




Decision Support System in Determining the Job Waiting Period for Graduates of Unimed Using the Mamdani Method of Fuzzy Logic

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Abstract

During the job search period as an educated unemployed person, it takes time to be accepted into the world of work. The time required to look for a job is a matter of uncertainty. So, we need a system that can be used as a reference in determining the job waiting period for graduates. The graduate job waiting period is when someone has not found a job after graduation. Several factors influence this. In this research, the factors used as job waiting period variables are GPA, length of study and achievement. Every graduate certainly has a different job waiting period. This research aims to determine the job waiting period for Graduates of Unimed by designing a decision support system using the Fuzzy Mamdani method. This research uses quantitative methods. Data was obtained by distributing questionnaires to Graduates of Unimed. It is hoped that the decision support system for determining the job waiting period can encourage students, especially Universitas Negeri Medan students, to improve their quality before entering the job. With the help of Matlab software, a decision support system using the Mamdani method can be used to determine the waiting period, where the result is that the job waiting period for Graduates of Unimed is fast in the 0-3 month category.

INTRODUCTION

One measure of the success of higher education is the timeliness of graduation and the speed with which students find jobs. To enter the job, students must prepare many things according to the needs of the desired job. As long as someone is still in the waiting period or job search period, it is said that the person is educated and unemployed, known as frictional unemployment [1]. According to Tjiptoherijanto, a long period of unemployment is defined as waiting for someone in the workforce to get a job [2].

In 2019, the Ministry of Research, Technology and Higher Education revealed in its research that 8.8% of the 7 million unemployed in Indonesia were graduates. Several contributing factors are the economic crisis, an unbalanced employment structure, the need for the number and type of educated workforce, an unbalanced supply of educated workforce, and the workforce being greater than employment opportunities [3].

Universitas Negeri Medan is one of the state universities in North Sumatra. The vision of Universitas Negeri Medan is **"to become a superior university in the fields of education, industrial engineering and culture"** with the strategic aim of producing graduates who are superior and professionals who have a noble character, have nationalism, have a global perspective and are leaders of change. There are several indicators in achieving this goal, including the percentage of speed and timeliness of students graduating and the rate of graduates who immediately work and get decent jobs. The graduates' achievements show Unimed's success in providing education that can produce graduates with good competencies. GPA will influence how long it takes for graduates to get their first job [4]. Cumulative Achievement Index or GPA, length of study, and organizational activeness influence the waiting period for graduates [5]. Wages, education and age influence the length of time looking for work [6], and those that influence the length of time in finding work include age, education and income [7]. Organizational activity, financial resources, potential and skills, personal ability to compete, study length, graduation GPA, and continuing education influence the job waiting period [8].

During the job search period as an educated unemployed person, it takes time to be accepted into the job. The time required to look for a job is a matter of uncertainty. So, we need a system that can be used as a reference in determining the job waiting period for graduates, especially Graduates of Unimed. These results can be used to see and determine the level of study success and as a reference for the evaluation process in producing graduates who are expected to be in demand in the job and are also helpful in contributing to the national and international accreditation process of higher education.

Decision Support Systems (DSS) help provide various alternatives in the decision-making process. Fuzzy logic is needed for decision-making in complex problems with no definite solution. Fuzzy logic has the value of fuzziness or fuzziness between true and false [9]. Fuzzy logic can adapt to changes and uncertainty in problems and tolerate inaccurate data [10]. Based on this concept, Fuzzy logic can help determine the job waiting period of graduates so that it becomes a reference for students to get jobs, thereby reducing the occurrence of educated unemployment.

The concept of a decision support system was introduced in the 1960s through computer time sharing, namely being able to carry out direct interaction on a computer, which does not require the intermediary of an information specialist. Around 1971, Decision Support Systems began to be popularized by G. Anthony Gorry and Michael S. Scott Morton. A decision support system is a computer-based interactive system that can instruct decision-makers to use data and models in solving unstructured problems. According to Jopih, globally, a decision support system aims to increase the decision-maker's capacity by offering more or better decision options and assisting in formulating the problems and circumstances faced. Thus, SPK can save money, resources and time. Decision support systems are designed to increase effectiveness and efficiency [11].

Fuzzy logic is a branch of artificial intelligence systems that emulates thinking abilities into algorithms that machines can read and execute. This algorithm is used when binary representation is impossible in various data processing situations. Fuzzy logic can make the meaning of ambiguous or vague statements into a logical definition [12].

Ebrahim Mamdani first popularized the Mamdani method in 1975. The max-min method is another name for the Mamdani method. Because the set of rules is independent, the membership value for each rule in this method in the form of implication (cause and effect) of the antecedent in the form of a conjunction (AND) is minimum (*min*), while the combined consequent is in maximum form (max) [13]. Mamdani Fuzzy Logic is a very flexible method that tolerates existing data. The advantage of Fuzzy Mamdani is that it is more intuitive and accepted by many parties. Mamdani Fuzzy Logic is a very adaptable method for accepting existing data. Four stages must be completed to get the output: 1. Fuzzyfication 2. Form a fuzzy knowledge base (rules in the form of IF-THEN) 3. Application of the implication function using the MIN function and composition between rules using the MAX function to produce a new set 4. Defuzzification using the Centroid method [14].

Based on the description above, the researcher wants to determine the job waiting period for graduates based on GPA, length of study, and achievements by designing a Decision Support System application to Determine the Job Waiting Period for graduates of Unimed. Using Fuzzy Logic, the Mamdan Method—Matlab software.

METHODS

The research was quantitative, with case studies of Universitas Negeri Medan graduates already working. The type of data used in conducting research is primary data. Primary data was obtained from respondents through questionnaires distributed to Universitas Negeri Medan Graduates. The data adequacy test is carried out to ensure that the data that has been collected and presented is objectively sufficient. The data adequacy test can be processed using the Slovin

formula $n = \frac{N}{N(E)^2 + 1}$ [15]. Then, carry out data validity and reliability tests to produce a

research instrument that is relatively good and trustworthy for use as a data collection tool and is said to be valid $r_{hitung} > r_{tabel}$ and reliable if the Cronbach's Alpha reliability coefficient is > 0.70 and < 0.90 [16].

This research has three input variables: GPA, length of study, and achievement—The output variable is the job waiting period in three fuzzy sets (fast, medium, and long). The existing data will be processed using the Mamdani method and with the help of Matlab software. Matrix Laboratory, or Matlab, is a program that can complete calculations in matrix form. Cleve Moler released an early version of Matlab in 1970. Initially, Matlab's goal was to solve problems with linear algebraic equations. This application improves usability and computing performance [17]. Matlab comes in different colours due to its unique capabilities in mathematics, physics, statistics, and visualization functions. Matlab includes various functions that can be used as problem solvers for various problems, from the simplest to the most complex [9].

The stages are:

1. Formation of Fuzzy Sets

Defining fuzzy variables and sets is the first stage in the fuzzyfication process. After that, the level of conformity between the fuzzy input data and the fuzzy set determined for each system input variable derived from each fuzzy rule is ensured. The Mamdani method divides

input and output variables into one or more sets. Fuzzy sets have two characteristics, including *linguistic*, namely the use of natural language to identify a group that represents a specific condition, such as YOUNG, OLD, and OLD. A numerical value is a number value that indicates the size of a variable, as in 40, 25, 20, and so on [18].

2. Implication Function Application

Each proposition (rule) in a fuzzy line of knowledge will be associated with a fuzzy relation. The implication function using the general form of the rule is *if x is A then y is B* where x and y are scalars, and A, and B are fuzzy sets. The statement that appears after IF is called the *antecedent* t , and the statement that appears after then is called the *consequent*.

3. Composition of Rules

In this rule composition, inference is obtained from the collection and correlation between units if the system consists of several rules. Three methods are used to perform fuzzy inference: max, additive, and probabilistic OR. Rule composition determines the correlation between rules obtained through knowledge of the rules (Inference). The method used to perform composition between all rules is the max method.

4. Defuzzification (Assertion Method)

Defuzzification or confirmation is a method for mapping values from a fuzzy set into crisp values. In this case, defuzzification is obtained using the centroid method. In this method, a crisp solution is obtained by taking the center point of the fuzzy area with the formula [9].

$$z^* = \frac{\int_z z_\mu(z) dz}{\int_z \mu(z) dz}, \text{kontinu}$$

$$z^* = \frac{\sum_{j=1}^n z_j \mu(z_j)}{\int_{j=1}^n \mu(z_j)}, \text{diskrit}$$

Fuzzy set operations are needed for inference or reasoning. As with conventional sets, fuzzy sets can be combined and modified using several defined operations. Zadeh created three basic fuzzy set operators: AND, OR, and NOT [19].

5. Previous Research

The method is the simplest and is also frequently used. This method is called the MIN-MAX (min-max inferencing) method and has the advantage of being very flexible, more intuitive and accepted by many parties [14]. The Mamdani method has a simple structure; the results show that the decision support system using the Mamdani method can produce an accuracy of 98% [20]. The Mamdani method is more recommended in determining decisions because the calculation results are closer to the actual results than other methods [21].

RESULTS AND DISCUSSION

1. Mamdani Method Fuzzy Logic Calculation Process

a. Formation of Fuzzy Sets

Variable GPA covers three sets of fuzzy, namely;

Table 1. Set Fuzzy Variable GPA

No.	Mark	Level Fuzzy
1.	0-3	Low
2.	2.5-3.5	Medium
3.	3-4	High

Based on the table above, the membership function for each fuzzy set variable can be formed as follows:

- Low GPA variable

$$\mu[X_1] = \begin{cases} 1 & , \quad x_1 \leq 2,50 \\ \frac{3,00 - x_1}{0,5} & , \quad 2,50 \leq x_1 \leq 3,00 \\ 0 & , \quad x_1 \geq 3,00 \end{cases}$$

- Medium GPA variable

$$\mu[X_1] = \begin{cases} 0 & , \quad x_1 \leq 2,5 \vee x_1 \geq 3,5 \\ \frac{x_1 - 2,5}{0,5} & , \quad 2,5 \leq x_1 \leq 3 \\ \frac{3,5 - x_1}{0,5} & , \quad 3 \leq x_1 \leq 3,5 \end{cases}$$

- High GPA variable

$$\mu[X_1] = \begin{cases} 0 & , \quad x_1 \leq 3 \\ \frac{4 - x_1}{1} & , \quad 3 \leq x_1 \leq 4 \\ 1 & , \quad x_1 \geq 4 \end{cases}$$

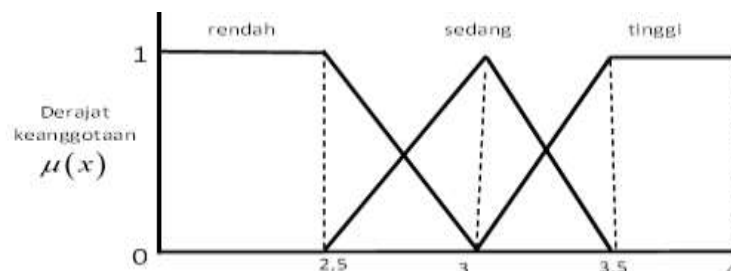


Figure 1. GPA Variable Membership Function

Variable Length of Study formed become three sets fuzzy, namely;

Table 2. Set Fuzzy Variable Long Studies

No.	Mark	Level Fuzzy
1.	7-10	Fast
2.	9-11	Medium
3.	10-14	Slow

Based on the table above, the membership function for each fuzzy set variable can be formed as follows:

- Variable Length of Study quickly

$$\mu[X_2] = \begin{cases} 1 & , \quad x_2 \leq 8 \\ \frac{10-x_2}{2} & , \quad 8 \leq x_2 \leq 10 \\ 0 & , \quad x_2 \geq 10 \end{cases}$$

- Medium Study Length Variable

$$\mu[X_2] = \begin{cases} 1 & , \quad x_2 \leq 9 \vee x_2 \geq 11 \\ \frac{x_2-9}{1} & , \quad 9 \leq x_2 \leq 10 \\ \frac{11-x_2}{1} & , \quad 10 \leq x_2 \leq 11 \end{cases}$$

- Study Length Variable is slow.

$$\mu[X_2] = \begin{cases} 0 & , \quad x_2 \leq 10 \\ \frac{x_2-10}{2} & , \quad 10 \leq x_2 \leq 12 \\ 1 & , \quad 12 \leq x_2 \leq 14 \end{cases}$$

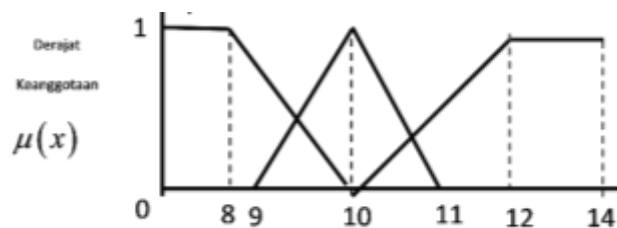


Figure 2. Membership Function of Study Length Variable

Variable Achievements are established to become three sets of fuzzy, namely,

Table 3. Set Fuzzy Variable Performance

No.	Mark	Level Fuzzy
1.	1-3	Little
2.	2-4	Medium
3.	3-10	Lots

Based on the table above, the membership function for each fuzzy set variable can be formed as follows:

- Few Achievement Variables

$$\mu[X_3] = \begin{cases} 1 & , \quad x_3 \leq 1 \\ \frac{3-x_3}{2} & , \quad 1 \leq x_3 \leq 3 \\ 0 & , \quad x_3 \geq 3 \end{cases}$$

- Medium achievement variable

$$\mu[X_3] = \begin{cases} 0 & , \quad x_3 \leq 1 \vee x_3 \geq 5 \\ \frac{x_3-3}{1} & , \quad 1 \leq x_3 \leq 3 \\ \frac{11-x_3}{1} & , \quad 3 \leq x_3 \leq 5 \end{cases}$$

- Lots variables are many.

$$\mu[X_3] = \begin{cases} 0 & , \quad x_3 \leq 3 \\ \frac{x_3-3}{2} & , \quad 3 \leq x_3 \leq 5 \\ 1 & , \quad 5 \leq x_3 \leq 10 \end{cases}$$

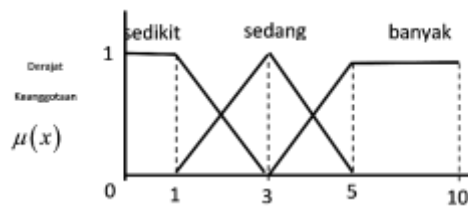


Figure 3. Achievement Variable Membership Function

The Job Waiting Period variable is formed into three fuzzy sets, namely

Table 4. Set Fuzzy Variable Waiting Period

No.	Mark	Level Fuzzy
1.	0-3	Fast
2.	3-6	Medium
3.	6-12	Long

Based on the table above, the membership function for each fuzzy set variable can be formed as follows:

- Variable Fast job waiting period

$$\mu[Y] = \begin{cases} \frac{3-y}{3}, & 0 \leq y \leq 3 \\ 0, & y \geq 3 \end{cases}$$

- Variable Medium job waiting period

$$\mu[Y] = \begin{cases} 0 & , \quad y \leq 3 \vee y \geq 6 \\ \frac{y-3}{1.5} & , \quad 3 \leq y \leq 5 \\ \frac{6-y}{1} & , \quad 5 \leq y \leq 6 \end{cases}$$

- Variable Long job waiting period

$$\mu[Y] = \begin{cases} 0 & , \quad y \leq 6 \\ \frac{y-6}{2} & , \quad 6 \leq y \leq 8 \\ 1 & , \quad y \geq 8 \end{cases}$$

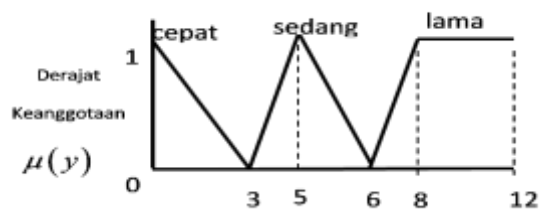


Figure 4. Variable Membership Function Job Waiting Period

b. Implication Function Application

Fuzzy rules were formed from input and output variables defined by analyzing data on the boundaries of each fuzzy set for each variable—twenty-seven fuzzy rules are in Table 5.

Table 5. Fuzzy Logic Rules

No	IF	IPK	And	Length of Study	And	Performance	Then	Waiting Period
1	if	Low	And	Slow	And	Lots	Then	Medium
2	if	Low	And	Slow	And	Medium	Then	Lama
3	if	Low	And	Slow	And	Little	Then	Lama
4	if	Low	And	Medium	And	Lots	Then	Medium
5	if	Low	And	Medium	And	Medium	Then	Lama
6	if	Low	And	Medium	And	Little	Then	Lama
7	if	Low	And	Fast	And	Lots	Then	Medium
8	if	Low	And	Fast	And	Medium	Then	Medium
9	if	Low	And	Fast	And	Little	Then	Medium
10	if	Medium	And	Slow	And	Lots	Then	Medium
11	if	Medium	And	Slow	And	Medium	Then	Medium
12	if	Medium	And	Slow	And	Little	Then	Lama
13	if	Medium	And	Medium	And	Lots	Then	Fast
14	if	Medium	And	Medium	And	Medium	Then	Medium
15	if	Medium	And	Medium	And	Little	Then	Medium
16	if	Medium	And	Fast	And	Lots	Then	Fast
17	if	Medium	And	Fast	And	Medium	Then	Medium
18	if	Medium	And	Fast	And	Little	Then	Medium
19	if	High	And	Slow	And	Lots	Then	Medium
20	if	High	And	Slow	And	Medium	Then	Medium
21	if	High	And	Slow	And	Little	Then	Medium
22	if	High	And	Medium	And	Lots	Then	Fast
23	if	High	And	Medium	And	Medium	Then	Fast

No	IF	IPK	And	Length of Study	And	Performance	Then	Waiting Period
24	if	High	And	Medium	And	Little	Then	Medium
25	if	High	And	Fast	And	Lots	Then	Fast
26	if	High	And	Fast	And	Medium	Then	Fast
27	if	High	And	Fast	And	Little	Then	Fast

1. Matlab R2017b program in the Mamdani Fuzzy Logic calculation process

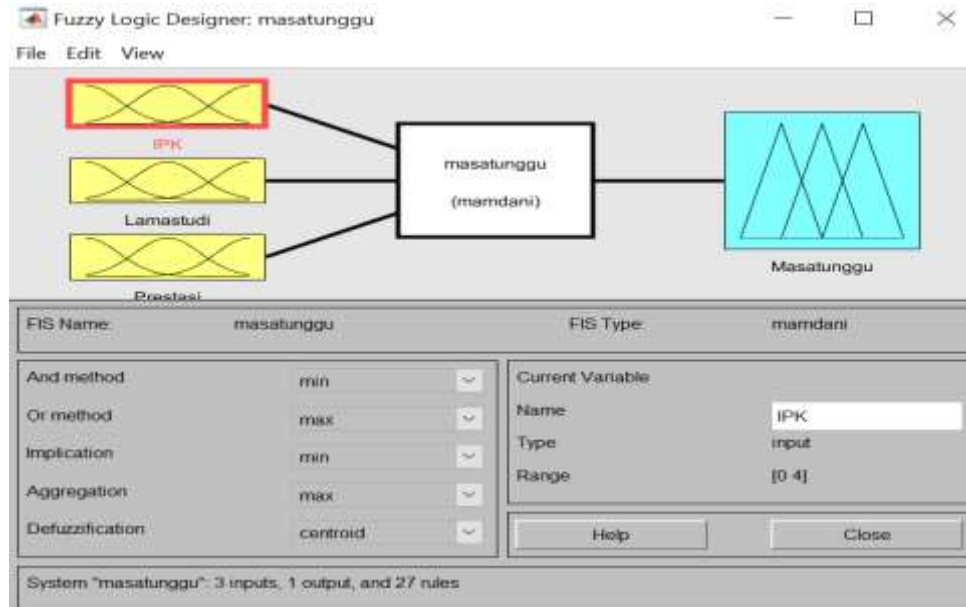


Figure 5. FIS Variable Editor Display

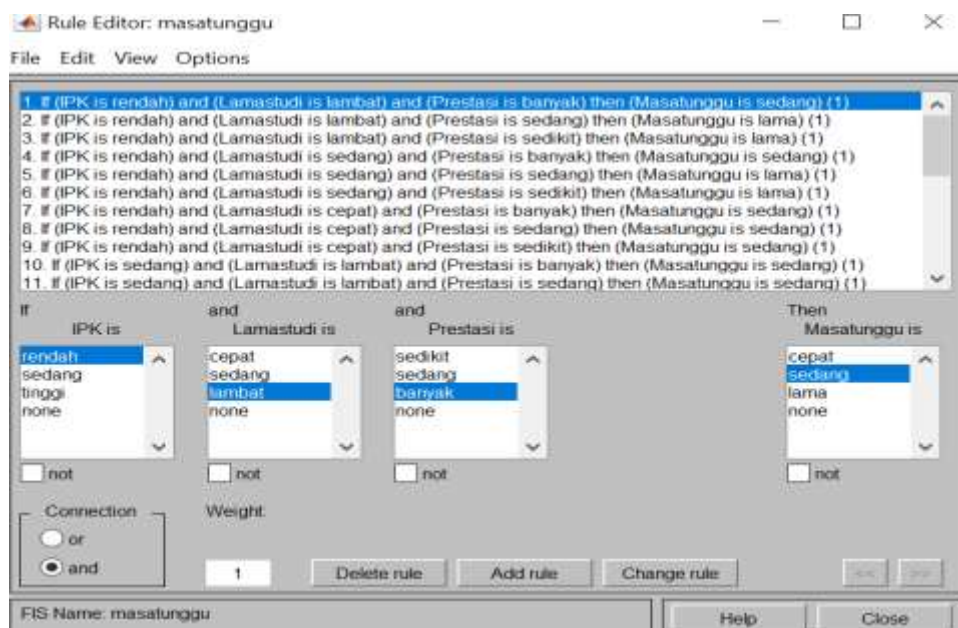


Figure 6. Rule Editor Display

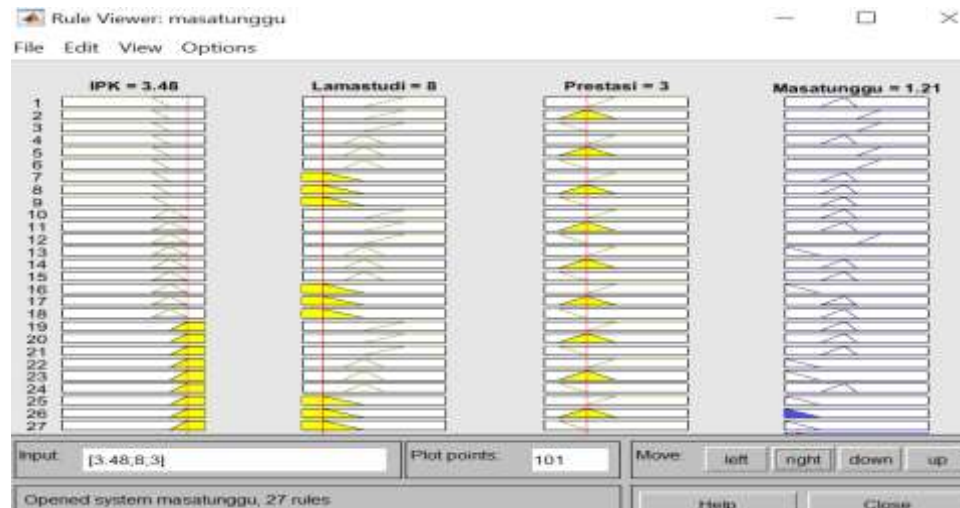


Figure 7. Waiting Period Calculation System

2. Designing a Job Waiting Period Application using the MATLAB GUI



Figure 8. Application display

Based on the results of using simulation with Matlab, the data obtained on the job waiting period of graduates with accurate data and using fuzzy Mamdani is as follows:

Table 6. Matlab simulation results

No.	GPA	Length of Study	Performance	Waiting Period	Mamdani	Error	MSE
1.	3.46	10	7	1	0.969	0.0031	0.000961
2.	3.45	8	2	2	1.8	0.2	0.04
...
100.	3.61	8	8	0	0.96	0.96	0.9216

3. Mean Square Error (MSE)

There are several indicators for measuring accuracy, including MSE (Mean Square Error = Average Square Error). Accuracy will be better if the MSE value is smaller [22]. From the results of applying fuzzy Mamdani to the Matlab program, accuracy calculations were carried out using MSE (Mean Squarer Error) as follows :

$$\begin{aligned} MSE &= \frac{1}{M} \sum (\hat{y}_i - y_i)^2 \\ &= \frac{1}{100} (129.137) \\ &= 1,29 \end{aligned}$$

CONCLUSION

Based on the research results, it can be concluded that the fuzzy Mamdani method decision support system for determining the job waiting period for Graduates of Unimed using the variables GPA, Length of Study and Achievement with a fuzzy set can be implemented using the MATLAB program with an MSE value of 1.29. Based on this system, the results show that the job waiting period for Graduates of Unimed graduating from 2020-2021 is fast. Based on the predetermined criteria, the job waiting period for graduates is in the 0-3 month category.

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