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WORD COUNT 2322 TIME SUBMITTED 15-SEP-2023 01:19PM
PAPER ID 102752171

Jurnal Mandiri IT
Vol. 11 No. 3, January (2023), pp. 101-108

ISSN 2301-8984 (Print)

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ARTICLE INFO

Article history:

Received Jan 11, 2023
Revised Jan 14, 2023
Accepted Jan 26, 2023

Keywords:

Fuzzy Inference System
Heavy Equipment
Spare Parts
Tsukamoto
Warehouse

ABSTRACT

PT. BIMA located on Jl. Perak Bar. No.379, Surabaya City always maintains the quality of spare parts and maintains port facilities with accurate planning with hundreds of personel who are professionally certified in their fields and have several service services including as one of the suppliers of equipment and spare parts, especially for heavy equipment such as Cranes, Excavators (Bego), Wheel Loaders, Wales Stump and other heavy equipment. In determining warehouse inventory, the Company can see from the exit of goods periodically either weekly or monthly. What often happens in various warehouses owned by PT. BIMA is in determining the stock of goods. There are times when the goods needed by the consulate are exhausted due to insufficient stock, especially in the monthly period. This research use Fuzzy Tsukamoto to problemsolving control systems that are suitable to be applied to systems, ranging from simple systems to complex or complex systems. Based on the tests that have been carried out In 16 tests, 11 spare parts of goods were obtained with the status of Good Stock information, meaning that the goods can be tested properly by the transaction system every month. Based on the test results of the Good Stock Control Unit 68.75%. Overstock Control Status amounted to 6.25%. The Tsukamoto Fuzzy System used in this research can provide stock recommendations to PT BIMA in a well-maintained stock status.

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1. INTRODUCTION

In this modern era, industrial competition is getting tougher, including industry automotive. One of the companies engaged in the automotive industry is PT BIMA(PT Berkah Industri Lifting Machine). PT BIMA which is located at Jl. Perak Bar. No. 379, Perak Utara, Kec. Cantian Customs, Surabaya City always maintain the quality of spare parts and maintain port facilities with Accurate planning with hundreds of professional personnel certified in their field and has several services including as a

supplier of equipment and spare parts, especially for heavy equipment such as Cranes, Excavators (Bego), Wheel Loaders, Wales Stumps and other heavy equipment.

Along with the need for repair and maintenance of port equipment and services wholesale trading of machinery, agents and authorized distributors of spare parts, supporting facilities maintenance, construction executing services, electrical installation and executing services installation of lift and transport equipment at the port that supports business management as a whole PT. BIMA continues to be determined and committed to dedicate positive impact of the development of 17 working areas in Indonesia. Supply Warehouse is the most important part of PT. BIMA's business. With the existence of a supply warehouse for the distribution of spare parts will reach consumers quickly and precisely.

The problem that often occurs in various warehouses owned by PT. BIMA is in determining the stock of goods. There are times when things are needed by consumers is exhausted due to insufficient stock, especially in the monthly period. This of course causes the company's name to fall due to the absence of a stock process on a regular basis. With a system that can predict the spare parts that will be sold, it will provide benefits for the company, especially in risk management in selling goods. Therefore, to solve the above problems, the Tsukamoto System Fuzzy Inference method is used in the system created. It is hoped that this system will be able to provide recommendations to the warehouse for how many spare parts to be provided and purchased on a monthly basis according to consumer needs (ANDIKA, 2022). And also by implementing the Fuzzy Inference System method aims to provide recommendations to the warehouse in managing the stock of goods in the warehouse (Alam, 2019).

2. RESEARCH METHOD

This section discusses the theoretical basis used in this research.

2.1 Forecasting

Forecasting is a calculation analysis technique that carried out with both qualitative and quantitative approaches to estimate future events by using reference data in the past (Mandala et al., n.d.). Forecasting aims to predict economic prospects and business activities as well as the influence of the environment on these prospects.

Forecasting is the most important part for every company or business organization in every management decision making. Fortune-telling itself can form the basis for short, medium and long term planning length of a company (Wahyuni, 2022). In a forecasting is needed the least possible error (error) in it. In order to minimize the level these errors, it would be better if the forecasting is done in numeric or quantitative units (Produksi et al., 2017).

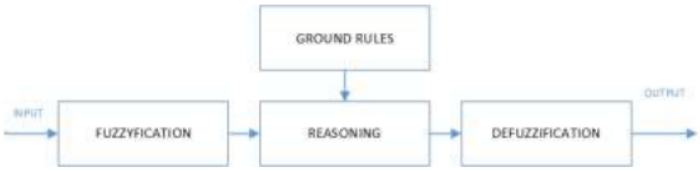


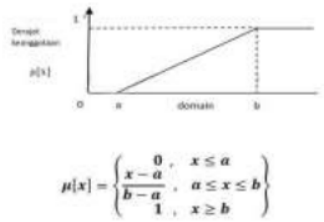
Figure 1. Fuzzy logic block diagram

2.2 Tsukamoto

The Tsukamoto Fuzzy Method is one of the fuzzy logic methods that is often used to assist decision making or forecastingc (Alamsyah et al., n.d.). In Tsukamoto's fuzzy inference method, each consequence of a rule in the form of IF-THEN must be represented by a fuzzy set with a monotonous membership functionc (Citra et al., 2022). As a result, the output of inference from each rule is given

explicitly (cnsp) based on the α-predicate (fire strength). The final result is obtained by using a weighted average and Membership Function (Fauzi et al., n.d.).

In a fuzzy set there are several representations of the membership function, one of which is a linear representation (Access & 2023, n.d.). In the linear representation, the mapping of inputs to degrees of membership is depicted as a straight line (Murnawan et al., 2021).



$$\mu[x] = \begin{cases} 0, & x \le a \\ \frac{x-a}{b-a}, & a \le x \le b \\ 1, & x \ge b \end{cases}$$

Figure 2. Linear representation up

$$\mu[x] = \begin{cases} 1, & x \le a \\ \frac{b-x}{b-a}, & a < x < b \\ 0, & x \ge b \end{cases}$$

Figure 3. Descending linear representation

Fuzzy conjunction
μ A∧B=μ A(x) ∩ μB(y)= min(μA(x), μB(y)) Fuzzy disjunction
μ A∨B=μ A(x) ∪ μB(y)= max(μA(x), μB(y)
In the Tsukamoto method, the implication of each rule is in the form of implication "Because Effect"/Implication of "Input-Output"

The following figure describes the prediction flow using the Fuzzy Tsukamoto method.

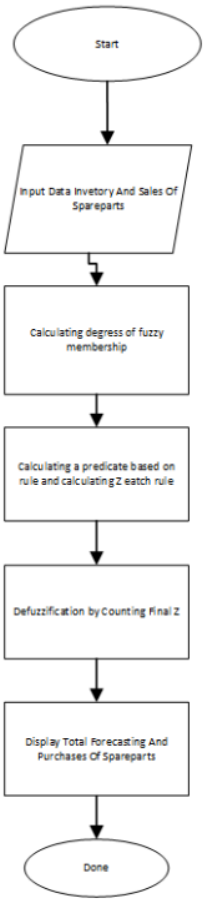


Figure 4. Tsukamoto flowchart

2.3 Data Flow Diagram

Data flow diagrams describes a diagram that can represent all processes contained in a system or can be said be the basis of the system. Data flow diagrams can look like the image below:Name, Nim, Gender, Database Value,Image,Computer Network, Software Engineering, Intelligent System, Interests, and Classification Results.

Figure 5. DFD level 0

2.4 Data Flow Diagram Level 1

DFD level 1 is a further stage of DFD level 0, where all processes in DFD level 0 will be fully detailed so that they are more complete and detailed. The existing main processes will be broken down into sub-processes. Solving this process is to make it easier for someone to do process analysis so that the purpose of making applications through the system can run smoothly and correctly. Here is a level 1 dfd of this System.Entity

2.5 Data Flow Diagram Level 2

DFD level 2 is a further stage of DFD level 1, where the process from Fuzzy Tsukamoto will be explained in more detail.

2.6 Initial Forms Menu

The initial form menu is the first form when the system is run. The following shows the appearance of the initial form or login form in Figure 6:

Figure 6. *Login Form Menu*

Users after logging in first and enter the username and password. After the username and password are filled in the the admin will be directed to the following form.

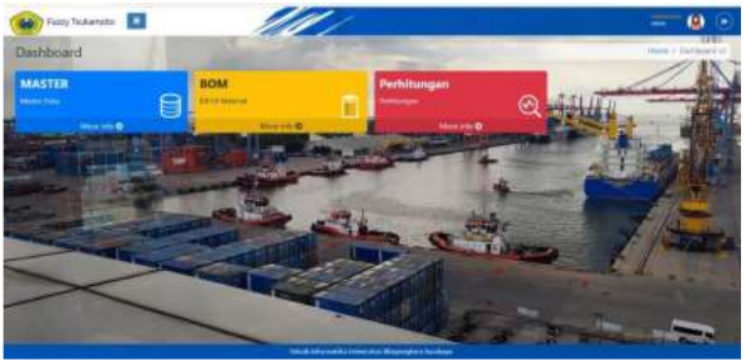


Figure 7. Display after login

2.7 Spare Parts Group Menu

Spare Parts Group Menu is a menu used to manage spare parts group data. The following shows the master data of the spare part groups used in this application:

Figure 8. Spare part groups

3. RESULTS AND DISCUSSIONS

In this chapter, system testing will be carried out on the Goods Stock Determination System using Fuzzy Tsukamoto at PT BIMA. The purpose of testing this system is to find out how accurate the system that is made is in supporting the number of goods purchased from the original purchase made by PT BIMA. Testing will be carried out on 10 items where the MSE and RMSE values will be sought from the calculations every year. Here are some items that will be tested.

Table 1. Item Name

NO	ITEMS NAME
1	Accu Battery 12v 80ah
2	Acetylene (C2h2)
3	Actuator Brake
4	Ban Dalam
5	Actuator Bracket
6	Adaptor
7	Cylinder Steering Lock
8	Oil Seal
9	Adaptor Valve 3/4
10	Drive Belt
11	Hand Pump
12	Hoist Drum
13	Lock Ring
14	Rocker Arm Front

In the test, a calculation will be carried out from changes in the stock of the system and the following are the parameters for changes in the stock of the system

Table 2. Table of Description of Stock Changes over the System

No	Total Changes In Stock	Description
1	Less Than 0	Not Enough
2	1 To10	Almost Less
3	11 To 20	Enough
4	21 To 50	Good Stock
5	51 And Above	Excess Stock

The first test was carried out on items accu battery 12V 80AH. The following is a table of criteria for sales, inventory, days and purchases of these items, following is Table 3:

Table 3. Accu battery 12V 80AH spare parts criteria

Criteria	Limitation	Lower Limit	Upper Limit	Middle Limit
Sale	A little	0	10	25
	Currently	5	15	
	Many	20	35	
Supply	A Little	0	14	32
	Currently	8	20	
	Many	26	40	
Time	Fast	0	3	
	Long	3	7	

Then it will be calculated for stock predictions that must be purchased by the user in 2019 through the system and the following are the results from the system.

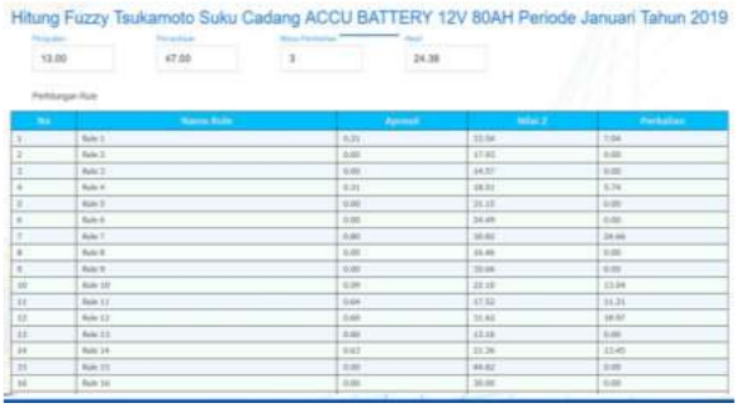


Figure 9. The following are the results of testing the Accu Battery 12V 80AH calculation for 2019.

4. CONCLUSION

The conclusions of this research are Tsukamoto Fuzzy System can provide stock recommendations to PT. BIMA in a well-maintained stock status. Based on the tests that have been carried out in 16 tests, 11 spare parts were obtained with Good Stock information status, meaning that 1 item can be tested properly by the transaction system every month. However, there is 1 spare part item whose status is Excess Stock, which means it can be detrimental to the company because the goods accumulate in the warehouse without any stock control on the item. Based on the test results, the Good Stock Control Percentage is 68.75%. Excess stock control status of 6.25%. Stock Control Status Fairly Good 25%.

From the results of research, there are several shortcomings and suggestions that can be used for further research are as follows : The system can provide recommendations to users in carrying out stock items every month. And it is expected to be able to use another Fuzzy Inference System method in order to be able to measure the accuracy of the results of stock items every month.

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