



Application of The Fuzzy Mamdani Method in Determining KIP-Kuliah Recipients for New Students

Yoga Ardiansah^{1*}, Nanda Try Luchia², Delvi Hastari³, T. M. Fathin Rifat⁴,
Rendhy Rachfaizi⁵, Nanda Aulia Putri⁶, Ella Silvana Ginting⁷

^{1,2,3}Department of Information System, Faculty Science and Technology,
Universitas Islam Negeri Sultan Syarif Kasim Riau, Indonesia

⁴Department of Internet Engineering Technology, Vocational High School,
Universitas Gajah Mada, Indonesia

⁵Department of Telecommunication Engineering, Faculty Electrical Engineering,
Telkom University, Indonesia

⁶Department of Electrical Engineering, Lunghwa University of Science and Technology, Taiwan

⁷Department of Management, Faculty of Technology Management and Business,
University Tun Hussein Onn Malaysia, Malaysia

E-Mail: ¹yogaard232@gmail.com, ²12050320445@students.uin-suska.ac.id,
³delvihastari19@gmail.com, ⁴tmfathin02@gmail.com, ⁵rendhyrachfaizi@gmail.com,
⁶nandaauliaputri29@gmail.com, ⁷ellaginting86@gmail.com

Received Dec 23th 2023; Revised Mar 10th 2024; Accepted Apr 18th 2024
Corresponding Author: Yoga Ardiansah

Abstract

Lectures are the last level of education passed. However, the opportunity to obtain further education cannot be owned just like that by everyone because of the economic factors they experience. Therefore, an assessment method is needed to support the decision of KIP-Kuliah recipients at the lecture level for new students within the Faculty of Science and Technology, Universitas Islam Negeri Sultan Syarif Kasim Riau. This research applies the Fuzzy Mamdani algorithm with Fuzzy Logic and is expected to be able to provide recommendations for worthy scholarship recipients so that the assistance provided is right on target. The results showed that 26,7% of students received the rejected status. Several experiments conducted, illustrate the performance of Fuzzy Logic in this research is very powerful in determining policies and as decision support. The implementation of the research results recommends the best selection from a series of decisions making.

Keyword: Decision Making, Fuzzy Mamdani, KIP-Kuliah, New Students, Recommendation

1. INTRODUCTION

An important factor to produce a bright future is getting the opportunity for further education [1]. However, not everyone has the opportunity to get further education due to the economic factors they experience [2]. Educational assistance programs known as scholarships are generally under the authority of the government, private companies or a foundation [3]. The Indonesian government offers assistance with two important criteria, namely economic need and academic achievement. Prospective recipients must qualify as people who come from families with weak economies but have good academic performance [4]. Government assistance has been started since 2010, this assistance has always been the target of many people from economically disadvantaged families. Prospective recipients of education assistance always increase every year, this is together with limited quotas and imbalances that cause the selection committee to experience difficulties [5].

The provision of scholarships is a way for the government to provide students who are good in terms of academic achievement, but less capable in terms of economic [6]. This makes scholarships one of the allowances provided by the government to individuals as tuition assistance so that they can complete their obligations to get knowledge to the final level. Scholarships take many forms. Most commonly such as helping with the costs that students must incur while studying at the academy [7]. Discipline and thoroughness are important factors in the selection process of prospective scholarship recipients to ensure that the selected recipients will be recipients who meet the criteria [8]. This learning assistance is provided with the qualifications, quality, and competence of scholarship recipients for deserving and appropriate students [9].



The determination of this educational assistance is carried out by selecting prospective recipients with the required criteria. If the prospective recipient progresses, the selection process will spend more time in order to produce the right candidate.

There are many other factors outside the criteria that make the determination of prospective recipients hampered [1], this is what triggers the occurrence of recipient discrepancies [2]. The possibilities that arise in the selection process are carried out by comparing one by one the criteria of each prospective recipient according to predetermined rules to find the best alternative value [10]. In this case, an assessment method is needed to support the decision of scholarship recipients which can reduce the selection process time [11], improve the quality of scholarship decisions so that the results obtained are objective and in accordance with the assessment criteria [8]. This is also applied in determining KIP-Kuliah recipients for new students within the Faculty of Science and Technology, Universitas Islam Negeri Sultan Syarif Kasim Riau.

Several studies in determining scholarship recipients have been applied before, such as research conducted by Humaira and friends in 2021 by applying the Fuzzy Mamdani Algorithm to support scholarship recipient decisions. Accuracy performance results were obtained which was 85% [12]. In 2022, Savitri and Suhaedi conducted another study with an accuracy of 92.1835%, this can be used as an example and guideline in the process of determining recipient status [13]. Previous research used nine parameters as input attributes, namely income, expenditure, house area, floor area per capita, distance of the house to the city, water source, sanitation, and electricity. This is solved using a fuzzy logic system (FLS). Some researchers are partly trying to improve FLS performance by improving training methods [5]. In 2023, Kholifaturrahman et al conducted research for the provision of decision support system recommendations using fuzzy mamdani. this study obtained a MAPE evaluation value of less than 10% which means very good [14]. Tran Manh Tuan et al conducted research in 2020 to implement the Mamdani Complex Fuzzy Inference System with Rule Reduction Using the M-CFIS-R Measure. The advantage obtained is the increase in overall system performance [15]. Another research was conducted by Salsabila Naura Putri and D R S Saputro who built fuzzy logic with curve shoulder in the mamdani inference system. The result shows five steps that used to construct inference system Mamdani which are fuzzification, operator fuzzy logic, implication, aggregation, and defuzzification [16].

Fuzzy inference systems help produce precise and accurate potential participants [17], as well as having a greater level of reality [18]. The Mamdani method is also used for decision making in the form of recommendations by conducting a fuzzification process using the center of gravity method [19]. This method has a remarkable ability to map an input to an output to provide research results that are always interesting [12]. This is due to the advantages of the fuzzy mamdani method which has a membership function as an example of a person's value pattern by focusing on linguistic values [20], as well as presenting a very easy-to-understand method that can solve time series data problems and time-periodic phenomena [21]. Therefore, this study will apply the Fuzzy Mamdani algorithm with Fuzzy Logic in determining KIP-Kuliah recipients for new students within the Faculty of Science and Technology, Sultan Syarif Kasim State Islamic University Riau. This research is expected to be able to provide recommendations for worthy scholarship recipients so that this educational assistance can be spread well.

This research focuses on sample data found around the case study. The data used amounted to 15 students. Not only recommendations, researchers hope this research will help future research to get benchmarks related to scholarship recommendations at the college level with a variety of different but interrelated variables.

2. MATERIAL AND METHOD

The stages contained in this study can be seen in Figure 1.

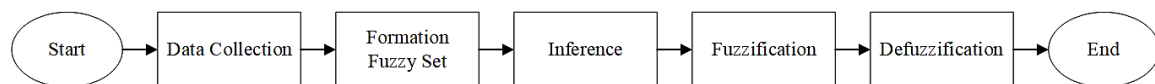


Figure 1. Research Methodology

Based on Figure 1, the research started from the data collection process carried out by distributing a questionnaire through the google form platform to new students in the research case study environment. After that, process by process is carried out according to the sequence of research to the final stage, namely the acquisition of research results.

One fuzzy method that is also often referred to as the Max-Min Method is Fuzzy Mamdani which was introduced in 1975 by Ebrahim Mamdani. There are 4 stages in this method in order to obtain the required output, namely [22]:

1. Fuzzy Set

Inputs and outputs are variables that split into fuzzy sets in this process. The fuzzification function will be appropriate when an input variable is specified.

2. Implication Function

In this stage, the relationship between variables becomes an implication function rule by using the min formula to express what the input variable relates to the output. The calculation process can be seen equation 1.

$$\min(\mu_{sf}(x_i), \mu_{kf}(x_i)) \tag{1}$$

3. Composition of Rules

The inference process is obtained through a collection of rules or their correlations. The fuzzy inference process is carried out with 3 methods. In this study using the Max Method (Maximum). This method works to obtain the result of the fuzzy set by calculating the maximum value and changing the fuzzy region so that it can be applied to the output with the union operator (OR) [23]. The formula 2 in general, namely.

$$\mu_{sf}(x_i) = \max(\mu_{sf}(x_i), \mu_{kf}(x_i)) \tag{2}$$

4. Defuzzification

This process is the process of inputting rule composition by using fuzzy sets. While the output is a number that exists in the domain of the fuzzy set and has been generated from each process [24]. Therefore, if the fuzzy set is within the scope of a range, then the output value is obtained from the value of a given range. The defuzzification method has a mamdani rule composition method, namely [25]. The center point (z^*) of the fuzzy region is the result of defuzzification [26]. The center point of the continuous variable used in this method is formulated 3.

$$z^* = \frac{\int_a^b z \cdot \mu(z) \cdot dz}{\int_a^b \mu(z) \cdot dz} \tag{3}$$

As for discrete variables formulated 4.

$$z^* = \frac{\sum_{j=1}^n z_j \cdot \mu(z_j)}{\sum_{j=1}^n \mu(z_j)} \tag{4}$$

3. RESULTS AND DISCUSSION

The data used in this study was obtained from a google form questionnaire filled out by 15 new students of the Faculty of Science and Technology, Sultan Syarif Kasim State Islamic University Riau. The input variables in this study are five variables, while the output variable is KIP-Lecture Status.

3.1. Fuzzy Set

The most important thing in the processing of the fuzzy method is the formation of fuzzy assemblies. In the fuzzy method, it is necessary to form a fuzzy set based on existing variables as in Table 1.

Table 1. Fuzzy Set

Function	Variables	Fuzzy set	Domain
Input	GPA	Low	2,00-3,00
		Medium	2,50-3,50
		High	3,00-4,00
	Parental Income (POT)	Low	IDR 500,000 – IDR 2,000,000
		Medium	IDR 1,000,000 - IDR 3,000,000
		High	IDR 3,000,000 - IDR 4,000,000
	Electricity Bill (TL)	Low	IDR 20,000 - IDR 220,000
		Medium	IDR 120,000 - IDR 320,000
		High	IDR 220,000 – IDR 420,000
	Parental Dependents (TOT)	Low	1-3
		Medium	2-4
		High	3-5
	Number of Vehicles (JK)	Low	None
		Medium	Less than 2
		High	More than 2
Output	KIP-College Status	Accepted	31-60
		Rejected	20-30

In Table 1, it can be seen that all input variables have three fuzzy sets each. This fuzzy set is used so that the membership function of each variable can be constructed by providing an overview of mapping points in the membership degree data input. The variable membership functions GPA, Income, Utility bill, Parental dependents and Number of vehicles can be described by a curve that can be seen in Figure 2.

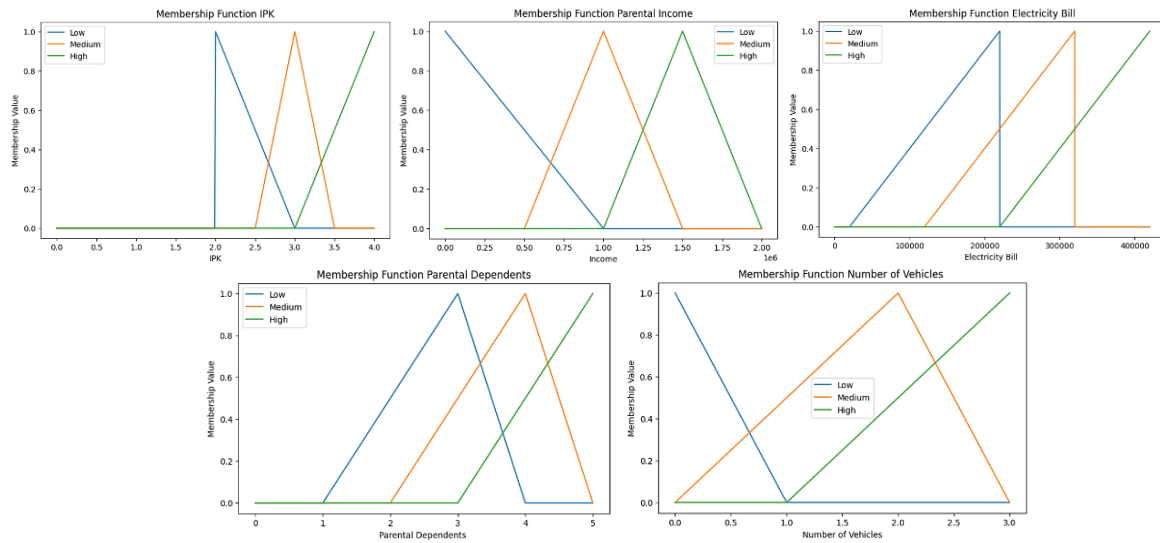


Figure 2. Membership Function

In Figure 2, you can see the membership function of each variable from GPA to the number of vehicles owned by students. The function in each variable indicates the membership value on the curve of a variable with input data points that undergo the mapping process. Figure 2 above displays the membership function curves that have been obtained by each variable.

3.2. Establishment of Rule Fuzzy Inference System

The next process is done by determining the rules used to calculate the fuzzy inference system output value. These rules that are formed can be seen in Table 2.

Table 2. Results of rules formed in fuzzy inference

Rules	GPA	POT	TL	TOT	JK	Output
1	Medium	High	Low	Medium	Medium	Medium
2	High	Medium	Low	High	Medium	High
3	High	High	High	Low	Low	High
4	High	Medium	High	High	Medium	High
5	High	Medium	Medium	Medium	High	High
6	High	High	Low	Low	Medium	High
7	High	High	Low	Medium	Medium	High
8	High	High	Low	High	Low	High
9	High	High	High	High	Medium	High
10	High	High	Low	Medium	Medium	High
11	Medium	High	Low	Low	Medium	Low
12	Medium	Medium	Low	Low	Medium	Low
13	Medium	High	Medium	Low	Low	Low
14	High	Medium	Medium	Medium	Low	Medium
15	High	Medium	High	High	Low	High

Table 2 shows that there are 15 fuzzy inference system rules from 15 student data. Each input variable affects the output that will be generated in each rule. All these rules utilize fuzzy logic in order to get the output from the pre-mapped inputs.

3.3. Fuzzification Process

The fuzzification stage works by calculating the value of the membership degree in the overall data. The membership degrees obtained from the 15 existing data can be seen in Table 3.

Table 3. Membership Degrees

Name	Input Variables	Low	Medium	High
Ms1	GPA	0,05	0,90	0,00
	POT	0,00	0,00	0,80
	TL	0,90	0,40	0,00
	TOT	0,00	1,00	0,50
	JK	0,00	1,00	0,50
Ms2	GPA	0,00	0,00	0,76
	POT	0,00	0,97	0,02
	TL	0,40	0,00	0,00
	TOT	0,00	0,00	1,00
	JK	0,00	0,00	1,00
...
Ms15	GPA	0,00	0,00	0,76
	POT	0,00	0,00	0,00
	TL	0,00	0,00	0,65
	TOT	0,00	0,00	1,00
	JK	0,00	0,50	0,00

Table 3 is the result of mapping the previous membership function curve. The acquisition of this membership degree is seen based on the variables contained in the research and the fuzzy set used. In general, the membership value interval rotates around 0-1.

3.4. Defuzzification

The defuzzification process in this study used the centroid method. Based on the calculation of defuzzification, the calculation results can be seen in Table 4.

Table 4. Calculation Results by Centroid Method

Name	GPA	Parents' income	Electricity bills	Dependent parents	Number of vehicles	Z value
Ms1	2,95	1600000	200000	4	2	49,3
Ms2	3,76	1012552	100000	5	3	24,94
Ms3	3,88	1700500	350000	3	1	45,13
Ms4	3,15	1050200	400000	5	2	53,11
Ms5	3,35	2500600	300000	4	3	42,44
Ms6	3,8	1770500	200000	3	4	49,92
Ms7	3,5	1340600	100000	4	2	23,59
Ms8	3,47	1300300	450000	5	1	30,01
Ms9	3,87	2600500	350000	5	3	49,7
Ms10	3,69	1860200	150000	4	2	53,92
Ms11	3,33	1300500	150000	2	3	44,36
Ms12	2,95	2050000	100000	3	2	56,47
Ms13	3	3050000	250000	3	1	52,04
Ms14	3,5	1010600	450000	4	1	24,95
Ms15	3,76	2500600	350000	5	1	49,46

Table 4 shows that out of 15 students, 26.7% of students get KIP-College Rejected status. While the other 73.3% get the KIP-College Accepted status. This acquisition is based on each calculation of the fuzzy mamdani stages of each input variable used in this study. The smaller the z value obtained by a student, the more likely he gets a rejected status. In this study, 4 out of 15 students received rejected status because the resulting z value was smaller than 31.

4. CONCLUSION

Based on the fuzzy mamdani method with fuzzy logic, the calculation results of determining the admission status of KIP-Kuliah were obtained from 15 new students at the Faculty of Science and Technology, Sultan Syarif Kasim State Islamic University Riau with 4 stages, namely, Fuzzy Association, Fuzzy Inference System Rule, Fuzzification to Defuzzification using the centroid method. After calculation, it was obtained from a total of 15 new students, 26,7% students were rejected while 73,3% others were accepted. This proves that determining the admission status of KIP-Kuliah from 15 new students at the Faculty of Science and Technology, Sultan Syarif Kasim State Islamic University Riau with the fuzzy mamdani method can provide an overview of the list of students who deserve assistance and get recommendations. The calculation of fuzzy mamdani using fuzzy logic also provides a precise and accurate determination of the admission status of KIP-

Lecture. Future research can apply the same variables but by focusing on comparing other fuzzy logic methods. Future research can also add more variables to see what factors can affect the fuzzy logic process in providing recommendations for scholarship recipients at the school level.

REFERENCES

- [1] I. Djufri, M. Abdurahman, and R. S. Sukur, "Sistem Pendukung Keputusan Seleksi Beasiswa PPA pada Akademi Ilmu Komputer Ternate Menggunakan Metode Topsis," *J. Sci. Technol.*, vol. 1, no. 1, pp. 1–12, 2020, doi: <https://doi.org/10.51135/justevollissue1page1-12>.
- [2] E. Prayitno and R. A. P. Putra, "PENERAPAN METODE TOPSIS DALAM PENGAMBILAN KEPUTUSAN PEMBERIAN BEASISWA PENDIDIKAN," vol. 2, no. 11, pp. 4461–4468, 2023, doi: <http://bajangjournal.com/index.php/JC>.
- [3] Y. Pratama, M. Pasaribu, J. Nababan, D. Sihombing, and D. Gultom, "Selection of Scholarship Recipient by Implementing Genetic Algorithm and Fuzzy Logic," *J. Phys. Conf. Ser.*, vol. 1933, no. 1, 2021, doi: 10.1088/1742-6596/1933/1/012069.
- [4] R. Rusmiati Aliyyah, U. Rosyidi, and R. Yazid, "An Evaluative Study of an Education Scholarship Program (BidikMisi) for Students in Indonesia," *J. Phys. Conf. Ser.*, vol. 1175, no. 1, 2019, doi: 10.1088/1742-6596/1175/1/012171.
- [5] R. P. F. Amaral, M. V. Ribeiro, and E. P. de Aguiar, "Type-1 and singleton fuzzy logic system trained by a fast scaled conjugate gradient methods for dealing with binary classification problems," *Neurocomputing*, vol. 355, pp. 57–70, 2019, doi: 10.1016/j.neucom.2019.05.002.
- [6] A. S. Nugroho, B. Murkhadam Budiantoro, B. A. Setiawan, and F. Mulyadi, "Analisis Perbandingan Metode SAW, WP, dan TOPSIS Pada Sistem Pendukung Keputusan Pemberian Beasiswa," *J. Ilmu Komput. dan Pendidik.*, vol. 1, no. 2, pp. 170–179, 2023, doi: <https://www.journal.mediapublikasi.id/index.php/logic/article/view/1534>.
- [7] R. Renaldo, E. Y. Anggraeni, and E. R. HC, "Metode Topsis Dalam Sistem Pendukung Keputusan Penentuan Penerimaan Beasiswa Di Stmik Pringsewu," *Expert J. Manaj. Sist. Inf. dan Teknol.*, vol. 9, no. 1, 2019, doi: 10.36448/jmsit.v9i1.1225.
- [8] A. Kurniawan, A. Firmansyah, F. A. Aziz, R. F. Sidhiq, and P. Rosyani, "Perbandingan Proses Seleksi Beasiswa PMDK dengan Metode SAW, WP dan TOPSIS," vol. 1, no. 2, pp. 161–169, 2023, doi: <https://www.journal.mediapublikasi.id/index.php/logic/article/view/1548>.
- [9] D. Ayudia, G. W. Nurcahyo, and S. Sumijan, "Optimalisasi Penentuan Kriteria Penerima Bantuan Program Indonesia Pintar dengan Metode TOPSIS," *J. Sistim Inf. dan Teknol.*, vol. 3, pp. 142–149, 2021, doi: 10.37034/jsisfotek.v3i3.58.
- [10] A. T. Cahyono, A. Wahyudi, F. Ramadhan, and A. Septian, "Analisis Perbandingan Metode Topsis, SAW dan AHP Dalam Menentukan Penerima Beasiswa SMA Di Al-fatih Parung," vol. 1, no. 3, pp. 504–509, 2023, doi: <https://journal.mediapublikasi.id/index.php/logic/article/view/1697>.
- [11] I. Dwi Jaya, "Sistem Pendukung Keputusan Kelompok Penerimaan Beasiswa PPA Menggunakan Metode TOPSIS dan BORDA," *Teknomatika*, vol. 13, no. 01, pp. 1–12, 2023, doi: <http://ojs.palcomtech.ac.id/index.php/teknomatika/article/view/589>.
- [12] Humaira, Rasyidah, Junaldi, and I. Rahmayuni, "The comprehensive Mamdani inference to support scholarship grantee decision," *Int. J. Informatics Vis.*, vol. 5, no. 2, pp. 120–126, 2021, doi: 10.30630/joiv.5.2.449.
- [13] A. Yunan and M. Ali, "Study and Implementation of the Fuzzy Mamdani and Sugeno Methods in Decision Making on Selection of Outstanding Students at the South Aceh Polytechnic," *J. Inotera*, vol. 5, no. 2, pp. 152–164, 2020, doi: 10.31572/inotera.vol5.iss2.2020.id127.
- [14] M. Kholifaturrahman, S. Rachmatullah, and B. Said, "Decision Support System for Single Tuition Scholarship Awardees in Higher Education Using Mamdani Fuzzy Inference," *J. Inf. Technol. Cyber Secur.*, vol. 1, no. 2, pp. 85–97, 2023, doi: 10.30996/jitcs.10009.
- [15] T. M. Tuan et al., "M-CFIS-R: Mamdani complex fuzzy inference system with rule reduction using complex fuzzy measures in granular computing," *Mathematics*, vol. 8, no. 5, 2020, doi: 10.3390/MATH8050707.
- [16] S. N. Putri and D. R. S. Saputro, "Construction fuzzy logic with curve shoulder in inference system mamdani," *J. Phys. Conf. Ser.*, vol. 1776, no. 1, 2021, doi: 10.1088/1742-6596/1776/1/012060.
- [17] M. Munawaroh, "Analisa dan Penerapan Fuzzy Inference System Metode Mamdani untuk Penentuan Penerima Beasiswa," *Int. J. Artif. Intell.*, vol. 6, no. 1, pp. 21–52, 2019, doi: 10.36079/lamintang.ijai-0601.31.
- [18] S. A. Savitri and D. Suhaedi, "Penerapan Inference Fuzzy Mamdani dalam Seleksi Penerima Bantuan Sosial Tunai Kabupaten Belitung Timur," *J. Ris. Mat.*, pp. 163–172, 2022, doi: 10.29313/jrm.v2i2.1383.
- [19] R. P. Finotti Amaral, I. F. M. Menezes, and M. V. Ribeiro, "An extension of the type-1 and singleton fuzzy logic system trained by scaled conjugate gradient methods for multiclass classification problems," *Neurocomputing*, vol. 411, pp. 149–163, 2020, doi: 10.1016/j.neucom.2020.05.052.

- [20] H. Humaira, R. Rasyidah, and I. Rahmayuni, "Designing mamdani fuzzy inference systems for decision support systems," Proc. ICAITI 2019 - 2nd Int. Conf. Appl. Inf. Technol. Innov. Explor. Futur. Technol. Appl. Inf. Technol. Innov., no. 1, pp. 111–115, 2019, doi: 10.1109/ICAITI48442.2019.8982153.
- [21] G. Selvachandran et al., "A New Design of Mamdani Complex Fuzzy Inference System for Multiattribute Decision Making Problems," IEEE Trans. Fuzzy Syst., vol. 29, no. 4, pp. 716–730, 2021, doi: 10.1109/TFUZZ.2019.2961350.
- [22] S. Latif, S. Suryadi, and R. Maulana, "PENYAKIT MATA MENGGUNAKAN METODE MAMDANI," JURNALFATEKSA J. Teknol. dan Rekayasa, vol. 8, no. 1, pp. 45–57, 2023, doi: <https://uswim.e-journal.id/fateksa/article/view/474>.
- [23] V. M. Nasution and G. Prakarsa, "Optimasi Produksi Barang Menggunakan Logika Fuzzy Metode Mamdani," J. Media Inform. Budidarma, vol. 4, no. 1, p. 129, 2020, doi: 10.30865/mib.v4i1.1719.
- [24] A. H. Nasyuha, M. Hutasuhut, and M. Ramadhan, "Penerapan Metode Fuzzy Mamdani Untuk Menentukan Stok Produk Herbal Berdasarkan Permintaan dan Penjualan," J. Media Inform. Budidarma, vol. 3, no. 4, p. 313, 2019, doi: 10.30865/mib.v3i4.1354.
- [25] W. Ismarnita and Respitawulan, "Penerapan Logika Fuzzy dalam Menentukan Tingkat Kerawanan Longsor di Suatu Wilayah," J. Ris. Mat., pp. 45–54, 2023, doi: 10.29313/jrm.v3i1.1737.
- [26] D. R. Setiawan, K. Kustanto, and Y. R. W. Utami, "Penentuan Jumlah Produksi Baju Batik Di Batik Merak Manis Dengan Metode Fuzzy Mamdani," J. Teknol. Inf. dan Komun., vol. 7, no. 1, pp. 42–48, 2019, doi: 10.30646/tikomsin.v7i1.417.