Recommendation System Cooperative Stock Goods Orders Using Fuzzy Tsukamoto

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Abstract- Various types of daily necessities are available at all-round cooperatives. The Udayana University Karya Bina Sejahtera Civil Servants Cooperative. This cooperative is included as an all-round cooperative that sells various kinds of daily goods and transactions occur every day with considerable intensity. This causes the cooperative to be able to fulfill the demand for goods from the buyer and keep the items sold in good condition. So that in storing the stock of goods must be able to adjust so that the goods are not excessive in inventory or less in the inventory of goods to be sold. Seeing the problems described above, the author feels the need to build a system that can help the cooperative in determining the number of goods ordered. The recommendation system can be built with several methods. One method that can be used is to use the fuzzy logic method. Researchers want to do a study that aims to help in recommending ordering purchases of goods to be ordered based on the number of sales transactions of goods needed from existing data. To make a recommendation for the number of orders for goods, it will be calculated using the Tsukamoto Fuzzy Logic method which is considered suitable to assist in terms of recommending the number of goods purchase orders. With the calculation of this fuzzy logic, the cooperative will later be able to pay attention to the determination of the number of purchase orders for goods so as not to cause excess stock or stock shortages. The development of a system of recommendations for planning stock items can help the cooperative to provide a reference for the number of orders that must be ordered in order to reduce the occurrence of ordering errors as previously explained, such as excess stock or lack of stock.

Index Terms— Recommendation system, Fuzzy Tsukamoto, Stock item, Cooperative.

I. INTRODUCTION

In the Store Unit of Karya Bina Sejahtera Civil Servants Cooperative Udayana University provides a variety of daily necessities and also food needs. The Cooperative of Civil Servants Karya Bina Sejahtera, Udayana University is included in the type of Multipurpose Cooperative. Because the cooperative serves a variety of business fields from savings and loan units to shopping units. To meet the demands of consumers who come shopping every day, of course the cooperative must provide a stock of goods sold in the store. The cooperative warehouse in the supply of goods is done by ordering to suppliers. The process of ordering the item itself will certainly determine how many items must be ordered.

Based on the results of the author's interview with the Cooperative Karya Bina Sejahtera, Udayana University, the cooperative has only been based on a minimum supply of goods in the warehouse that will run out. The existence of a calculation process or careful consideration in the warehouse, can later help many things in the transaction process such as avoiding the accumulation of goods and avoiding empty inventory. Another impact of the number of orders that are not right is that the cooperative can suffer losses because if the goods are piled up and are not selling well, the item will expire and eventually will suffer losses. Seeing the problems described above, the author feels the need to build a system that can help the cooperative in determining the number of goods ordered. The recommendation system is a program that can predict an item [1]. The development of a system of recommendations for planning stock items can help the cooperative to provide a reference for the number of orders that must be ordered in order to reduce the occurrence of ordering errors as previously explained, such as excess stock or lack of stock.

The recommendation system can be built with several methods. One method that can be used is to use the fuzzy logic method. Researchers want to do a study that aims to help in recommending ordering purchases of goods to be ordered based on the number of sales transactions of goods needed from existing data. To make recommendations for the number of orders for goods will be calculated using the

Fuzzy Logic method which is considered suitable to assist in terms of recommending the number of goods purchase orders. The use of Fuzzy Logic by utilizing rules which are provisions used by the cooperative by taking the variable number of maximum sales in one day, minimum initial stock, and order lead time. With the calculation of fuzzy logic, the cooperative will have to pay attention to the determination of the number of purchase orders so that later it will not cause excess stock or stock shortages.

II. Literature Review

A. Recommendation System

The recommendation system is a personalization tool that provides a clear information in accordance with the wishes of each user [2]. The Recommendation System utilizes a person's opinion on an item in a particular domain or category, to help someone choose a product. Therefore the Recommendation System requires the right recommendation model so that what is recommended is in accordance with the wishes of the customer, and makes it easier for customers to make the right decisions in determining the products to buy [3].

B. Fuzzy Logic

Fuzzy logic was first discovered by professor Lotfi A. Zadeh, from the University of California, in June 1965. Fuzzy logic is a generalization of classical logic that only has two membership values, namely 0 and 1. In fuzzy logic, the truth value of a statement ranges from completely true, until completely wrong. With fuzzy set theory, an object can be a member of many sets with different membership degrees in each set. This concept is different from the classic set (crisp). Classic set theory depends on two valued logic to determine whether an object is a set of members or not. [4]

C. Fuzzy Tsukamoto

In this base model, in general there are three steps to determine the number of orders based on stock data and data requirements using the Tsukamoto method, namely defining variables, inference, and defuzzyfication (determining crisp output) : [5]

1. Defining Fuzzy Variables

At this stage, the membership value of the set of needs and stocks is currently sought using the fuzzy set membership function by taking into account the maximum and minimum data values of each variable. The membership function is the value of the degree of membership of a fuzzy set. The membership function uses a curve that shows the mapping of the input data values into membership values or membership degrees and has an interval of values between 0-1 [6].

2. Inference

Inference is the process of combining many rules based on available data [7]. From a number of existing function variables, several fuzzy rules can be formed.

3. Defuzzyfication

In Tsukamoto's method, to determine the crisp output, a centralized defuzzyfication is used, namely:

$$Z = \frac{a1*z1+a2*z2+a3*z3+a4*z4+a5*z5+a6*z6+a7*z7}{a1+a2+a3+a4+a5+a6+a7}$$

D. Warehouse

Warehouse is a place that is used to store goods in the form of raw material, work in process goods or finishs goods. The definition of warehouse that is in warehousing which means it is an activity related to the warehouse. [8]

A.Warehouse Role and Function

According to Ahmad Arwani (2009) the role of warehouses can be categorized into three functions: [9]

1. Storage function

The most basic function of the warehouse is the storage of goods, both raw, semi-finished, and finished goods. The aim of management is how optimal space is to store products at a certain cost.

2. The function serves customer requests

The activity of receiving goods from manufacturers or suppliers and fulfilling requests from warehouse branches or customers as a focus of logistics activities. Warehouse has the role of providing services by ensuring reasonable product availability and order cycles. This system will reduce costs, because shipments from manufacturers can be made periodically, just by the quantity of trucks or box cars. By storing a certain amount of stock, it will help manufacturers from the demand for the fluactive.

3. Distribution and consolidation functions

This distribution function makes the warehouse an extension of sales and marketing in ensuring the delivery of products and information to customers as a point of sale (points of sale). This function is created as a result of the characteristics of transportation costs. Shipping in large quantities, economically cheaper costs compared to shipments on a smaller scale. In certain systems, the distribution and consolidation functions are the main function of the distribution warehouse.

III. Research Methods

A. Data Collection

The data collection phase is done to find out what data will be needed to solve this problem, which previously has been carried out literature studies and field studies. Method used to collect data by contacting the Karya Bina Sejahtera Cooperative to obtain data and conduct interviews directly with the speakers who will use the system.

The type of data used in this study is how to obtain it, namely primary data. Primary data is a source of data that directly provides data to data collectors [10]. Primary data must be searched through sources or respondents, namely

people who are the object of research or people who are used as a means of information and data.

B. Method Used

The method used in this research ordering recommendation study is Fuzzy Logic by the Tsukamoto FIS method. The FIS method Tsukamoto presents each rule using fuzzy sets, with a monotonous membership function. To determine the exact crisp / yield output value (Z), it is sought by changing the input (in the form of fuzzy sets obtained from the composition of fuzzy rules) into a number in the fuzzy set domain. This method is called the defuzzification method. The defuzzification method used in the Tsukamoto method is a centralized average defuzzification method (Center Average Deffuzyfler). While for the software development methodology used is the waterfall method.

IV. Analysis And Results

A. Completion using the Fuzzy Tsukamoto Method manually

One example of a calculation of the results of recommendations for ordering goods manually using fuzzy logic is as follows:

Karya Bina Sejahtera Cooperative every day serves food needs transactions in stores managed by Karya Bina Sejahtera Cooperative from every customer who comes shopping. Using data obtained from Karya Bina Sejahtera Cooperative, a manual calculation will be made using the Tsukamoto base model.

there are a number of goods needed by each customer, it is known that in January 2015 from 1 - 31 there are a number of data on the needs, stock, and ordering of goods with the name HEALTHY RICE 5KG. How many items should the order be recommended for the following month?

Date	Goods Needs	Stock of goods	Ordering goods
2-1-15	1	1	
5-1-15	8	8	30
6-1-15	5	5	
7-1-15	5	5	
8-1-15	10	10	
9-1-15	5	5	
12-1-15	2	2	40
13-1-15	1	1	
14-1-15	1	1	
16-1-15	1	2	
21-1-15	1	1	
22-1-15	2	2	
23-1-15	3	3	
26-1-15	5	5	
27-1-15	2	2	
28-1-15	4	4	
29-1-15	7	7	

Table 1. Data from Needs, Stocks and Orders HEALTHY RICE 5KG

Solving :

From table 1, first and foremost data are searched for maximum and minimum for 1 period, namely in January 2015 which will be presented in table 2.

Data	Total	Unit
Maximum Needs	10	KG
Medium Needs	5	KG
Minimum Needs	1	KG
Maximum Stock	10	KG
Medium Stock	5	KG
Stok Minimum	1	KG
Maximum Order	40	KG
Medium Order	35	KG
Minimum Order	30	KG

Table 2. Maximum, Medium, Minimum Data

In solving the above problems using the Tsukamoto method manually, there are several steps taken. These steps are: defining fuzzy variables, inference, and defuzification (determining crisp output).

1. Modeling fuzzy variables (Fuzzyfication)

There are 3 fuzzy variables that will be modeled, namely: the needs, stock, and ordering of goods.

1. Needs; consists of 3 fuzzy sets, which are LITTLE, MEDIUM, MANY. The membership needs function is represented based on the data in table 2. LITTLE, MEDIUM, MANY set of membership functions below:

$$\text{KplLitle}[X] = \begin{cases} 1 & , \ x < 1 \\ \frac{10-x}{(10-1)} & , \ 1 \le x \le 10 \\ 0 & , \ > 10 \end{cases}$$

$$\text{KplMedium}[X] = \begin{cases} 1 & , \ x = 5 \\ \frac{x-1}{(5-1)} & , \ 1 \le x \le 10 \\ \frac{10-x}{(10-5)} & , \ 5 \le x \le 10 \\ 0 & , \ x < 1 \vee x > 10 \end{cases}$$

$$\text{KplMany}[X] = \begin{cases} 0; & x < 1 \\ \frac{x-1}{10-1}; & 1 \le x \le 10 \\ 1; & x > 10 \end{cases}$$

The value of a LITTLE, MEDIUM, MANY set of many needs variables is

KplLittle[7] = 0.33

KplMedium[7] = 1.5

KplMany[7] = 0.66

2. Stock; consists of 3 fuzzy sets, which are LITTLE, MEDIUM, MANY. The membership needs function is represented based on the data in table 2. LITTLE, MEDIUM, MANY set of membership functions below:

$$\text{StkLittle}[Y]=\begin{cases}1 & , \ y<1\\ \frac{10-y}{(10-1)} & , \ 1\le y\le 10\\ 0 & , \ >10\end{cases}$$

$$\text{StkMedium}[Y]=\begin{cases}1 & , \ y=5\\ \frac{y-1}{(5-1)} & , \ 1<y<5\\ \frac{10-y}{(10-5)} & , \ 5<y<10\\ 0 & , y<1 \vee y>10\end{cases}$$

$$\text{StkMany}[Y]=\begin{cases}0; & y<1\\ \frac{y-1}{10-1}; & 1\le y\le 10\\ 1; & y>10\end{cases}$$

The value of the membership set is LITTLE, MEDIUM, MANY of the stock variables:
StkLittle[7] = 0.33
StkMedium[7] = 1.5
StkMany[7] = 0.66

3. Order; consists of 3 fuzzy sets, which are LITTLE, MEDIUM, MANY. The membership needs function is represented based on the data in table 2. LITTLE, MEDIUM, MANY set of membership functions below:

$$\text{PmsLittlet}[Z]=\begin{cases}1 & , \ z<40\\ \frac{40-z}{(40-30)} & , \ 30\le z\le 40\\ 0 & , \ >40\end{cases}$$

$$\text{PmsMediu}[Z]=\begin{cases}1 & , \ z=35\\ \frac{z-30}{(35-30)} & , \ 30<z<35\\ \frac{40-z}{(40-35)} & , \ 35<z<40\\ 0 & , \ z<30 \vee z>40\end{cases}$$

$$\text{PmsMany}[Z]=\begin{cases}0 & , \ z<30\\ \frac{z-30}{(40-30)} & , \ 35\le z\le 40\\ 1 & , \ z>40\end{cases}$$

2. Inference

Inference is the process of combining many rules based on available data. From a number of existing function variables, several fuzzy rules can be formed:

[R1] IF LITTLE need And MANY stock THEN LITTLE ordering goods.
The antecedent membership value for fuzzy rules [R1] denoted by α1 is obtained by the following formula:
α1 = KplLittle ∩ StkMany
= min (0.33, 0.66)
= 0.33
According to the membership function of the LITTLE Order Order group in fuzzy rules [R1];
z1 = 40 – 0.33*(40 – 30)
= 36.66

[R2] IF LITTLE need And MEDIUM stock THEN LITTLE ordering goods.
The antecedent membership value for fuzzy rules [R2] denoted by α2 is obtained by the following formula:
α2 = KplLittle ∩ StkMedium
= min (0.33, 1.5)
= 0.33
According to the LIT Order Order membership function in fuzzy rules [R2];
Z2 = 40 – 0.33*(40 – 30)
= 36.66

[R3] IF LITTLE need And LITTLE stock THEN LITTLE ordering goods.
The antecedent membership value for fuzzy rules [R3] denoted by α3 is obtained by the following formula:
α3=KplLittle ∩ StkLittle
= min (0.33, 0.33)
= 0.33
According to the LITLLE Order set membership function in fuzzy rules [R3];
Z3 = 40 – 0.33*(40 – 30)
= 36.66

[R4] IF MEDIUM need And MANY stock THEN LITTLE ordering goods.
The antecedent membership value for fuzzy rules [R3] denoted by α4 is obtained by the following formula:
α4=KplMedium ∩ StkMany
= min (1.5, 0.66)
= 0.66
According to the LIT Order Order membership function in the fuzzy [R4] rule;
Z4 = 40 – 0.66*(40 – 30)
= 33.33

[R5] IF MEDIUM need And MEDIUM stock THEN MEDIUM ordering goods.
The antecedent membership value for fuzzy rules [R5] denoted by α5 is obtained by the following formula:
α5=KplMedium∩StkMedium
= min (1.5, 1.5)
= 1.5

According to the set membership function, order goods is in fuzzy rules [R5];
Z5 = 40 – 1.5*(40 – 30)
= 25

[R6] IF MEDIUM need And LITTLE stock THEN MANY ordering goods.
The antecedent membership value for fuzzy rules [R6] denoted by α6 is obtained by the following formula:
α6=KplSMedium∩StkLittle
= min (1.5 , 0.33)
= 0.33
According to the LOTS Ordering membership function in fuzzy rules [R6];

Z6 = 0.33*(40 – 30) + 30
= 33.33

[R7] IF MANY need And MANY stock THEN MANY ordering goods.

The antecedent membership value for fuzzy rules [R7] denoted by α7 is obtained by the following formula:

α7=KplMany ∩ StkMany
= min (0.66, 0.66)
= 0.66

According to the LOTS ordering function membership function in fuzzy rules [R7];

Z7 = 0.66*(40 – 30) + 30
= 36.66

[R8] IF MANY need And MEDIUM stock THEN MANY ordering goods.

The antecedent membership value for fuzzy rules [R8] denoted by α8 is obtained by the following formula:

α8=KplBanyak∩StkSedang
= min (0.66,1.5)
= 0.66

According to the LOTS Ordering membership function in fuzzy rules [R8];

Z8 = 0.66*(40 – 30)+ 30
= 36.66

[R9] IF MANY need And LITTLE stock THEN MANY ordering goods.

The antecedent membership value for fuzzy rules [R9] denoted by α9 is obtained by the following formula:

α9=KplBanyak∩StkSedikit
= min (0.66, 0.33)
= 0.33

According to the LOTS Ordering membership function in fuzzy rules [R9];

Z9 = 0.33*(40 – 30)+ 30
= 33.33

3. Defuzzyfication

In the Tsukamoto method, to determine the crisp output, the centralized average defuzzyfication is used, below:

$$Z = \frac{a1*z1+a2*z2+a3*z3+a4*z4+a5*z5+a6*z6+a7*z7+a8*z8+a9*z8}{a1+a2+a3+a4+a5+a6+a7+a8+a9}$$

$$Z = \frac{(0.33*36.66)+(0.33*36.66)+(0.33*36.66)+(0.66*33.33)+(1.5*25)+(0.33*33.33)+(0.66*36.66)+(0.66*36.66)+(0.33*33.33)}{0.33+0.33+0.33+0.66+1.5+0.33+0.66+0.66+0.33}$$

Z = 32.393801169590

So, according to the calculation by the Tsukamoto method above based on real data obtained from the Karya Bina Sejahtera Cooperative with the name HEALTHY RICE 5KG item in the period of January 2015, the results of recommendations for the next period were obtained with the number 32.393801169590 items rounded to 32 items.

B. System Design

The following is a system design that is built using a flowchart, ERD (Entity Relationship Diagram), DFD (Data Flow Diagram) :

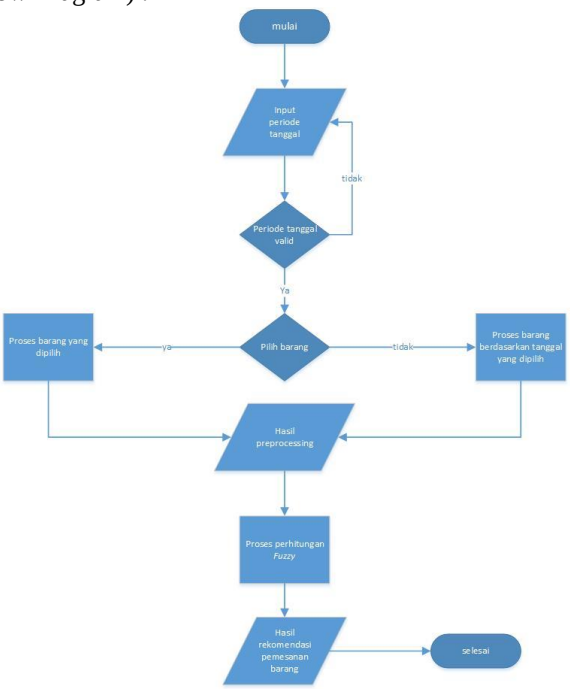

Figure 1. Flowchart of System

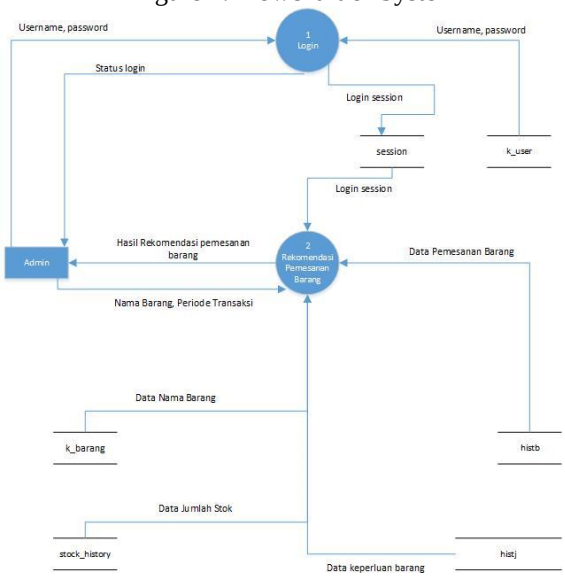

Figure 2. Data Flow Diagram of System

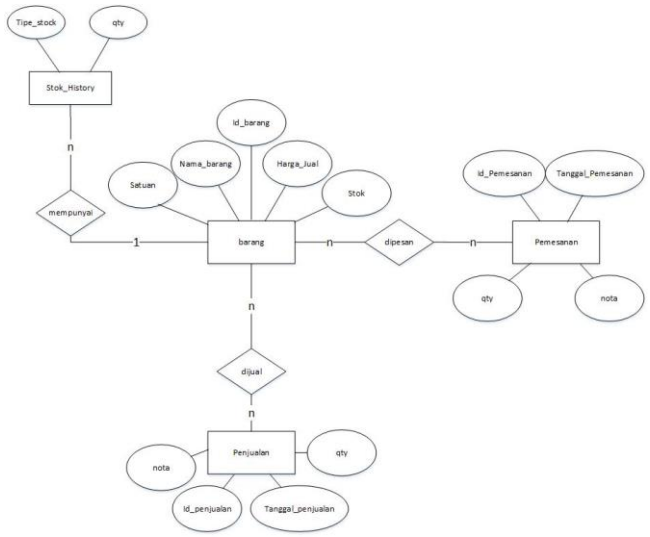

Figure 3. Entity Relationship Diagram of System

C. System Interface Implementation

The system interface will be implemented using the PHP and CSS programming language by using the Bootstrap 3 framework. The following will be presented a screenshot of the results of the implementation of the interface design created.

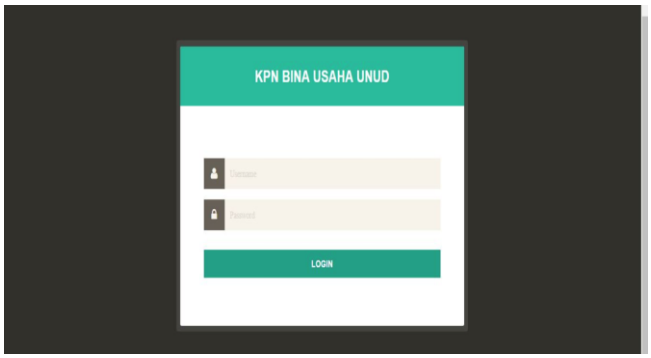

Figure 4. Login Interface Display

The login interface in Figure 4 above, the user will log into the system by entering a username, password, before being able to use the recommendation system for ordering goods. There is a username textbox as a place to enter the username of the user recommendation system and password textbox as a place to enter the password of the user. The user's previous username and password have been stored in the database.

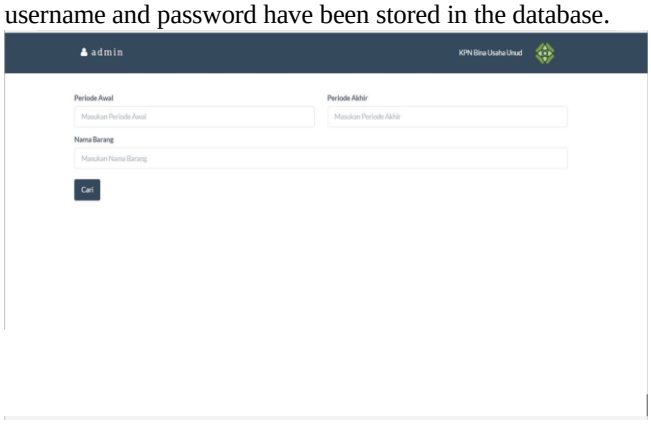

Figure 5. Display of input search items

In the item search input interface in Figure 5 above, the user can search for goods based on the input period of the item and the desired item name to get the results of the recommendation. The user must search by filling in the input period period and item name and then clicking the search button so the system can display data based on input from the user.

Figure 6. Display of Fuzzy Recommendations

In figure 6 above is a display of the results of the search search date period and name of goods carried out by the user. Where at this stage the system will display information in the form of total needs, total stock, total orders along with the number of recommendations from items entered by the user.

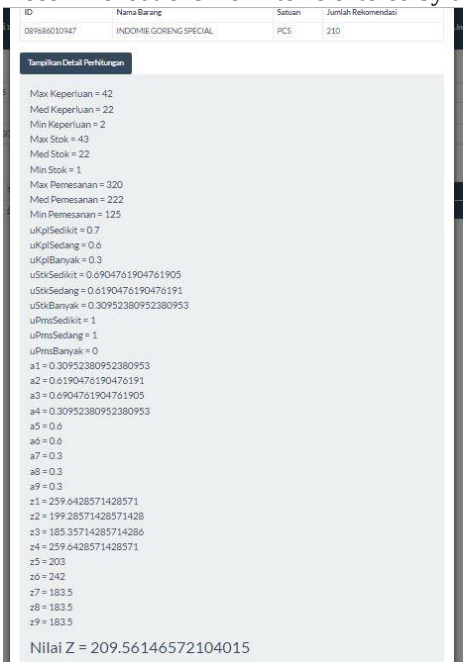

Figure 7. Display Detail Recommendations

In Figure 7 above is a display of the detailed calculation of the Fuzzy Tsukamoto method. Where if the user presses the ShowDetail Calculation button, the system will display the variables according to the steps used to determine the recommendations based on the Tsukamoto fuzzy method.

V. CONCLUSION

Based on the research that has been done, it can be concluded that:

- Implementation of fuzzy logic using the Tsukamoto method in the system of goods purchase order recommendations can calculate recommendations for determining goods purchase orders at Karya Bina Sejahtera Cooperative.
- The fuzzy logic of the Tsukamoto method managed to provide recommendations based on historical transaction data.
- The system can assist Cooperative employees in determining the amount of goods purchased as a stock in the Cooperative mini market.

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