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Smallest of Maximum to find α-predicate for DeterminingCattle Health Conditions

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ABSTRACT

Beef cattle is one of the livestock that can produce various human needs. All parts of a cattle, ranging from meat, skin, bones to cattle dung, can be utilized so that beef cattle are rate to have high economic value and become one of the common livestock to be cultivated. In beef cattle breeding, there are obstacles in maintaining and achieving the desired production results, one of which is cattle's death due to disease infection. Lose one or a group of cattle unpredictably, effecting a loss of investment and losses for the breeder. Biosecurity is required to reduce the risk of death from disease and maintain beef cattle's health and quality. However, the lack of awareness and concern of breeders in the biosecurity implementation has resulted in the high mortality rate for beef cattle in Indonesia. This study tries to apply the fuzzy algorithm into an animal inspection expert system at the Cimanggu Animal Clinic. The expert system can support collaboration between veterinarians and breeders in the implementation of biosecurity. The Smallest of the Maximum method provides to get the α-predicate from the ranking of possible diagnoses of cattle diseases. Then α-predicate is reprocessed by defuzzification of the Tsukamoto model and produces handling suggestions and information on the cattle's condition.

Key words : Cattle Health, Fuzzy Algorithm, Smallest of Maximum, Fuzzy Tsukamoto

I. INTRODUCTION

Over the years, beef cattle have become a crucial part of Indonesians' livelihood, especially for people who live in rural areas and agricultural areas [1]. Beef cattle is a meat-producing resource with high economic value and has an essential meaning in fulfilling human life needs. Indonesia's beef cattle population ranges from 16.6 million head[2], where 43% are in Java, 25% in Eastern Island, and 32% were located on another island in Indonesia. Beef cattle with the Balinese race are recommended to be the original Indonesian cow most suitable to be bred and used as livestock by Indonesia [3]. A beef cattle or a beef cattle group can produce various kinds of human life necessities, mainly as a food ingredient in meat, and other products such as skin, bones, and animal manure can use for other needs. Meat derived from beef cattle has become a source of animal food in Indonesia[4]. The potential for beef consumption in the fourth largest population country is considered very good, with the average consumption of beef is 2.72 kg/capita/yr, and it is projected that beef consumption will reach 3.36 kg/capita/year in 2024, along with there is a growth in population, income, and consumption of animal protein[5].

Care and maintenance are critical for beef cattle farms to maintain the desired production and profit. Due to death, livestock's unexpected loss resulted in farmers' investment losses and losses [6]. Based on Indonesia's livestock and animal health statistics agency in 2017, the mortality percentage of 2014 has increased from 1.93% to 2.74% or around 440,469 cows of the total registered[2]. The problem of antimicrobial resistance makes the higher death level of beef cattle. Also, beef cattle are less resistant to parasitic infections and diseases, especially cattle with Balinese breeds, are susceptible to Malignant Catarrhal Fever (MCF), which is transmitted from other livestock [3].

For this reason, biosecurity, which is a series of preventing the spread of disease, is a significant part of being implemented in livestock health programs [7]. However, the application of biosecurity in raising livestock still faces many obstacles, ranging from traditional breeding habits, lack of knowledge about the implementation of biosecurity, to the lack of interest of breeders in conducting animal health checks to doctors [8]. Collaboration between veterinarians and breeders are precious to encourage increased adoption of the practice of biosecurity in the maintenance and breeding of animals [9].

Fuzzy algorithms with various models have been widely applied in various information systems in the health sector. In this research, the fuzzy algorithm is applied to the information system of the animal health service. The test is conducted using one of the results of the examination performed by the doctor and then becomes a fuzzy set to produce a set of membership values. The α-predicate value is obtained by applying the membership value to each IF-THEN rule and calculated using the Smallest of Maximum method. The beef cattle condition's output value calculation uses the Tsukamoto Method with the weighted average value's final result.

The contribution of this research is to create an expert system that can assist veterinary clinics in conducting examinations and determining the health condition of cows. With the existence of an expert system, it is hoped that it can reduce the examination time, which requires monitoring several times in examining the health condition of beef cattle.

II. STUDY LITERATURE AND PREVIOUS RESEARCH

A. Beef Cattle

Cattle are animals that are deliberately bred as a source of food [10]. The animals that are mostly raised include cows, chickens, goats, sheep, and pigs. Beef cattle are included in large ruminants and are among the most widely bred animals [3]. Almost the same as agriculture and plantations, the breeding and maintenance of livestock, or what is commonly referred to as livestock, includes livestock activities, including feeding, breeding, maintenance, health care, and product utilization. Animal husbandry is intended explicitly for breeding animals that will be used as food or industrial material. Livestock products from beef cattle include meat and textile materials. Also, animal manure can fertilize the soil, and animal power can be used as a means of transportation, and for plowing the land [11].

B. Cattle Health

Cattle health is a condition in which the animal body with all the cells that make up and the body fluids it contains physiologically usually function [12]. The implementation of biosecurity is essential to maintain cattle health. Biosecurity is the observation of sick cattle by examining cattle suspected of being sick and conducting medication to prevent disease spread to other livestock [8]. Examining suspected sick animals is a process to determine and observe the change in livestock through signs or symptoms that appear and can be made conclusions and diseases and adapt known cause [7]. Cow disease can be caused by viruses, bacteria, parasites, and chemicals[13]. Diseases in livestock can produce significant economic losses for breeders in particular and the broader community in general because many livestock diseases that not only attack livestock but can also be transmitted to humans are called "ZOONOSIS" diseases [6].

C. Fuzzy Logic

Generally, fuzzy logic is a computational method that adopted the term computer language of human linguistic of natural communication into a process of "counting" [14]. Following human thinking development, this fuzzy logic has become famous for research because of its ability to bridge machine language, which is completely precise with human language, which tends to be incorrect or called powerful words [15]. Indeed, the words used in fuzzy are not as precise as numbers, but the words used are closer to human intuition, such as the words "feel," "roughly," " more or less," and so on. Fuzzy algorithms have been developed and produce differences in determining the expected output results. Three methods are often used, namely Mamdani, Sugeno, and Tsukamoto.

D. Previous Research

The application of fuzzy algorithms in information systems can be applied to expert systems in health services and produce doctors' recommendations in diagnosing diseases in humans [14]. The fuzzy algorithm can produce a system that can shorten and predict diabetes based on parameters in patients' form of symptoms [16]. An advanced stage in developing an algorithm can also help a system that can predict depression, which has been quite challenging to diagnose with one doctor's monitoring with an accuracy of up to 86% [15]. Also, previous research combining image processing with fuzzy algorithms can produce an accuracy of up to 96.15% and is equivalent to experts' performance in conducting early detection of glaucoma in humans [17].
Based on literature studies from several previous studies, the fuzzy algorithm is considered good enough to be applied to an expert system and helps in the automatic diagnosis of a disease. For this reason, this research aims to contribute by creating an expert system that can assist veterinary clinics in examining and determining the health condition of beef cattle by identifying using several symptom parameters in beef cattle. With the existence of an expert system, it is hoped that it can reduce the examination time, which requires monitoring several times in examining the health condition of beef cattle.

III. RESEARCH METHOD

A. Data Collection

This research took place at the Cimanggu Animal Clinic, which provides doctor services for the care and examination of animals, including beef cattle. Data retrieval refers to the examination module in the clinical animal health service system, as described in figure 1, and then implements the fuzzy algorithm into the module.

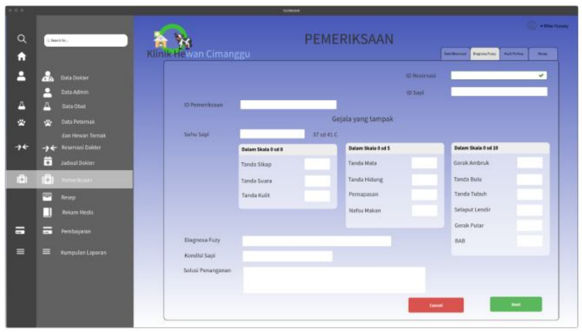

Figure 1.Examination system in Cimanggu Animal Clinic

The examination system at the clinic is converted into a fuzzy set to produce fuzzification values. Fuzzification is the initial process of a series in the fuzzy logic algorithm process. The fuzzification process converts non-fuzzy variables (numeric variables) into fuzzy variables (linguistic variables). The input value is still in the form of a numeric variable. Before processing, it must be converted into a fuzzy variable [18].

B. Inference System

Fuzzy inference systems are also known as fuzzy rule-based systems, fuzzy associative memory, fuzzy models, or fuzzy controllers [19]. In fuzzy inference, several rules are made to process the fuzzification results and get crisp output results.

An inference engine with the Smallest of the Maximum method is used to get the α-predicate value for each rule (r1, r2, r3, rn). The smallest of the Maximum method determines the smallest domain value from the maximum membership value [20][20]. The maximum value of membership combined using logic ∩to take the minimum and applied to each fuzzy rule made [21], with the following formula:

$$\alpha - \mathrm{p} = MIN[\mu x_1, \mu x_2, \mu x_3, \mu x_4, \ldots \mu x_n]$$

C. Defuzzification

Fuzzy algorithms have been developed and produce differences in determining the expected output results. One method that is considered appropriate in this study is the fuzzy algorithm with the Tsukamoto model. The Tsukamoto method is an extension of monotonous reasoning. In the Tsukamoto method, each consequence of the IF-THEN rules must be presented with a fuzzy set with a monotonous membership function [22]. The Tsukamoto method's defuzzification makes each rule's inference output crisp based on the α-predicate (fire strength). The final result is obtained using weighted averages. Tsukamoto Method formula :

$$Z = \frac{\alpha_1 z_1 + \alpha_2 z_2}{\alpha_1 + \alpha_2}$$

IV. RESULT AND DISCUSSION

The first process of fuzzy is by calculating according to the fuzzy set that has been made to get the value of each entered symptom, and then it is represented on the curve of the beef cattle's condition based on the symptom value entered. With the Smallest of Maximum method (SOM), n use-values maximum membership between 0 and 1 of the calculation result obtained from calculating the value put on the symptoms will be applied to each fuzzy rule been made to find the minimum value of her. End process with defuzzification by applying fire strength values into calculating the output to generate outputs inspected beef cattle health conditions.

A. Fuzzification

Fuzzy modeling is based on the concept of fuzzy sets. A fuzzy set is made by looking at 14 input symptoms in the clinical examination module. Each input symptom is calculated for each membership value and described into three areas: the lower area of the representation for linear downward, the middle area of the triangle-shaped curve representation, and the upper area as the representation for linear upward. In this study, the fuzzy algorithm applying to one of the examination results from Cimanggu Animal Clinic and then becomes a fuzzy set intended for limiting variable values of fuzzification to be used as input for the inference engine. The fuzzification results in the following table 1.

Table 1. Result fuzzyfication from examinationproccess

No	Variabel	Result Examination	Range Score			Score	Group
			Below	Medium	Top		
1	Temperature	Hot	0-36	37-40	39-41	40,5	Group Temperature
2	Sound	Snore	0-3	1-7	5-8	7,3	Group Examination One
3	Gesture	Sluggish	0-3	1-7	5-8	2,5	
4	Skin	Normal	0-3	1-7	5-8	4,0	
5	Eye	Normal	0-2	1-4	3-5	5,0	Group Examination Two
6	Appetite	Lack	0-2	1-4	3-5	2,1	
7	Scout	Slimy	0-2	1-4	3-5	2,1	
8	Respiration	Choke	0-2	1-4	3-5	2,0	
9	Movement	Normal	0-4	2-8	6-10	5,0	Group Examination Three
10	Body	Edema	0-4	2-8	6-10	7,1	
11	Mucus	Red	0-4	2-8	6-10	6,0	
12	Spinning Movement	Normal	0-4	2-8	6-10	5,0	
13	Defecate	Normal	0-4	2-8	6-10	5,0	
14	Hair	Normal	0-4	2-8	6-10	5,0	

B. Temperature Group

The Temperature group has three areas, namely cold areas, normal areas, and hot areas. The entered variable value of 40.5 ℃ for the temperature group will be calculated into each area as a value by applying the following formula :

Cold temperature group :

$$\mu[temperatureCold]\begin{cases} 1 & : jika\ x \le 36 \\ \dfrac{38 - x}{38 - 36} & : 36 \le x \le 38 \\ 0 & : jika\ x \ge 38 \end{cases}$$

Normal temperature group :

$$\mu[temperatureNormal]\begin{cases} 0 & : jika\ x \le 37 \\ \dfrac{x - 37}{38.5 - 37} & : 37 \le x \le 38.5 \\ \dfrac{38.5 - x}{40 - 38.5} & : 38.5 \le x \le 40 \end{cases}$$

Hot temperature group :

$$\mu[temperatureHot]\begin{cases} 0 & : jika\ x \le 39 \\ \dfrac{41 - x}{41 - 39} & : 39 \le x \le 41 \\ 1 & : jika\ x \ge 41 \end{cases}$$

From the entered values, the maximum membership value is 0.8 and is included in the linear representation up as the hot area and is depicted in Figure 2.

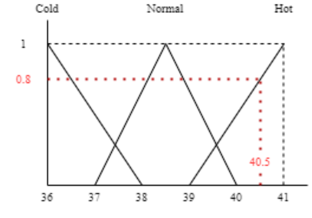

Figure 2. Result for cattle temperature

C. Examination Group One

A first examination group is a group of symptom variables seen in cows consisting of attitude symptoms, voice symptoms, and skin symptoms. In this one examination group, a constraint is created with input values from 0 to 8. The input values of fuzzification are treated as and are applied to the following formula:

Bottom Group :

$$\mu[examinationOneBelow]\begin{cases} 1 & : jika\ x \le 0 \\ \frac{3-x}{3-0} & : 0 \le x \le 3 \\ 0 & : jika\ x \ge 3 \end{cases}$$

Middle Group :

$$\mu[examinationTwoMedium]\begin{cases} 0 & : jika\ x \le 1 \\ \frac{x-1}{4-1} & : 1 \le x \le 4 \\ \frac{7-x}{7-4} & : 4 \le x \le 7 \end{cases}$$

Top Group

$$\mu[examinationTwoTop]\begin{cases} 0 & : jika\ x \le 5 \\ \frac{8-x}{8-5} & : 5 \le x \le 8 \\ 1 & : jika\ x \ge 8 \end{cases}$$

The calculation result for the maximum value of membership of the sound symptom (1) is 0.8, and the representation is shown in linear ascending. Gesture symptom (2) produces a value of 0.5, and the representation is in a linear decline. At the same time, Skin Symptoms (3) shows a result of 1 or normal and is on a triangle curve.

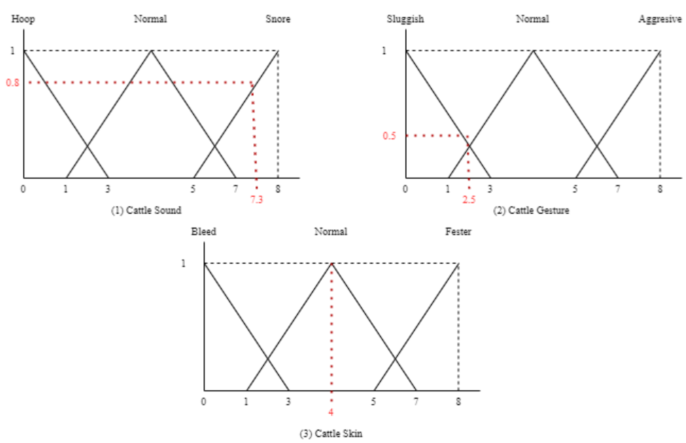

Figure 3. Result for examination group one

D. ExaminationGroupTwo

The second examination group consisted of symptoms in the eyes, appetite, scout, and respiration. In examination group two, a boundary was created with the input value from 0 to 5. The fuzzification value for each symptom is applied as x to find the maximum membership value with the following formula :

Bottom Group

$$\mu[examinationTwoBelow]\begin{cases} 1 & : jika\ x \le 0 \\ \frac{2-x}{2-0} & : 0 \le x \le 2 \\ 0 & : jika\ x \ge 2 \end{cases}$$

Normal Group

$$\mu[examinationTwoMedium]\begin{cases} 0 & : jika\ x \le 1 \\ \frac{x-1}{2.5-1} & : 1 \le x \le 2.5 \\ \frac{4-x}{4-2.5} & : 2.5 \le x \le 4 \end{cases}$$

Top Group

$$\mu[examinationTwoTop]\begin{cases} 0 & : jika\ x \le 3 \\ \frac{5-x}{5-3} & : 3 \le x \le 5 \\ 1 & : jika\ x \ge 5 \end{cases}$$

The maximum value for 1 or standart membership is found in eye symptoms (1), and its representation is shown on a triangular curve. Meanwhile, the maximum value for three other symptoms, namely appetite symptoms (2), scout symptoms (3), and respiration symptoms (4), produced the same value of 0.7 and represented on a triangle curve but decreased linearly.

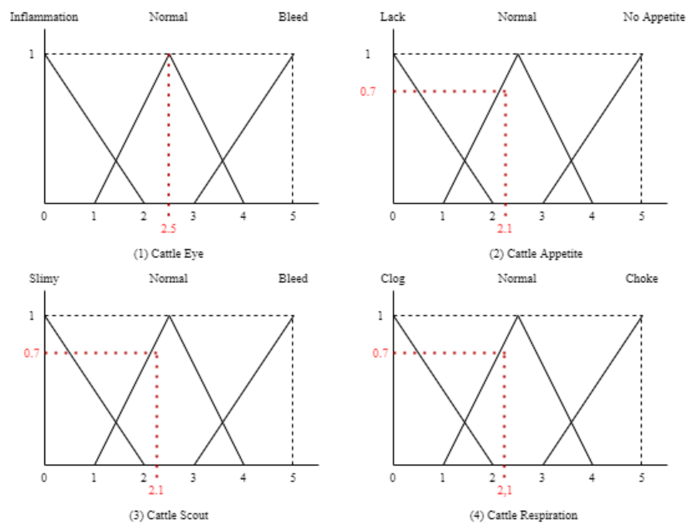

Figure 4. Result for examination group two

E. ExaminationGroupThree

Examination group three was defined with an input value of 0 to 10, consisting of movement symptoms, body symptoms, mucus symptoms, spinning symptoms, defecate symptoms, and hair symptoms. The fuzzification value is applied as an x value and is calculated by the following formula :

Bottom Group

$$\mu[examinationThreeBelow]\begin{cases} 1 & : jika\ x \leq 0 \\ \dfrac{4-x}{4-0} & : 0 \leq x \leq 4 \\ 0 & : jika\ x \geq 4 \end{cases}$$

Normal Group

$$\mu[examinationThreeMedium]\begin{cases} 0 & : jika\ x \leq 2 \\ \dfrac{x-5}{2-5} & : 2 \leq x \leq 5 \\ \dfrac{8-x}{8-5} & : 5 \leq x \leq 8 \end{cases}$$

Top Group

$$\mu[examinationThreeTop]\begin{cases} 0 & : jika\ x \leq 6 \\ \dfrac{10-x}{10-6} & : 6 \leq x \leq 10 \\ 1 & : jika\ x \geq 10 \end{cases}$$

The result of the maximum membership value of 0.3 in body symptoms (2) is represented as a linear upward, and Mucus (3) shows a value of 0.7 in linear decline. While other symptoms, namely movement symptoms (1), spinning motion symptoms (4), defecate symptoms (5), and feathers symptoms (6), show the maximum value of membership results, one or showing normal condition, and are shown on the middle curve.

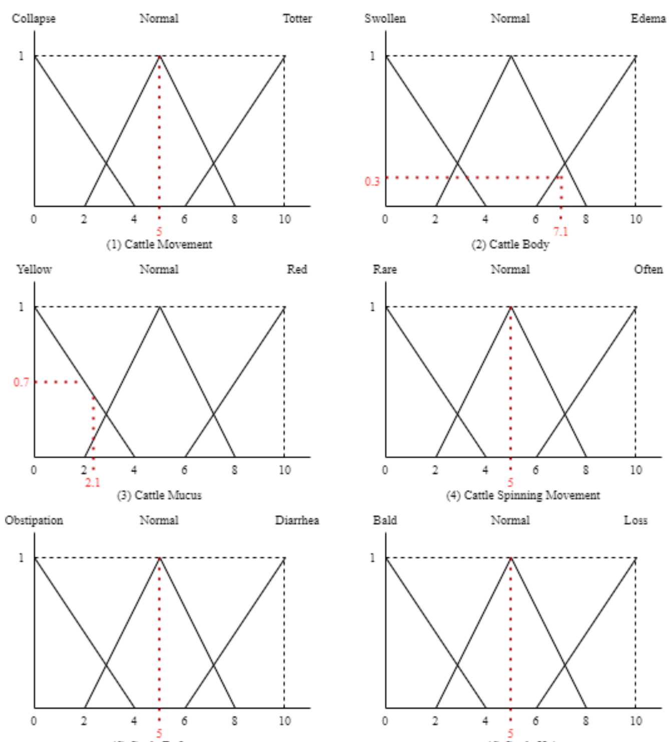

Figure 5Result for group examination three

F. Rule Fuzzy

In this study, there were five beef cattle diseases and a series of fuzzy rules, namely Anthrax Disease (R1), SepticemiaDisease(R2), SurraDisease(R3), MCF Disease(R4), and Scabies Disease (R5).

[R1] IF Temperature is Hot AND Movement is Collapse AND Eye is Bleed AND Gesture is Sluggish AND Scout is Bleed AND Respiration is Choke AND Skin is Bleed THEN Disease is Anthrax

[R2] IF Temperature is Hot AND Gesture is Sluggish AND Appetitte is Lack AND Scout is Slimy AND Respiration is Choke AND Sound is Snore AND Body is Edema AND Mucus is Red THEN Disease is SepticemiaDisease

[R3] IF Temperature is Hot AND Eye is Inflamation AND Gesture is Sluggish AND Hair is Loss AND Appetitte is Lack AND Scout is Slimy AND SpinningMovement is Often THEN Disease is SurraDisease

[R4] IF Temperature is Hot AND Movement is Totter AND Eye is InflamationAND Gesture is Aggresive AND Appetitte is Lack AND Scout is Slimy AND Respiration is Clog AND Mucus is Yellow AND Defecate is Diarrhea THEN Disease is McfDisease

[R5] IF Gesture is AggresiveAND Hair is Loss AND Skin is Fester THEN Disease is Scabies

With the Smallest of Maximum (SOM) method, each membership value's maximum value is applied to each fuzzy rule to obtain the minimum value.

α-p1 = MIN (µHotTemperature∩µCollapseMovementµBleedEye ∩µSluggishGesture∩µBleedScout∩µChokeRespiration∩µBleedSkin)

= MIN (0.8, 1.0, 1.0, 0.5, 0.7, 0.7, 1.0) = 0.5

α-p2 = MIN (µHotTemperature∩µSluggishGesture∩µLackAppetite∩µSlimyScout∩µChokeRespiration∩µSnoreSound∩µEdemaBody∩µRedMucus)

= MIN (0.8, 0.5, 0.7, 0.7, 0.7, 0.8, 0.3) = 0.3

α-p3 = MIN (µHotTemperature∩µInflamationEye∩µSluggishGesture∩µLossHair∩µLackAppetite∩µSlimyScout∩ µOftenSpinningMovement)

= MIN (0.8, 1.0, 1.0, 0.5, 1.0, 0.7, 0.7, 1.0) = 0.5

α-p4 = MIN (µHotTemperature∩µTotterMovement∩µInflamatio nEye∩μAggresiveGestureμLackAppetite∩μSlimyScout∩μClogRespiration∩μYellowMucus∩μDiarrheaDefecate)

= MIN (0.8, 1.0, 0.5, 0.7, 0.7, 0.7, 0.7, 1.0) = 0.5

α-p5 = MIN (μAggresiveGesture∩μLossHair∩μFesterSkin)

= MIN (0.5, 1.0, 1.0) = 0.5

G. Defuzzyfication

This research's output range shown in table 2 with a scale of 0-8 and 3 areas, namely minor sick, moderate sick, and badly sick.

Table 2. The Output Range

No	Area	Remark	Suggestion
1	0-4	Minor Sick	Can be handled alone (without veterinarian)
2	2-8	Moderate Sick	It is recommended to be handled by a veterinarian
3	6-10	Badly Sick	Must be handled by a veterinarian immediately

To get the output results for the condition of the cattle being checked, the final result of fire strength is obtained by taking the minimum α- predicate (α-p) from each rule and returning it to the output result range to get the x value with the following formula calculation:

$[conditionLow]x1 = (4 - x1)/(4 - 0) = \alpha\text{-p}$
$[conditionNormal]x21 = (x21 - 2)/(5 - 2) = \alpha\text{-p}$
$[conditionNormal]x22 = (8 - x22)/(8 - 5) = \alpha\text{-p}$
$[conditionTop]x3 = (x3 - 6)/(10 - 6) = \alpha\text{-p}$

The final defuzzification process shows the condition of the beef cattle is very sick and requires immediate veterinary treatment, with calculations using the Tsukamoto method yielding a value of 7.9

$$Z = \frac{\propto 1z1 + \propto 2z2 + \propto 3z3 + \propto 4z4 + \propto 5z5}{\propto 1 + \propto 2 + \propto 3 + \propto 4 + \propto 5}$$

$$Z = \frac{(8 * 0.5) + (7.2 * 0.3) + (8 * 0.5) + (8 * 0.5) + (8 * 0.5)}{0.5 + 0.3 + 0.5 + 0.5 + 0.5}$$

$$Z = 7.9$$

V. CONCLUSION

Based on the research, testing one of the results of the inspection of cattle with the Smallest of the Maximum method in the defuzzification process shows a minimum α-predicate value of 0.3 in the second rule and produces information on diagnosing diseases suffered by cattle is Surra disease. The minimum value is then processed using the Tsukamoto method, resulting in a value of 7.9 and indicates that the cattle's condition is very sick and must be immediately handled by a veterinarian.

In this study, the classification of symptom data into fuzzy sets was carried out without the guidance and only looking for similarities in symptoms based on literature studies. Therefore, further research is recommended to develop the use of fuzzy algorithms on classified data with supervision, especially for models Tsukamoto using the center of the area or weighted average.

REFERENCES

[1] T. Ekowati, E. Prasetyo, and M. Handayani, "The factors influencing production and economic efficiency of beef cattle farm in Grobogan Region, Central Java," *J. Indones. Trop. Anim. Agric.*, vol. 43, no. 1, pp. 76–84, 2018, doi: 10.14710/jitaa.43.1.76-84.

[2] Directorate General of Livestock and Animal Health Services Indonesia, *Livestock and Animal Health Statistics 2018*. 2018.

[3] H. Martojo, "Indigenous Bali Cattle is Most Suitable for Sustainable Small Farming in Indonesia The Bali cattle breed," vol. 47, pp. 10–14, 2012, doi: 10.1111/j.1439-0531.2011.01958.x.

[4] G. M. Sullivan and K. Diwyanto, "A Value Chain Assessment of the Livestock Sector in Indonesia Interventions for Improving the Beef Cattle Industry in Indonesia," no. February, pp. 62–21, 1021.

[5] A. Agus, T. Satya, and M. Widi, "Current situation and prospect of beef cattle production in Indonesia," pp. 1–8, 2018.

[6] K. Mõtus, T. Niine, A. Viltrop, and U. Emanuelson, "Herd-Level on-Farm Mortality in Extensively Managed Beef Herds," *J. Appl. Anim. Welf. Sci.*, vol. 00, no. 00, pp. 1–20, 2019, doi: 10.1080/10888705.2019.1696679.

[7] J. Siekkinen, K., Heikkila, J., Tammiranta, N., Rosengren, H., & Heikkila, "Measuring the costs of biosecurity on poultry farms : a case study in broiler production in Finland," *Acta Vet. Scand.*, pp. 1–8, 2012, [Online]. Available: http://www.actavetscand.com/content/54/1/12.

[8] V. S. Lestari, D. P. Rahardja, P. Mappigau, S. T. Rohani, S. N. Sirajuddin, and P. S. Selatan, "Beef cattle farmers behavior toward biosecurity," vol. 44, no. 60, pp. 204–212, 2019, doi: 10.14710/jitaa.44.2.204-212.

[9] J. M. Cardwell *et al.*, "Assessing the impact of tailored biosecurity advice on farmer behaviour and pathogen presence in beef herds in England and Wales," *Prev. Vet. Med.*, vol. 135, pp. 9–16, 2016, doi: 10.1016/j.prevetmed.2016.10.018.

[10] B. Santoso and B. W. H. E. Prasetiyono, "The Regional Analysis of Beef Cattle Farm Development in Semarang Regency," vol. 43, no. 1, pp. 86–94, 2020.

[11] F. Ekawasti, W. Nurcahyo, A. Hari, and T. Shibahara, "Parasitology International Molecular characterization

of highly pathogenic Eimeria species among beef cattle on Java Island , Indonesia," *Parasitol. Int.*, vol. 72, no. January, p. 101927, 2019, doi: 10.1016/j.parint.2019.101927.

[12] M. Zachut, Š. Marcela, A. M. De Almeida, G. Gabai, A. Mobasheri, and L. E. Hernández-castellano, "Biomarkers of fitness and welfare in dairy cattle : healthy productivity," pp. 4–13, 2020.

[13] K. Mõtus, A. Viltrop, and U. Emanuelson, "Reasons and risk factors for beef calf and youngstock on-farm mortality in extensive cow-calf herds," 2017, doi: 10.1017/S1751731117003548.

[14] Z. Niswati, F. A. Mustika, and A. Paramita, "Fuzzy logic implementation for diagnosis of Diabetes Mellitus disease at Puskesmas in East Jakarta," *J. Phys. Conf. Ser.*, vol. 1114, no. 1, 2018, doi: 10.1088/1742-6596/1114/1/012107.

[15] M. H. Fazel Zarandi, S. Soltanzadeh, A. Mohammadi, and O. Castillo, "Designing a general type-2 fuzzy expert system for diagnosis of depression," *Appl. Soft Comput. J.*, vol. 80, no. 2019, pp. 329–341, 2019, doi: 10.1016/j.asoc.2019.03.027.

[16] I. K. Mujawar and B. T. Jadhav, "Web-based Fuzzy Expert System for Diabetes Diagnosis," *Int. J. Comput. Sci. Eng.*, vol. 7, no. 2, pp. 995–1000, 2019, doi: 10.26438/ijcse/v7i2.9951000.

[17] A. Soltani, T. Battikh, I. Jabri, and N. Lakhoua, "A new expert system based on fuzzy logic and image processing algorithms for early glaucoma diagnosis," *Biomed. Signal Process. Control*, vol. 40, pp. 366–377, 2018, doi: 10.1016/j.bspc.2017.10.009.

[18] I. Ranggadara, "Fuzzy Tsukamoto and ITIL for improvement strategy on incident ticket services," *Int. J. Innov. Technol. Explor. Eng.*, vol. 8, no. 10, pp. 897–903, 2019, doi: 10.35940/ijitee.J9063.0881019.

[19] L. Chusna, N. Available, L. Chusna, N. Kamila, and I. Ranggadara, "International Journal of Advanced Trends in Computer Science and Engineering Fuzzy Sugeno Algorithm for Clustering Document Management," vol. 9, no. 1, 2020.

[20] A. O. Olajide, A. T. Busayo, and E. T. Olawale, "Analyzing the Effects of the Different Defuzzification Methods in the Evaluation of Java components ' Customizability for Reusability," no. 9, pp. 962–971, 2017.

[21] T. Allahviranloo and R. Saneifard, "Defuzzification Method for Ranking Fuzzy Numbers Based on Center of Gravity," vol. 9, no. 6, pp. 57–67, 2012.

[22] A. Hermawan, I. Ranggadara, A. Suharso, I. Prihandi, and Suhendra, "Fuzzy tsukamoto for determinen linen priority," *Int. J. Eng. Adv. Technol.*, vol. 9, no. 1, pp. 2749–2755, 2019, doi: 10.35940/ijeat.A9764.109119.