assessment is good)
3. If (SKP score is good) and (behavior value is good) then (work performance assessment is good)
4. If (SKP score is Good) and (behavioral value is Less) then (work performance assessment is Enough)
5. If (SKP score is Very Good) and (behavioral score is Enough) then (work performance assessment is Good)
6. If (SKP score is very good) and (behavioral score is good) then (work performance assessment is very good)

7. If (SKP score is very good) and (behavioral score is very good) then (work performance assessment is very good)
8. If (SKP score is Good) and (behavioral value is Less) then (work performance assessment is Good).

3.4 Affirmation

In the Mamdani method, the input of the defuzzification process is a fuzzy set obtained from the composition of fuzzy rules, while the resulting output is a number in the domain of the fuzzy set. So if given a fuzzy set with a certain range, it must be able to take a certain crisp value as output. With the formation of fuzzy rules as shown in Figure, a rules view is formed which can be seen as follows:

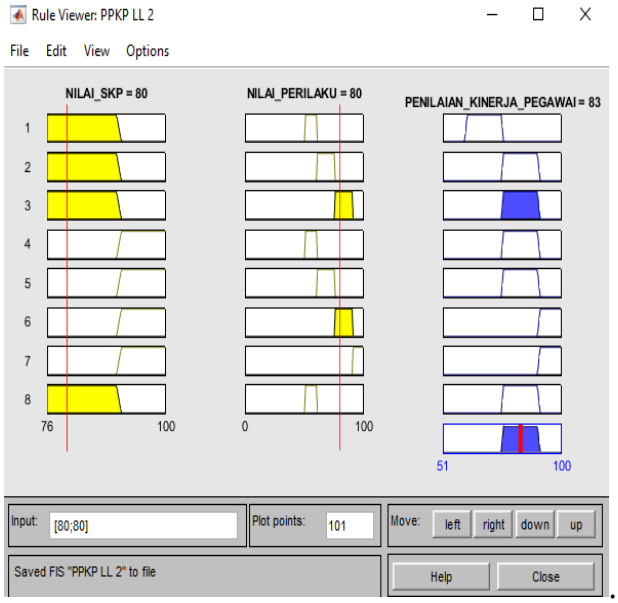

Figure 11. Defuzzification

By obtaining the rules view in MATLAB, the results of the defuzzification are also obtained, where the SKP value and behavior value are inputted into the view of the existing rules. Then the value of employee achievement will appear by the fuzzy rules that have been made with the output in the form of a domain number in the fuzzy set. To get employee achievement values according to MATLAB calculations, we can input the SKP value and behavior value in the existing Rulers View column, by sliding the vertical line on the input variable or directly entering the variable value. input in the input field.

3.5 Error Calculation

In calculating the error using MAPE (Mean Absolute Percentage Error) in this case, MAPE is an error measurement that calculates the percentage deviation between the actual data and the forecast data [15]. Data on employee achievement values from LPMP will be used as α_t. While the value of employee work performance based on the fuzzy Mamdani results will be used as $\widetilde{\alpha_t}$.

$$\text{MAPE} = \frac{\sum_{t=1}^{n} \frac{|\alpha_t - \widetilde{\alpha_t}|}{\alpha_t}}{n} \text{x } 100\%$$

$$= \frac{295{,}33}{50} \times 100\%$$

$$= 6\%$$

Based on the results of the MAPE calculation in the above case, it can be seen that the error value using MAPE is 6%. Therefore, the truth rate of the cases in this study is 94%.

4. CONCLUSION

Based on the problem formulation, discussion, and research results regarding employee achievement assessment based on SKP values and behavioral values, it can be concluded that:

1. The application of fuzzy logic with the Mamdani method is effectively applied in the MATLAB software application to assist the agency in measuring the value of employee work performance. From the test results with the MATLAB software, the percentage of true value is 94%, which means that it is close to very good in assessing the work of Maluku LPMP employees. And the resulting error rate is 6% of the 100% error rate
2. Based on the results of the Employee achievement assessment by applying the fuzzy logic of the Mamdani method then the results are compared with research data obtained from the Maluku LPMP, it can be said that the application of the fuzzy logic of the Mamdani method can be used as a good measuring tool to assess employee achievement based on the value of SKP and the employee behavior value. LPMP Maluku.

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