OPEN ACCESS
J. OF INISTA, VOL. 6, NO. 2, PP.108-115, MAY 2024

ISSN : 2622-8106 (ONLINE)
DOI 10.20895/INISTA.V6I2.1030

Journal of Informatics, Information System, Software Engineering and Applications

The Applications of Mamdani Fuzzy in Water Selection of Pangas Catfish Ponds

Laureta Mauren Michelli [1], Hardian Alkori [2], Firda Kamal [3], Rexy Gilang Ramadhan [4], Rizki Mugi Setya Adi [*5], Auliya Burhanuddin [6]

[1,2,3,4,5,6] *Informatics Engineering, Telkom Purwokerto Institute of Technology*
Jl. DI Panjaitan No. 128, South Purwokerto, Indonesia

[1] 20102002@ittelkom-pwt.ac.id
[2] 20102153@ittelkom-pwt.ac.id
[3] 20102125@ittelkom-pwt.ac.id
[4] 20102144@ittelkom-pwt.ac.id
[5] 20102156@ittelkom-pwt.ac.id
[6] auliya@ittelkom-pwt.ac.id

[*] *Second Company*
Address Including Country Name

[2] second.author@second.com

Received on 30-03-2023, revised on 04-05-2023, accepted on 20-02-2024

Abstract

In fisheries, the selection of pond water for Pangas catfish is essential because it affects the production and quality of fish. This research aims to apply the Mamdani fuzzy method in selecting suitable pond water for Pangas catfish. The method includes collecting data on water quality and environmental conditions, constructing the Mamdani fuzzy system, and evaluating the results of pond water selection. The study results show that the Mamdani fuzzy method can provide a suitable solution in selecting pond water for Pangas catfish by combining several factors such as temperature, pH, and oxygen solubility. The quality of water can be determined by evaluating the z-calculation results. If the z value is close to 1 or higher, the water quality is considered good, while a z value close to or less than 0 indicates poor water quality. This concept can be considered when selecting suitable pond water for Pangas catfish to increase fish production and quality.

Keywords: Mamdani fuzzy, Pangas catfish, Selection of ponds water

Corresponding Author:
* Rizki Mugi Setya Adi
Informatics Engineering, Telkom Purwokerto Institute of Technology
Jl. DI Panjaitan No. 128, South Purwokerto, Indonesia
Email: 20102156@ittelkom-pwt.ac.id

I. INTRODUCTION

FISH are aquatic animals that are a food source that humans need[1]. Pangas catfish is a type of fresh fish with a slender body, silvery-white color, and blue back. This fish has no scales, the head is relatively small, and the mouth is slightly down at the tip of the head, characteristic of catfish[2]. The dorsal fin has stiff, serrated fingers on the back. The caudal fin is forked and symmetrical in shape.

Pangas catfish have a large size, eat anything, and tolerate poor water conditions and low water pH due to the relatively low dissolved oxygen concentration (O_2)[3]. Pangas catfish are nocturnal (activity takes place at night). In addition, Pangas catfish like to hide in holes along the banks of the river where they live[4].

Pangas catfish (Pangasius) is a fish species that plays a role in Indonesia’s economic development, and according to data from the Directorate General of Aquaculture (2019), Pangas catfish production increased by 391.151 tons in 2018 or an increase of 22.25% compared to 319.966 tons in 2017[5]. Pangas catfish is a superior freshwater culture product rich in white meat[6]. The entrepreneurial potential of the aquaculture industry is increasingly attractive, along with the increasing demand for freshwater fish farming from the current average, so it requires attention from all parties to increase freshwater fish production.

The success rate of freshwater fish farming depends on the environment, namely soil and water. Soil is a determining factor in the success of cultivation, and suitable soil is loam or clay[7]. Water is also an absolute necessity for fish survival. For cultivation to be optimal, constant attention must be paid to the quantity and quality of water[1].

In cultivating Pangas catfish, of course, some things need to be considered, one of which is the water quality parameter where the cultivation is carried out[4]. Water quality is essential to fish survival, development, growth, and productivity [8]. Determining water quality is based on the general principle of one or two parameters and classifying them into good and bad conditions. If the parameters measured ideally are available, the water quality is considered good, but the water quality is not good outside the ideal conditions. Therefore, no water quality assessment reflects the actual growth of fish. Things that affect water quality in Pangas catfish ponds include the water's temperature, pH, and oxygen content [9]. In principle, temperature can be fatal for an organism. There are no temperature extremes, but a gradual change in temperature causes a sudden natural temperature drop that causes death[10]. pH is a measure of acidity that is used to indicate the level of acidity or alkalinity of a solution[11]. A low or high pH can affect fish life[8]. Water also contains oxygen dissolved in it. Lack of oxygen can stress fish, make them susceptible to disease, and interfere with fish growth[12]. Each parameter also has limits on ideal conditions that indicate good pool water quality, namely water temperature (25-30^{o}C), water pH (6,5-8,6), and dissolved oxygen content (>1,7 mg/L)[9]. Maintaining water quality is a must in maintaining Pangas catfish. pH and water temperature depend on weather conditions, the number of fish kept, and fish activity. The need for oxygen is also closely related to conditions and the number of fish and water level. Therefore, it is necessary to select pond water according to the water quality to maintain Pangas catfish[13].

First, a study entitled “Sistem Kontrol Kualitas Air pada Akuaponik Ikan Nila dan Cabai Rawit Berbasis Embedded System menggunakan Fuzzy Logic” written by Satrio Priambodo, Anang Andrianto, Dwiretno Istiyadi Swasono in 2022. The research aims to control water quality in Aquaponics tilapia and cayenne pepper based on dissolved oxygen content, total dissolved solids, and hydrogen power. To maintain the content in the water using a pump that has been set according to the needs of each parameter. To control water conditions automatically, fuzzy logic is used to adjust the amount of concentrate for each parameter as needed. The output of this calculation is the running time of the pump. This system is applied to a concrete pond measuring 4 x 1,5 x 1 meter with aquaponic products from 100 fish and 20 red chili plants[13].

Second, the research entitled “Model sistem pakar menggunakan FIS Mamdani untuk Penentuan Tekanan Udara Ban” written by Rusliyawati and Agus Wantoro in 2021, this study aims to create a fuzzy system to determine the ideal air pressure for vehicle tires using the Fuzzy Mamdani method with several parameters that can be taken into account such as vehicle load (Kg), weather or temperature (Degrees), distance (Km), wheels (Inches) and tire thickness (Inches). This study's average difference in results was 1,24% for the front tire pressure and 2,47% for the rear tire pressure[14].

Third, the research entitled “Implementasi Fuzzy Pada Monitoring Dan Kontrol Kualitas Air Tangki Pembibitan Ikan Menggunakan LabView” was written by Andi Farmadi, Dwi Kartini, and Muliadi in 2021. This study aims to monitor water quality using the fuzzy inference method, and interface development for monitoring is carried out. From the results of system development, it can be monitored and controlled for the water quality of fish farming ponds[15].

Fourth, the research entitled “Sistem Inferensi Fuzzy Mamdani untuk Menentukan Tingkat Kualitas Air Pada Kolam Bioflok Dalam Budidaya Ikan Lele” written by Heriyawan Pujiharsono and Danny Kurnianto in 2019, the purpose of this study was to determine the ideal water quality for catfish farming using Fuzzy Mamdani method with input parameters such as water pH, temperature and dissolved oxygen. The results of this study show that the accuracy of applying the Fuzzy Mamdani method is quite good in determining the water quality in catfish ponds, with an accuracy of 89,92%[9].

The author conducted this research based on the underlying problems and previous study results regarding the Fuzzy Mamdani method, which is quite good. This research was undertaken to implement the Fuzzy Mamdani method for selecting the water quality of Pangas catfish ponds to obtain a relationship between the pond water quality level and the fish's condition. This research is expected to help Pangas catfish farmers cultivate these fish in healthy conditions, disease-free, high quality, and suitable for consumption.

II. RESEARCH METHOD

This study used the fuzzy Mamdani method to determine water quality based on three input parameters: temperature, pH, and oxygen content. In its calculations, fuzzy Mamdani has four process steps: fuzzification, implication function, application, rule composition, and defuzzification[13], as shown in Figure 1.

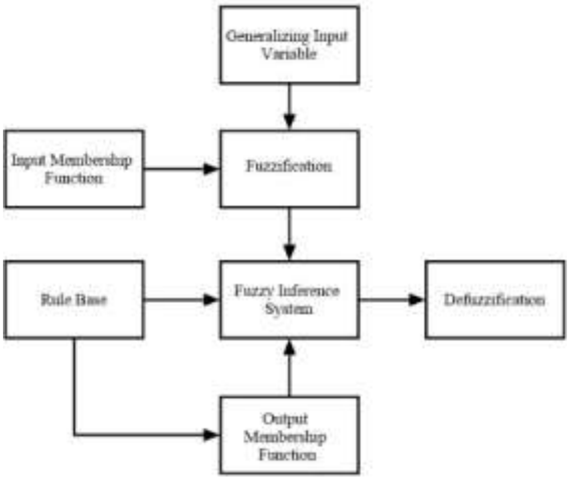

Fig. 1. Research method

Fuzzification represents pure values in fuzzy sets with fuzzy membership functions [9]. Temperature parameters are divided into cold, normal, and hot. The water temperature suitable for cultivating Pangas catfish is between 25-30ºC[6]. Therefore, this temperature range is normal. So, at a temperature range of 0-25ºC, it becomes gray between cold and normal, while at a temperature of 25-50ºC, it turns gray between normal and hot.

The pH parameter is divided into three groups: acidic, neutral, and alkaline. Acidic solutions vary from pH 0 to 6, neutral from pH 7, and alkaline from 8 to 14. The correct pH value for Pangas catfish in ponds is 6,5-8,6[9]. Hence, it is classified as neutral in this pH range. So, in the pH 1-6,5 range, it becomes gray between acidic and neutral, and pH 8,6-14 becomes gray between neutral and alkaline.

The oxygen content parameters are divided into three groups, namely low, medium, and high, with DO (Dissolved Oxygen) units. Pangas catfish can live with oxygen levels of 3-7 Mg/L but ideally live with oxygen levels of 5-6 Mg/L[13]. Therefore, oxygen levels of 1-3 Mg/L are categorized as low, while oxygen levels of 3-4 Mg/L are classified as moderate, and oxygen levels of 5-7 Mg/L are categorized as high.

Output water quality parameters are divided into two groups: bad and good. When classifying water quality, use a value of 0 for poor water quality and 1 for good water quality so that the value range from 0 to 1 is grayed out between poor and good.

The implication process is carried out to combine the three input parameters from the groups that have been made into output. The correlation of three input parameters consisting of several fuzzy sets with this output becomes a rule with causal correlation. The implication method used in this study is Min, which follows the Mamdani fuzzy rules.

In rule composition, the results of the rules observed in the previous step are combined into a fuzzy set. At this stage, the max method is used, namely the fuzzy set solution, which is obtained by taking the maximum value from the rule, then using it to change the fuzzy area and applying it to the output. The Mamdani fuzzy defuzzification process in this study uses the centroid method. This method will determine the average value of each fuzzy set used. The stages of the defuzzification process are as follows:

- First, in defuzzification, use the centroid method to determine the midpoint value of each fuzzy set.
- Second, determine the membership value of each fuzzy set used.
- Third, determine the resulting value in each fuzzy set by multiplying the midpoint with the membership value.
- Fourth, add up the value of each fuzzy set and divide the value by the membership value.

Based on the steps above, the value of the division results is used as a reference for determining the water quality of Panga's catfish ponds.

RESULTS AND DISCUSSION

This study discussed the selection of pond water quality for Panga's catfish. It uses three input parameters: temperature, water pH, and oxygen levels, while there is only one output parameter: water quality. The following is a graph of the membership function for each parameter shown in Figures 2, 3, 4, and 5.

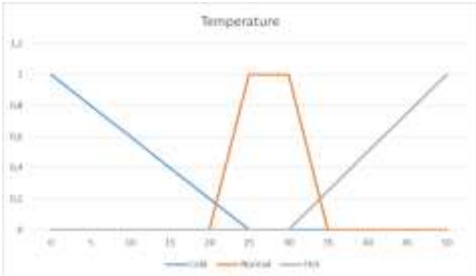

Fig. 2. Graph of the Temperature Membership Function

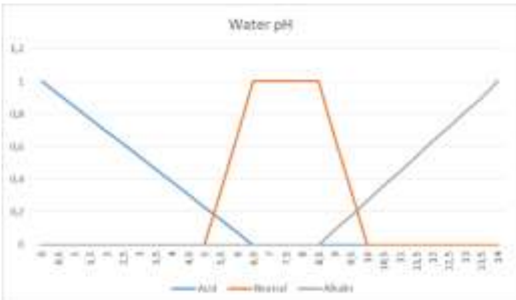

Fig. 3. Graph of Water pH Membership Function

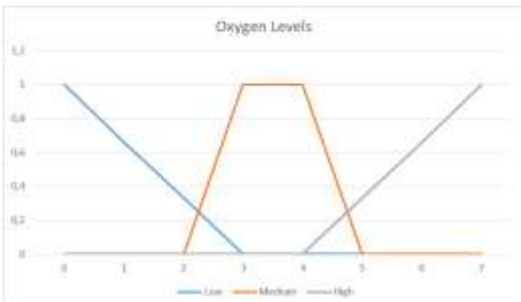

Fig. 4. Oxygen Rate Membership Function Graph

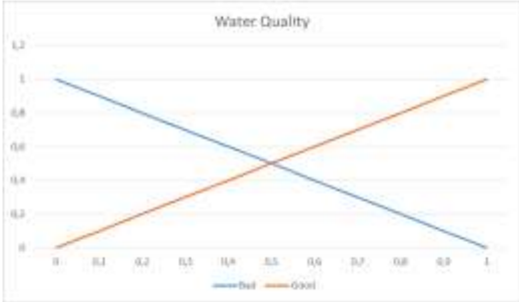

Fig. 5. Graph of Water Quality Membership *Function*

Based on the existing input parameters, membership functions are made, as shown in Figures 2 to 4, while the output parameters are shown in Figure 5. The membership function of the temperature parameter is divided into three, namely cold, normal, and hot (Figure 2). The membership function of the water pH parameter is divided into three: acidic, neutral, and alkaline (Figure 3). The membership function of the oxygen level parameter is divided into three parts: low, medium, and high (Figure 4). The membership function of the water quality parameters is divided into two parts, namely bad and good (Figure 5). It is the water quality parameter that will determine whether the pond water is suitable for Pangas catfish or not.

In addition to the membership function, Mamdani rules are applied to determine the water quality suitable for Pangas catfish. The following Mamdani rules are shown in Figure 6.

Input: Temperature, pH, Oxygen level
Output: Water Quality

1. IF Temperature COLD AND PH ACID AND Oxygen LOW THEN Water Quality BAD
2. IF Temperature COLD AND PH ACID AND Oxygen MEDIUM THEN Water Quality BAD
3. IF Temperature COLD AND PH ACID AND Oxygen HIGH THEN Water Quality BAD
4. IF Temperature COLD AND PH NEUTRAL AND Oxygen LOW THEN Water Quality BAD
5. IF Temperature COLD AND PH NEUTRAL AND Oxygen MEDIUM THEN Water Quality BAD
6. IF Temperature COLD AND PH NEUTRAL AND Oxygen HIGH THEN Water Quality BAD
7. IF Temperature COLD AND PH ALKALI AND Oxygen LOW THEN Water Quality BAD
8. IF Temperature COLD AND PH ALKALI AND Oxygen MEDIUM THEN Water Quality BAD
9. IF Temperature COLD AND PH ALKALI AND Oxygen HIGH THEN Water Quality BAD
10. IF Temperature NORMAL AND PH ACID AND Oxygen LOW THEN Water Quality BAD
11. IF Temperature NORMAL AND PH ACID AND Oxygen MEDIUM THEN Water Quality BAD
12. IF Temperature NORMAL AND PH ACID AND Oxygen HIGH THEN Water Quality BAD
13. IF Temperature NORMAL AND PH NEUTRAL AND Oxygen LOW THEN Water Quality BAD
14. IF Temperature NORMAL AND PH NEUTRAL AND Oxygen MEDIUM THEN Water Quality GOOD
15. IF Temperature NORMAL AND PH NEUTRAL AND Oxygen HIGH THEN Water Quality BAD
16. IF Temperature NORMAL AND PH ALKALI AND Oxygen LOW THEN Water Quality BAD
17. IF Temperature NORMAL AND PH ALKALI AND Oxygen MEDIUM THEN Water Quality BAD
18. IF Temperature NORMAL AND PH ALKALI AND Oxygen HIGH THEN Water Quality BAD
19. IF Temperature HOT AND PH ACID AND Oxygen LOW THEN Water Quality BAD
20. IF Temperature HOT AND PH ACID AND Oxygen MEDIUM THEN Water Quality BAD
21. IF Temperature HOT AND PH ACID AND Oxygen HIGH THEN Water Quality BAD
22. IF Temperature HOT AND PH NEUTRAL AND Oxygen LOW THEN Water Quality BAD
23. IF Temperature HOT AND PH NEUTRAL AND Oxygen MEDIUM THEN Water Quality BAD
24. IF Temperature HOT AND PH NEUTRAL AND Oxygen HIGH THEN Water Quality BAD
25. IF Temperature HOT AND PH ALKALI AND Oxygen LOW THEN Water Quality BAD
26. IF Temperature HOT AND PH ALKALI AND Oxygen MEDIUM THEN Water Quality BAD
27. IF Temperature HOT AND PH ALKALI AND Oxygen HIGH THEN Water Quality BAD

Fig. 6. Mamdani Rules Applied

Based on these rules, calculate the implication function of each rule using the Min method and the composition of the rules using the Max function to determine the water quality of Pangas catfish ponds.

The test randomly assigns values to each input parameter by combining all possible temperature, water pH, and oxygen content values. The rules include the three parameters that describe the water quality level. The water quality test value data are listed in Table I.

TABLE I. WATER QUALITY TESTING DATA

No	Temperature (°C)	pH	Oxygen	Water Quality
1	1,73	1,15	1,66	?
2	2,58	1,16	1,78	?
3	7,55	1,37	2,04	?
4	11,52	1,74	2,29	?
5	12,15	1,92	2,34	?
6	13,64	2,13	2,46	?
7	14,59	2,62	2,59	?
8	15,97	4,81	2,91	?
9	17,27	4,91	2,92	?
10	18,43	5,11	3,13	?
11	21,25	5,55	3,26	?
12	23,68	6,37	6,66	?
13	25,66	7,33	6,21	?
14	27,05	7,11	5,82	?
15	28,58	8,2	3,88	?
16	30,31	9,22	4,0	?
17	30,63	10,36	4,06	?
18	30,94	10,66	4,83	?
19	32,19	10,74	5,24	?
20	34,49	10,97	5,32	?
21	34,75	11,93	5,47	?
22	35,6	12,24	5,57	?
23	36,01	12,4	5,86	?
24	37,87	12,88	6,11	?
25	37,99	13,5	6,28	?
26	43,38	13,58	6,34	?
27	44,04	13,98	6,63	?

Based on the data in Table I, determine the rule that will be used according to the existing rules. The rule's use is as shown in Table II.

TABLE II. FUZZY INFERENCE SYSTEM RULES

No	Input			Output (Water Quality)
	Temperature	pH	Oxygen	
1	Cold	Acid	Low	Bad
2	Cold	Acid	Low	Bad
3	Cold	Acid	Low	Bad
4	Cold	Acid	Low	Bad
5	Cold	Acid	Low	Bad
6	Cold	Acid	Medium	Bad
7	Cold	Acid	Medium	Bad
8	Cold	Acid	Medium	Bad
9	Cold	Acid	Medium	Bad
10	Cold	Neutral	Medium	Bad
11	Normal	Neutral	Medium	Good
12	Normal	Neutral	High	Bad
13	Normal	Neutral	High	Bad
14	Normal	Neutral	High	Bad
15	Normal	Neutral	Medium	Good
16	Normal	Neutral	Medium	Good
17	Normal	Alkali	Medium	Bad
18	Normal	Alkali	High	Bad
19	Normal	Alkali	High	Bad
20	Hot	Alkali	High	Bad
21	Hot	Alkali	High	Bad
22	Hot	Alkali	High	Bad
23	Hot	Alkali	High	Bad
24	Hot	Alkali	High	Bad
25	Hot	Alkali	High	Bad
26	Hot	Alkali	High	Bad
27	Hot	Alkali	High	Bad

After determining the rule used, calculate each parameter's membership degree value and continue the implication process with the Min rule. The next step is implementing a rule function using the Max method to perform rule composition on all rules. Then, when finished, do the defuzzification process. This process is carried out using the centroid method. Based on the defuzzification process, the results of mapping water quality based on input temperature, water pH, and oxygen levels are randomly presented in Table III.

TABLE III. MAMDANI TEST RESULT WITH VARIOUS INPUTS

No	Input Parameters			Z Value	Water Quality
	Temperature	pH	Oxygen		
1	1,73	1,15	1,66	0,398	Bad
2	2,58	1,16	1,78	0,406	Bad
3	7,55	1,37	2,04	0,425	Bad
4	11,52	1,74	2,29	1,361	Good
5	12,15	1,92	2,34	1,204	Good
6	13,64	2,13	2,46	0,398	Bad
7	14,59	2,62	2,59	0,404	Bad
8	15,97	4,81	2,91	0,438	Bad
9	17,27	4,91	2,92	0,441	Bad
10	18,43	5,11	3,13	0,450	Bad
11	21,25	5,55	3,26	0,535	Good
12	23,68	6,37	6,66	0,860	Good
13	25,66	7,33	6,21	0,860	Good
14	27,05	7,11	5,82	1,008	Good
15	28,58	8,2	3,88	1	Good
16	30,31	9,22	4,0	0,398	Bad
17	30,63	10,36	4,06	1,204	Good
18	30,94	10,66	4,83	1,400	Good
19	32,19	10,74	5,24	1,058	Good
20	34,49	10,97	5,32	1,808	Good
21	34,75	11,93	5,47	1,589	Good
22	35,6	12,24	5,57	1,400	Good
23	36,01	12,4	5,86	1,325	Good
24	37,87	12,88	6,11	1,093	Good
25	37,99	13,5	6,28	1,093	Good
26	43,38	13,58	6,34	0,861	Good
27	44,04	13,98	6,63	0,858	Good

From the test results in Table III, it can be seen that if the Z value resulting from the calculation using the Mamdani method is close to 1 or more than one, then it is clear that the output results are that the water quality is good. On the other hand, if the resulting value is less than 0 or close to 0, then the water quality is bad. If you look at it in detail, each of the existing parameters (temperature, water pH, and oxygen levels) will influence each other for an output result, whether the water quality is bad or good for the Pangas catfish to live in.

III. CONCLUSION

This study uses the Mamdani Fuzzy Logic method to build a pond water selection model for Pangas catfish through several stages: forming fuzzy sets, applying the implication function with the Min function, rule composition with the Max function, and defuzzification using the centroid method. Water quality can be good if the z calculation results are close to 1 or more; if the resulting z value is less than 0 or close to 0, the water quality is poor.

REFERENCES

[1] I. D. W. Fachri Ayudi Fitrony, Fitri Marisa, "Sistem Pendukung Keputusan Rekomendasi Budidaya Ikan Air Tawar Menggunakan Metode Topsis dan Analisis Keuangan Payback Periode," *J. SPIRIT*, vol. 11, no. 1, pp. 30–38, 2019.

[2] R. R. S. P. S. Dewi, A. Alimuddin, A. O. Sudrajat, and K. Sumantadinata, "Karakteristik minyak ikan dari limbah pengolahan filet ikan patin siam (Pangasius hypopthalmus) dan patin jambal (pangasius djambal)," *J. Ris. Akuakultur*, vol. 7, no. 2, p. 171, 2012.

[3] F. Rearing and S. C. Pangasionodon, "Optimasi Pemberian Pakan Buatan pada Pendederan Ikan Patin (Pangasionodon Hypohpthalmus) di Kolam Yang Dipupuk," *J. Fish. Sci.*, vol. 10, no. 1, pp. 45–52, 2008.

[4] Ade Suhara, "Teknik Budidaya Pembesaran Dan Pemilihan Bibit Ikan Patin (Studi Kasus Di Lahan Luas Desa Mekar Mulya, Kec. Teluk Jambe Barat, Kab. Karawang)," *J. Buana Pengabdi.*, vol. 1, no. 2, pp. 1–8, 2019, doi: 10.36805/jurnalbuanapengabdian.v1i2.1066.

[5] P. Putinur, R. B. S. Salampessy, and A. Poernomo, "Karakterisasi Pelaku Usaha Patin untuk Mendukung Jambi sebagai Sentra Patin Nasional," *Bul. Ilm. Mar. Sos. Ekon. Kelaut. dan Perikan.*, vol. 7, no. 1, p. 29, 2021, doi: 10.15578/marina.v7i1.8843.

[6] Danilo Gomes de Arruda, "Pembuatan prototipe penentu kesegaran ikan patin Berbasis sensor TCS 230 Making Prototypes for Freshness of Patin Fish Based on TCS 230 Sensor," vol. 10, no. 01, p. 6, 2021.

[7] M. S. Dr. Atty Tri Juniarti, S.E. and S. E. Darra Gusti Putri, "Faktor-Faktor Dominan yang Mempengaruhi Kinerja," *Angew. Chemie Int. Ed. 6(11), 951–952.*, pp. 2013–2015, 2021.

[8] S. R. Fauzia and S. H. Suseno, "Resirkulasi Air untuk Optimalisasi Kualitas Air Budidaya Ikan Nila Nirwana (*Oreochromis niloticus*)," *J. Pus. Inov. Masy.*, vol. 2, no. 5, pp. 887–892, 2020.

[9] H. Pujiharsono and D. Kurnianto, "Mamdani fuzzy inference system for mapping water quality level of biofloc ponds in catfish cultivation," *J. Teknol. dan Sist. Komput.*, vol. 8, no. 2, pp. 84–88, 2020, doi: 10.14710/jtsiskom.8.2.2020.84-88.

[10] R. K. Putra Asmara, "Rancang Bangun Alat Monitoring Dan Penanganan Kualitas Ait Pada Akuarium Ikan Hias Berbasis Internet Of Things (IOT)," *J. Tek. Elektro dan Komput. TRIAC*, vol. 7, no. 2, pp. 69–74, 2020, doi: 10.21107/triac.v7i2.8148.

[11] E. Mufida, R. S. Anwar, R. A. Khodir, and I. P. Rosmawati, "Perancangan Alat Pengontrol pH Air Untuk Tanaman Hidroponik Berbasis Arduino Uno," *INSANtek*, vol. 1, no. 1, pp. 13–19, 2020.

[12] D. Wicaksono, T. L. Bhakti, R. B. Taruno, M. R. S. Subroto, and A. Mustikasari, "A galvanic-based dissolved oxygen level monitoring sensor system in freshwater ponds," *J. Teknol. dan Sist. Komput.*, vol. 9, no. 2, pp. 83–89, 2021, doi: 10.14710/jtsiskom.2021.13996.

[13] S. Priambodo, A. Andrianto, and D. I. Swasono, "Sistem Kontrol Kualitas Air pada Akuaponik Ikan Nila dan Cabai Rawit Berbasis Embedded System menggunakan Fuzzy Logic," vol. 7, no. 3, pp. 230–237, 2022.

[14] R. Rusliyawati and A. Wantoro, "Decision support system model using FIS Mamdani for determining tire pressure," *J. Teknol. dan Sist. Komput.*, vol. 9, no. 1, pp. 56–63, 2021, doi: 10.14710/jtsiskom.2020.13776.

[15] A. Farmadi and D. Kartini, "Iplementasi Fuzzy Pada Monitoring dan Kontrol Kualitas Air Tangki Pembibitan ikan Menggunakan LabView," vol. 9, no. 2, pp. 76–87, 2021.