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Application of Fuzzy Infrence System Mamdani Method to Determine the Amount of Durian Pancake Production

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A B S T R A C T

UMKM is one of the drivers of the economy in the village so that its existence is very important and important to pay attention to so that it can still produce and employ people in rural areas. and on the part of the owner who has not applied technology to their business, one of which is the production plan, at this time the production plan is only based on estimates, so it often happens that there is too much stock left or until the sales stock runs out. The purpose of this study was to make a determination system of production with fuzzy logic in the hope this system can help SMEs pancake durian determine the number of correct production in order to minimize inventory items left or run out of inventory. The data material used is the supply of and demand for visits supply demand from the lowest to the medium and the highest so that the range can be concluded and processed using the Mamdani fuzzy method so that the calculation of the amount of production can be determined precisely.

1. Introduction

Durian pancakes are processed durian fruit foods that are characteristic of SMEs in Jati Baru Un Durian V Village, currently, the marketing of durian pancakes is not only in demand by local consumers but has also been distributed to large cities on the island of Java, with all the limitations of workers, expiration date (Expired) limitations on the place of production, as well as storage, of course, the prediction of determining the amount of production is needed so that there is no shortage or excess stock in order to maintain maximum profits, that is the problem with the pancake business owner, namely, there is no algorithm or system to determine the determination of production precisely and accurately.

The purpose of this research is to create a system to determine the amount of pancake production in order to predict proportional production based on inventory/stock data and market demand. the highest and lowest supply in a given period, current demand, and current supply. With various decision constraints that exist, of course, a method is needed to solve the problem of determining production. there are different ways to map the problem of the determination of the production of goods with constraint inputs (demand and supply) and output (production), one of the ways that can be used is the application of the fuzzy logic meaning of the word logic is derived from the ancient Greek word (logos) which means the result of a thought that is spoken in words and expressed in language. Logic is a branch of philosophy. While the meaning of Fuzzy in Indonesian is vague, diffuse, or fuzzy, in other words, fuzzy logic is fuzzy logic.

Fuzzy logic can solve problems that have vague or unclear values are no longer a problem because the current computer not only recognizes Boolean logic which in principle has a firm value (crisp) but can also recognize logic that has a vague or unclear value. In fuzzy logic /*Fuzzy Logic*, data can be true/true or

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false/false at the same time but how much the truth or error value depends on how much weight the membership has [9]

2. Research Methods

2.1 Fuzzy Infrence System Mamdani Mamdani

A method is often known as the Maxmin method. This method was introduced by Ebrahim Mamdani in 1975. To get the output, it is necessary to take the steps for forming a fuzzy set, applying the implication function and the composition of the rules [kurniati]

a. When evaluating the rules in the inference engine, the Mamdani method uses the MIN function and the inter-rule composition uses the MAX function to generate a new fuzzy set.
b. The defuzzification process in the Mamdani method uses the Centroid method with the following formula:

$$z = \frac{\int \mu(z).z \, dz}{\int \mu(z) \, dz} \quad \textbf{(1)}$$

3. Result and Discussion

The following has been processed data obtained from Sister Hani's Durian Pancakes

Table 1
Data analysis

No	Bulan-Tahun	Jumlah Permintaan	Jumlah Persediaan	Jumlah Produksi
1	Juni 2020	700	400	1100
2	Juli 2020	760	240	1000
3	Agustus 2020	1105	95	1200
4	Sep-20	876	24	900
5	Oktober 2020	720	230	950
6	Nopember 2020	957	43	1000
7	Desember 2020	980	120	1100
8	Januari 2021	1070	130	1200
Highest Demand				**1105**
Lowest Demand				**720**
Average Demand				**942**
Highest Stock				**400**
Lowest Stock				**24**
Average Stock				**160,25**
Highest Production				**1200**
Lowest Production				**900**

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No	Bulan-Tahun	Jumlah Permintaan	Jumlah Persediaan	Jumlah Produksi
Average Production				**1056,25**

3.1 System Analysis

Fuzzy Mamdanioften is also known as the Max-Min Method. This method was introduced by Ebrahim Mamdani in 1975. To get the output, it takes 4 stages, namely:

a. Formation offsets fuzzy (fuzzification)
b. Composition Rule
c. Implication function application
d. Affirmation (Defuzzification)

Following is an example of a manual calculation presented from the system to be run. Based on data from sister hani durian pancakes

Table 2
Range of fuzzification values

Variable	Set of	Value Range
Demand	Low	720; 942
	Medium	720; 942; 1105
	High	942;1105
Inventory	Low	24; 160
	Medium	24; 160; 400
	Height	160; 400
Production	Low	900; 1056;
	Medium	900; 1056 ; 1200;
	Height	1056 ; 1200;

Based on the fuzzy input design, the following fuzzy membership function is used to determine pancake production.

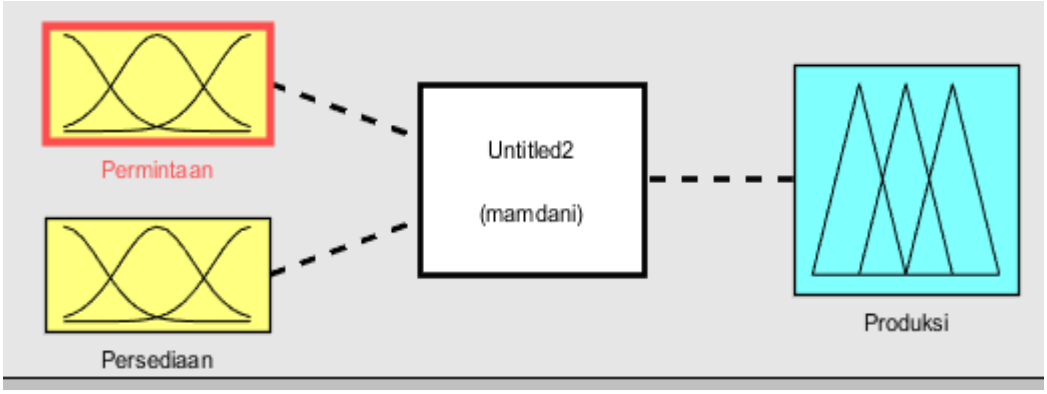

Fig 1. Membership Function

If the demand is 1035 and the supply is 300, what is the production amount if the data is supplied by fuzzy Mamdani?

a. Demand

Variable The demand variable is the historical number of requests for durian pancakes for the last 6 months, the demand variable has 3 fuzzy sets, namely low, medium and high which are presented in the following

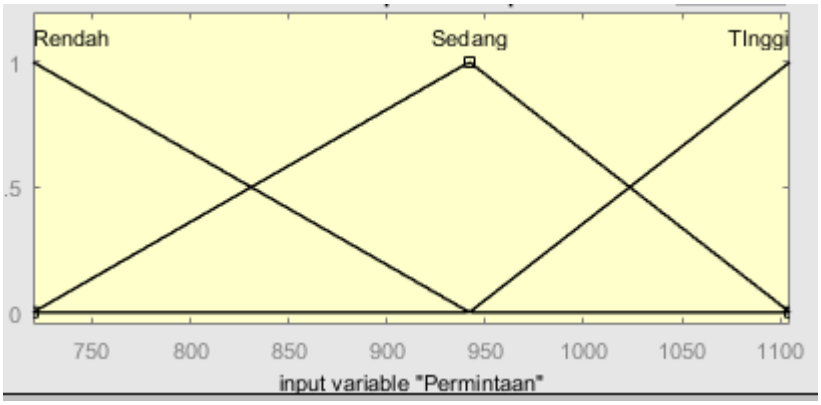

Fig 2. Demand input variables

Low Demand Membership functions as follows:

$$\mu\text{Low Demand}[X]\begin{cases}1, & x = 720\\ \dfrac{942-x}{942-720}, & \\ 0, & x \geq 942\end{cases}$$

Medium Demand Membership functions as follows:

$$\mu\text{Medium Demand}[X]\begin{cases}1, & x = 942\\ \dfrac{x-720}{942-720}, & \\ \dfrac{942-x}{942-720}, & \\ 0, x \leq 729 \text{ Atau } x \geq 1105 & \end{cases}$$

High Demand Membership functions as follows:

$$\mu\text{High demand}[X]\begin{cases}1, & x > 1105\\ \dfrac{x-942}{1105-942} & \\ 0, & x < 942\end{cases}$$

Demand = 1035

The Low Demand Membership Function [1035] is described as follows:

$$\mu\text{Low Demand}[1035]\begin{cases}1, & \\ 0, & 1035 \geq 942\end{cases}$$

$$1035 \geq 942 = 0$$

The Medium Demand Membership Function [1035] is described as follows:

$$\mu\text{Medium Demand}[1035]\begin{cases}1, & \\ b \leq x \leq c = \dfrac{c-x}{c-b}, = \dfrac{1105-1035}{1105-942} & \\ 0, & \end{cases}$$

$$\mu\text{Medium Demand}[1035]\ \frac{70}{163} = 0{,}43$$

The High Demand Membership Function [1035] is described as follows:

$$\mu\text{High Demand}[1035]\begin{cases}1, & \\ \leq x \leq b = \dfrac{x-a}{b-a}, & \dfrac{1035-942}{1105-942} \\ 0, & \end{cases}$$

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$$\mu\text{High Demand } [1035] = \frac{93}{163} = 0{,}57$$

b. Stock Variable

The variable is the historical amount of demand for durian pancakes for the last 6 months. The inventory variable has 3 fuzzy sets, namely low, medium, and high which are presented in the following

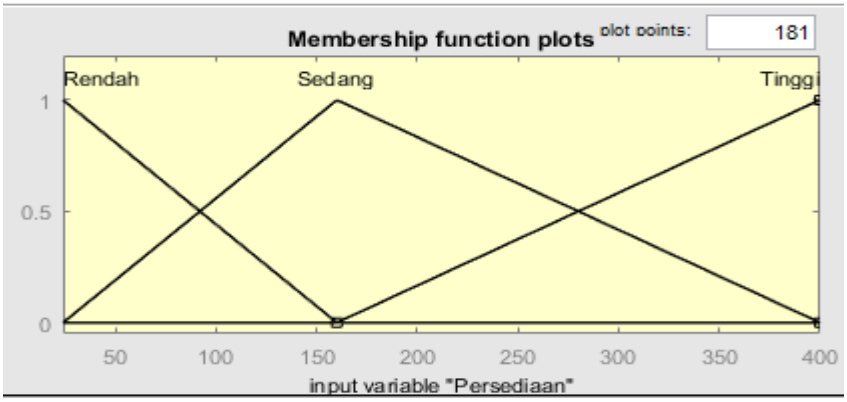

Fig 3. Inventory input variable

Low Stock Membership functions as follows:

$$\mu\text{Low Stock}[X]\begin{cases} 1, & x = 24 \\ \dfrac{160 - x}{160 - 24}, & \\ 0, & x \geq 160 \end{cases}$$

Medium Stock Membership functions as follows

$$\mu\text{Medium Stock }[X]\begin{cases} 1, & x = 160 \\ \dfrac{x - 24}{160 - 24}, & \\ \dfrac{160 - x}{160 - 24}, & \\ 0, x \leq 24 \text{ Atau } x \geq 400 & \end{cases}$$

High Stock Membership functions as follows:

$$\mu\text{High Stock}[X]\begin{cases} 1, & x > 400 \\ \dfrac{x - 160}{400 - 160} & \\ 0, & x < 160 \end{cases}$$

Stock = 300

The Low Stock Membership Function [300] is described as follows:

$$\mu\text{Low Stock}[300]\begin{cases} 1, & \\ 0, & 300 \geq 160 \end{cases}$$

$$300 \geq 160 = 0$$

The Medium Stock Membership Function [300] is described as follows:

$$\mu\text{MediumStock }[300]\begin{cases} 1, & x = 160 \\ b \leq x \leq c = \dfrac{c - x}{c - b}, = \dfrac{400 - 300}{400 - 160} & \\ 0, & \end{cases}$$

$$\frac{100}{240} = 0{,}42$$

The Low Stock Membership Function [300] is described as follows:

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$$\mu\text{High Stock } [300] \begin{cases} 1, \\ a \le x \le b = \dfrac{x - a}{b - a}, & \dfrac{300 - 160}{400 - 160} \\ 0, \end{cases}$$

$$\frac{140}{240} = 0{,}58$$

Table 3
Stock and Demand

Stock			**Demand**		
Low	Medium	High	**Low**	Medium	High
0	0,43	0,57	0	0,42	0,58

Fuzzy inference is the stage of combining many fuzzy rules based on available data. By combining fuzzy sets using the Mamdani method, 9 fuzzy rules are obtained, as follows:

[R1] If Demand is LOW And Inventory is LOW Then Production is LOW,
Min { Demand is Low; Low Inventory }
Min { 0 ; 0 } = 0, [Low Production = 0]
[R2] If Demand is LOW And Inventory is Medium Then Production is Low
Min { Demand is Low; Medium Inventory }
Min { 0 ; 0.43 } = 0 [Low Production = 0]
[R3] LOW Demand And High Inventory Then LOW Production,
Min { Low Demand; High Inventory }
Min { 0 ; 0.57 } = 0 [Low Production = 0]
[R4] IfAnd Inventory is LOW Then Production is MEDIUM,
Demand is MediumMin { Demand is Medium; Low Inventory }
Min { 0.42 ; 0} = 0 [Medium Production = 0]
[R5] IfAnd Inventory isThen Production is,
Demand is MediumMediumMediumMin { Demand is Medium; Medium stock }
Min { 0.42 ; 0.43} = 0.43 [Medium Production = 0.43]
[R6] IfAnd Inventory is HIGH Then Production is MEDIUM
Demand is MediumMin { Demand is Medium; High inventory }
Min { 0.42 ; 0.57} = 0.42 [Medium Production = 0.42]
[R7] If Demand is HIGH And Inventory is LOW Then Production is HIGH
Min { Demand is High; Low Inventory }
Min { 0.58 ; 0} = 0 [High Production = 0]
[R8] If High Demand And Medium Inventory Then High Production
Min { High Demand; Medium Inventory }
Min { 0.58 ; 0.43} = 0.43 [High Production = 0.43]
[R9] If High Demand And High Inventory Then High Production
Min { High Demand; High Inventory }
Min { 0.58 ; 0.57} = 0.57 [High Production = 0.57]
From the fuzzy rules obtained the following values
R.5 Min { 0.42; 0.43} = 0.43 [Medium Production = 0.43]
R.6 Min { 0.42 ; 0.57} = 0.42 [Medium Production = 0.42]
R.8 Min { 0.58 ; 0.43} = 0.43 [High Production = 0.43]
R.9 Min { 0.58 ; 0,57} = 0,57 [High Production = 0,57]
Of the 4 fuzzy rules, only the highest output is selected, namely R5 and R9

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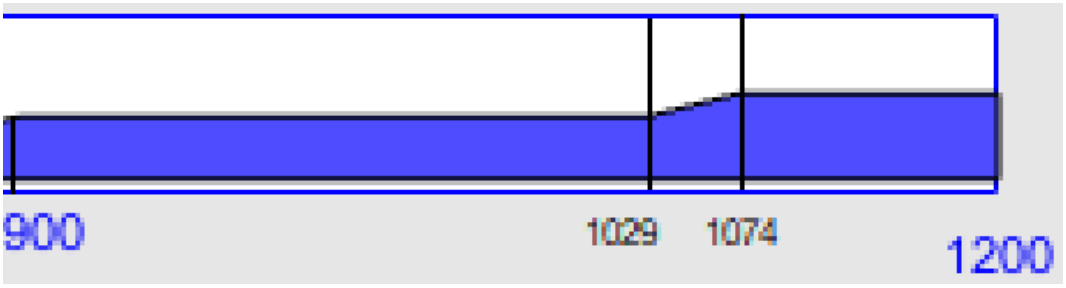

Fig 4. Fuzzy Result Regional Solution

In the fuzzy result area solution obtained is divided into five regions,
Then find the point of intersection of t1 and t2

$$\frac{t1 - 900}{1200 - 900} = 0{,}43$$

t1 = (0,43 x 300) + 900
t1 = 1029

$$\frac{t2 - 900}{1200 - 900} = 0{,}57$$

t2 = (0,57 x 300) + 900
t2 = 1071

then create a new membership based on the highest rule results

$$\mu(z) \begin{cases} 0{,}43 & z \leq 1029 \\ a \leq z \leq b = \frac{z-a}{b-a}, = \frac{z-900}{1200-900} & \\ 0{,}57 & z \geq 1074 \end{cases}$$

the point of intersection of t1 and t2 divides the area into d1 d2 and d3
then mamdani method with centroid or CoA

$$Z^* = \frac{\int \mu(z) z\, dZ}{\int \mu(z)\, dZ} = \frac{M1+M2+M3}{A1+A2+A3}$$

Counting moment (M)

$M_1 = \int_{900}^{1029} 0{,}43\ z\, dz$
$= 0{,}43 \text{ x } \frac{1}{2} z^2$
= (0,215 x 1.058.841) – (0,215 x 0)
= 53.500

$$M_2 = \int_{1029}^{1071} \frac{z-900}{1200-900} z\, dz = \int_{1029}^{1074} \frac{z-900}{300} z\, dz$$

= 22.070.58
$M_3 = \int_{1071}^{1200} 0{,}57\ z\, dz$
$= 0{,}58 \text{ x } \frac{1}{2} z^2$
= (0,29 x 1.440.000) – (0,29 x 1.153.476)
= 417.600 - 334.508,04
= 83.493,315
And then Counting Luas

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$$L_1 = \int_{900}^{1029} 0{,}43 \; dz$$

= 55.47

$$L_2 = \int_{1029}^{1071} \frac{z-900}{1200-900} z \; dz$$

= 21

$$L_3 = \int_{1071}^{1200} 0{,}57 \; z \; dz$$

= 73.53

From the results of calculations using the Mamdani method, based on the number of requests of 1035 and supplies of 300, in February 2021 Pancake SMEs can produce durian pancakes as many as 1060 durian pancakes.

c. Simulation with Matlab

Next make a fuzzy Mamdani design with matlab with 2 inputs, namely demand and supply variables and 1 output variable, namely production variables

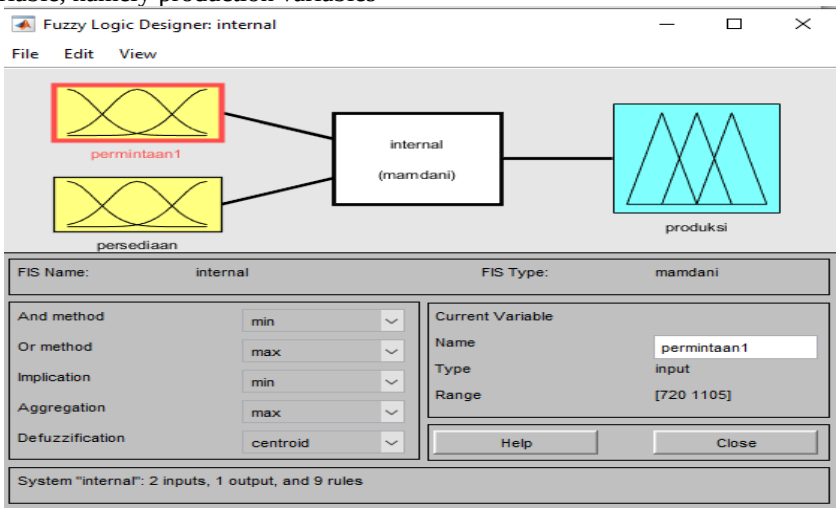

Fig 5. Fuzzy Mamdani design with Matlab

Next create a request variable membership function

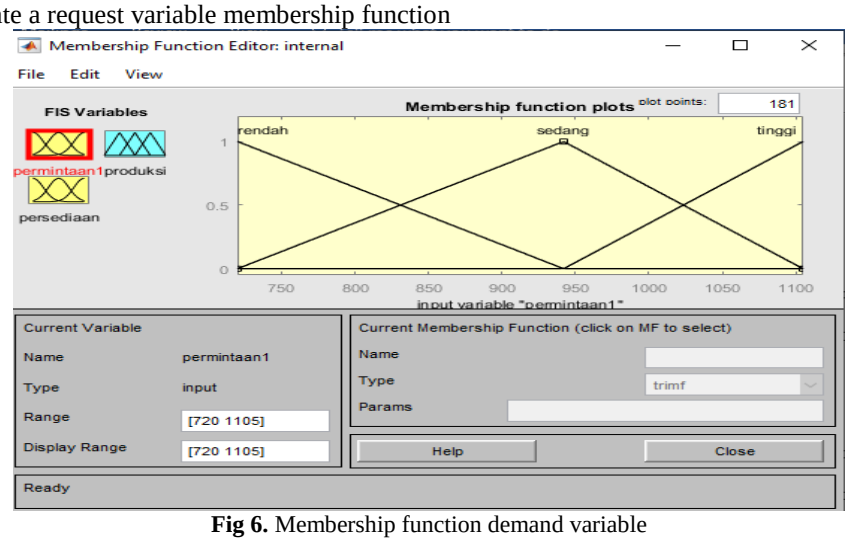

Fig 6. Membership function demand variable

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Next, create a membership function for stock variables.

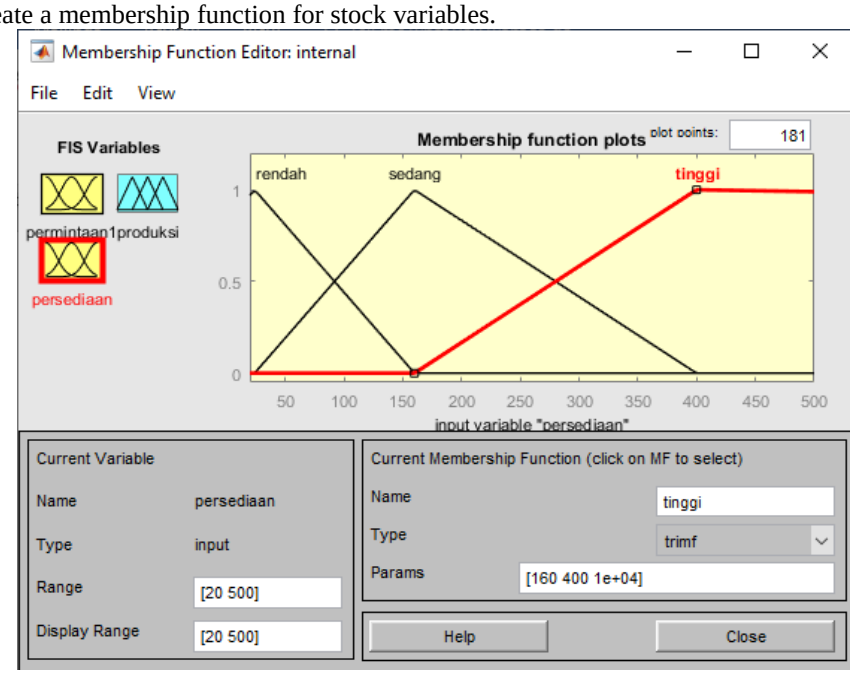

Fig 7. Membership function for inventory variables

Next, create a membership function of production variables

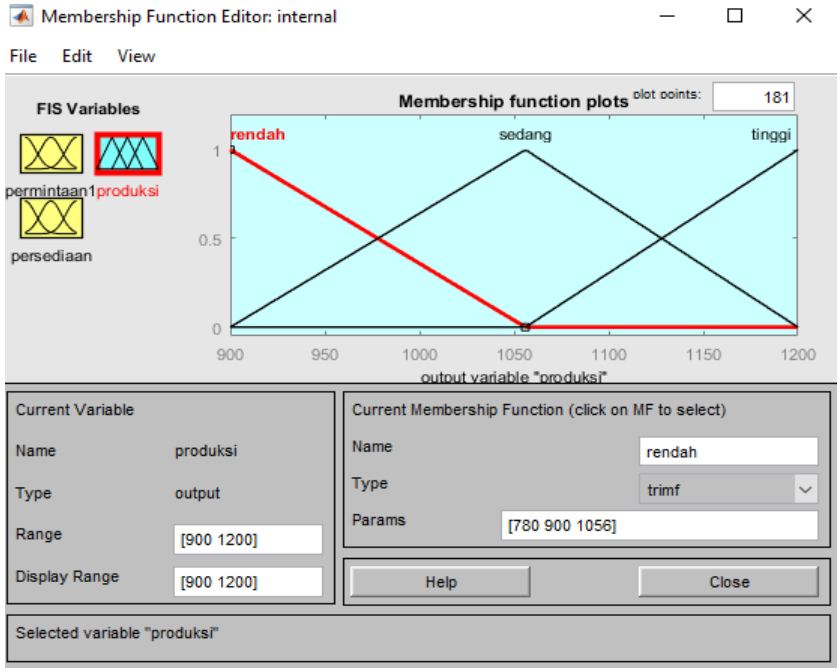

Fig 8. Membership function production variables

Furthermore, there are nine rules of rule-making in this research

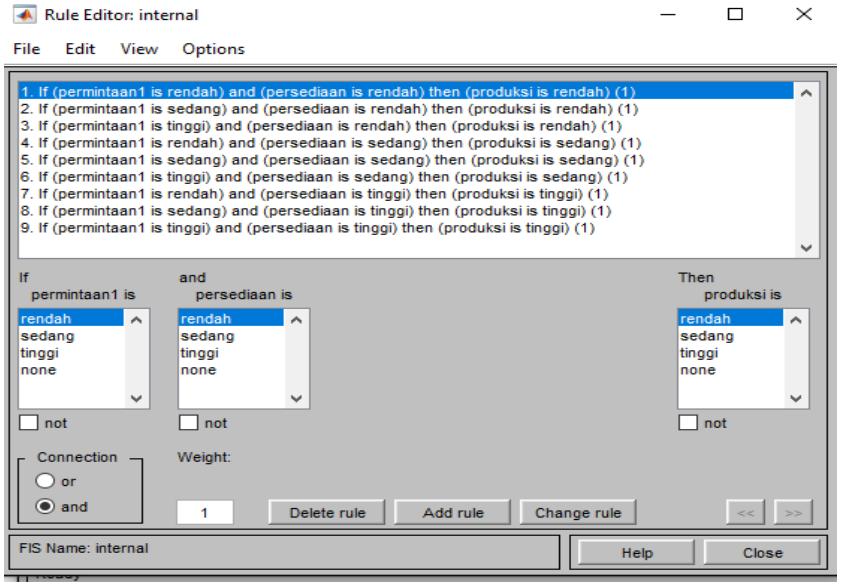

Fig 9. Making the rule

Subsequently view the rule and enter input demand in 1035 and supplies 300 as shown below

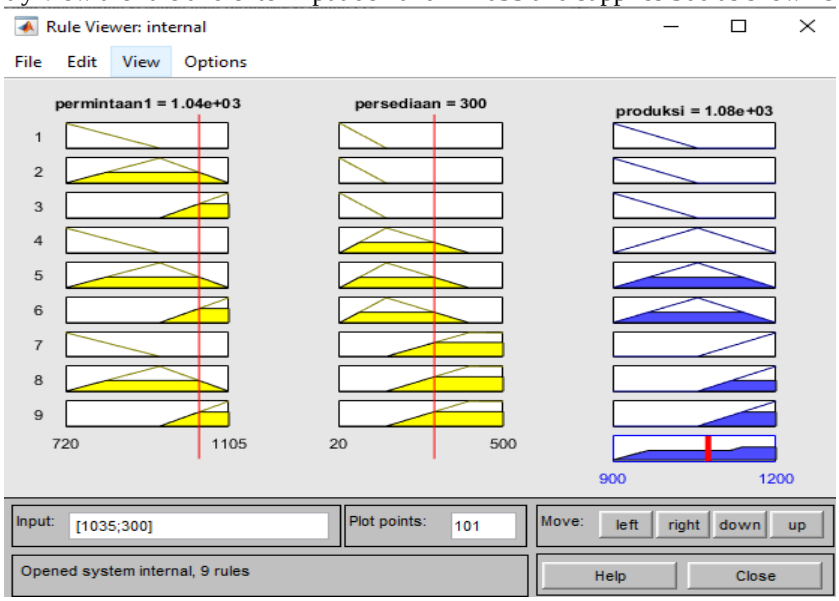

Fig 10. View Rule

4. Conclusion

Following are the conclusions of this study:

a. The application of the Mamdani method of fuzzy inference system has been successfully applied to determine the amount of pancake production based on demand and supply data
b. The application of the Mamdani fuzzy inference system to determine pancake production is feasible because the simulation results show relevant outputs for pancake production based on demand and supply data.
c. The simulation is carried out with Matlab software by showing the appropriate results between manual calculations and the Matlab application

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