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COMPARATIVE ANALYSIS OF PRODUCTION PREDICTION OF SILUNGKANG SONGKET AND PANDAI SIKEK SONGKET WITH MAMDANI FUZZY INFERENCE SYSTEM (FIS) METHOD

Devia Kartika[1)], Rima Liana Gema[2)]
[1] Faculty of Computer Science, Universitas Putra Indonesia YPTK Padangi, Jl. Raya Lubuk Begalung
email: Devia.kartika11@gmail.com
[2] Faculty of Computer Science, Universitas Putra Indonesia YPTK Padangi, Jl. Raya Lubuk Begalung
email:rimalianagema@gmail.com

Abstract

Fuzzy logic is widely applied in various fields, such as industry, communications, etc. Fuzzy logic was developed to solve an obscure problem. The problem that arises in the production at MSMEs Songket Silungkang and Songket Pandai Sikek at this time is that there is no system used as a reference in determining the amount of production in the future. Where this method can utilize demand and supply data in the past which is then processed with fuzzy stages so as to produce production figures. The government has prioritized the development of the Silungkang songket handicraft business, which is a regional specialty, in order to enter the export market. In the early stages, the priority of the regional government was to increase the production of craftsmen by facilitating coaching for micro, small and medium enterprises (MSMEs), especially those engaged in songket crafts, to continue to be developed by increasing quality and creativity. By applying the Fuzzy Inference System method in predicting the production of Songket Silungkang Kota Sawahlunto and Songket Pandai Sikek Kota Agam can help several parties such as the government, micro, small and medium enterprises in making efforts to handle and make good decisions towards increasing the production of Songket MSMEs in each region. and can provide a comparison of the predicted results of production for the coming period so that it can produce the optimal number of songket based on market demand.

Keywords: Production, Songket, Fuzzy Inference System, MSMEs

INTRODUCTION

The development of the small and medium industrial sector which has cooperative advantages in an effort to improve people's welfare is not as easy as it is said , in fact the development of the small and medium industrial sector is always faced with the same problem, namely lack of production

One type of small and medium industry that is currently experiencing development is the traditional songket craft industry. Even though it is not as famous as batik which has been declared the national dress of Indonesia, the popularity of the songket cloth has been expanding especially since the last three years. One of the songket-producing provinces in Indonesia is West Sumatra which is centered on two regions, namely Pandai Sikek and Silungkang

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From previous research [1] , which only discusses the prediction of songket silungkang production, which every month the production goes well and is always stable. Therefore, the researcher wants to compare the results of the predictions with other types of songket , namely Songket Pandai Sikek. With the aim, we can see the public interest in this local work which is very global. The government prioritizes the development of songket handicraft businesses, one of which is Silungkang songket and Songket Pandai Sikek, which are a regional specialty, in order to enter the export market. The export potential of Silungkang songket and Songket Pandai Sikek is very large, considering that these crafts are quite popular abroad, especially Malaysia. In the early stages , the priority of the regional government was to increase the production of craftsmen by facilitating coaching for micro, small and medium enterprises (MSMEs), especially those engaged in songket crafts, to continue to be developed by improving quality and creativity. Each songket has its own uniqueness. This study discusses the comparison of production predictions at each Songket MSMEs. Every time they produce MSMEs Songket Silungkang and Songket Pandai Sikek, they only make predictions by manual calculation. By using manual calculations there is sometimes a shortage because the amount of production does not match the demand. To be able to overcome this problem and help make it easier to predict the amount of songket production per month, a system is needed to automatically predict using artificial intelligence.

Starting from this problem , it can be seen from previous research, namely that a dashboard application was built to determine the priority of PT Telkom technicians using fuzzy logic [2]. In this research [3] discusses predicting rainfall with fuzzy logic. Where will the matching process and data class be carried out. The prediction results show an accuracy of 82.19%. The target data is adjusted into 5 categories, namely sunny, light rain, moderate rain, heavy rain and storm based on BMKG standards . Whereas in this study, the Fuzzy Inference System with the Tsukamoto Method can predict the level of professional competence of educators by including components or scores of professional competence of educators [4].

Fuzzy logic is believed to be very flexible and tolerant of existing data [5]. By using fuzzy logic, it is expected that a model of a system that is capable of predicting and predicting the amount of production at Songket Silungkang MSMEs and Songket Pandai Sikek will be produced.

Fuzzy logic is a methodology of "counting" with the variable words (linguistic variable), instead of counting with numbers. The words used in fuzzy logic are not number-specific, but they are much closer to human intuition. Humans can immediately "feel" the value of the variable words they use daily, [3].

According to [5], fuzzy logic is a set theory, the mathematical concept that

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underlies fuzzy reasoning is quite easy to understand. In addition, fuzzy logic is very flexible, meaning that it is able to adapt to changes and uncertainties that accompany problems. Fuzzy logic is applied to the category classification of each variable. So it is possible to find differences in results during the calculation process.

In the production prediction research comparison analysis using fuzzy logic , there are several methods used to be but the use of fuzzy inference system mamdani be selected in resolving this problem.

By applying the fuzzy inference system method in analyzing the comparative predictions of the production of Songket Silungkang in Sawahlunto City and Songket Pandai Siket in Agam City, this can help several parties such as the government, micro, small and medium enterprises in making efforts to handle and make good decisions on increasing production respectively

RESEARCH METHODS

In this study, collecting data in the form of production, demand and supply , describes research work information [6]. The research begins by identifying the problem, namely using the mamdani fuzzy inference system method which helps determine the prediction criteria for the production of Songket Silungkang and Pandai Sikek which are needed by determining the demand and supply.

The research objective is to determine the prediction of the production results of each MSMEs Songket by applying the mamdani fuzzy inference system and testing a prediction method that can describe how the production is every month so that it can be measured the extent of people's interest in traditional works such as songket using Fuzzy Mamdani.

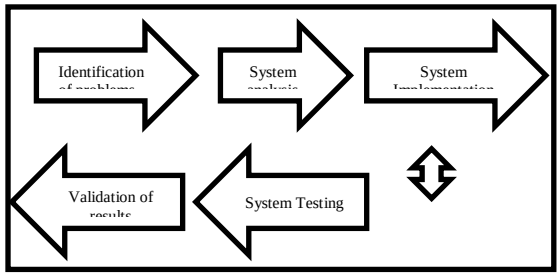

Figure 1. Research Framework

RESULTS AND DISCUSSION

The data that has been taken from the results of interviews and data collection then becomes the set value for each variable, as shown in Figure 2

No	Bulan	UMKM Silungkang			UMKM Pandai Sikek		
		Persediaan (Helai)	Permintaan (Helai)	Produksi (Helai)	Persediaan (Helai)	Permintaan (Helai)	Produksi (Helai)
1	Januari 2016	176	61	186	95	40	80
2	Feb2016	155	71	122	70	34	90
3	Maret 2016	176	58	157	76	55	57
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•
33	Sept 2018	193	45	212	125	40	50
34	Okt 2018	137	64	193	27	50	75
35	Nov 2018	116	40	60	26	45	65

Figure 2. Random Data on Demand, Inventory and Production

Data Processing and Fuzzy Analysis

This stage begins by determining the input variables that will be used to determine the amount of production as the output. As in Figure 3.

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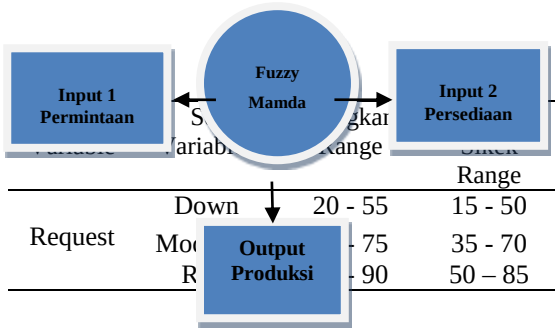

			Range
Request	Down	20 - 55	15 - 50
	Mo	- 75	35 - 70
	R	- 90	50 – 85

Figure 3. Fuzzy Analysis

FUZZY LOGIC CALCULATION PROCESS

Fuzzy Set Formation(Fuzzyfication)

There are two main variables for input and 1 variable for output to determine the amount of production . demand 1, input supply 2. As output, namely production . As seen in table 1.

Function	Variable	Silungkang Songket	Pandai Sikek Songket
Input	Request	20 - 80	15-70
	Stock	50 – 210	25 – 125
Output	Production	80 – 230	20-110

Table 1. The Talking Universe

Analysis for Variable Demand

The demand variable has a value that is expressed in terms of falling , medium and rising . Where each condition has a predetermined value range from the Silungkang MSMEs . The specified value ranges from the lowest value of 20 strands to the highest value of 8 0 strands and from the MSME Pandai Sikek side, the set values range from the lowest value of 15 strands to the highest value of 7 0 strands. The fuzzy set for input 1 is shown in table 2.

Tabel 2. Association Fuzzy For Input 1

membership fuzzy Diagram of request input

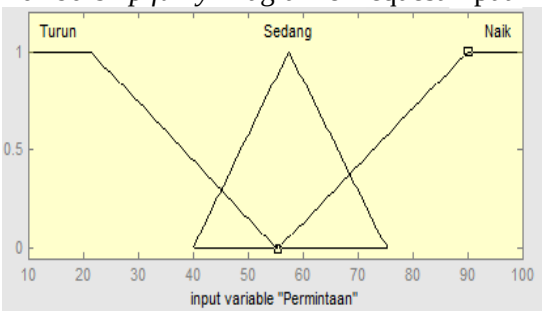

Figure 4. Membership Function of Silungkang Songket Request Variable

From the fuzzy membership diagram ,it can be seen that the fuzzy set equation for songket silungkang.

$$\mu_{r\,(decrease)} = \begin{cases} 1 & ; 0 \le a \le 20 \\ \dfrac{55 - a}{55 - 20}; & \\ 0 & ; a \ge 55 \end{cases}$$

Medium fuzzy set equation :

$$\mu_{r\,(moderate)} = \begin{cases} \dfrac{a - 40}{55 - 40}; & 1; 40 \le a \le 75 \\ \dfrac{75 - a}{75 - 55}; & 40 \le a \le 90 \\ 0 ; a \le 55 \text{ atau } a \ge 90 & \end{cases}$$

The fuzzy set equation increases

$$\mu_{r\,(increase)} = \begin{cases} 0 & ; a \le 40 \\ \dfrac{90 - a}{} & \end{cases}$$

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90 - 55
1 ; a 55 ≤ a ≥ a 90

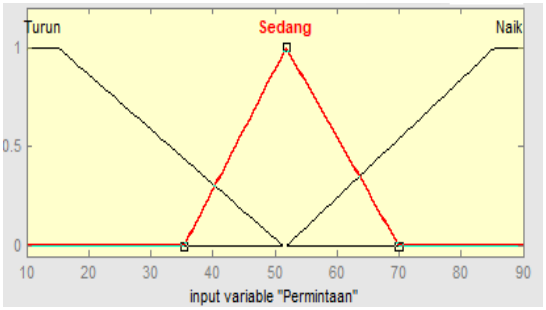

Figure 5. Membership Function Variabel request for Pandai Sikek Songket

From the fuzzy membership diagram can be seen the equation of the fuzzy collection From the fuzzy membership diagram, it can be seen that the fuzzy set equation

$$\mu_{r\,(Decrease)} = \begin{cases} 1 & ; 0 \le a \le 15 \\ \dfrac{50 - a}{50 - 15}; & \\ 0 & ; a \ge 50 \end{cases}$$

Medium fuzzy se equation :

$$\mu_{r\,(medium)} = \begin{cases} \dfrac{a - 35}{50 - 35}; & 1; 35 \le a \le 70 \\ \dfrac{70 - a}{70 - 55}; & 35 \le a \le 85 \\ 0 \; ; a \le 50 \text{ atau } a \ge 85 & \end{cases}$$

Increase fuzzy set equation

$$\mu_{r\,(Increase)} = \begin{cases} 0 & ; a \le 35 \\ \dfrac{85 - a}{85 - 50}; & \\ 1 \; ; a \; 50 \le a \ge a \; 85 & \end{cases}$$

Analysis for Inventory Variables for the songket Pandai Sikek

The inventory variable has a value that is expressed in a few, medium and many conditions. Where each condition has a predetermined value range from the MSMEs Silungkang and Pandai Sikek. The inventory variable has a value that is expressed in a few, medium and many. each condition has a predetermined value range from the MSMEs Silungkang and Pandai Sikek.

The range of values for the songket Silungkang set of lowest value 50 strands to the highest value of 210 strands while at Songket Sikek Clever set the lowest score 25 strands to the highest value of 100 piece set of fuzzy input 2 are shown in Table 3.

Variable	Set Variable	Silungkang Range	Pandai Sikek Range
Stock	Little	50 – 145	25 – 75
	Moderate	100 – 195	50 – 100
	Many	145 – 230	75 - 125

Table 3. The Set Fuzzy For Input 2

Diagram membership fuzzy for stock input can be seen in Figure 5.

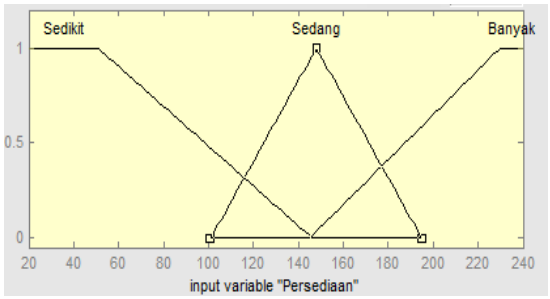

Figure 5. Membership Function Variable Silungkang Songket Invntory

From the fuzzy membership diagram, we can see the fuzzy set equation :

$$\begin{cases} 1 & ; 0 \le a \le 50 \end{cases}$$

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$$\mu_{r\,(little)} = \begin{cases} \dfrac{145 - a}{145 - 50}; \\ 0\ ;\ a \geq 145 \end{cases}$$

Medium fuzzy set equation

$$\mu_{r\,(Modarate)} = \begin{cases} \dfrac{a - 100}{145 - 100}; & 1;\ 100 \leq a \leq 145 \\ \dfrac{195 - a}{195 - 145}; & 145 \leq a \leq 195 \\ 0\ ;\ a \leq 100 \text{ atau } a \geq 195 \end{cases}$$

Increased Fuzzy Set Equation

$$\mu_{r\,(Increase)} = \begin{cases} 0 \quad ;\ a \leq 230 \\ \dfrac{230 - a}{230 - 145}; \\ 1\ ;\ a \ \ 145 \leq \ a \ \geq a\ 230 \end{cases}$$

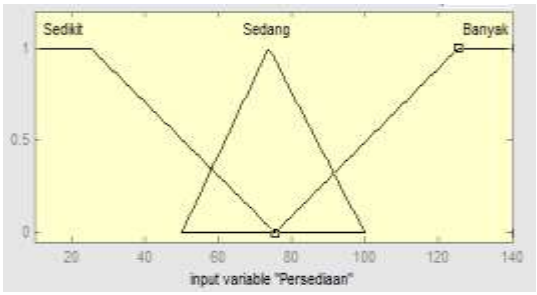

Figure 6. Membership Function of Pandai Sikek Songket Inventory Variable

From the fuzzy membership diagram , we can see the Little fuzzy set equation :

$$\mu_{r\,(little)} = \begin{cases} 1 \quad ;\ 0 \leq a \leq 25 \\ \dfrac{75 - a}{75 - 25}; \\ 0\ ;\ a \geq 75 \end{cases}$$

Medium fuzzy set equation

$$\mu_{r\,(medium)} = \begin{cases} \dfrac{a - 50}{75 - 50}; & 1;\ 50 \leq a \leq 75 \\ \dfrac{100 - a}{100 - 75}; & 75 \leq a \leq 100 \\ 0\ ;\ a \leq 50 \text{ atau } a \geq 100 \end{cases}$$

Increased fuzzy set equation

$$\mu_{r\,(Bertambah)} = \begin{cases} 0 \quad ;\ a \leq 125 \\ \dfrac{125 - a}{125 - 75}; \\ 1\ ;\ a \ \ 125 \leq \ a \ \geq a\ 75 \end{cases}$$

The function of the degree of membership of production variables

The production variable has a value that is expressed in a reduced, increased condition. Where each condition has the lowest value range of 80 strands to the highest value of 220 strands for Songket Silungkang. And the lowest value of 20 strands to the highest value of 100 strands for Songket Pandai Sikek. The fuzzy set for the output is shown in Table 4.:

Fuzzy variable name	Set Variables	Silungkang Range	Pandai Sikek Range
Produksi	Less	80 - 130	20 - 50
	Moderate	131 - 180	51 - 80
	Increased	181 - 230	81 –110

Table 4. The Set Fuzzy of Producion for Output

The membership function diagram for production output can be seen in Figure 7 and Figure 8.

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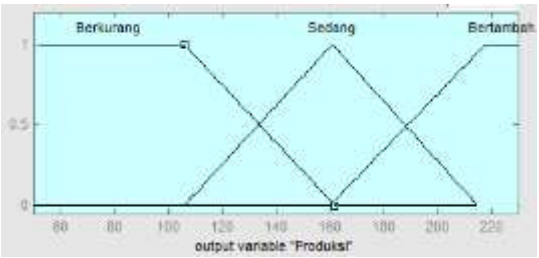

Figure 7. Membership Function Variable Silungkang songket production

From the fuzzy membership diagram, it can be seen that the fuzzy set equation is reduced:

$$\mu_r \text{ (decrease)} = \begin{cases} 1 & : d \le 130 \\ \frac{180 - d}{180 - 130} & ; 130 \le d \le 180 \\ 0 & ; d \ge 18 \\ 1 & \end{cases}$$

From the fuzzy membership diagram, it can be seen that the moderate fuzzy set equation is:

$$\mu_r \text{ (moderate)} = \begin{cases} 0 & : d \le 130 \text{ atau } \ge 230 \\ \frac{d - 130}{180 - 130}; & 130 \le d \le 180 \\ \frac{230 - d}{230 - 180}; & 180 \le d \le 230 \end{cases}$$

Increased Fuzzy Set Equation

$$\mu_t \text{ (Increased)} = \begin{cases} 0 & ; d \le 180 \\ \frac{d - 180}{230 - 180}; & 180 \le d \le 230 \\ 1 & ; z \ge 230 \end{cases}$$

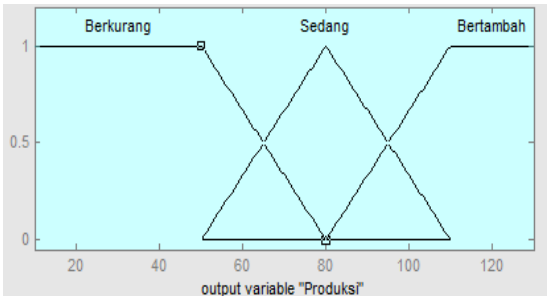

Figure 8. Membership Function Variable Production of Pandai Sikek Songket

From the fuzzy membership diagram, it can be seen that the fuzzy set equation

$$\mu_r \text{ (decreased)} = \begin{cases} 1 & : d \le 50 \\ \frac{80 - d}{80 - 50} & ; 50 \le d \le 80 \\ 0 & ; d \ge 80 \end{cases}$$

From the fuzzy membership diagram , it can be seen that the moderate fuzzy set equation is:

$$\mu_r \text{ (Moderate)} = \begin{cases} 0 & : d \le 50 \text{ atau } \ge 110 \\ \frac{d - 50}{80 - 50}; & 50 \le d \le 80 \\ \frac{110 - d}{110 - 80}; & 80 \le d \le 110 \end{cases}$$

Increased Fuzzy Set Equation

$$\mu_t \text{ (Increased)} = \begin{cases} 0 & ; d \le 80 \\ \frac{d - 80}{230 - 180}; & 180 \le d \le 110 \\ 1 & ; z \ge 110 \end{cases}$$

Formation of Fuzzy Rules or Application of Implication Functions

At this stage, the formation of fuzzy rules is formed from two input variables and one output variable, by analyzing the data against the boundaries of each fuzzy set of input and output variables . Then we get 9 fuzzy rules that are used, using the following rules.

No	Variable		
	Input		Output
	Request	Stock	Production

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1	Less	Less	Less
2	Less	Moderate	Less
3	Less	Increased	Less
4	Moderate	Less	Increased
5	Moderate	Moderate	Moderate
6	Moderate	Increased	Moderate
7	Less	Less	Increased
8	Increased	Moderate	Increased
9	Increased	Increased	Increased

Table 5. Rule Table

Arranging or grouping all fuzzy rules that have a solution or the possibility of occurring, such as in the fuzzy rule formation stage into MATLAB, it can be seen in Figure 9 below.

Figure 9. Fuzzy Rules or Rule Base

In Figure fuzzy rules or rule base (a set of rules based on fuzzy logic to state a condition) combines all input variables which represent the output of each fuzzy set which results in a number in the domain of the fuzzy set.

The rule base can be combined using a rule viewer (showing fuzzy inference diagrams, each rule of the rule base) by changing the input variables to produce the output variables. The prediction or defuzzyfication results can be seen in Figures 10 and 11 below.

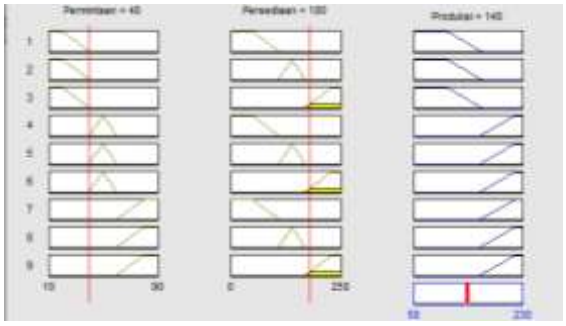

Figure 10. Rule View (Defuzzyfication) for Silungkang Songket

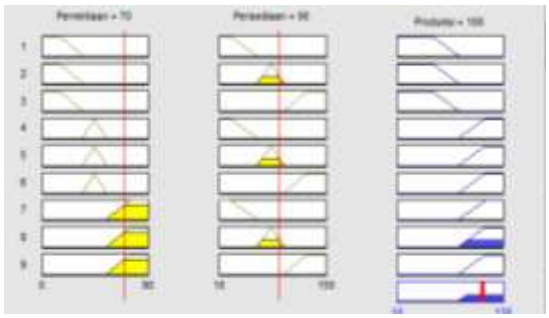

Figure 11. Rule View (Defuzzyfication) for Pandai Sikek Songket

Based on Figures 9 and 10 (Defuzzification), how much demand and supply data is available can be applied, so we can find out how many products must be produced.

For example, in the fuzzyfikasi picture at the input of inputs to demand 40 and supplies 180 the number of products that must be produced is 140 . The red vertical line on the demand and supply input variables shows the value of the fuzzy set for each fuzzy rule, while the thick red vertical line on the production output variable shows the prediction (defuzzyfication) for each value of the input demand and supply variables . By shifting the red vertical lines on the demand and supply variables or entering the demand and supply values in the input

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column, it can be seen the number of products that must be produced.

Comparison of manual count with Fuzzy to determine Silungkang Songket Production

Inference Engine (Min Function)

[R1] = IF Demand is less and inventory is less THEN Production of songket is reduced

α-predicate$_1$ = µDecrease ∩ Slightly
= min (µLess, µLittle)
= min (0,3 ; 0)
= 0

[R2] = IF Demand is LESS and Inventory is THEN Production of songket is LESS

α-predicate$_2$ = µLess ∩ Medium
= min (µLess, µMedium

[R3] = IF Demand is reduced and Inventory increases THEN Production of songket is reduced

α-predicate$_3$ = µDecrease ∩ Increase)
= min (0,3 ; 0,3)
=0,3
= min (µDecrease, µIncrease)
= min (0,3 ; 0,5)
=0,3

[R4] = IF Demand is Moderate and Inventory is LITTLE THEN Production of songket is increasing

α-predikat$_3$= µmedium ∩ µslighty
= min (µmedium, µslighty)
= min (0.2; 0)
= 0

[R5] = IF Demand is MEDIUM AND Inventory IS MEDIUM THEN Production of goods is MEDIUM

α-predicate$_4$ = µmedium ∩ medium
= min (µmedium , µmedium)
= min (0.2; **0,3**)
= 0.2

[R6] = IF MEDIUM Demand And Inventory INCREASES THEN MEDIUM PRODUCTION

α-predicate$_4$ = µmedium ∩ increasing
= min (µmedium, µincreasing)
= min (0.2; 0,5)
= 0.2

[R7] = IF Demand increases and supply is LITTLE THEN Production of songketincreases

α-predicate$_4$ = µincreased∩ slighty
= min (µincreased , µslighty)
= min (0; 0,5)
= 0

[R8] = IF Demand is increasing and supply is currently increasing Production of songket is increasing

α-predicate$_4$ = µincreased ∩ medium
= min (µincreased , µmedium)
= min (0 ; 0,2)
= 0

[R9] = IF Demand increases and supply increases THEN Production of goods increases

α-predicate$_4$ = µincreased ∩ increased
= min (µ increased , µ increased)
= min (0; 0,5)
= 0

Defuzzyfication

The final step in this process is defuzzification or also known as the affirmation stage. The method used is the centroid method. The following converts fuzzy sets to real numbers

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[Rule 02] µProduction of Silungkang Songket is reduced (x) = 0,3, then the value x is ;

Production (*reduced*)

= 180 – *x / 18 0 -130*= 0.3
= (180 – (0,3 x 50)
= 180 – 15
= 165

[Rule 03] µProduction of Silungkang Songket is reduced (x) = 0 , 3 , then the value of x is;

Production (*reduced)*

= 180 – *x / 18 0 -130*= 0.3
= (180 – (0,3 x 50)
= 180 – 15
= 165

[Rule 05] µProduction of Silungkang Songket Increases (x) = 0 , 2 then the value of x is;

Production (medium)

= (d - 130) / 180 – 130 = 0,2
= (d – 130) /50 = 0,2
= (0,2 x 50) + 130
= 140

[Rule 06] µProduction of Silungkang Songket Increases (x) = 0 , 2 then the value of x is;

Production (medium)

= (d - 130) / 180 – 130 = 0,2
= (d – 130) /50 = 0,2
= (0,2 x 50) + 130
= 140

By using the defuzzy weighted average method , the production value of songket silungkang is obtained :

$$Z1 = \frac{(0,3*165) + (0,3*165) + (0,2*140) +(0,2*140)}{0,3+ 0,3 + 0,2 + 0,2}$$

$$= \frac{49,5 + 49,5 +28+ 28}{1}$$

= **155 Strands (Medium)**

So, by using the defuzzy weighted average method , the production value of songket silungkang is obtained

It can be seen the results of the comparison of the system / testing with the matlab application in determining the production of silungkang songket and the results of manual search using fuzzy have results that are not much different.
The meaning of the range that the same is in the range of Medium is 130 -180.

CONCLUSION

From the results of predictions and calculations, the following conclusions :

1. In determining the amount of songket songket production, the author conducted several tests, namely expert testing, fuzzy testing and testing using Matlab.
2. With the Mamdani Fuzzy Inference System (FIS) method, it helps and speeds up the data processing process, to get a decision in determining the criteria for the amount of songket production does not require a long process and time.
3. The author makes a system to fulfill the amount of production using Mamdani fuzzy logic by forming knowledge or rules generated by the Matlab application system to be able to help the Songket Silungkang MSMEs and Songket Pandai Sikek UMKN.

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