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Analysis Prediction of Glove Production Quantity Using Sugeno's Fuzzy Logic (Case Study: PT Medisafe Technologies)

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Abstract
Purpose: These days there are often problems in the world sometimes have uncertain or vague answers. Therefore, fuzzy logic is one method for conducting such uncertain analysis. This thesis discusses the application of fuzzy logic Analysis of Prediction of Glove Production Quantities using the Sugeno method. The problem that is solved is to predict or predict the amount of production of goods because some workers in the company predict production figures by filling or the minds of the workers themselves based on the previous year's production output data
Study method/design/approach: The first step for this study is to determine the input and output variables that are firm sets and then convert each variable into a fuzzy set consisting of Little, Medium, and Many by fuzzification process. It then processes the fuzzy set data through base rules defined by the minimum method to retrieve the smallest membership degree value previously calculated through the membership function representation. And the last one is the Sugeno Method Defuzzification, which is to find the value of the average weight centrally
Results/Findings: Based on prediction analysis calculations using Stock and production data from December 2018 to January 2023, the predicted amount obtained in the following year is higher than the actual production amount in the previous year. At the realization event in October 2020, the actual production output obtained from the glove factory of PT. Medisafe Technologies amounted to 210,155,428 pcs , while the prediction results from calculations using the Sugeno fuzzy logic model amounted to 283,042,696 pcs. The error accuracy value using MAPE is 1.66%, which means that the accuracy of truth is 99.4%. So forecasting the amount of production using the Sugeno fuzzy logic model is very good for the company.
Novelty / Originality / Value: The novelty of this study lies in the development of a model using the fuzzy sugeno method to predict the amount of glove production. This approach discusses to forecast the number of glove production in a company per month interval based on data on the amount of production in the previous year as an output variable and supplies data and raw material demand as input variables.

Keywords: Fuzzy Logic**,** Sugeno**,** Production, Prediction, Membership Function. Fuzzification, Defuzzification, Model Evaluation
Month Received 20xx / Revised Month 20xx / Month Received 20xx

INTRODUCTION

Production is an activity to produce something in the form of goods or services. Technically, production is the process of changing form in managing input (input) into output (output). Planning the right amount of production affects the supplies of raw materials according to needs. In the process of determining the production of goods there are several decision constraints, namely maximum and minimum demand in a certain period, maximum and minimum Supply in a certain period and current demand and current supply [1].

Predicting the amount of production in the company is something that must be considered before carrying out the production process. Various factors must be considered to determine the amount of production of goods in order to avoid risk. Some food and non-food industry companies face a problem of

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increasingly fierce competition. Therefore, companies need to plan production quantities in order to meet market demand with the appropriate time and quantity [2].

PT. Medisafe Technologies located in Tanjung Morawa area, Deli Serdang Regency is a company engaged in industry as an exporter and supplier of gloves abroad. PT. Medisafe Technologies must carry out effective and efficient forecasting of production quantities. Prediction of the amount of production is the process of determining the number of products that will be produced in a certain period of time in the future. This prediction is useful to assist companies or producers in planning and managing the resources needed to achieve production targets.

In Mathematics, there are various methods and techniques that can be used to forecast production quantities. Such as simplex methods, Naive Bayes algorithms, branch and bound methods, multiple linear regression, and fuzzy logic. One method that can be used in this study in determining the amount of production is by applying fuzzy logic [3].

The reason for choosing to predict the amount of production in this study is because the company forecasts production figures by filling or the minds of the workers themselves based on the previous year's production output data. Therefore, the author tries to make a model using fuzzy logic to process data obtained from companies to make it easier to calculate predictions of the amount of industrial goods production over time

Fuzzy logic or fuzzy logic is logic that deals with the concept of partial truth, in contrast to classical logic which states that everything must be worth a member between 0 and 1. Fuzzy logic allows membership values that are in the range between 0 and 1 [4]. The reasons for choosing fuzzy logic in this study are:

1. The concept of fuzzy logic is easy to understand. The mathematical concept underlying fuzzy reasoning is very simple
2. Highly flexible
3. Have tolerance on any data that is not precise
4. Based on natural or human language.

There are several methods used in fuzzy reasoning systems, namely the Tsukamoto Method, the Mamdani Method and the Sugeno Method. However, in this study, the author chose the Sugeno Method because it has advantages with other methods, namely being able to produce output values or outputs from more accurate average weight calculations because they use simple linear functions that are easy to understand and are able to process series or time clump data.

The Sugeno method in fuzzy inference systems is also known as the MIN method. This method uses linguistic rules as its reasoning. This method was introduced by Takagi Sugeno-Kang in 1985. The reasoning of this method is almost the same as that of Mamdani. But the difference is that the final result is not a fuzzy set but a constant or linear equation.

METHOD

Location and Time of Research

The location of the research data collection is the Glove Company of PT. Medisafe Technologies is located on Jl. Batang Kuis Gg. Tambak Rejo Psr.IX, Buntu Bedimbar, Kec. Tj. Morawa, Deli Serdang Regency, North Sumatra and the data processing process is carried out at the Computer Science Study Program Laboratory of Medan State University. The time of this study was approximately two months.

Types of Research

The method used in this study is a quantitative research method, because the data on supply, demand and expenditure or production obtained are in the form of quantitative data. The type of data used in this study is quantitative data. Quantitative Data is a type of data that can be measured or calculated directly as a numerical or numerical variable. In this study, the data was sourced from secondary data obtained from PT Medisafe Technologies documents.

Data Collection Techniques

This research is an analysis, where the author makes a model using Python Programming Language to process data to obtain predictions of production numbers. Data Collection Techniques carried out are observation through interviews and collecting data obtained from PT. Medisafe Technologies.

Variables of Research

The variables used in this study are variables in the fuzzy set. The formation of this fuzzy variable consists of variables that will be used as input variables and output variables. Each variable has a notation and a speech universe with the smallest to largest number [5]. The variables needed based on research data are for input variables consisting of Supplies and Demands and output variables consisting of Production.

Research Flowchart
The flow of this research is listed in the following figure:

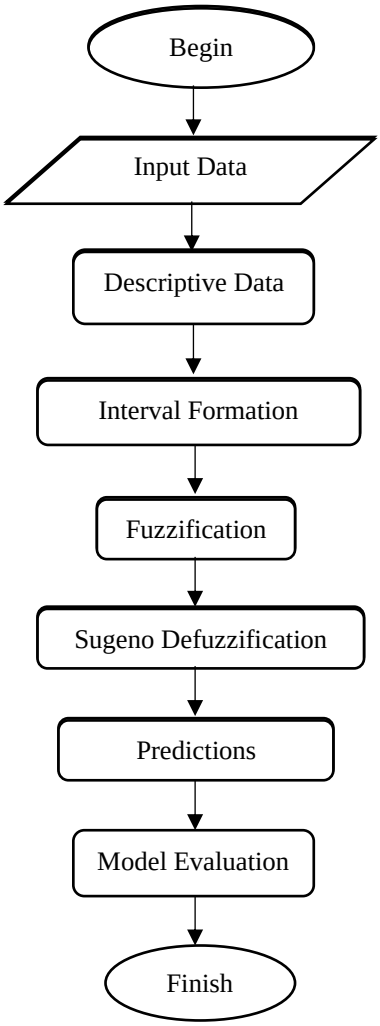

Figure 1. Research Flowchart

In Figure 1 is are search process that is used as a foundation in conducting research using efficient and systematic measures. The following is an explanation of each research procedure based on the flowchart:

a) Input Data

Data is entered using a tool called Pandas which is a python library to process data sets in excel form. Data is taken in the range of December 2018 to January 2023, consisting of the amount of supply and demand, as well as the amount of production.

b) Descriptive Data

Data consists of fuzzy input variables, namely stock goods consisting of the amount of stock available (stock) and the amount of stock reduced or used (Less), and output variables, namely the amount of production. Then create a fuzzy base of rules and sets based on the data obtained.

c) Interval Formation

The interval formed is through the membership function. The representation of the membership function to be used is the Shoulder Curve. The Shoulder Curve representation is an area that describes the midpoint of a variable with a triangular shape showing rise and fall on the left side with intervals of 1 and 0. The following is the shoulder curve representation formula for determining membership degree values:

$$\mu(x) = \begin{cases} 0 \ ; \ x \leq a \ atau \ x \geq d \\ \frac{x-a}{b-a} \ ; \ a < x \leq b \\ 1 \ ; \ b < x \leq c \\ \frac{d-x}{d-c} \ ; c < x < d \end{cases} \quad (1)$$

Information:
a = smallest domain with degree 0
b = smallest domain with degree 1
c = largest domain with degree 1
d = largest domain with degree 0
x = input converted to fuzzy number

d) Fuzzification

Enters input data into the membership representation formula based on intervals and finds membership degree values based on input variables and fuzzy sets using the shoulder curve representation formula in equation (1). Next, finding the value of the α-predicate is done by combining the value of the degree of membership in the previous linguistic variable with the AND operation, then taking the smallest value. If the membership degree value of one of the rule bases equals zero (α=0) then the weight value cannot be calculated. The AND operation formula for the MIN value is as follows:

$$\mu_{A \cap B} = \min (\mu_A(x), \mu_B(y)) \quad (2)$$

e) Defuzzification Sugeno Method

The step to find the final result or output of the production quantity is the defuzzification of the sugeno method. Defuzzification involves input values obtained from the composition of fuzzy rules. The result is a firm or tangible value. Thus, given a fuzzy set within a certain range, a specific value can be obtained as the final result. If the sugeno method uses a rule composition, defuzzification is carried out by finding the average weight centralized [6]. Here is the formula to find the final value using the sugeno method:

$$Z = \frac{\sum_{i=1}^{n} \alpha_n z_n}{\sum_{i=1}^{n} \alpha_n} \quad (3)$$

With:
Z = Average weight
α_n = Value of the nth rule
z_n = Index output value

f) Prediction (Forecasting)

The Forecast value is calculated according to several existing rules.

g) Model Evaluation

After finishing defuzzifying and implementing the python program, the next step is to evaluate the model using Mean Absolute Percentage Error (MAPE). to perform comparative calculations between actual data and prediction data. The comparison is absolutized, then calculated as a percentage against the original data. The percentage result is then obtained the mean value [7]. MAPE is formulated as follows:

$$MAPE = \frac{\sum_{i=1}^{n} \frac{|X_i - F_i|}{X_i} x100\%}{n} \quad (4)$$

With:
X_i= actual i-th period
F_i= Prediction of the i-th period
n = many periods.

RESULTS AND DISCUSSION

Descriptive Data

The data used is primary data sourced from the glove factory PT. Medisafe Technologies. Where the data is stock data or raw materials produced every month in one year. Data obtained from December 2018 to January 2023. Data consists of input variables and output variables. For input variables is stock report

data consisting of variables: the amount of raw materials available, raw materials demanded and production output. The following is a Table of Research Data Overview based on research variables.

Table 1. Research Data Overview

Period	Supplies	Demand	Production
Dec-20	3.963.442	204,854,257	204,880,317
Jan-21	4.066.012	159,814,887	161.670.825
Feb-21	3.168.224	169,908,634	171.956.232
Mar-21	3.884.740	185,691,502	189.061.802
Apr-21	3.679.794	180,342,062	183.041.300
May-21	4.472.525	144,131,922	146.881.605
Jun-21	5.034.095	176,613,049	179.783.094
Jul-21	8.525.023	182,594,884	185.375.920
Aug-21	9.340.255	182,199,406	186.283.446
Sep-21	11.291.171	174,068,264	177.143.442
Oct-21	11.651.216	187,951,786	191.429.980
Nov-21	11.597.962	182,324,494	185.148.361
Dec-21	8.899.782	173,634,043	176.919.613
...	...	...	...
Jan-23	20.759.500	118,799,231	118.213.770

The following data are presented input variables and output variables in diagram form:

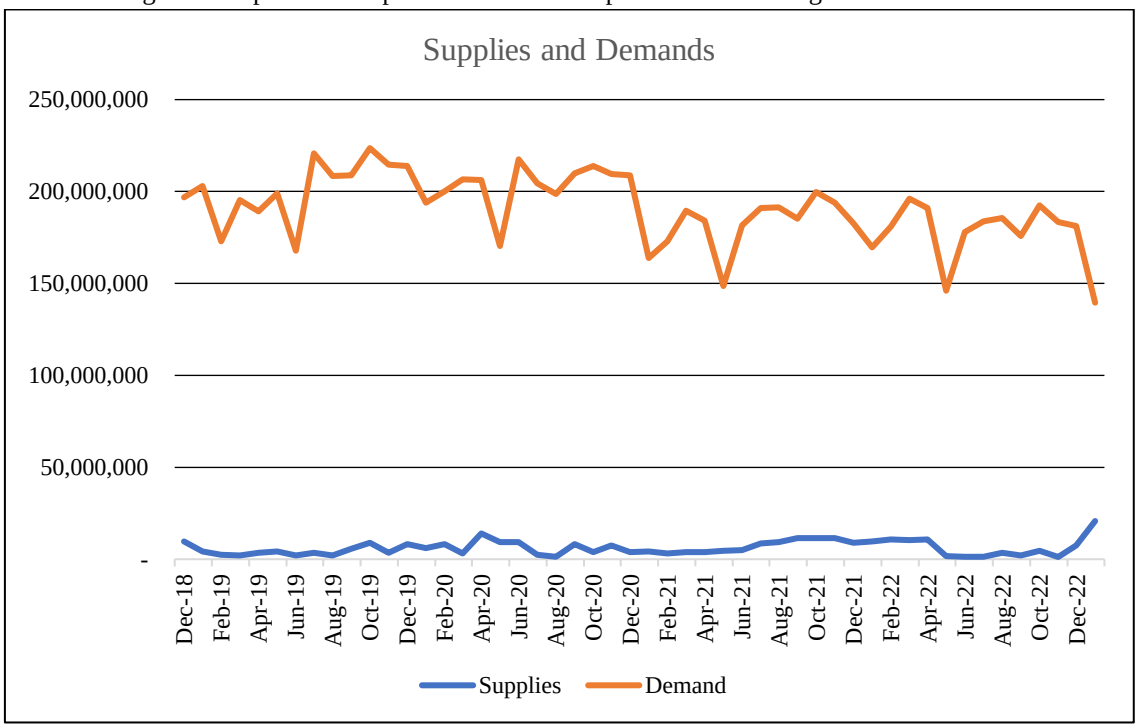

Figure 2. Input Variable Data diagram

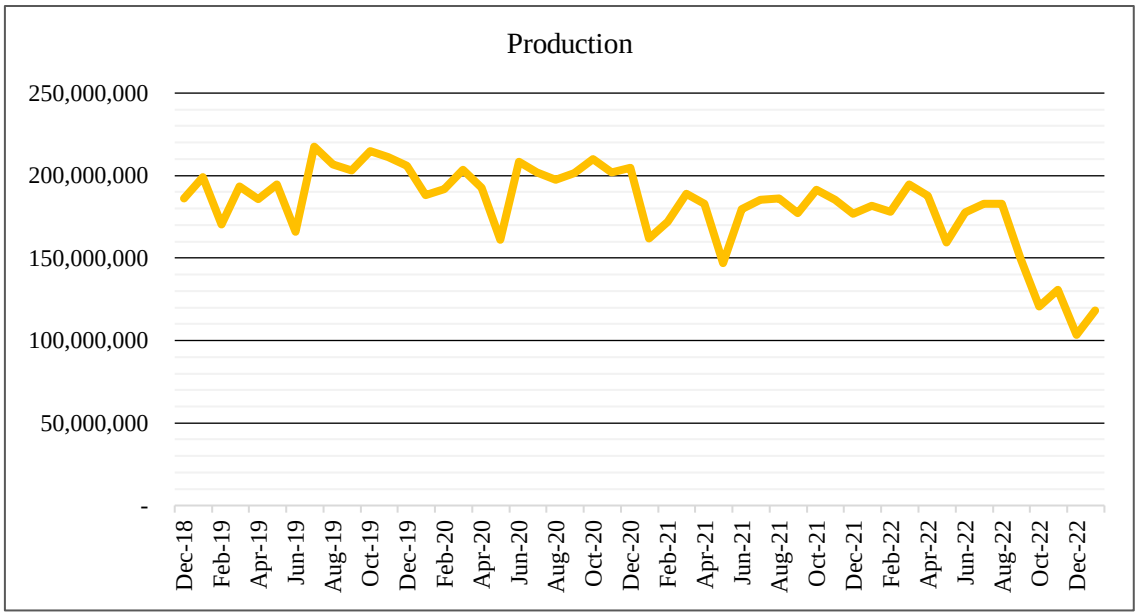

Figure 3. Output Variable Data diagram

Based on the description of research data, one-year data in 2021 can be concluded, the supplies used or reduced in the largest reduction variable reached 4,180,098 pcs, and the smallest reached 112,999 pcs. The most stock is 11,651,216 pcs, and the smallest reaches 3,168,224 pcs. Currently the company is capable of producing hundreds of millions of pcs of gloves every month, and is expected to produce as much as the same amount per month.

Fuzzy Set

The Fuzzy set that each variable uses as the basis of rules designed to determine the amount of glove production:

Table 2. Minimum and Maximum Values of Input and Output Variables

Function	**Variable Name**	**Domain**
Input	Supplies	[1.214.275-20.759.550]
	Demand	[118.691.502- 217,401,568]
Output	Production	[101.516.344- 194.455.463]

Rule Based

In this problem there are 3 variables, namely 2 input variables, a supplies variable and a demand variable. As for output, there is 1 variable, namely production. The Supply variable consists of 3 linguistic values, namely few, medium, and many, the demand variable is the amount of goods that come out or are used, then the linguistic value is up, medium, and down, and the Production variable is the amount of production, then the linguistic value is add, medium, and reduce. Next. The rule consists of 9 important points, namely:

Table 3. Fuzzy Rule Basis for Determining Production Quantities

Rule	**Variable**		
	Input		***Output***
	Supplies	**Demand**	**Production**
R1	Many	Up	Add
R2	Many	Medium	Medium
R3	Many	Down	Reduce
R4	Medium	Up	Add
R5	Medium	Medium	Medium
R6	Medium	Down	Reduce
R7	Few	Up	Add

R8	Few	Medium	Medium
R9	Few	Down	Reduce

A. Representation of Membership Functions

The data on the input variable is applied to the membership representation formula based on the intervals 1 and 0 and finds the membership degree value based on the input variable and the fuzzy set using the shoulder linear curve representation formula in the equation (1).

a) Supplies

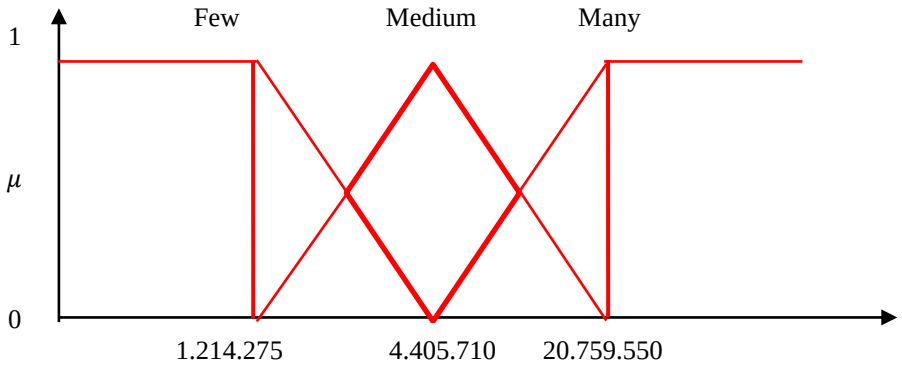

Figure 4. Supplies Variable Set

$$\mu\text{Few}(x) = \begin{cases} 1 & ; x \leq 1.214.275 \\ \frac{4.405.710 - x}{4.405.710 - 1.214.275} & ; 1.214.275 \leq x \leq 4.405.710 \\ 0 & ; x \geq 4.405.710 \end{cases} \quad (5)$$

$$\mu\text{Medium}(x) = \begin{cases} 1 & ; x \leq 1.214.275 \; atau \; x \geq 20.759.550 \\ \frac{x - 4.405.710}{4.405.710 - 1.214.275} & ; 1.214.275 \leq x \leq 4.405.710 \\ \frac{20.759.550 - x}{20.759.550 - 4.405.710} & ; 4.405.710 \leq x \leq 20.759.550 \end{cases} \quad (6)$$

$$\mu\text{Many}(x) = \begin{cases} 1 & ; \quad x \leq 4.405.710 \\ \frac{x - 4.405.710}{20.759.550 - 4.405.710} & ; 4.405.710 \leq x \leq 20.759.550 \\ 0 & ; \quad x \geq 20.759.550 \end{cases} \quad (7)$$

b) Demand

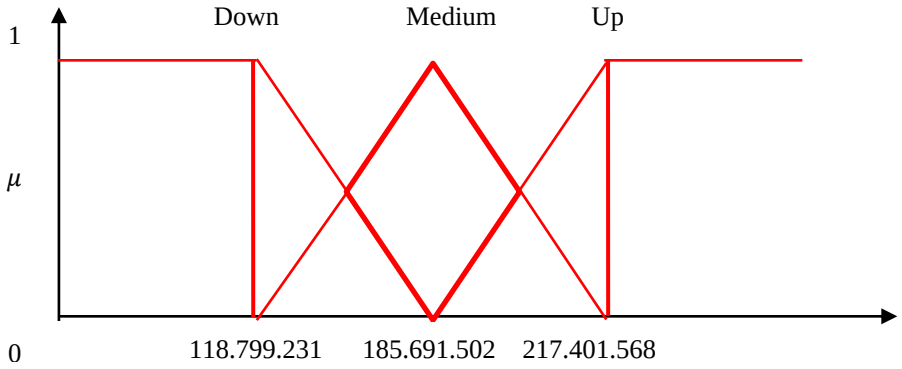

Figure 5. Demands Variable Set

$$\mu\text{Down}(y) = \begin{cases} 1\ ;\ y \le 118.799.231 \\ \frac{185.681.502 - y}{185.681.502 - 118.799.231}\ ; 118.799.231 \le y \le 185.681.502 \\ 0\ ;\ y \ge 185.681.502 \end{cases} \quad (8)$$

$$\mu\text{Medium}(y) = \begin{cases} 1\ ;\ y \le 185.681.502\ atau\ y \ge 217.401.568 \\ \frac{y - 185.681.502}{185.681.502 - 118.799.231}\ ; 118.799.231 \le y \le 185.681.502 \\ \frac{217.401.568 - y}{217.401.568 - 185.681.502}\ ; 185.681.502 \le y \le 217.401.568 \end{cases} \quad (9)$$

$$\mu\text{Up}(y) = \begin{cases} 1\ ;\ y \le\ 185.681.502 \\ \frac{y - 185.681.502}{217.401.568 - 185.681.502}\ ; 185.681.502 \le y \le 217.401.568 \\ 0\ ; y \ge 217.401.568 \end{cases} \quad (10)$$

c) Production

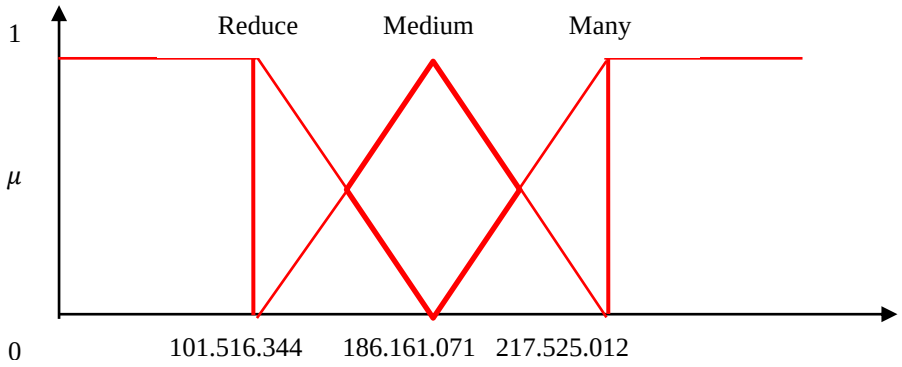

Figure 6 Set of Production Variables

$$\mu\text{Reduce}(z) = \begin{cases} 1\ \ ;\ z \le 101.516.344 \\ \frac{186,161,071 - z}{186,161,071 - 101.516.344}\ ;\ 101.516.344 \le z \le 186,161,071 \\ 0\ \ ;\ z \ge 186,161,071 \end{cases} \quad (11)$$

$$\mu\text{Many}(z) = \begin{cases} 1\ ; z \le 101.516.344\ atau\ z \ge 217,525,012 \\ \frac{z - 186,161,071}{186,161,071 - 101.516.344}\ ; 101.516.344 \le z \le 186,161,071 \\ \frac{217,525,012 - z}{217,525,012 - 101.516.344}\ ; 186,161,071 \le z \le 217,525,012 \end{cases} \quad (12)$$

$$\mu\text{Add}(z) = \begin{cases} 1\ ;\ z \le 186,161,071 \\ \frac{z - 186,161,071}{217,525,012 - 186,161,071}\ ; 186,161,071 \le z \le 217,525,012 \\ 0\ ;\quad z \ge 217,525,012 \end{cases} \quad (13)$$

Fuzzification

The next step is to determine the membership degree of the pre-created membership function to easily find the value of the α predicate for each rule. The following is the calculation of the degree of membership.along with the weight value (z_n) on the basis of rules if known October 2020 data:
Supplies = 3.849.340
Demand = 210.113.397

1) Membership Degree of Supplies

The degree of membership of the Supplies variable corresponds to the rule base:

$$\mu Sp.\,Few(3.849.340) = \frac{4.405.710 - 3.849.340}{4.405.710 - 1.214.275} = \frac{556.370}{3.191.495} = 0{,}1$$

$$\mu Sp.\,Medium(3.849.340) = \frac{3.849.340 - 1.214.275}{4.405.710 - 1.214.275} = \frac{2.635.065}{3.191.495} = 0{,}8$$

$$\mu Sp.\,Many(3.849.340) = 1 \text{ (due x} \leq 4.405.710)$$

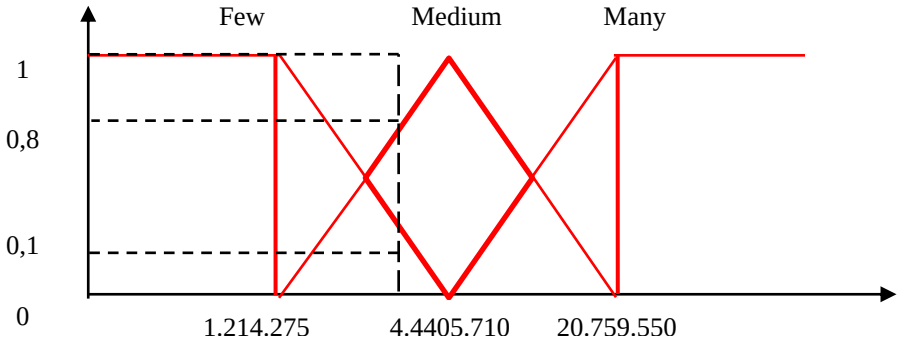

Figure 7 Membership Degrees Graph for Supplies

Based on the graph in Figure 7, the Supplies Data in October 2020 of 3,849,340 pcs is located in the position of the medium set because the lines in the data are known to be in the medium set area and are near the medium limit and the membership degree values obtained from the calculation are 0.1, 0.8, and 1

2) Membership Degree of Demand

Thememberships rate for the Request is on a rule basis:

$$\mu Dm.\,Down(210.113.397) = 0 \text{ (due y} \geq 723.345)$$

$$\mu Dm.\,Medium(210.113.397) = \frac{217.401.568 - 210.113.397}{217.401.568 - 185.681.502} = \frac{7.288.171}{31.720.066} = 0{,}2$$

$$\mu Dm.\,Many(210.113.397) = \frac{210.113.397 - 185.681.502}{217.401.568 - 185.681.502} = \frac{24.431.895}{31.720.066} = 0{,}7$$

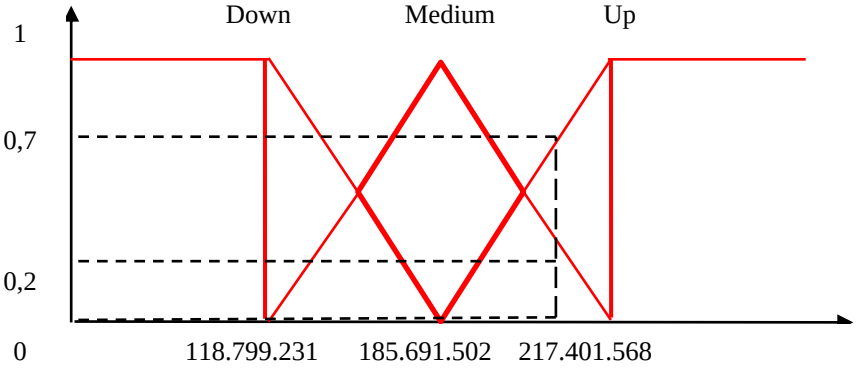

Figure 8. Membership Degrees Graph for Demand

Based on the graph in Figure 8, Demand Data in October 2020 of 210,113,397 pcs is located in the position of the set up because the line in the data is in the area of the set down and the membership degree values obtained from the calculation are 0, 0.2, and 0.7.

3) Implication Function

The next step is to determine the value of the α-predicate. To determine the value of α-predicate is done by combining each value of the degree of membership in linguistic variables with the MIN operator. It then takes the MIN value and calculates the weight value (z_n) for each rule that is met. Here is the solution using equation (2):

[R1] If Supplies are Many, and Demands are Up, then Productions are Add;

$$\alpha - \text{predicate}_1 = \min\left(\mu Sp_{Many}(3.849.340), \mu Dm_{Up}(210.113.397)\right)$$
$$= \min(1; 0{,}7)$$
$$= 0{,}7$$

Weight Value z_1:

$$\frac{z_1 - 186.161.071}{31.363.941} = 0{,}7$$
$$z_1 = 21.954.758 + 186.161.071$$
$$z_1 = 208.115.829$$

[R2] If Supplies are Many, and Demands are Medium, then Productions are Medium ;

$$\alpha - \text{predicate}_2 = \min\left(\mu Sp_{Many}(3.849.340), \mu Dm_{Medium}(210.113.397)\right)$$
$$= \min(1; 0{,}2)$$
$$= 0{,}2$$

Weight Value z_2:

$$\frac{217.525.012 - z}{116.008.668} = 0{,}2$$
$$z_2 = 23.201.733 + 217.525.012$$
$$z_2 = 240.726.745$$

[R3] If Supplies are Many, and Demands are Down, then Productions are Reduce;

$$\alpha - \text{predicate}_3 = \min\left(\mu Sp_{Many}(3.849.340), \mu Dm_{Down}(210.113.397)\right)$$
$$= \min(1; 0)$$
$$= 0 \text{ (weight value cannot be calculated)}$$

[R4] If Supplies are Medium, and Demands are Up, then Productions are Add;

$$\alpha - \text{predicate}_4 = \min\left(\mu Sp_{Medium}(3.849.340), \mu Dm_{Up}(210.113.397)\right)$$
$$= \min(0{,}8; 0{,}7)$$
$$= 0{,}7$$

Weight Value $(z_4) =$

$$\frac{z - 186.161.071}{31.363.941} = 0{,}7$$
$$z_4 = 21.954.758 + 186.161.071$$
$$z_4 = 208.115.829$$

[R5] If Supplies are Medium, and Demands are Medium, then Productions are Medium;

$$\alpha - \text{predicate}_5 = \min\left(\mu Sp_{Medium}(3.849.340), \mu Dm_{Medium}(210.113.397)\right)$$
$$= \min(0{,}6; 0{,}2)$$
$$= 0{,}2$$

Weight value (z_5):

$$\frac{z - 186.161.071}{84.644.727} = 0{,}2$$
$$z_5 = 16.928.945 + 186.161.071$$
$$z_5 = 203.090.016$$

[R6] If Supplies Are Medium, and Demands are Medium, then Productions are Reduce;

$$\alpha - \text{predicate}_6 = \min\left(\mu Sp_{Medium}(3.849.340), \mu Dm_{Down}(210.113.397)\right)$$
$$= \min(0{,}8; 0)$$
$$= 0 \text{ (weight value cannot be calculated)}$$

[R7] If Supplies are Few, and Demands are Up, Productions are Add;

$$\alpha - \text{predicate}_7 = \min\left(\mu SP_{Few}(3.849.340), \mu Dm_{Up}(210.113.397)\right)$$
$$= \min(0{,}1; 0{,}7)$$
$$= 0{,}1$$

Weight value z_7:

$$\frac{z - 186.161.071}{31.363.941} = 0{,}1$$

$$z_7 = 3.136.394 + 186.161.071$$

$$z_7 = 189.297.465$$

[R8] If Supplies are Few, and Demands are Medium, then Productions are Medium;

$$\alpha - \text{predicate}_8 = \min\left(\mu SP_{Few}(3.849.340), \mu Dm_{Medium}(210.113.397)\right)$$
$$= \min(0{,}1; 0{,}2)$$
$$= 0{,}1$$

Weight value z_8:

$$\frac{217.525.012 - z}{116.008.668} = 0{,}1$$

$$z_5 = 11.600.866 + 217.525.012$$

$$z_5 = 229.125.878$$

[R9] If Supplies are Few, and Demands are Down, then Productions are Decreases;

$$\alpha - \text{predicate}_9 = \min\left(\mu SP_{Few}(3.849.340), \mu Dm_{Down}(210.113.397)\right)$$
$$= \min(0; 0{,}7)$$
$$= 0 \text{ (weight value cannot be calculated)}$$

Sugeno Defuzzification

The defuzzification process involves input values obtained from the composition of fuzzy rules that produce firm or tangible values. Thus, given a fuzzy set within a certain range, a specific value can be obtained as the final result. If the sugeno method uses a rule composition, defuzzification is carried out by finding the average weight centralized [6]. The data obtained per month is calculated through a model using Python Programming Language with *skfuzzzy* library to process fuzzification and defuzzification calculations.Here is the calculation of the defuzzification of Production Quantities in October 2020 manually based on the basic rules that meet the following equation (3):

$$Z = \frac{a_1 z_1 + a_2 z_2 + a_3 z_3 + a_4 z_4 + \cdots + a_9 z_9}{\sum_{i=1}^{n} a_n}$$

$$Z = \frac{\begin{array}{c}208.115.829(0{,}7) + 240.726.745(0{,}2) + 208.115.829(0{,}7) + 240.726.745(0{,}2) \\ +189.297.465(0{,}1) + 229.125.878(0{,}1)\end{array}}{0{,}7 + 0{,}2 + 0{,}7 + 0{,}2 + 0{,}1 + 0{,}1}$$

$$Z = 283.042.696$$

The calculation of defuzzification of the number of glove production using the Sugeno fuzzy method in October 2020 was 283,042,696 pcs.

B. Predictions

The prediction stage is to reduce the amount of production based on actual data and the amount of production from the results of Sugeno Defuzzification (z). Research data from December 2018 to January 2023 was processed and calculated through a model using the Python Programming Language. Here is the calculation table of Defuzzification in the same way and the actual production amount.(y_{akt})

Period	Defuzzification Predictions	Production Current	| z – Production |
Dec-18	319.524.156	186.161.071	133.363.085
Jan-19	298.946.061	198.975.557	99.970.504
Feb-19	348.994.068	170.441.175	178.552.893
Mar-19	307.462.280	193.464.249	113.998.031
Apr-19	319.984.187	185.893.433	134.090.754
May-19	305.473.590	194.723.737	110.749.853
Jun-19	358.679.787	165.838.615	192.841.172
Jul-19	273.453.422	217.525.012	55.928.410
Aug-19	287.952.191	206.572.344	81.379.847
Sep-19	292.812.334	203.143.625	89.668.709
Oct-19	276.839.678	214.864.283	61.975.395

Nov-19	281.920.054	210.992.294	70.927.760
Dec-19	288.796.578	205.968.365	82.828.213
Jan-20	316.074.592	188.192.789	127.881.803
Feb-20	310.050.697	191.849.138	118.201.559
Mar-20	292.282.468	203.511.895	88.770.573
Apr-20	309.162.251	192.400.459	116.761.792
May-20	369.287.416	161.074.969	208.212.447
Jun-20	285.709.254	208.194.023	77.515.231
Jul-20	294.512.651	201.970.811	92.541.840
Aug-20	301.112.895	197.543.712	103.569.183
Sep-20	295.075.638	201.585.463	93.490.175
Oct-20	283.042.696	210.155.428	72.887.268
Nov-20	294.734.474	201.818.804	92.915.670
Dec-20	290.330.276	204.880.317	85.449.959
Jan-21	367.926.365	161.670.825	206.255.540
Feb-21	345.919.181	171.956.232	173.962.949
Mar-21	314.621.771	189.061.802	125.559.969
Apr-21	324.970.152	183.041.300	141.928.852
May-21	404.972.148	146.881.605	258.090.543
Jun-21	330.859.580	179.783.094	151.076.486
Jul-21	320.877.485	185.375.920	135.501.565
Aug-21	319.314.251	186.283.446	133.030.805
Sep-21	335.789.789	177.143.442	158.646.347
Oct-21	310.729.589	191.429.980	119.299.609
Nov-21	321.271.864	185.148.361	136.123.503
Dec-21	336.214.612	176.919.613	159.294.999
Jan-22	327.147.796	181.822.894	145.324.902
Feb-22	334.409.496	177.874.611	156.534.885
Mar-22	305.895.027	194.455.463	111.439.564
Apr-22	316.952.816	187.671.338	129.281.478
May-22	373.535.361	159.243.181	214.292.180
Jun-22	334.821.214	177.655.885	157.165.329
Jul-22	325.462.218	182.764.560	142.697.658
Aug-22	325.117.731	182.958.213	142.159.518
Sep-22	396.946.050	149.851.495	247.094.555
Oct-22	493.347.522	120.570.098	372.777.424
Nov-22	454.710.295	130.815.070	323.895.225
Dec-22	575.202.285	103.412.244	471.790.041
Jan-23	503.181.305	118.213.770	384.967.535
Total	**16.702.409.597**	**9.119.746.010**	**7.582.663.587**

In the previous study, we knew the Application of Sugeno's Fuzzy Method to Determine the Optimum Production Amount In Case Study: PT Jordan Bakery Pekanbaru [8], the actual Production Amount of Optimum Bread in January 2014 was 2098 pcs, while the Prediction Target Using Sugeno's Fuzzy Logic was 2250 pcs. This means that the sugeno method can be used to predict the amount of bread production and based on Table 4.4 above, it can be seen that the difference in the calculation of the amount of glove production from the Company's data with the prediction of the amount of production using sugeno fuzzy logic. The results show that the calculation of the predicted number of glove production using Sugeno's fuzzy logic is greater than the number of glove production from the actual data. One of the results of the difference is in the calculation in January 2022, where the calculation of the actual production amount from the Company is 181,822,894 pcs while the calculation of the amount of production using sugeno fuzzy logic is 327,147,096 pcs. That is, the results obtained using sugeno fuzzy logic are greater than the calculation of the actual production amount on the part of the Company.

C. Model Evaluation

Perform testing by evaluating the model using MAPE (*Mean Absolute Percentage Error*) to calculate the comparison between the Actusl Production Amount and the Production Amount Prediction from the final Defuzzification result. These results are seen in Table 4.4. Then the comparison is absolutized and calculated in percentage form against the actual data. The reason for using MAPE as a model evaluation compared to RMSE (*Root Mean Square* Error) and MAE (*Mean Absolute Error*) is that MAPE measures relative error in the form of percentages that are easier to interpret and the data has greater scale variation. The MAE provides a measure of error with a target variable in the same unit as the RMSE but does not provide relative error percentage information. Here is a calculation of the results of model testing. The MAPE calculation uses the following equation (4):

$$MAPE = \frac{\frac{|16.702.409.597 - 9.119.746.010|}{9.119.746.010}}{50} \times 100\%$$

$$MAPE = 1{,}66\ \%$$

Forecasting ability is very good if MAPE value is < 10%, forecasting is good if MAPE value is 10−20%, forecasting is adequate if MAPE value is 20−50% and forecasting is bad if MAPE value > 50% [3]. So that the calculation results of the average overall error percentage of 1.66% can be said to have a very good ability to predict or forecast the number of glove production.

CONCLUSION

Determination of forecasting the amount of production of tangaa gloves using three variables consisting of two input variables namely: Supplied and Demand, and on the output variable, namely: production. To get results using Fuzzy Sugeno required the following stages: (a) Formation of Fuzzy Associations, (b) Basic fuzzy rules. (c) the composition of the ground rules. (d) Defuzzification by centralized average weight method.

Based on fuzzification calculations, for the limit of values is determined according to each member of the set according to the data range on the input variable. Judging from the data in October 2020, Count Supplies was 3,849,340 pcs and demand on raw materials was 210,113,397 pcs. To determine the limit of this value, a calculation will be carried out looking for the value of the degree of membership according to the representation formula of each fuzzy set. In the Supplies variable, the degree value of the bit set is 0.1, the medium set is 0.8 and the lot set is 1. In the Demand variable, the value of the degree of the descending set is 0 and the medium set is 0.2 and in many sets it is 0.7. These values are entered into the MIN formula in the 9 basic rules to find the threshold used by each rule. Based on the minimum value sought, the basic rules that are met are 6 rules because the rest of the rules are the minimum value of the member's degree equal to 0 (zero) so that the weight value cannot be determined.

Based on prediction analysis using Stock and production data from December 2018 to January 2023, the predicted amount obtained in the following year is higher than the actual production amount in the previous year. In the calculation of realization in October 2020, the actual production output obtained from the glove factory of PT. Medisafe Technologies amounted to 210,155,428 pcs , while the prediction results from calculations using the Sugeno fuzzy logic model amounted to 283,042,696 pcs. With higher prediction figures for the next year, PT Medisafe Technologies pays more attention and increases the amount of stock available so that the stock used to produce medical gloves.

The predicted results of the Number of Glove Production using Sugeno fuzzy get a MAPE value of 1.66%. This means that it has a very good ability to determine the amount of glove production.

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