E-ISSN 2830-1013
P-ISSN 2830-1021
JIIET JOURNAL INTERNATIONAL Inspire Education Technology

Implementation of the Mamdani Fuzzy Method to Evaluate the Performance of Lecturers in the Research Field

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***Abstract*— Today, information technology, especially soft computing technology, has grown very rapidly. One of the soft computing technologies that has been widely developed is fuzzy logic, because it can be used to measure various phenomena that are ambiguous, disguised or fuzzy. One of the research topics that uses the application of fuzzy logic is the assessment system in the field of research. Research by Lecturers at the University of Graha Nusantara Padangsidimpuan in Simlitabmas Data Still in the Guidance Category to upgrade to the Middle Category UGN Padangsidimpuan lecturers are challenged to be able to develop, devote, and apply the knowledge needed in research. For that we need an application that can be used to calculate and record the performance of Lecturers on the resulting Research. The purpose of this study is to apply fuzzy logic with the Mamdani method in assessing the research performance of lecturers at the University of Graha Nusantara Padangsidimpuan. This research uses Mamdani Fuzzy Logic. Fuzzy Mamdani method is a way to map an input space into an output space. This method is a mathematical framework used to represent uncertainty, ambiguity, imprecision, lack of information, and partial truth. The stages of research using the Mamdani method are Creating Input Variables taken from Sinta-accredited Articles, Simlitabmas Grant Articles and Articles in International and National Journals. Finding the Max-Min Value of Each Variable. Creating a fuzzy set using the Mamdani method. Creating Assertions with Defuzzification using Matlab.**

***Keywords*— Fuzzy Logic, Mamdani Method, Research Field**

Manuscript received Dec 29, 2022; revised Dec 4, 2022; accepted Dec 6, 2022. Date of publication 17 Dec. 2022.

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How to cite: Alwendi, Alwendi., Samosir, K., Suo, M., Yang, F. (2022). Implementation of the Mamdani Fuzzy Method to Evaluate the Performance of Lecturers in the Research Field. *Journal International Inspire Education Technology (JIIET)*, 1(3), 138-144. https://doi.org/10.55849/jiiet.v1i3.128

Published by: Sekolah Tinggi Agama Islam Al-Hikmah Pariangan Batusangkar

I. INTRODUCTION

According to Junaidi et al (2020), teaching staff is an important component to enter high-quality lecturers, therefore to become teaching staff must have high abilities in accordance with these limitations (Wawan et al., 2021). Meanwhile, Universitas Graha Nusantara (UGN) Padangsidimpuan has a vision of becoming a superior, independent and nationally competitive higher lecturer by 2030 (Rustum et al., 2020). To realize this vision, UGN has one of its missions,

namely Organizing education, research and community service, as well as conducting studies and periodic studies. (Sadi, 2020) so that the UGN faculty can develop, dedicate and apply their knowledge in research so that it can be upgraded to the intermediate category. (Devaraj et al., 2020) For this reason, an application is needed that can be used to calculate the lecturer's (Hardianto & Nurhasanah, 2020) performance score on the research he produces (Budi Indra Gunawan & Unan Yusmaniar Oktiawati, 2020) To make it easier to see the performance of lecturers (Sofhian et al., 2016) from the research results they produce, the researchers use fuzzy logic applications. (Anisah et al., 2021) Various theories of the development of fuzzy logic show that fuzzy logic can be used to model various systems in general.(Rodríguez et al., 2008) To evaluate research performance, researchers used 3 input variables, namely through Sinta, Simlitabmas, and the journal publication cluster.(Izvozchikova et al., 2022) To get these results, we need to go through the stages of fuzzy set construction, application of implication functions, and compilation of rules.(Acosta-Prado et al., 2021) The results obtained indicate that the evaluation of academic results using fuzzy logic (Abbasipayam & Makrova, 2022) can show differences in the final value of lecturer research activities. (Ain et al., 2022)To obtain these results, it is necessary to carry out the stages of forming a fuzzy set, applying the implication function and compiling rules (Li et al., 2010). The results obtained indicate that the assessment of academic (Alwendi, 2021) performance using fuzzy logic can show differences (Baliuta et al., 2020) in the final value of lecturer research activities.(Tariq et al., 2020) Based on the explanation contained in the background (Tahri et al., 2022) a problem can be formulated, namely, (Aslam, 2020) how to determine the value of lecturer research (Alwendi & Masriadi, 2021). using the Fuzzy Mamdani (Yetilmezsoy et al., 2021) method as an alternative tool to calculate the value of lecturer research (Keviczky et al., 2019) at Graha Nusantara Padangsidimpuan University.(Ningrum et al., 2021) 1. Knowing the results obtained from the results of calculations using fuzzy logic to assess the performance of lecturers 3. Knowing the use of the Mamdani fuzzy logic method in evaluating the research (van Krieken et al., 2022) activities of lecturers at Graha Nusantara Padangsidimpuan University in 2020-2021. Provide knowledge about how to determine the evaluation of research activities A lot of research has demonstrated the ability of fuzzy logic (Mudia, 2020) in dealing with vague and uncertain linguistic information. For the purpose of representing human perception, fuzzy logic (Rani Roopha Devi & Mahendra Chozhan, 2020) has been employed as an effective tool in intelligent decision making. Due to the emergence of various studies(Ain et al., 2022) on fuzzy logic-based decision-making methods (Mittal et al., 2020) of the Faculty of Graha Nusantara Padangsidimpuan University using the Fuzzy Mamdani method .

a. An ascending linear representation that represents the increase in the set, starting from the domain value which has zero membership degree (Wu & Xu, 2021), moving to the right to the domain value which has the same higher degree of membership.

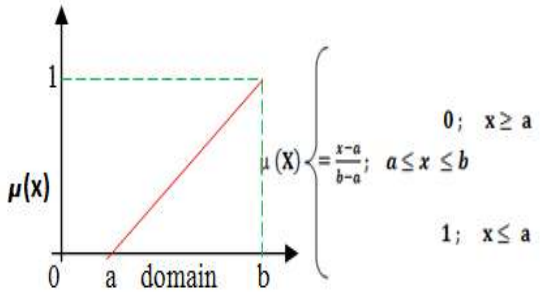


Fig 1. Linear representation

b. a descending linear Representation is the inverse of the first. A straight line starts from the left of the domain value with the highest membership degree, then decreases to the domain value with the lowest membership degree. (Kimura et al., 2008)

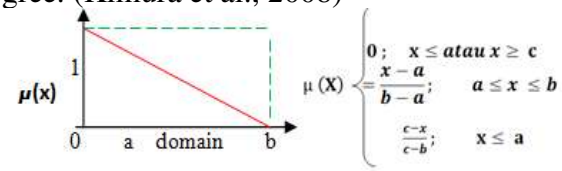
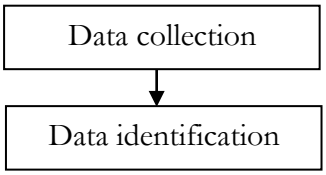
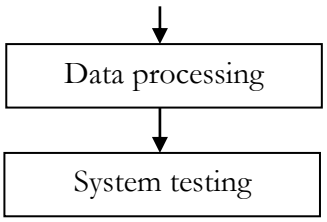


Fig 2. Decreasing Linear Representation

II. METHOD

The steps carried out in this study are shown in Figure 3 below.





Based on the research steps in Figure 3, each step can be explained as follows:

1. Data collection The data needed for this research is research data from the Faculty of Graha Nusantara University in 2020 and 2021 which is taken from data from the Sinta cluster, Simlitabmas and journal publications.
2. Data identification Data identification is done to select the variables needed to perform calculations and analyze the problem.
3. Data processing The data processing stage is to create a Mamdani fuzzy system using Matlab software.
4. System test At the system testing stage, testing and simulation will be carried out to evaluate lecturer research activities using fuzzy logic.

III. RESULTS AND DISCUSSION

This study examines the Mamdani fuzzy method in evaluating research activities of the Faculty of Graha Nusantara Padangsidimpuan University using an application built with Matlab R2013a software. In this study, it consists of 3 input variables, namely the variables that are used as evaluation materials, which include variables from Sinta, Simlitabmas and Klater Jurnal, which will provide 33 rules or 27 rules. The fuzzy set for the input and output variables is presented in Table 1 below:

Table 1
Formation of fuzzy sets for variables Input and output variables

Function	Variable		Universe Of Talk	Fuzzy Set
Input	Sinta	C1-C3	0-41	a little
			42-83	Currently
			84-123	many
		4-C5	0-41	a little
			42-83	Currently
			84-123	many
		S6-S0	0-41	a little
			42-83	Currently
			84-123	many
	Simlitabmas	RAP	0-129	a little
			130-258	Currently
			259-388	many
		natural resources	0-129	a little
			130-258	Currently
			259-388	many
	Journal Cluster	national journal	0-41	a little
			42-83	Currently
			84-123	many
		International Journal	0-41	a little
			42-83	Currently
			84-123	many
Output	Cluster PT	built	0-41	a little
			42-83	Currently
			84-123	many
		intermediate	0-129	a little
			130-258	Currently
			259-388	many

In the mamdani method, the implication function used for each rule is a minimum function. After determining the membership function of a variable, fuzzy logic rules are formed. Based on the available data, fuzzy rules can be formed. Rules of analysis Evaluation of lecturers' scientific activities in terms of input variables and output variables As in table 2 below.

Table 2
Derivatives of Final Stage Evaluation Variables

Rule	Entrance		GO OUT	Final Score
1	A little	A little	→	A little
2	A little	Currently	→	A little
3	a little	many	→	Currently
4	Currently	a little	→	A little
5	Currently	Currently	→	Currently
6	Currently	many	→	many
7	many	a little	→	Currently
8	many	Currently	→	many
9	many	many	→	many

In this study, the discussion process was carried out in several stages, namely:

1. Determine the input variables taken from the lecturer's research assessment data, where the variables used are the sinta variable, the simlitabmas variable, and the journal cluster variable.
2. Fuzzification: determining the degree of membership of the input and output variables.
3. Fuzzy logic operations must be performed if the previous part of more than one statement performs fuzzy logic operations. The final result of this operation is the degree of truth of the antecedent, which is a single number. Fuzzy operators to perform operations and and or can be made independently.
4. Implication: Apply the implication method to determine the final form of fuzzy set output. The consequence or inference of a fuzzy rule is determined by filling the output of the fuzzy set with the output variable. The implication function used is Min.
5. Aggregation: The process of combining the outputs of all if-then rules into one fuzzy set using the Max function.
6. DefuzzificationThe inference process in the application of fuzzy statements uses the MIN implication function. In addition, the composition of all fuzzy outputs is done using max. Then do validation or called defuzzification using Centroid. In this method, a crisp solution is obtained by taking the center point of the fuzzy area as follows :

Fuzzy Statement Analysis Using Matlab

The validation of research evaluation data for graha nusanatara university lecturers using the mamadani method can also be done using the matlab fuzzy toolkit version R2013a. This software serves to interpret the variables of lecturer research activities

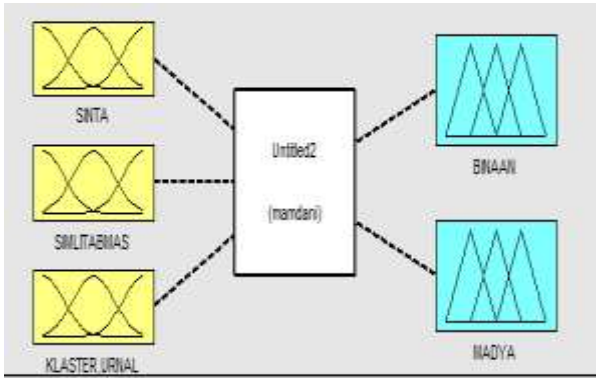


Fig 4. Input and output variables of the Mamdani method

This study has 3 input variables and 2 output variables. The input variables consist of Sinta, Simlitabmas, and cluster. 2020 and 2021. While the minor and interim release variables. This can be seen in Figure 4.

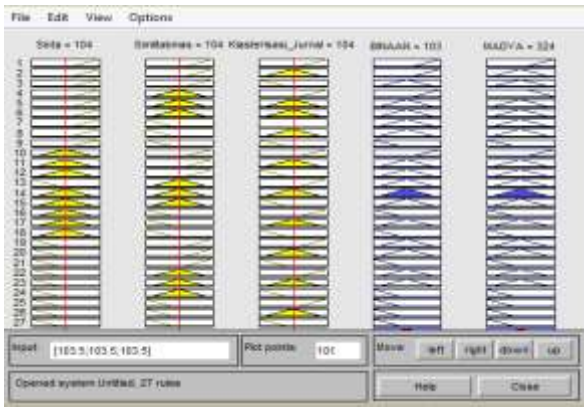


Fig 5. Defuzzification Calculation Process

Defuzzification fills the output variable with one number using the centroid or area center method. The last step in this implementation is the process of taking the input value to get the output value. In this study, the input value is 104, the initial output value is 103, and the final stage output is 324.

Measurement accuracy rate

The definition of accuracy is how close the measurement result is to the actual number. Because this study is so precise, we start with the number of measurements, the Y value of the Mamdani method, which uses a standard set of values to give the correct result. The default value of the Mamdani method is the value of the output variable for assessing lecturer research activities, determined using the membership function.

1. If the conclusion is the result of a fuzzy assessment, and the final assessment results are the same, then it is declared accurate.
2. If not, then the result is NOT ACCURATE
3. The result of the accuracy of the Mamdani method is 9 and the value of the fuzzy calculation is 16. Thus, the percentage of accuracy of the Mamdani method can be calculated.
4. To evaluate outstanding lecturers according to the following equation:

% Akurasi=((Jumlah aturan akurat))/(Nilai Fuzzy) X100

% Akurasi=((9))/16 X100= 56.25%

CONCLUSION

Based on the results of the tests and discussions that have been described, the following conclusions Fuzzy logic with the Mamdani method can be used to predict the evaluation of lecturer activities from the results of the panel research that has been carried out. There is a significant difference between the Matlab software and calculations performed manually. This system can only evaluate lecturer performance in general.

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