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Sales and Stock Purchase Prediction System Using Trend Moment Method and FIS Tsukamoto

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ABSTRACT

The purpose of this research is to build decisions support model to predict sales and stock purchase using Trend Moment method and Tsukamoto Fuzzy Inference System. Trend moment is a simple statistical-based forecasting method widely used to forecast sales in a company using historical data. Tsukamoto is a fuzzy inference system that uses monotonic reasoning to determine output. The object of this research is sales and purchase data for Ice Cream X Depo Jambi products from August 2019 to April 2020. The study aims to build a decision support model web-based to predict sales and purchases of ice cream X stock at Jambi depots. Fuzzy Tsukamoto in this study will be used to predict product stock purchases after predicting future sales using trend moments. The system input is in product data form, data of ice cream sales history, and data of ice cream stock purchase. Sales history data will be use to calculate slope and constanta that will predict future sales trends. Stocks purchase history data along with sales trend prediction value will be use to calculate the membership degree of fuzzy variables, perform the aggregation process on fuzzy rules, and then carry out the defuzzification process to produce output prediction values for future ice cream stock purchases. from the prediction model implemented in the decision support system, sales prediction data has an accuracy of 71% while stock purchase predictions have an accuracy of 85%.

Keywords : Predict, Sales, Stock, Purchase, Trend Moment, Fuzzy Tsukamoto, Fuzzy Inference System, Decision Support, Fuzzy variable, Aggregration, Defuzzification

1. Introduction

Purchasing is an imperative activity carried out by companies and organizations in fulfilling inventory, providing a continuity of supply for the customers (Ramadhan dan Utama, 2019). Every company must maintain the availability of sufficient goods so that the company's operational activities can run expeditiously. Good procurement decisions is needed by organizations based on accurate and reliable data (Ramadhan & Utama, 2019). However, conventional inventory models mostly cope with a known

demand and adequate supply, but are not realistic for many industries (Aengchuan & Phruksaphanrat, 2018). Future customer behavior prediction will provides key information for sales and marketing departments efficiently (Martinez, 2020).

Depo Matahari Jambi is the one of ice cream distributor in Jambi city. The sale of ice cream can be affected by factors such as weather, season, location and holidays. Sales can also be a complex problem, especially in the case of lack of data, missing data, and the presence of outliers (Pavlyshenko, 2019). Corresponding historical sales records as time series data can be used as reference to predict the future sales volume (Chen, 2018)). This quantitative methods are used when a certain amount of past data is available and we assume that there is a possible trend in them (Velastegui et.al, 2020).

Therefore, purchasing stocks that are in accordance with demand and stock availability is important in the ongoing business process at Depo Matahari. During this time, to find out the total purchase of ice cream stocks, the Depo has to calculate the remaining ice cream in the freezer and total ice cream ordered. This method is indeed easy, but with the number of competitors in the ice cream business and with the development of technology, companies should be able to carry out business process effectiveness by utilizing past sales data to predict the number of stock purchases. Nowdays, retail in revolution industry 4.0 era is progressively demanding the accurate prediction of consumer's purchase intention ((Bag, Tiwari, & Chan, 2019). In addition, historical sales data are also can be used by companies to analyze the factors that affect the sale of ice cream to consumers each month which can be additional information to be taken into account in predicting the purchase of ice cream stock from the factory.

Tsukamoto's fuzzy inference system (FIS) method is an alternative in this research to build a prediction model for purchasing ice cream stocks purchase. In Tsukamoto's FIS, the rule representation is presented with a fuzzy set in the form of monotonous reasoning. This method was chosen because it is flexible and tolerates for existing data and is easy to apply. To predict stock purchases, the inputs used are the variable stock purchases and the sales variables. The data used in this study are data on product sales and stock purchases from October 2019 to April 2020 from various flavors of ice cream.

This study aims to build a web-based decision support model to predict ice cream sales and stock purchases at Depo Matahari Jambi. While the benefits to be achieved from this research include: helping companies to make predictions and information on product sales and stock purchases each week, increasing the company's effectiveness in determining product inventory, and helping companies evaluate sales and stock purchase data so that from the information presented can know the trend of sales of ice cream products each month where this can help companies make decisions related to stock purchases and can anticipate changes in trends that may occur.

2. Previous Findings

Several studies have been conducted previously related to the prediction of sales and purchases of product stock. Fauzi, Fitri, and Benrahman (2021) researched to develop an information system for monitoring sales and predicting the stock of goods, namely credit. The forecasting method used is the Moving Average method wherein this method several past actual data are used to generate predictions for the next sales. Mathematically, the moving average is simple, that is, it only takes into account the sales variable in the previous certain period (Fauzi, Fitri, & Benrahman, 2021). Izyuddin and Wibisono (2020) created an application that can be used to predict sales of the best-selling AC product with the C.45 classification algorithm (Izyudin & Wibisono, 2020). The variables used for the prediction process are sales data on each product. Another study by Nurlaeli and Umilasari (2019) on the application of the Trend Moment method for forecasting drug sales stocks at pharmacies. The trend moment in this study only uses the sales stock variable in a certain period to make predictions. The output of the system is a prediction of the amount of drug stock that must be provided by the pharmacy

Research by Valerian and Hakim (2018) on the application of the Apriori Algorithm to predict stationery stock. The Apriori algorithm in this study is used to determine association rules that meet the support and confident value of the level of purchase of stationery sales products that are often purchased by consumers. Junianto (2017) researched the demand for Dompet Pulsa using the Fuzzy Inference System Mamdani method. The variables used to determine demand predictions are Sales and Inventory variables. In this FIS, each input variable is then subdivided into three sets, which will then be subjected to a defuzzification process that aims to convert the inference results expressed in a fuzzy set to a real number. The output of this research is fuzzy rules in the form of IF-THEN which is then used to forecast demand.

In the studies mentioned above, it can be seen that most of the research focus is only on forecasting product stock purchases. While predictions for sales themselves are not discussed. This research developed will calculate the purchase of stock of ice cream products and calculate predictions of future ice cream sales. This research will combine Trend Moment and Fuzzy Inference System Tsukamoto Method. Prediction of ice cream sales in the future will be calculated using the trend moment method. Then the results of sales predictions will be used as one of the variables to predict the purchase of ice cream stock. Prediction or Forecasting is the art and science of predicting future events, by taking historical data and projecting it into the future, using some form of mathematical model. Then forecasting can be said as an activity to implement models that have been developed in the future. The trend moment method is used in this study to predict product sales in the coming week.

Selling is an integrated effort to develop strategic plans aimed at satisfying the needs and desires of buyers in order to get sales that generate profits. Sales are also a source of life for a company, because the company can get profit and an effort to attract consumers who are made to find out their attractiveness so they can find out the results of the products produced (Karmila & Rusda, 2019). Meanwhile, Trent moment is a method that uses certain statistical and mathematical calculation methods to determine the straight line function instead of the broken lines formed by the company's historical data. The application of the Trend Moment method can be done by using historical data from a variable, while the formula used in the preparation of this method is (Ilyas, Marisa, & Purnomo, 2018)

$$Y = a + bX \quad (1)$$

Where:
Y = Trend value
a = contanta
b = slope
X = time indeks (begin from 0,1,2,….n)
Counting a and b value use formula :

$$b = \frac{n(\sum XY) - (\sum X)(\sum Y)}{n(\sum X^2) - (\sum X)^2} \quad (2)$$

$$a = \frac{(\sum Y) - b(\sum X)}{n} \quad (3)$$

Where
$\sum Y$ = cumulative historical data
n = time period amount
$\sum X$ = time cumulative amount

To predict the stock of ice cream products that must be purchased every week, FIS Tsukamoto is used. According to Thamrin et. al (2014), Fuzzy Tsukamoto is one type of inference system that has a monotonous membership function. This method is very flexible and tolerates existing data. In addition, Tsukamoto fuzzy is more intuitive, accepted by many parties, and is more suitable for input received from humans, not machine. In inferencing, the Fuzzy Tsukamoto method uses the following stages:

1. Fuzzyfication, namely the process of converting the system input values in the form of firm values into linguistic variables using membership functions stored in the fuzzy knowledge base. The result is the value of the degree of membership.
2. The formation of a fuzzy knowledge base, each of which rules is in the form of IF..THEN.

3. Inference Engine. The Tsukamoto method uses the MIN implication function to produce the α-predicate value of each rule (α1, α2, α3, .. αn). After getting the α-predicate value of each rule, the α-predicate value is used to explicitly calculate the inference result output of each rule in the form of z1, z2, z3,… .. zn.
4. Defuzzyfication. To produce the final results obtained using the method of weighted average.

$$Z = \frac{\sum \alpha i.zi}{\sum \alpha i} \quad (4)$$

Where :

Z = Defuzzyfication result

αi = alpha predicate

zi = inference result for each rule

3. Research Methodology

The research method for the Sales and Stock Purchase Prediction System Using Trend Moment Method and FIS Tsukamoto is using RAD (Rapid Application Development) method. This method can be used to resolve delays and system problems where data processing is still conventional. Where the data obtained based on observations and interviews. The RAD (Rapid Application Development) model used is as following stage :

a. Business Modeling. The business modeling of this new ice cream stock purchasing system is an illustration of the work activities carried out in the company in purchasing miami ice cream products from distributors. In the new system, the process of checking Ice Cream products and calculating the amount of Ice Cream stock is carried out by the Administrator using the application
b. Data Modeling. In this data modeling, researchers use DFD (Data Flow Diagrams) and Flowcharts to describe the database and analyze database requirements such as user data, product data, sales data and sales prediction data using the export to pdf function and can view predictive data reports. sale and purchase of miami ice cream stock.
c. Application Modeling. At this application modeling stage, data structure and interface design is carried out using several tools such as Visual Studio Code, Server Applications which include DBMS MySQL, PHP and others as well as Web Browsers to describe the system that is running and the system to be developed. . logically using algorithms. Here the researcher performs the design stage of the web page display system interface and web pages for admins according to existing needs.
d. Application Testing. The purpose of application testing is to ensure that the application is made according to its design and all functions can be used properly without any errors. Application testing is usually carried out by researchers to ensure

the resulting application is in accordance with the results of software requirements analysis and software system design. Therefore, it is necessary to use the Black Box method to find out malfunctions, interfaces, and performance errors.

Furthermore, a research framework is prepared which are the stages that will be carried out in solving the problems discussed. This research framework contains an explanation of the stages of the process carried out during research activities so that the research process is in accordance with the expected goals. The stages of the research framework used are as Figure 1 follows:

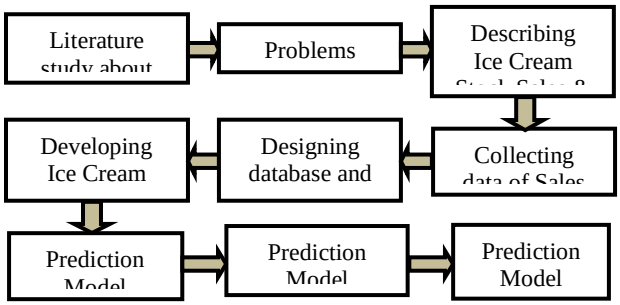

Figure 1. Research Framework

4. Results and Findings Analysis

The purpose of this implementation phase is to determine the accuracy of the prediction model using trend moment and fuzzy Tsukamoto. The model built using the PHP programming language, MySQL database management software, and W3 School and Bootstrap framework. The following is the result of model implementation and analysis of the result.

4.1 Model Implementation

1. Implementation of Product Prediction Menu

The product prediction menu in Figure 2 display product list prediction. Inthis menu user can choose which ice cream product will predict. Suppose user choose Lolly Grif product

Figure 2 . Select Products For Prediction Menu

2. Implementation of Product Sales and Stock Prediction Menu.

The menu in Figure 3 is used to display the process of predicting sales of ice cream products using the trend moment method and then using the sales prediction results to predict the purchase of ice cream stock, using the Tsukamoto fuzzy inference system.

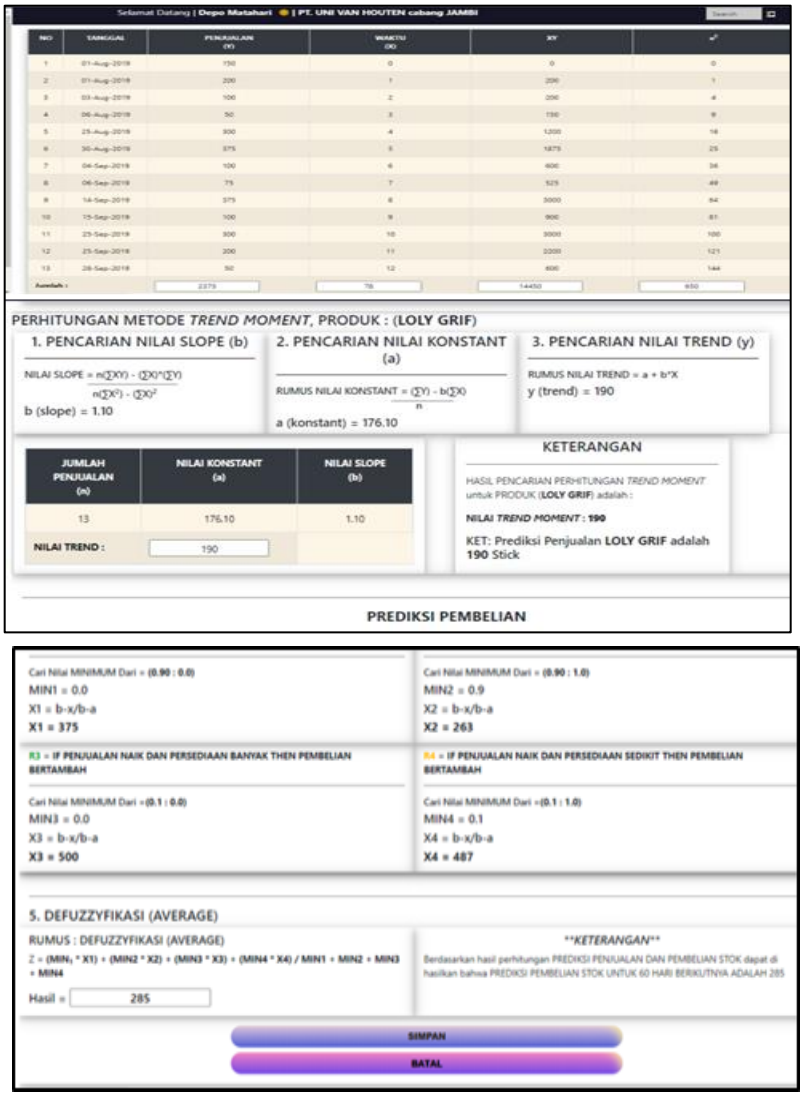

Figure 3 Product Sales and Stock Prediction Menu

3. Implementation of Product Prediction Result Menu

Menu in Figure 4 display the prediction result of sales and stock purchase from Lolly Grif product. The prediction result then compare with actual data and display in Prediction VS Actual Menu in Figure 5.

Figure 4. Product Prediction Result Menu

Figure 5. Prediction VS Actual Menu

a. Result Analysis

Determining the level of accuracy of the prediction model is done by comparing the predicted data with the actual data. For example, testing data of Lolly Grif ice cream products from October 2019 to April 2020. The results present in the Table 1 below where A is Actual data and P is Prediction result

Table 1 . Prediction Data Accuracy

No	Date	Sales		% Accuracy	Stock Purchase		% Accuracy
		A	P		A	P	
1	Okt 2019	100	190	30 %	500	472	94 %
2	Nov 2019	175	175	100 %	500	511	98 %
3	Des 2019	200	232	86 %	375	293	78 %
4	Jan 2020	200	200	100 %	375	287	76 %
5	Feb 2020	175	82	46 %	375	375	100 %
6	Mar 2020	100	155	65 %	375	279	74 %
7	Apr 2020	125	175	71 %	375	282	75 %
		Average :		**71 %**	**Average :**		**85 %**

From data on Table 1 we can see that accuracy average of sales prediction using Trend Moment methode is 71% and accuracy average of stock purchase prediction using FIS Tsukamoto is 85%. The Condition happened because, in October 2019, the data used to predict sales were sales data from August 2019 to September 2019. The sales in August 2019 increase because there were several celebrations and competitions according to Indonesia Independence day. Therefore sales data in August affected sales prediction data in October 2019, where the accuracy between sales prediction data and actual sales was 30%, far below the minimum sales prediction threshold of 70 %.

In February 2019, the prediction system using time-series sales data from December 2019 to January 2020. in early January 2020, many resellers are on vacation or returning home according to the new year celebration and start selling again in mid-January 2020. So only a slight data can use for prediction. It makes so the accuracy between sales prediction data and actual sales is 46%, far below the minimum sales prediction limit of 70%.

5. Conclusion

From the result that has been explain above, Trend Moment method can be used to modelling sales predictio using time-series sales data. The accuracy of the prediction are determine by the amount of time-series sales data that use and also influence by eksternal factors such holiday season. Stock Purchase prediction using Tsukamoto fuzzy inference system has better accuracy prediction because it use several variable to do fuzzyfication and generate fuzzy rule prediction. The accuracy of FIS Tsukamoto can be also influence by external factors.

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7. Author's Note

The author declares that there is no conflict of interest regarding the publication of this article. The author confirms that the data and papers are free from plagiarism.

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