Application of The Fuzzy Tsukamoto Method in Determining Household Industry Products

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Abstract

Production system at UD. Mie Akwang is a home industry that provides raw materials for noodle production. Uncertain consumer demand and supplies that are not in accordance with demand make it difficult for this industry to determine the amount of production that will be produced. Previously, this home industry did not have a valid rule to determine the amount of production that must be achieved. Therefore, a decision support system was developed using the Fuzzy Tsukamoto method. This method is the right method in making decisions that use several criteria to produce decisions on the amount of production. In this study, the data used is in the form of data on the amount of production in April 2021. From the calculation process that has been carried out, it can be concluded that if the demand is 28,950 portions and the supply is 30,000 portions, the total production produced is 31,207 portions. The results of these calculations are implemented in the form of a production system and the results obtained are the same, namely 31,207 portions.

1. Introduction

Fuzzy logic is a logic that can be true or false at the same time. This is because fuzzy logic contains a value of vagueness or obscurity with a membership value characteristic between 0 and 1[1],[2]. Fuzzy logic can be used as an alternative problem solving because fuzzy logic has several advantages such as having easy-to-understand concepts, being able to adapt to changes or uncertainties, or being able to adapt to changes or uncertainties. describe linear functions in a complex manner. The fuzzy logic method used by the author in this thesis is the Fuzzy Tsukamoto method[3],[4]. This method was chosen by the author because every consequence of the IF-THEN rule is represented by using a fuzzy set on a monotonous membership function[5]. As a result, the output of each rule is then obtained by using the centralized average. Production is an activity that creates, produces or activities carried out to add value to the use or benefit of an item or service. The main purpose of the company to produce is to meet consumer needs and produce semi-finished goods to meet the needs of further production. To achieve this goal, the company must produce according to consumer demand and inventory in the warehouse. Consumer demand and inventory are the company's concern because consumer demand sometimes changes according to needs and existing supplies can also be adjusted to consumer demand. UD. Mie Akwang is one of the companies that carry out production activities. The production carried out is in the form of wonton noodle production. Consumer demand that changes from time to time and sometimes inappropriate supplies cause UD. Mie Akwang has difficulty in determining the amount of wonton noodle production produced. The problems faced by UD. Mie Akwang can be solved by using fuzzy logic method.

By using fuzzy logic is expected to overcome the problems that occur in UD. Mie Akwang. Several previous studies that used fuzzy logic methods in solving noodle production problems, including [6],[7] in his research concluded that fuzzy logic can increase the efficiency and effectiveness of production figures and sales figures are more stable and can reduce losses caused by the tendency of differences in production and sales figures. noodle sales assisted using the Fuzzy Logic application. In a further study conducted by [8] in his research, it was concluded that the Takagi-Sugeno Fuzzy Inference System method can predict the purchase of instant noodles with prediction results that there is a difference in MAPE (Mean Absolute Percentage Error) error of 35.55%. In a study conducted by [9] in his research, it was concluded that the Fuzzy Mamdani method was useful for obtaining the amount of instant noodle production of PT. Indofood CBP Sukses Makmur Tbk is optimal by looking at the results of the MPE (Mean Percentage Error) calculation of the actual production amount with the forecasted production amount from Fuzzy Mamdani of -18,03183 so that the Fuzzy Mamdani method can be used as a tool in determining production planning decisions.

2. Literature Review

Fuzzy logic is an appropriate way to map an input space into an output space. The basis of fuzzy logic fuzzy set theory. In fuzzy set theory, the role of membership degree as a determinant of the existence of elements in a set is very important. The value of membership or the degree of membership or membership function is the main characteristic of reasoning with fuzzy logic[10]. A fuzzy set is a range of values, each value has a membership degree between 0 to 1. The basic principle and mathematical equation of fuzzy set theory is a theory of grouping objects within vague boundaries[11]. The Tsukamoto method is an extension of monotonous reasoning. In the Tsukamoto method, every consequence of the IF-THEN rule must be represented by a fuzzy set with a monotonous membership function. As a result,

the inference output of each rule is given in a crisp (crisp) based on the - predicate (fire strength). The final result is obtained using a weighted average[12]

In its inference, the Tsukamoto method uses the following stages[13] Fuzzification is a process carried out to change real variables into fuzzy variables" [14]. Defuzzification, using the average method (Average)" [15], [16].

$$Z* = \frac{\sum \alpha i z i}{\sum \alpha i}$$

Information :
Z = Output variable
i = Value predicate
zi = Output variable value

The final output (z) is obtained using the averag weighted

$$Z = \frac{\alpha-predicate_1 * z_1 + \alpha-predicate_2 * z_2 + \cdots + (\alpha-predicate_n * z_n)}{\alpha-predicate_1 + \alpha-predicate_2 + \cdots + (\alpha-predicate_n)}$$

Research conducted by Donni Nasution with the title Fuzzy Application To Predict Egg Noodle Factory Production Figures With the Mamdani Method states that Fuzzy Mamdani can increase the efficiency and effectiveness of production figures and more stable sales figures can reduce losses caused by the tendency of differences in production and sales figures egg noodles per day. Another study conducted by Nofrida Elly Zendrato, et al with the title Planning for Amount of Instant Noodle Production with Fuzzy Mamdani's Centroid Defuzzification that the MPE (Mean Percentage Error) calculation results from the actual production amount with the forecasted production amount from Fuzzy Mamdani of - 18,03183 . Meanwhile, according to Ahmad Bahroini, et al in a study entitled Prediction of Demand for Instant Noodle Products Using the Fuzzy Takagi-Sugeno Method, the results of the prediction of stock demand for instant noodles using the Takagi-Sugeno fuzzy inference method contained a MAPE error difference of 35.55%.

3. Result and Discusion

The data processing is carried out using the Fuzzy Tsukamoto algorithm which will then be implemented with a program design using Microsoft Visual Studio 2010. This study uses production data during April 2021 as shown in table 1 below:

Tabel 1: Research data

No	Request	Stock	Production
1	25.000 portion	26.250 portion	27.450 portion
2	36.000 portion	36.360 portion	36.360 portion

Calculations using the Fuzzy Tsukamoto algorithm in determining the amount of production if it is known that the number of requests = 28950 and the amount of inventory = 30000 is as follows:

3.1. Fuzzyfication

There are 3 variables used and modeled using a linear representation membership function. The 3 variables are:

a.   Request, the membership function used in the demand variable is the set Down, Up. The set are:

$$\mu X[Down] = \begin{cases} 1 & x < 25000 \\ \frac{36000-x}{36000-25000} & 25000 < x < 36000 \\ 0 & x > 36000 \end{cases}$$

$$\mu X[Up] = \begin{cases} 0 & x > 36000 \\ \frac{x-25000}{36000-25000} & 25000 < x < 36000 \\ 1 & x < 25000 \end{cases}$$

The membership value of the above set is:

μx Up (28950)   = (36000-28950) /11000
                                    = 0.640909
μx Down (28950)   = (28950-25000) /11000
                                     = 0.359091

b.   Stock

The membership function used in the inventory variable is the set of Few, Many. The set are:

$$\mu y [a\ litle] = \begin{cases} 1 & y < 26250 \\ \frac{36360-y}{36360-26250} & 26250 < y < 36360 \\ 0 & y > 36360 \end{cases}$$

$$\mu y [many] = \begin{cases} 0 & y > 36360 \\ \frac{y-26250}{36360-26250} & 26250 < y < 26250 \\ 1 & y < 26250 \end{cases}$$

The membership value of the above set for the inventory variable is:

μy a litle (30000)   = (36360-30000) /10110
                                    = 0.62908
μy many (30000)   = (30000-26250) /10110
                                    = 0.37092

c. Production
The membership function used in the production variable is the set Decrease, Increase. The set are:

$$\mu z\,[\text{Increase}] = \begin{cases} 0 & z > 36360 \\ \frac{z-27450}{36360-27450} & 27450 < z < 36360 \\ 1 & z < 27450 \end{cases}$$

$$\mu z\,[\text{Reduce}] = \begin{cases} 1 & z < 27450 \\ \frac{36360-z}{36360-27450} & 27450 < z < 36360 \\ 0 & z > 36360 \end{cases}$$

3.2. Fuzzy Rule Formation
In this study used 4 fuzzy rules which can be shown in table 2 below:

Table 2: Fuzzy Rules

Rule	Request	Stock	Production
1	Down	A Litle	Reduce
2	Down	Many	Reduce
3	Up	A Litle	Increase
4	Up	Many	Increase

3.3. Inference Process Based on α--Predicate
At this stage, the process of calculating the values of the α--predicate is carried out to obtain the output value (Z) using the MIN function. The stages, namely:

a. Rule 1

α-predicate	= Min (0.640909 ; 0.62908)
Z	= 0.62908

$$0.62908 = \frac{36360-x}{8910}$$

36360-x	= 0.62908 x 8910
36360-x	= 5605.104
-x	= 5605.104 - 36360
-x	= -30755
x	= 30755

b. Rule 2

α-predicate	= Min (0.640909 ; 0.37092)
Z	= 0.37092

$$0.37092 = \frac{36360-x}{8910}$$

36360-x	= 0.37092 x 8910
36360-x	= 3304.896
-x	= 3304.896 - 36360
-x	= -33055
x	= 33055

c. Rule 3

α-predicate	= Min (0.359091 ; 0.62908)
Z	= 0.359091

$$0.359091 = \frac{x-27450}{8910}$$

x-27450	= 0.359091 x 8910
x-27450	= 3199.5
x	= 3199.5 + 27450
x	= 30649.5

d. Rule 4

α-predicate	= Min (0.359091 ; 0.37092)
Z	= 0.359091

$$0.359091 = \frac{x-27450}{8910}$$

x-27450	= 0.359091 x 8910
x-27450	= 3199.5
x	= 3199.5 + 27450
x	= 30649.5

3.4. Defuzzification

The defuzzification process from the previous calculation, namely:

$$Z = \frac{(0.62908 \; x \; 30755) + (0.37092 \; x \; 33055) + (0.359091 \; x \; 30649.5) + (0.359091 \; x \; 30649.5)}{0.62908 + 0.37092 + 0.359091 + 0.359091}$$

$$= \frac{19347.35905 + 12260.75668 + 11005.95682 + 11005.95682}{1.718181818}$$

$$= \frac{53620.02936}{1.718181818}$$

$$= 31207$$

From the results of the defuzzification process above, it can be concluded that to determine the amount of wonton noodle production produced, if it is known that the demand is 28950 portions and the supply is 30000 portions, the total production is 31207 portions.

3.5. Implementation with Microsoft Visual Studio 2010

The results of experiments conducted by the author using the Microsoft Visual Studio 2010 application to implement the results of the calculations that have been carried out. The decision menu is a trial menu that contains the process of determining the amount of wonton noodle production produced by entering the values that are the determinants. The calculate button on the menu has a function to calculate the value of the input that has been filled in, the cancel button functions to cancel all inputted data, the save button functions to save data, and the close button functions to close or exit the decision form. The display of the decision menu is as follows:
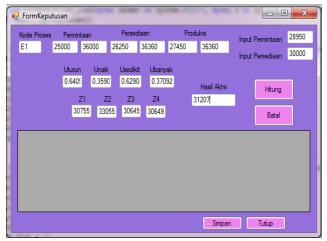

Figure 1: Decision Menu

4. Conclusion

Based on the stages of research that has been carried out on the application of the Fuzzy Tsukamoto algorithm in determining the amount of production, it can be concluded that the Fuzzy Tsukamoto method is proven to be able to determine the amount of production in the home industry based on the number of requests and the amount of supply.

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