Journal of Applied Science, Technology & Humanities
Volume 1, Issue 3, June, 2024, Pages 187-195

ISSN 3032-5765 (Online)
DOI: https://doi.org/10.62535/0m1ks522

Application of Mamdani Fuzzy Logic System on Catfish Sorting System (*Clarias* sp.)

Rega Firgiawan Anwar [1]*

[1]* Departement of Technology and Management of Applied Aquaculture Collage of Vocational Studies, IPB University
firgiawanrega@apps.ipb.ac.id

Ibnu Prastio Wibisono[2] Aliffia Anassyahtira Hamzah[3], Nur Azizah[4], Amanda Ghurin Syalju[5], Muhammad Habib Al Mutawakkil[6], Moh Fahri Aulia Priatna[7], Handika Dwi Al Falah[8], Amanda Suci Ramadhani[9], Fitriana Lestari[10], Muhammad Abdul Sidiq[11], Ratu Nabilla Rahmawati[12], Muhammad Widagdo Sidharto[13], Hafis Suwandi[14], Siti Rahmah Khairunisa[15].

Departement of Technology and Management of Applied Aquaculture Collage of Vocational Studies, IPB University
[2]akuuibnu@apps.ipb.ac.id, [3]01aliffia@apps.ipb.ac.id, [4]502211853742azizah@apps.ipb.ac.id, [5]241236amanda@apps.ipb.ac.id, [6]mhabibal@apps.ipb.ac.id, [7]mohfahriauliapriatna@apps.ipb.ac.id, [8]handikadwialfalahhandika@apps.ipb.ac.id, [9]amandaarmdhni_amanda@apps.ipb.ac.id, [10]fitrianafitriana@apps.ipb.ac.id, [11]abdulsidiq@apps.ipb.ac.id, [12]ratunabillarahmawati@apps.ipb.ac.id, [13]Smantiwidagdo@apps.ipb.ac.id, [14]suwandi10hafis@apps.ipb.ac.id, [15]rahmakhairunisa@apps.ipb.ac.id.

Abstract

In catfish farming activities, there is a sorting process and a calculation process that is carried out manually or conventionally which causes a lack of effectiveness of labor and time in cultivation and causes fish wounds or injuries after the sorting activity. This research aims to make the sorting process easier and more flexible. By considering factors such as weight, length and other physical conditions in a fuzzy manner, the system can provide more accurate decisions in determining the quality and type of fish, increase sorting efficiency, and reduce errors in fish grouping process. Logic systems can provide more accurate assessments, allowing fish producers or traders to better sort fish according to market standards and consumer needs. The data analysis method used uses qualitative methods. Data is analyzed by identifying patterns, themes and categories through the coding and interpretation process. Fuzzification in the development of an automatic fish sorter uses weight (gram) and length (cm) parameters as input while the output is a measure of consumption. Using this tool is said to be more effective than conventional fish sorting.

Keywords: sort, catfish, fuzzy

INTRODUCTION

Indonesia is a country with very rich natural resources. Natural resources on land and at sea are very valuable natural resources. One of the supports of the Indonesian economy is the fisheries sector (Pujono et al., 2019). The availability of the Fisheries Sector is very important in meeting the consumption needs of the Indonesian people. Based on data from the Ministry of Maritime Affairs and Fisheries (KKP), fisheries production in 2020 was targeted at 26.46 million tons and the realization was 23.16 million tons or reached 87.53% and the fish production for the fisheries sector was also targeted at 26.46 million tons meet the needs of national fish consumption. The national fish consumption rate in 2020 was 56.39 kg/capita, exceeding the target of 54.49 kg/capita/year in 2020 (Salurianto et al., 2021).

Freshwater fish is one of the most consumed and demanded fishery sectors by people in Indonesia. One type of freshwater fish that is in great demand is catfish because it has a delicious taste, its meat is easy to process, and the price is affordable. In addition, catfish also has fast growth, so its production is relatively stable. Data released by the Ministry of Maritime Affairs and Fisheries (KKP) in 2022 shows that catfish production in Indonesia is 1.06 million tons with a value of IDR

18.93 trillion in 2021. In detail, catfish production from cultivation was 1.03 million tons with a value of IDR 7.79 trillion last year. Meanwhile, catfish production from the capture of inland public waters (PUD) was 34,915.83 tons with a value of IDR 1.13 trillion (Dahliana & STIP Yapi Bone, 2023).

One of the obstacles that occurs in fish farming activities is uneven fish growth (Wiyoto et al., 2023). In terms of growth, not all fish grow to the same weight, therefore farmers must sort fish according to consumption with each weight that has been determined according to market needs. If done manually, there are several disadvantages, including the weight of the fish is not in accordance with market needs which will harm the cultivator and the sorting process can take a lot of time and require labor costs so that it is prone to human error (Siskandar et al., 2020).

The existence of these obstacles is the reason for this research to refer to an automatic system in sorting fish based on weight to make it easier for farmers to do sorting and save time. This automatic fish selection system applies fuzzy logic as a method that allows the sorting tool to understand and respond to uncertain input data in a way that is similar to the way humans think. Fuzzy logic is an improvement of Boolean logic that deals with the concept of partial truth. Fuzzy logic has degrees of membership in the range 0 to 1 and fuzzy logic indicates the extent to which a value is true and the extent to which a value is false. In this study, the Mamdani method or commonly called the Min-Max method is used in the application of fish sorting classification based on size. Mamdani fuzzy method has a smaller error rate than the mamdani method in terms of prediction. So it is hoped that the sorting system with the mamdani fuzzy method can provide convenience for cultivators (Maryam et al., 2021).

The purpose of applying fuzzy logic to a consumer fish sorting system is to enable more flexible classification of consumer fish, given variations in the physical characteristics of fish. By considering factors such as weight, length and other physical states in a fuzzy manner, the system can provide more accurate decisions in determining the quality and type of fish, improve sorting efficiency, and reduce errors in the fish grouping process. The logic system can provide more accurate judgment, allowing fish producers or traders to better sort fish according to market standards and consumer needs.

METHODS

Research Time and Location Research Time

This research was conducted on May 3 - May 17, 2024, at the Campus of IPB University Bogor Vocational School, Jl. Raya Pajajaran, Bogor City, West Java 16128. This research designs a catfish sorting conveyor based on consumption size using a fuzzy logic controller.

Data Collection Methods

This research method employs a literature review approach to gather data from various sources that substantiate the research. These sources include books, magazines, scientific journals, and other relevant articles.

Fuzzy Variables

The input and output indicators of the fuzzy logic system are set based on variables that can determine the size of the fish, fuzzy variables also have value as a decision determining factor.. As shown in Figure 1, Figure 2, and Figure 3. In a fuzzy logic system, needs a rules to run the system listed in Figure 4 and the program of a rules shown in Figure 5.

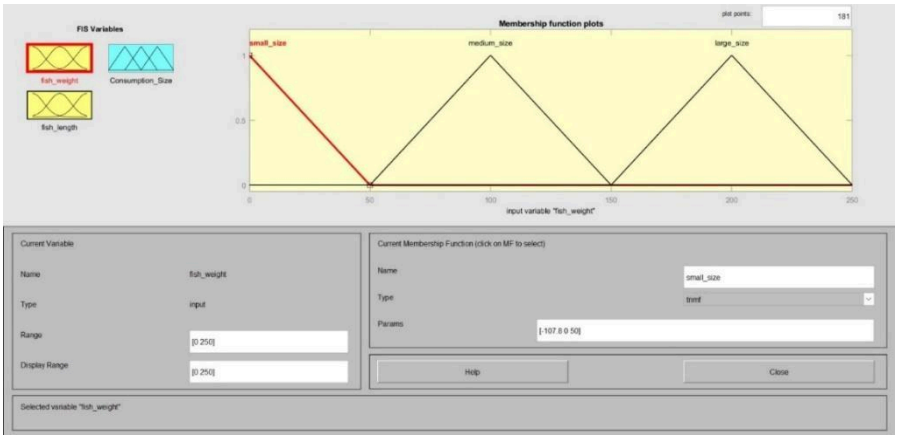

Figure 1 The set of fish weight variables

Based on Figure 1 shows that the variable fish weight from the range of 0≤x≤50 grams is categorized as small fish weight, range of 50≤x≤150 grams is categorized as medium fish weight, range of 150≤x≤250 is categorized as large fish weight.

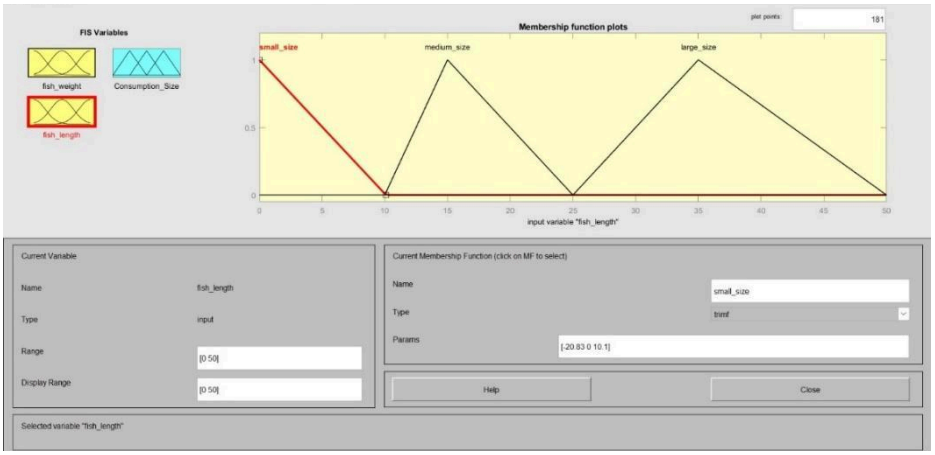

Figure 2 The set of fish length variables

Based on Figure 2 shows that the variable length of fish from the range 0≤x≤10 cm is categorized as small fish length, range 10≤x≤25 cm is categorized as medium fish length, range 25≤x≤50 cm is categorized as large fish length.

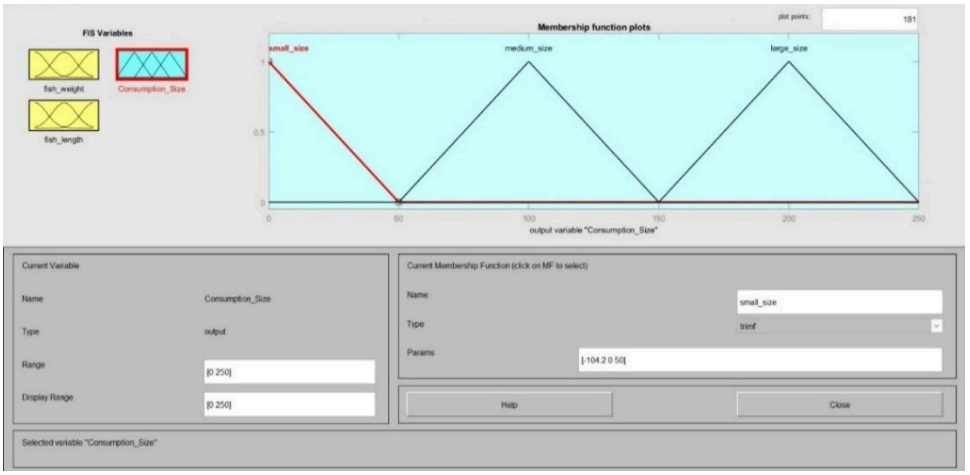

Figure 3 The set of consumption measure variables

Based on Figure 3 shows that the output of fish length and fish weight will be generated through data from previous inputs; with these results, the fish can be sorted according to the size and weight that has been set.

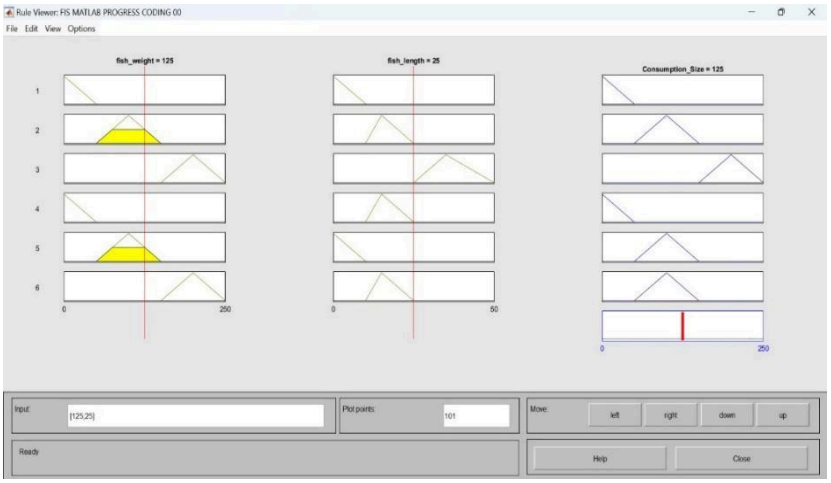

Figure 4 The set of data rules fuzzy logic

Based on Figure 4 shows components data from fuzzy logic system rules, developed with MATLAB. The graphic illustrates individual data between fish lenght, and consumption size. The fish weight range is 0 to 250, the fish length range is 0 to 50, and the consumption size range is 0 to 250.

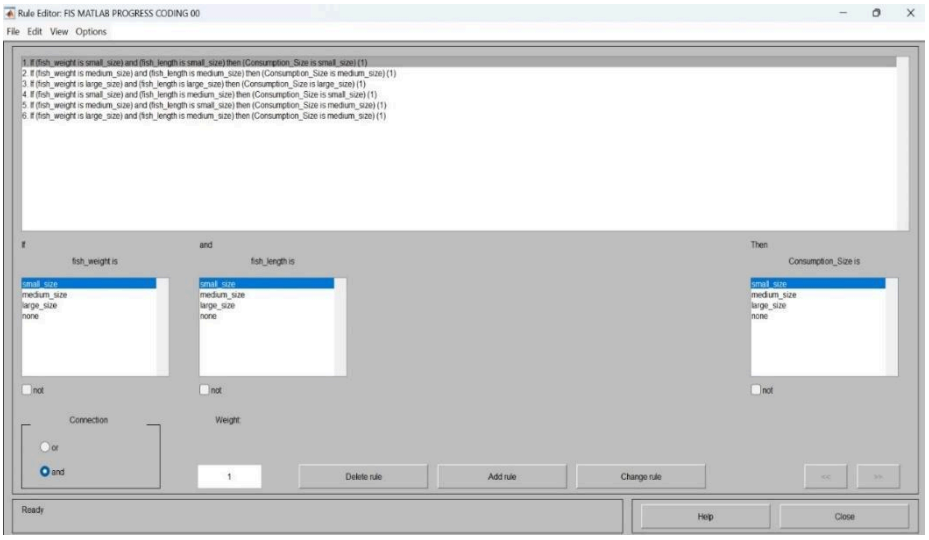

Figure 5 The set of program rules fuzzy logic

Based on Figure 5 shows data program of fuzzy logic system, the programs make up integrated data components as the core driving system fuzzy logic to make a decision, from fuzzy logic rules using “IF” as a premis, “AND” as a conjugation or connecting word, “THEN” as a conclusion.

Data Analysis Method

The data analysis method uses qualitative methods. The data is analyzed by identifying patterns, themes, and categories through the cg and interpretation. Qualitative research with a fuzzy approach combines two different research approaches, namely qualitative and fuzzy logic. Qualitative methods are used to understand phenomena or problems in a deep context, while fuzzy logic handles uncertainty and subjectivity in data.

1. Assignment of Fuzzy Variables and Factors

   Identify the relevant variables in the research context and determine the domain and level of uncertainty or fuzziness. This involves applying fuzzy concepts to describe the variability and uncertainty in the data (Santosa et al., 2021).

2. Qualitative Data Collection

In the context of the sorting mechanism, the assignment of fuzzy variables and factors can be done to enable the system to efficiently classify the incoming objects into the appropriate categories. By taking data from the length and weight of the fish.

3. Fuzzy Analysis

   Fuzzy analysis in sorters involves the use of fuzzy logic to process input object data and generate decisions based on non-strict rules. By applying the concept of fuzzy membership, the sorting tool can classify objects more flexibly, overcome the uncertainty and complexity of their attributes, and produce more adaptive decisions according to changing conditions and contexts (Rifai & Fitriyadi, 2023).

4. Interpretation

   Fuzzy systems in sorters can be interpreted as methods that allow sorters to understand and respond to uncertain input data in a manner similar to how humans think. By using fuzzy rules, the sorting tool can classify incoming items into certain categories flexibly, based on the degree of membership in each category that represents a degree of probability or uncertainty. This allows the sorter to make decisions on how to sort or route the items more adaptively and responsively to changing environmental conditions.

RESULT AND DISCUSSION

This research designs fuzzy logic with the help of Matlab software which will then be used as the basis for determining the output value of the automatic catfish sorting system with fuzzy logic. There is a Mamdani fuzzy logic design in matlab Figure 4 with the mamdani method which has 2 input variables and 1 output variable. The input variables are fish length and fish weight, and the output variable is the size of consumption.

System Implementation

The tool is designed to resemble a conveyor line in the form of a simple machine that moves from one place to another, the sorting tool is run with several assemblies of components such as microcontrollers and RTCs stored in the machining box and there are several other components such as infrared sensors, servo motors, ultrasonic sensors and balance sensors inside the tool chamber because these components play a role in capturing fish sensors that pass through the conveyor line. The function of the conveyor is as a means of moving goods from one place to another in the sorting process (Prayuda, I., 2022) The control system of the catfish sorting tool will work by rotating the conveyor to move the catfish before entering the catfish size reader container, then the infrared sensor will read the number and length of catfish.

Automatic sorting of fish using fuzzy logic based on weight using load cell sensor. A sensor is a device that measures physical quantities and converts them into signals that can be read and used. This technology applies a sensor quality reading system. (Siskandar, Wiyoto, Santosa, Sari, et al., 2023) The use of load cell sensors in accordance with their functions according to (Siskandar, Wiyoto, Santosa, Hidayat, et al., 2023) load cell sensors are sensors used to track the pressure or weight of an object. Load cell sensors are generally used as the main element of digital weighing systems and use the principle of pressure and can be used in measuring the weight of dumbo catfish. The fish that will enter the weighing process will go through the Infrared Sensor in a closed circuit on the conveyor that leads to the scale. Infrared sensors will read the number of fish passing, then the servo will close automatically. After the weight of the catfish is read according to its weight, the servo motor 1 will rotate at an angle of 45 ° then tilt the container and the servo motor 2 will rotate according to the direction and the infrared sensor will detect catfish passing through the final catfish storage container according to the weight and number of sorted fish, then the LCD will display the results of the weight and number of catfish (Kurniawan et al., 2020).

Fuzzy Logic Implementation

Fuzzification in the development of an automatic fish sorter uses the parameters of weight (grams) and length (cm) as input while the output is in the form of consumption size. After getting the input value from the sensor, the process continues until getting the membership degree value from

defuzzification (Faizin & Mujilahwati, 2020) The fish sorting system uses the Fuzzy logic method for rules represented in the form of IF-THEN, where the output or consequent of the system is not in the form of a Fuzzy set, but in the form of a constant or linear equation (Bangun et al., 2019), 2019) The possible membership values in this fuzzy logic are between 0 and 1. Input variable input is one of the important components, therefore an input membership function is needed. This study uses two types of membership functions, namely sensor input and consumption size output. The sensor input membership function is in the form of weight and length which has 3 fuzzy sets of small, sufficient, and large. The output of the membership function is the consumption size which has three fuzzy sets, namely small, saleable, and large (Novira et al., 2020) The implementation of fuzzy logic in this automatic fish sorting system is in accordance with (Maryam et al., 2021) which also applies Fuzzy Logic to control weight, as a servo motor drive and a catfish counter with infrared and an appropriate way to map a scope into an output space (Fachrul Rahmadany et al., 2023).

Figure 6 Fuzzy logic design in matlab

Based on Figure 4 shows the fuzzy design that has been made with the Matlab application which includes input and output.

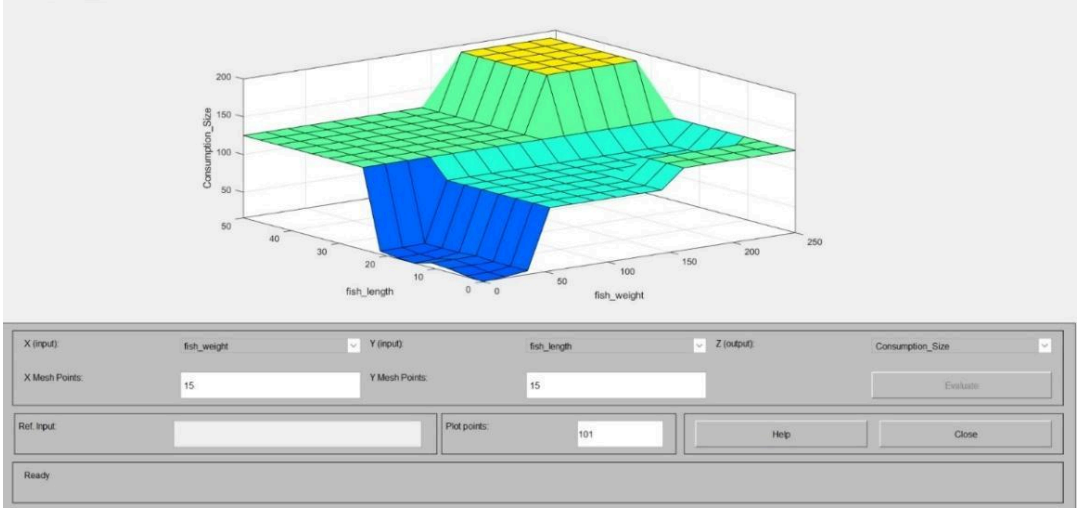

Figure 7 Surface Data

Based on the Figure 7, a surface display in the form of 3D graph is shown to illustrate the relationship between input data of fish weight and length with output data from consumption size decisions based on shape and color.

Table 1 Function of variable indicator fuzzy logic

Function	Variables	Fuzzy sets
Input	Length (cm)	Small
		Medium
		Big
	Weight (gr)	Small
		Medium
		Big
Output	Consumption size	Small
		Medium
		Big

Based on Table 1 shows that there are variable indicators used in the fuzzy logic system. In the input function, there are two variables, namely length (cm) and weight (gr), with the same fuzzy sets, namely small, medium, and large. In the output function in the form of fish size as a variable, the fuzzy set will be determined based on the two input variables until a fuzzy set indicator is found at the output in the form of small, marketable, and large.

Catfish that are ready for consumption are catfish that have a size between 18 cm to 20 cm with a weight per tail of 125 grams or even more than that (Putri Firdausi et al., 2024), in 1 kg of catfish contains 8 fish weighing 125 grams per tail (Bidayani et al., 2023) However, if the weight of catfish reaches 200 grams per tail then per kg only contains 5 to 6 fish (Astari et al., 2021). Catfish to reach consumption size requires a maintenance time of about 2 to 3 months with daily feeding. Catfish that have a size below the consumption size or have not yet entered the consumption size, the size range of 50.0-65.4 gr/head (shallow size) will usually be returned to the cultivation container for re-cultivation activities (raised). After rearing, catfish that will enter the consumption size will be sorted again. Catfish that have a large size (jumper) are usually less salable for sale. Jumper catfish size is the size of fish with a large size that is less desirable by the market, because the characteristics of meat owned by large catfish are not good for consumption, so usually catfish that have a large size will be sold at fishing spots or treated again to be used as prospective catfish broodstock (Jusadi et al., 2016).

Catfish when it is big is less marketable because the taste and texture of catfish meat is less desirable by the public. The sorting process to separate consumption size catfish from overweight catfish is in accordance with the statement (Naufal Allaudin & Nasuha, 2023). Usually, the harvest is sold directly to the collecting traders; traders buy catfish for consumption size, so if there is excess weight) that is not the size of consumption; it is not purchased / not sold for; it needs further management so that farmers will not lose. The processing is by striving to become processed fish products that can be more durable, given the nature of catfish that spoil quickly, such as Abon Catfish and catfish nuggets (Prawoto et al., 2018).

The fuzzy logic-based fish sorting mechanism utilizes thinking principles that approach the humans way, to make decision under conditions of uncertainty. The system classifies fish into categories such as 'small', 'medium', and 'large' based on parameters such as length and weight, with uses membership functions that define the extent to which a fish falls within each category. For example, a fish 15 cm long and weighing 200 grams can have certain levels of membership in the 'small' and 'medium' categories, allowing for more refined and adaptive decisions. . With this approach, the sorting system can accommodate natural variability in fish size, increasing the accuracy and efficiency of the overall sorting process

CONCLUSION

The catfish sorting tool with the addition of fuzzy logic intelligence is an effective and efficient effort to help catfish farmers in sorting catfish based on fuzzy logic intelligence. Effective and efficient to help catfish farmers sort catfish based on the size of the fish. Variety of fish sizes. This system can help reduce labor costs and increase profits and catfish production capacity. Profits and catfish production capacity. Based on the results, the logic system can provide more accurate judgment, allowing fish farmers to sort fish better. The data analysis method used used qualitative methods, data were analyzed by identifying patterns, themes, and categories through the process of coding and interpretation. Fuzzification on the development of an automatic fish sorter uses the

parameters of weight (gram) and length (cm) as inputs while the outputs are weight (gram) and length (cm). (cm) as input while the output is in the form of consumption size.

REFERENCES

Astari, A. A. E., Merta, K., Sudiartini, N. W. A., & Sukarini, N. P. P. (2021). Studi Kelayakan Usaha Dan Strategi Pengembangan Budidaya Ikan Lele Di Kota Denpasar (Studi Kasus Petani Ikan Lele Di Ubung Kaja). Jurnal JDM, 4(2), 108-125.Bangun, R., Sortir, A., Penghitung, D., Otomatis, M., Mikrokontroler, B., Eva, A., Yulyawan, K., Baihaqi, M. A., Fathuddin Noor, M., & Arigosandy, V. (N.D.). E-ISSN: Xxxxx Jurnal Informatika Dan Teknik Elektro. In Jurnal INTRO (Vol. 2, Issue 1). Https://Ejournal.Upm.Ac.Id/Index.Php/Intro

Bangun, R., Sortir, A., Penghitung, D., Otomatis, M., Mikrokontroler, B., Eva, A., Yulyawan, K., Baihaqi, M. A., Fathuddin Noor, M., & Arigosandy, V. (N.D.). E-Issn: Xxxxx Jurnal Informatika Dan Teknik Elektro. In *Jurnal Intro* (Vol. 2, Issue 1). Https://Ejournal.Upm.Ac.Id/Index.Php/Intro

Bidayani, E., Supitri, S., & Robin, R. (2023). Faktor-Faktor Yang Mempengaruhi Permintaan Ikan Konsumsi Air Tawar Di Pasar Tradisional Kota Pangkalpinang. *Jurnal Perikanan Unram*, *13*(2), 331–343. Https://Doi.Org/10.29303/Jp.V13i2.494

Budidaya, P., Lele, I., Tasyah, N. N., Mulyono, M., Farchan, M., Panjaitan, A. S., Thaib, E. A., Aup, J., Minggu, P., Selatan, J., Pelatihan, P., Kp, P., Kelautan, K., Perikanan, D., Gedung, I., Bahari, M., Lantai, I., Medan, J., Timur, M., & 16 Jakarta, N. (2020). *Novira Nanda Tasyah Dkk. Jurnal Agroqua Performa Budidaya Ikan Lele Sangkuriang (Clarias Gariepinus) Sistem Bioflok Dengan Intervensi Grading (Performance Of Sangkuriang Catfish (Clarias Gariepinus) Catfish Cultivation With Grading Interventions)*. *18*(2). Https://Doi.Org/10.32663/Ja.V%Vi%I.1297

Dahliana, B., & Stip Yapi Bone, J. (2023). Strategi Pengembangan Budidaya Ikan Lele (Clarias Sp.) Pada Kolam Terpal Strategy For Development Of Catfish Cultivation (Clarias Sp.) In Tarp Ponds. *Jurnal Pertanian Agros*, *25*(2).

Fachrul Rahmadany, Zen, N. A., & Danny Kurnianto. (2023). Prototype Detection System Of Papaya Murability Using Fuzzy Logic Method Based On Color Sensor. *Journal Of Informatics And Telecommunication Engineering*, *7*(1), 57–70. Https://Doi.Org/10.31289/Jite.V7i1.8712

Faizin, A. N., & Mujilahwati, S. (N.D.). *Seminar Nasional Teknologi Komputer & Sains (Sainteks) Sistem Informasi Dan Visualisasi Pasang Surut Air Laut Pada Pelabuhan Perikanan Nusantara Brondong Menggunakan Metode Fuzzy Logic Berbasis Android*.

Jusadi, D., Fitriani, F., Ekasari, J., & Vinasyiam, A. (2016). Tingkat Keragaman Ukuran Benih Ikan Lele Clarias Sp. Yang Diberi Artemia Dengan Periode Yang Berbeda. *Jurnal Akuakultur Indonesia*, *15*(2), 156. Https://Doi.Org/10.19027/Jai.15.2.156-161

Kurniawan, R., Hasibuan, M. S., & Prayuda, I. (N.D.). *Infokum Is Licensed Under A Creative Commons Attribution-Non Commercial 4.0 International License (Cc By-Nc 4.0) Automatic Fish Sorter With Microcontroller Based Sugeno Fuzzy Logic*. Http://Infor.Seaninstitute.Org/Index.Php/Infokum/Index

Maryam, S., Bu, E., & Hatmi, E. (2021). Penerapan Metode Fuzzy Mamdani Dan Fuzzy Tsukamoto Dalam Menentukan Harga Mobil Bekas. In *Journal Of Informatics, Electrical And Electronics Engineering* (Vol. 1, Issue 1). Https://Djournals.Com/Jieee

Naufal Allaudin, A., & Nasuha, A. (2023). Automatic Catfish Sorter And Counter Based On Weight Classification. In *Journal Of Robotics, Automation, And Electronics Engineering* (Vol. 1, Issue 1). Https://Journal.Uny.Ac.Id/V3/Jraee

Prawoto, E., Susilawati, H., & Faqih, N. (2018). *Strategi Inovasi Produk Olahan Dan Manajemen Pemasaran Guna Meningkatkan Daya Jual Lele (Ukm Peternak Lele Di Desa Kalibeber, Mojotengah, Wonosobo)*. 123–127.

Putri Firdausi, A., Eny Indriastuti, C., Kusumanti, I., Eka Ramadhani, D., Arafah Tunisa, R., Zidan Akmal Maulana, A., Amar Taufiqurrahman Sasmita, G., Fizry Alnur Rizky, M., Wiyoto, W., Aurora Adycha, P., Fajar Maulana Ihsan, M., Studi Teknologi Dan Manajemen Pembenihan Ikan, P., Vokasi, S., & Pertanian Bogor, I. (N.D.). Efektivitas Budidaya Ikan Lele Dengan Recirculating Aquaculture System (Ras) Di Sujafish Farm, Kecamatan Cikole, Kota Sukabumi. *Risalah Kebijakan Pertanian Dan Lingkungan*, *11*(1), 1–12.

Rifai, D., & Fitriyadi, F. (2023). Penerapan Logika Fuzzy Sugeno Dalam Keputusan Jumlah Produksi Berbasis Website. *Hello World Jurnal Ilmu Komputer*, *2*(2), 102–109. Https://Doi.Org/10.56211/Helloworld.V2i2.297

Salurianto, C., Sari, M. I., & Hapsari, G. I. (N.D.). *Pengembangan Alat Penyortir Ikan Berdasarkan Panjang Ikan Menggunakan Sensor Ping*.

Santosa, S. H., Hidayat, A. P., & Siskandar, R. (2021). Safea Application Design On Determining The Optimal Order Quantity Of Chicken Eggs Based On Fuzzy Logic. *Iaes International Journal Of Artificial Intelligence*, *10*(4), 858–871. Https://Doi.Org/10.11591/Ijai.V10.I4.Pp858-871

Siskandar, R., Indrawan, N. A., Rifa Kusumah, B., & Husen Santosa, S. (N.D.). *Penerapan Rekayasa Mesin Sortir Sebagai Penentu Kematangan Buah Jeruk Dan Tomat Merah Berbasis Image Processing Implementation Of Sortir Machine Engineering As Determination Of Maturity Of Orange And Red Tomato Based On Image Processing*. Https://Doi.Org/10.23960/Jtep-L.V9.I3.222-236

Siskandar, R., Wiyoto, W., Santosa, H., Hidayat, A. P., Kusumah, B. R., Danang, M., Darmawan, M., & Santosa, S. H. (2023). *Easychair Preprint Prediction Of Freshwater Fish Disease Severity Based On Fuzzy Logic Approach, Arduino Ide And Proteus Isis Prediction Of Freshwater Fish Disease Severity Based On Fuzzy Logic Approach, Arduino Ide And Proteus Isis*.

Siskandar, R., Wiyoto, W., Santosa, S. H., Sari, J. E., Darmawangsa, G. M., Hidayat, A. P., Dardanella, D., & Kusumah, B. R. (2023). Potential Readings Of Water Turbidity Values Based On Optical Sensors On Fish-Rearing Biofloc Media. *Photonics Letters Of Poland*, *15*(1), 1–3. Https://Doi.Org/10.4302/Plp.V15i1.1176

Suryadijaya, D., Putri, M., & Saragih, D. (2023). Implementasi Fuzzy Sugeno Dalam Pemilihan Benih Unggul Ikan Mas Koki (Studi Kasus : Prodi Budidaya Perairan Fakultas Pertanian Una). *Jurnal Teknologi Informasi*, *7*(1).

Wiyoto, W., Siskandar, R., Dewi, R. K., Lesmanawati, W., Mulya, M. A., & Ekasari, J. (2023). Effect Of Stocking Density On Growth Performance Of African Catfish Clarias Gariepinus And Water Spinach Ipomoea Aquatica In Aquaponics Systems With The Addition Of Ab Mix Nutrient. *Jurnal Akuakultur Indonesia*, *22*(1), 47–54. Https://Doi.Org/10.19027/Jai.22.1.47-54