

PRODUCTION OPTIMIZATION USING FUZZY INFERENCE SYSTEM TSUKAMOTO

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Abstract- This paper discusses the application of Fuzzy Inference System Tsukamoto for decision making in production planning at crude palm oil (CPO) company. In this study, the optimal amount of CPO production in year 2014 are available. The objective is to help the production manager's for determine the optimal number of CPO production, so that can be effective and efficient in production planning. Data demand, inventory and production in 2014 as the input for FIS Tsukamoto to determine the optimal number of productions. There are three steps of FIS Tsukamoto to generate the inputs. Firstly is the Fuzzification, in this step the data input that call crisp set are transformed to the fuzzy set using the fuzzy theory. Secondly is the Inference, in this step all the fuzzy set must be sent to knowledge base that contains n fuzzy rule in the form of IF-THEN. Fire strength (antecedent membership values or α) will be sought at each rule. If more than one rule, it will be an aggregation of all the rules there are nine rules used in this study. Lastly is the defuzzification, the results of the second step above which still in fuzzy sets, then recovered into the crisp sets as an output by using the Center of Gravity Method. In conclusion, the result of the calculation shows that the FIS Tsukamoto can be optimized in terms of the amount of production and profits at Palm Oil Mill Company.

Keywords- Fuzzy Logic, Decision Making, Production Planning, Fuzzy Inference System Tsukamoto

I. INTRODUCTION

Operation management has three fundamental works, namely planning, implementation of the plan, and monitoring the process. Planning is the first step in the production management. Planning is a prerequisite for execution and control. Without a plan, there is no basis for action and no basis for evaluating the results achieved [3]. The operation managers have the responsibility to make a plan and have important position in every company. Some of the tasks an operations manager was making decisions about planning, how many products will be produced, how much material will be used, how many workers and many more [7].

Every day an operations manager, especially production managers make decisions [6]. Not easy for a production manager to make decisions because they are constantly faced with uncertainty and a variety of other complex production issues [5]. These problems include the decline in the number of productions which cause a decrease in the profit of the company. As is the case in crude palm oil firm, the problems of vagueness on the number of productions also always happen because of many factors caused. Required methods effective and efficient to alleviate these problems. For this research, methods of Fuzzy Inference System Tsukamoto were applied to the production planning, CPO to determine the amount of optimal production.

Fuzzy Inference System Tsukamoto method is also one of a method for decision making. Especially in many uncertainties and vagueness situations, this method is very flexible and has a tolerance for any

data existing [1][2]. The Fuzzy Inference System uses reasoning monotony in the process of solving problems. The workings of this method is to use the data production, inventory and demand data as input and then processed through the three stages of process to optimize the amount of the input of the third. The first phase, i.e. the transformation of Fuzzification input data be fuzzy sets. The second stage is the fuzzy inference process by entering the sets that has been formed into the rule. Finally, Defuzziification is the process of aggregation of fuzzy sets, fuzzy sets and changed into a crisp sets. Type Style and Fonts

II. RESEARCH METHODOLOGY

In obtain the optimal amount of production in order to remain stable so that it can increase the profit of the company. The following three stages of FIS Tsukamoto, which are Fuzzification, Inference and Defuzzification:

A. Fuzzification

Fuzzification is the process of converting a non-fuzzy variables (numerical variables) into a fuzzy variables (linguistic variables) [4]. The variables that will be used must be defined first such as variable demand, inventory and production. Each variable has a fuzzy set. As an example, for variable inventory, the used fuzzy set is down, Moderate, and Up. Then, after that seek membership value of each set of fuzz, on each variable. Membership value obtained by representing each fuzzy set with a membership function. There are six functions that can be used which are, representation of Linear, triangular curve, the curve

shape of the shoulder, s-curve, trapezoidal curve, and the curve of the oval shape

B. Inference

Inference is the process of combining many rules based on available data. Fuzzy inference system receives input crisp. This input is then sent to a knowledge base that contains n fuzzy rules in the form of IF-THEN. After determining the rules that will be used, then find the value of the antecedent membership or fire strenght (α), and the estimated value of goods to be manufactured (z) of each rule, using the membership value of each fuzzy set.

C. Defuzzyfication

Determine the crisp output value will be the number of goods produced (Z), by changing the input (in the form of fuzzy sets derived from the composition of fuzzy rules) into a number of fuzzy sets in the domain. Defuzzyfication method used in the Tsukamoto method is centered average method. This formulation is to determine the crisp output value that will be the number of goods produced (Z), by changing the input (in the form of fuzzy sets derived from the composition of fuzzy rules) into a number of fuzzy sets in the domain. This is the centered average method equation :

$$Z = \frac{\sum_{i=1}^n \alpha_i . z_i}{\sum_{i=1}^n \alpha_i} \tag{1}$$

III. RESULTS AND DISCUSSIONS

After running the FIS Tsukamoto, the result is shown the different results of the calculation between the companies with the FIS Tsukamoto method. Significant differences can be seen more clearly Figure 1 below, shows that the company produces the goods is unstable, sometimes there are high and low. As for the total inventory is also the same as the total production, which is unstable, sometimes the amount of residual CPO produced very little, so that if it happens then to the next month, the company had to work hard to produce higher CPO.

This happens because the company only has a little reserve to meet the next higher demand. As you know that the raw material of CPO is a perishable. Materials can only survive within 24 hours after being picked from the fields. Raw materials are also imported from the fields far away from the mill, thus becoming a long production lead time. In addition, the amount of raw materials is uncertain, because of factors such as weather, pests and others. Therefore, the company produces CPO to taste according to the number of customer orders.

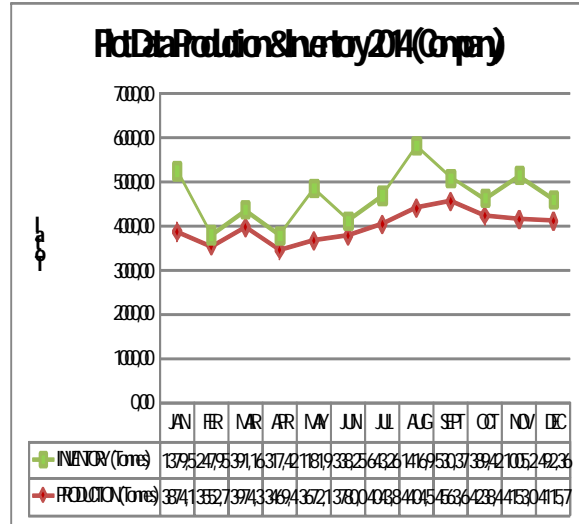


Figure 1: Plot Data for Production & Inventory Crude Palm Oil 2014 (Company). Source: The result of analysis, 2015

While the results of optimization using FIS Tsukamoto is much different with the results of the calculation of the company. Seen in Figure 2, the plot shows results fairly stable production data and the amount of inventory that is high enough. The resulting total production is the optimal amount of production, which can be a standard amount of production to meet customer orders. So that later the company remains productive and earn a profit. The amount of inventory that has been optimized by FIS Tsukamoto is a high number. However, it is appropriate for the crude palm oil company, because with such a high number of inventory, the company had reserves of CPO for sale for the next month.

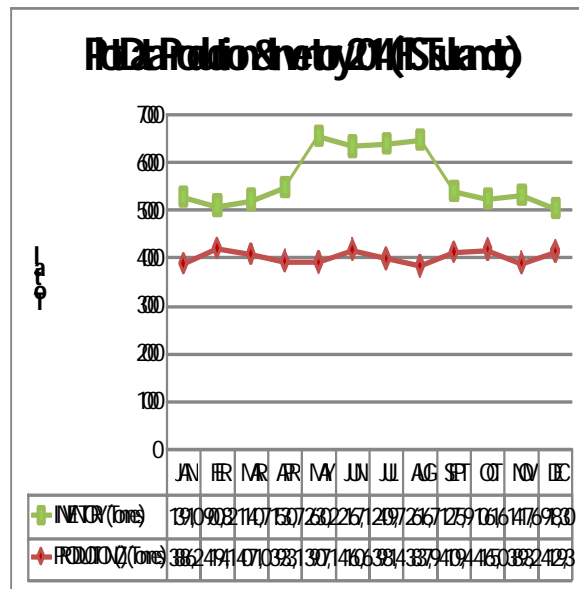


Figure 2: Plot Data for Production & Inventory Crude Palm Oil 2014 (FIS Tsukamoto)

In detail, the comparison of the products and profits of the company and FIS Tsukamoto calculation, as shown in Table 4.20 below:

Table 2: Total Product and profit from the company 2014.
Source: (Researcher, 2015 & MPOC, 2014)

COMPANY			
MONTH	PRICES (RM/Tonnes)	TOTAL PRODUCT (Tonnes)	PROFIT (RM)
JAN	2.534	5253.62	13,312.67
FER	2.635	3800.74	10,014.95
MAR	2.862	4365.47	12,493.98
APR	2.696	3786.88	10,209.43
MAY	2.605	4854.10	12,644.93
JUN	2.436	4118.33	10,032.25
JUL	2.404	4687.08	11,267.74
AUG	2.174	5821.52	12,655.98
SEPT	2.059	5094.00	10,488.55
OCT	2.179	4627.87	10,084.13
NOV	2.219	5158.32	11,446.31
DEC	2.155	4608.14	9,930.54
TOTAL		56176.07	134,581.46

Table 3: Total Product and profit from the results of calculation of FIS Tsukamoto 2014.
Source: (Researcher, 2015 & MPOC, 2014)

FUZZY INFERENCE SYSTEM TSUKAMOTO			
MONTH	PRICES (RM/Tonnes)	TOTAL PRODUCT (Tonnes)	PROFIT (RM)
JAN	2.534	5277.27	13,372.60
FER	2.635	5094.93	13,425.14
MAR	2.862	5211.84	14,916.29
APR	2.696	5463.94	14,730.78
MAY	2.605	6537.36	17,029.82
JUN	2.436	6327.73	15,414.35
JUL	2.404	6391.11	15,364.23
AUG	2.174	6454.76	14,032.65
SEPT	2.059	5385.38	11,088.50
OCT	2.179	5226.68	11,388.94
NOV	2.219	5310.81	11,784.69
DEC	2.155	5047.67	10,877.73
TOTAL		67729.48	163,425.71

As seen from Table 2 and 3, there is a very significant difference between the results of the calculation of the company and the FIS Tsukamoto. Total company's products for one year is 56176.07 tonnes, with profits when sold for RM 134, 581.46. Meanwhile, FIS Tsukamoto produced a total of 67729.48 tonnes as much product and profit around RM 134, 581.46. There is a difference from the results, because the calculation result FIS Tsukamoto slightly more compared to the results of the calculation of the company. The difference is as much as 11553.41 tonnes and approximately RM 28, 844.25. The result of the calculation shows that the

FIS Tsukamoto can be optimized in terms of the amount of production and profits at companies Sindora Palm Oil Mill.

CONCLUSIONS

Fuzzy Inference System Tsukamoto is a method of decision making to determine the optimal amount of production. The conclusions of this study are the method can be applied to the FIS Tsukamoto CPO company and disappear and more effective compared to methods used at the company. FIS Tsukamoto is also more give you an advantage in terms of profit. Therefore the methods appropriate for the FIS Tsukamoto help operation managers in production planning.

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