

Application Of Sugeno's Fuzzy Inference System In Determining Inventory Goat Milk

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Abstract

Goat milk is one of the milk that is traded by the community because this milk has many benefits that are good for the health of the body and prevent bone damage in old age. Thalebkawnhinca Farm is a business that trades goat's milk both per liter and per pack. The erratic supply of goat's milk causes consumer demand cannot be fulfilled and the milk sales process becomes hampered. Therefore, this study aims to apply fuzzy logic with the Sugeno method in determining the amount of goat milk supply at Thalebkawnhinca Farm based on data on demand and sales of milk in April 2021. Based on data on demand and sales of goat's milk, the amount of milk supply that must be added if known demand of 90 liters and sales of 75 liters amounted to 25.1953125 liters. The result of this research is the implementation of a milk supply system that can be used in determining and providing information on the amount of goat's milk supply to the owner of the Thalebkawnhinca Farm.

Keywords: Goat's Milk, Animal Husbandry, Fuzzy Logic, Fuzzy Sugeno

1. Introduction

Fuzzy logic is a reasoning that has a value of ambiguity between false or true at the same time. In fuzzy logic, the membership value has the main characteristic that it lies in the range of values between 0 to 1 [1], [2], [3]. Fuzzy logic can be an alternative in solving a problem because Fuzzy Logic has several advantages such as having easy-to-understand concepts, being able to adapt to uncertainty or change, being able to describe linear functions as a whole, or having tolerance for inaccurate data [4],[5]. In fuzzy logic there are several algorithms that can be used, namely Fuzzy Tsukamoto, Fuzzy Sugeno, and Fuzzy Mamdani. The Fuzzy Sugeno algorithm is widely used in research because this algorithm is more flexible and efficient in dynamic systems [6]. This algorithm produces output in the form of linear equations or constants.

Inventory is all goods or merchandise provided by a business owner to meet every consumer need [7]. The main function of inventory is to provide a continuous supply of materials, keep prices up and take a profit. The purpose of the inventory itself is to meet consumer demand or needs, eliminate the risk of void of goods, provide the best service to consumers, and the company can maintain that there is no stock out that can cause risks that may occur. Sufficient inventory can affect the smooth sales process to generate maximum profit. Conversely, insufficient inventory can hamper sales, resulting in losses for the company. Thalebkawnhinca Livestock is an industry that provides various kinds of products such as fertilizer, animal feed, livestock in the form of goats, processed tofu, and fresh goat's milk. The problem that often occurs is the difficulty of determining the amount of goat's milk supply that must be added by the owner to be able to meet consumer demand and sales activities can run well.

In overcoming the problems faced by Thalebkawnhinca Farm, there are several ways or methods that can be used, one of which is the fuzzy logic method. Several previous studies that used the fuzzy logic method include research conducted by [8],[9],[10] where in her research it was concluded that the application of the Fuzzy Sugeno method can be used by industry players in deciding the amount of drug purchases based on sales data and inventory data. In a study conducted by [11], it was concluded that the Fuzzy Sugeno method is better than the fuzzy Tsukamoto method in calculating the prediction of ordering Jordan bread because the Sugeno method has an average prediction accuracy rate of 0.0176% while the truth level the average prediction of the tsukamoto method is 0.504288%. Research conducted by [12] concluded that fuzzy logic with the Sugeno method can be used to help residents decide the best price for choosing the land used in the construction of minimarkets and be able to assess near or far distances that can determine the selling price of the land [13].

2. Research Methodology

The research method is a method used to obtain and collect data in the form of primary data or secondary data, which is useful for compiling a scientific work in solving the author's problems. This research was conducted to apply Sugeno's Fuzzy Inference System in determining the amount of goat's milk supply at Thalebkawanhinca Farm. In this research methodology, a framework will be described that explains the stages of research from beginning to end so that research results are easy to understand and the process of obtaining data to be used in research. Research design is a plot or research framework carried out by researchers. The research design is useful for explaining and solving the problems that exist in the research. The following is the design flow of this research.

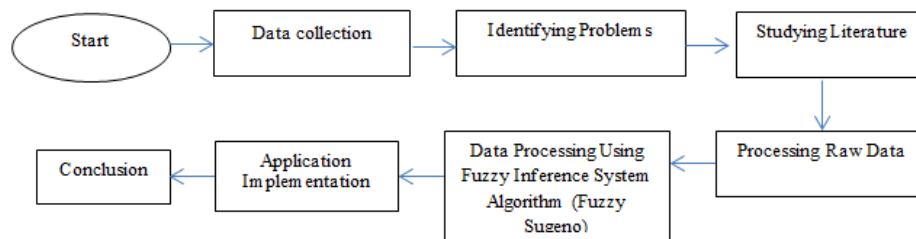


Figure 1. Research Design

The data collection method used in this research is by conducting observations and interviews, where the observations made are checking and collecting data at the Thalebkawanhinca Farm. In addition to making observations, researchers also conducted direct interviews with farm owners. Sources of research data obtained from observations made by researchers at the Thalebkawanhinca Farm. Where the results of the observations that have been made will be input into Microsoft Excel then calculations will be carried out. Research instrument is a tool that is made to process and accommodate various data to be collected in research. There are two kinds of research instruments that can be used, namely research instruments using qualitative methods and research instruments using quantitative methods. Qualitative research is a data collection technique by conducting in-depth observations and interviews, while quantitative research is a data collection technique using raw data which is then processed using statistics and then conclusions are drawn from hypotheses, for example questionnaires. In this study, the research instrument used by the author is qualitative research. This study uses the Fuzzy Sugeno algorithm to determine the amount of goat's milk supply. The modeling of the Fuzzy Sugeno algorithm can be seen in Figure 2 below:

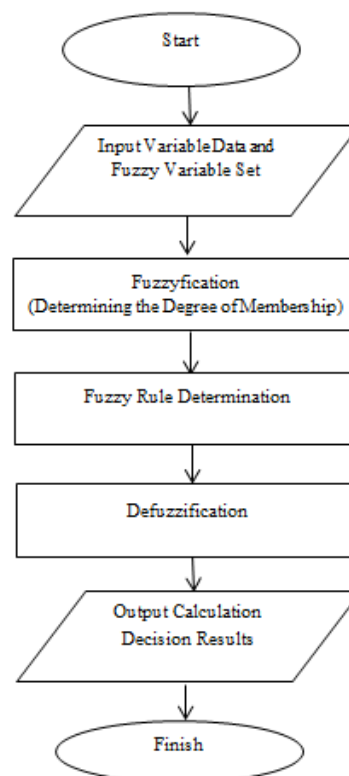


Figure 2. Flowchart of the Fuzzy Sugeno Algorithm

Figure 2 above describes the completion steps carried out by the author starting from inputting variable data and a set of fuzzy variables then the next process is to determine the degree of membership. After the degree of membership has been determined, the next process is the formation of fuzzy rules that will be used to then carry out the defuzzification process. From the defuzzification process, the output of the final calculation results from the Fuzzy Sugeno algorithm is obtained.

3. Results And Discussion

The results in this study are divided into 3 stages, namely manual calculations using the Fuzzy Sugeno Algorithm, system implementation using Microsoft Visual Studio 2010, and discussion of the system that has been created. The data used by the author is goat's milk supply data during April 2021 at Thalebkwahinca Farm.

3.1. Data Processing Using Fuzzy Sugeno Algorithm

In this study, data processing was obtained from the results of interviews with the owners of the Thalebkwahinca Ranch which consisted of one month during April 2021. The following is a table of research data.

Table 1. Research Data

Date	Request	Sale	Stock
01/04/2021	25 liter	30 liter	40 liter
02/04/2021	30 liter	40 liter	40 liter
03/04/2021	40 liter	50 liter	50 liter
05/04/2021	25 liter	30 liter	40 liter
06/04/2021	30 liter	50 liter	50 liter
07/04/2021	50 liter	60 liter	60 liter
08/04/2021	25 liter	35 liter	40 liter
09/04/2021	60 liter	50 liter	50 liter
10/04/2021	70 liter	80 liter	80 liter
12/04/2021	30 liter	45 liter	45 liter
13/04/2021	25 liter	40 liter	40 liter
14/04/2021	40 liter	55 liter	60 liter
15/04/2021	50 liter	40 liter	40 liter
16/04/2021	95 liter	90 liter	90 liter
17/04/2021	25 liter	35 liter	40 liter
19/04/2021	30 liter	35 liter	40 liter
20/04/2021	50 liter	40 liter	45 liter
21/04/2021	25 liter	35 liter	40 liter
22/04/2021	40 liter	50 liter	50 liter
23/04/2021	80 liter	75 liter	75 liter
24/04/2021	30 liter	45 liter	50 liter
26/04/2021	70 liter	60 liter	60 liter
27/04/2021	40 liter	60 liter	60 liter
28/04/2021	50 liter	45 liter	50 liter
29/04/2021	25 liter	40 liter	40 liter
30/04/2021	30 liter	45 liter	50 liter

The following are the steps in the manual calculation process using the Fuzzy Sugeno method in determining the amount of goat's milk supply. The problem that occurs is what is the amount of inventory if it is known that the number of requests = 90 liters and the number of sales = 75. Fuzzyfication stage is the stage where the author determines the fuzzy set and the domain used. The following is a table of fuzzy sets and domains.

Table 2. Fuzzy Set and Domain

Variabel Name	Domain
Request (X)	25 - 95
Sale (Y)	30 - 90
Stock (Z)	40 - 90

The fuzzy set above can be represented in a membership function with a membership value. The membership function used in this study is a linear membership function. Membership function for the Request variable, namely:

$$\mu_X[\text{Down}] = \begin{cases} 1 & x < 25 \\ \frac{95-x}{95-25} & 25 < x < 95 \\ 0 & x > 95 \end{cases}$$

$$\mu_X[\text{Up}] = \begin{cases} 0 & x > 95 \\ \frac{x-25}{95-25} & 25 < x < 95 \\ 1 & x < 25 \end{cases}$$

The membership values for the Demand Variables are:

$$\mu_{\text{Down}}[90] = (95-90/70) = 0,071428571$$

$$\mu_{\text{Up}}[90] = (90-25/70) = 0,928571429$$

The membership value for Sales Variables, namely:

$$\mu_{\text{Down}}[75] = (90-75/60) = 0,25$$

$$\mu_{\text{Up}}[75] = (75-30/60) = 0,75$$

The next stage is the author determines the fuzzy rules that will be used. In this study, the author uses 4 fuzzy rules. The following are the 4 fuzzy rules.

Table 3. Formation of Fuzzy Rules

No	Request	Sale	Stock
1	Ride	Hight	$Z = x - y$
2	Ride	Low	$Z = 1.25 * x - y$
3	Down	Hight	$Z = x$
4	Down	Low	$Z = x$

3.2. Calculating the -predicate Value of Each Rule

At this stage, the value of -predicate will be calculated for each predetermined rule. The following is the calculation process.

R1 = If Demand Increases And Sales Are High Then Inventory = x-y

$$\text{Pred}_1 = (0,928571429 ; 0,75)$$

$$= 0,75$$

$$Z_1 = x-y$$

$$= 90-75$$

$$= 15$$

R2 = If Demand Is Up And Sales Is Low Then Inventory =
1,25 * x-y

$$\text{Pred}_2 = (0,928571429 ; 0,25)$$

$$= 0,25$$

$$Z_2 = 1,25 * x-y$$

$$= 1,25 * 90-75$$

$$= 1,25 * 15$$

$$= 18,75$$

R3 = If Demand Drops And Sales High Then Inventory =

$$\text{Pred}_3 = (0,071428571 ; 0,75)$$

$$= 0,071428571$$

$$Z_3 = x$$

$$= 90$$

R4 = If Demand Drops And Sales Are Low Then Inventory = x

$$\text{Pred}_4 = (0,071428571 ; 0,25)$$

$$= 0,071428571$$

$$Z_4 = x$$

$$= 90$$

3.3. Defuzzification Stage (Confirmation)

At this stage, the crunch output calculation process is carried out. Where the output is a number from the domain of the fuzzy set. The defuzzification stage for the calculation of -predicate in each previous rule, namely

$$\begin{aligned}
 Z &= \frac{(0,75 \times 15) + (0,25 \times 18,75) + (0,071428571 \times 90) + (0,071428571 \times 90)}{0,75 + 0,25 + 0,071428571 + 0,071428571} \\
 &= \frac{11,25 + 4,6875 + 6,428571429 + 6,428571429}{1,142857143} \\
 &= \frac{28,79464286}{1,142857143} \\
 &= 25.1953125
 \end{aligned}$$

So from the results of the defuzzification process above, it can be seen that to meet the number of requests = 90 liters and total sales = 75 liters, the amount of inventory that must be added to meet the number of requests and sales above is 25.1953125 liters.

4. Conclusion

Fuzzy logic with the Fuzzy Sugeno method can be used to perform calculations in determining the amount of goat's milk supply at Thalebkawanhinca Farm by using predetermined variables. Research conducted using the Fuzzy Sugeno method is able to provide solutions to the Thalebkawanhinca Animal Husbandry in determining the amount of goat's milk supply so that consumer demand and milk sales can be met.

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