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Using Fuzzy Tsukamoto Method In Forecasting The Amount Medication Requrementsat In The Hospital

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Abstract: The pharmaceutical installation as one of the hospital service locations is an inseparable part of the hospital health service system which is oriented towards patient service, including pharmaceutical services needed by patients such as consumable medical equipment that is affordable for all levels of society and the provision of quality medicines. The problem that arises is the uncertain number of patients and the medicines needed by each patient are different and often the supply of medicines that are currently needed by the community is empty, while medicines that are less needed are in abundant stock. Mistakes in ordering medicines can cause shortages or excesses of medicine stock. They tend to only use estimates of the amount of remaining stock without any special methods being used. Even hospital pharmacies tend to buy too many medicines because of uncertain demand and fear of shortages. A method that can help in predicting the amount needed for medicines is by applying the fuzzy Tsukamoto method. The prediction process begins with testing drug data in 2022 to predict the amount needed for medicines in 2023 before finally the drug data for 2023 is used to predict the amount needed in 2024.The prediction process will use drug sales data in the form of the amount of inventory, the amount needed and remaining stock to build a prediction model that projects the amount of drug need in the year 2023. This approach will involve analyzing historical data and applying the Tsukamoto method to produce predictions of the amount needed for all drugs in the following year.

Keywords: Drugs, Fuzzy, Predictions, Tsukamoto,

INTRODUCTION

The pharmaceutical installation as one of the hospital service locations is an inseparable part of the hospital health service system which is oriented towards patient service, including pharmaceutical services needed by patients such as consumable medical equipment that is affordable for all levels of society and the provision of quality medicines. According to R. Sanjoyo, medicine is an object that is formulated by medical personnel to assist in determining diagnosis, prevention, healing, recovery, improving health, and contraception

Medicine supplies are more optimal if they can convey information regarding the stock of medicines that have run out or whether there is still a lot of stock (stock control) (Dewanti et al., 2022). The problem that arises is the uncertain number of patients and the medicines needed by each

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patient are different and often the supply of medicines that are currently needed by the community is empty, while medicines that are less needed are in abundant stock. Mistakes in ordering medicines can cause shortages or excesses of medicine stock. Excess in ordering medicines causes a buildup of medicines and over time they will expire and can no longer be used resulting in the medicines being burned (Furqan et al., 2016).

Malahayati Islamic Hospital is one of the hospitals that treats many patients in Medan City whose treatment requires many types of medicine. When reordering stock of medicines at the Malahayati Islamic Hospital, they tend to only use estimates of the amount of remaining stock without any special methods being used. Even hospital pharmacies tend to buy too many medicines because of uncertain demand and fear of shortages.

In previous research entitled the decision support system for determining the number of drug orders at pharmacies using the fuzzy Tsukamoto method with test results for ordering 19 bottles of TJ Pure Honey, with calculations using the fuzzy Tsukamoto method, the inventory of goods in the warehouse was more stable, such as the process of receiving goods and releasing goods in the warehouse in balance (Rodiana et al., 2020) .

In other previous research conducted by Hanifah Urbach Sari et al, with the title "Application of the Fuzzy Inference System in Blood Queries at the Indonesian Red Cross Pematangsiantar". This research applies fuzzy Tsukamoto to determine the number of blood requests using 3 variables, namely donors, supply and demand. The results of this research indicate that the Indonesian Red Cross (PMI) Pematangsiantar can request approximately 380 blood bags per month (Sari et al., 2019) . Based on the background of the problem, the problem formulation in this research is: How does Tsukamoto's fuzzy method apply in predicting the amount of medicine needed at the Malahayati Islamic Hospital? How to determine the prediction of the amount of medicine needed at the Malahayati Islamic Hospital.

The aims of this research are: Implying Tsukamoto's fuzzy method in predicting the amount of medicine needed at the Malahayati Islamic Hospital. Determine predictions of the amount of medicine needed at the Malahayati Islamic Hospital.

LITERATURE REVIEW

Prediction

Predictions are guesses or estimations regarding the occurrence of events or incidents in the future. Predictions do not provide a definite answer about what will happen, but try to get as close as possible to what will happen. Prediction requires taking historical data and projecting it into the future with some form of mathematical model (Pinem & Utomo, 2020). The aim of prediction is to obtain information about what will happen in the future with the greatest probability of event.

Fuzzy Logic

In fuzzy logic, the membership value of an element in a set ranges from 0 to 1. Fuzzy membership functions can be represented in the form of linear, triangular, trapezoidal, shoulder-shaped, S, and Gaussian curves. This logic is a calculation method that assesses truth using numerical language, where truth is expressed in a value range between 0 to 1. In making the best decisions and conclusions in fuzzy logic calculations using an inference system. The inference system itself is a calculation framework based on fuzzy sets, fuzzy rule bases, and fuzzy reasoning (Prabowo & Mandala Putra, 2022).

Basic Operations of Fuzzy Sets

AND operator

This operator is related to the intersection operation on the set of α-predicates. As a result of operations with the AND operator. Obtained by taking the smallest membership value between the elements in the sets concerned

$$\mu_{A\cap B} = \min\left(\mu_A[X], \mu_B[Y]\right)$$

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OR operator
This operator is related to the union operation on the set of α-predicates as a result of operations with the OR operator. Obtained by taking the largest membership value between the elements in the sets concerned.

$$\mu_{A\cup B} = \min\left(\mu_A\left[X\right], \mu_B\left[Y\right]\right)$$

NOT operator
This operator is related to the complement operation on the set of α-predicates as a result of operations with the NOT operator. Obtained by subtracting the membership value of the elements in the set in question from 1.

$$\mu_A = 1 - \mu_A\left[X\right]$$

Membership Functions

The membership function is a curve that shows the mapping of data input points into membership values which have a value interval between 0 and 1(Salendah et al., 2022). One method used to obtain the value of reliable membership is with a function approach.

Fuzzy Tsukamoto

Tsukamoto's method is an extension of monotonous reasoning. In the monotonic reasoning method, the crisp value in the consequent area can be obtained directly based on the fire strength of the antecedent. One of the conditions that must be fulfilled in this reasoning method is that fuzzy sets are consequently monotonous (both increasing and decreasing). Each consequence of a rule in the form of IF-THEN must be presented with a vague set with a uniform membership function.As a result of this method, the output of conclusions (inference) from each rule will be given explicitly (script) based on α-predicate (fire strength). The final results were obtained using a weighted average (Numan et al., 2020). The result of the implication function of each rule is called α-predicate or can be written α.

αi= μA∩B = min(μAi[x],μBi [y]), Ai = 1,2,3, ...

With
αi = minimum value of membership degree in the ith rule
μAi[x] = membership degree of fuzzy set A in the ith rule
μBi [y] = membership degree of fuzzy set B in the ith rule

Defuzzification is the process of changing fuzzy output values into firm output values. The final results are obtained using the weighted average equation using the weight average method. The formula used is as follows

$$Z = \frac{\sum z_i \cdot \alpha_i}{\sum \alpha_i}, i = 1,2,3...$$

With:
Z : weighted average value
αi: α-predicate value in the ith rule
zi: consequent value in the ith rule

. Meanwhile, in the health sector, it is not only used to predict the availability of medicines, but is also applied in making estimates of blood supplies in certain hospital institutions. This has been researched by (Puspitasari et al, 2022)

***Mean Absolute Percentage Error* (MAPE)**

Mean Absolute Percentage Error (MAPE) is useful in evaluating the accuracy of forecasts. MAPE indicates how big the error in forecasting is compared to the real value. MAPE is used in this research to determine the level of percentage error produced in the forecast results for the desired period (Fahirah &

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Wulandari, 2020). MAPE is formulated as follows:

$$MAPE = \frac{\sum_{t-1}^{N} \frac{X_t - F_t}{X_t}}{N} \; x\, 100 \quad \text{.......(2.4)}$$

Information :
$MAPE$ = Mean Absolute Percentage Error
Xt = Actual data in period t
Ft = Forecasting data in period t
N = Total number of data periods

METHOD

Research Time

The research period starts from February to June with an agenda of activities, namely submitting titles, preparing proposals, collecting data, analyzing data, preparing reports and uploading journals. Submission of titles was carried out in the 3rd week of February, preparation of proposals was carried out in the 4th week of February to the 2nd week of March, data collection was carried out in the 3rd week and 4th week of March, data analysis was carried out in April 1st week to 4th week, report preparation is carried out in April 4th week to 2nd week of May and journal upload in May 3rd week.

RESULT

Determining Variables and Fuzzy Sets

This research aims to develop a prediction system for the number of medicines needed at Malahayati Hospital using a predictive approach based on drug sales data during 2023. The system to be developed will utilize historical data analysis methods from 14 types of medicines sold, with a focus on predicting the number of medicines needed in in 2024.

The available data includes the amount of drug inventory, the amount needed and remaining drug sales in 2022 and 2023. The prediction process will use drug sales data in the form of the amount of inventory, the amount needed and remaining stock to build a prediction model that projects the amount of drug need in the year 2023. This approach will involve analyzing historical data and applying the Tsukamoto method to produce predictions of the amount needed for all drugs in the following year. The following is a data table that is used as a research reference.

Table 1 Drug Data for 2022

No	Medicine name	Year 2022			Year 2023		
		P	S	JK	P	S	JK
1	Acetylcysteine	58102	10120	47982	61007	10423	47221
2	Adalat Oros	17963	3311	14652	19040	3476	11826
3	Amlodipin	56254	12815	43439	60754	13583	33031
4	Asam Folat	32879	8580	24299	33865	8751	26093
5	Lansoprazole	47168	12551	34617	49054	13053	38716
6	Bisoprolol	84876	46200	38676	89968	48972	48983
7	Calcium Lactate	46409	14047	32362	50121	14749	29232
8	Candesartan	21582	2233	19349	22013	2366	23764
9	Cavicur	39149	13409	25740	40323	14481	20773
10	Diazepam	18337	1496	16841	19437	1525	13872
11	Livron	81136	36245	44891	86815	37694	37927

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No	Medicine name	Year 2022			Year 2023		
12	Mecobalamin	74063	16258	57805	77766	17070	66872
13	Funar	14311	2211	12100	15598	2343	18632
14	Allopurinol	39325	7425	31900	40111	7944	24642

Information
P: Amount of Medicine Inventory
S: Remaining drug stock
JK: Amount of Medicine Required

Determining Variables and Fuzzy Sets

Determining fuzzy variables is the initial step in developing a prediction system for the number of drug needs using the Fuzzy Tsukamoto algorithm. In this research, there are 3 input variables that will be used as references for prediction results. The input variables used are inventory, number of needs and remaining stock, then the output variable is the prediction of the number of drug needs in the following year. Each attribute is broken down into several fuzzy sets to capture all the values for each attribute.

- Supply

In table 1 it can be seen that the amount of drug inventory varies for each type of drug. To create a membership function for the inventory variable, the minimum and maximum values from the existing data are searched first, then the range of values is divided into 3 set members. The following is the membership set of the Inventory variable

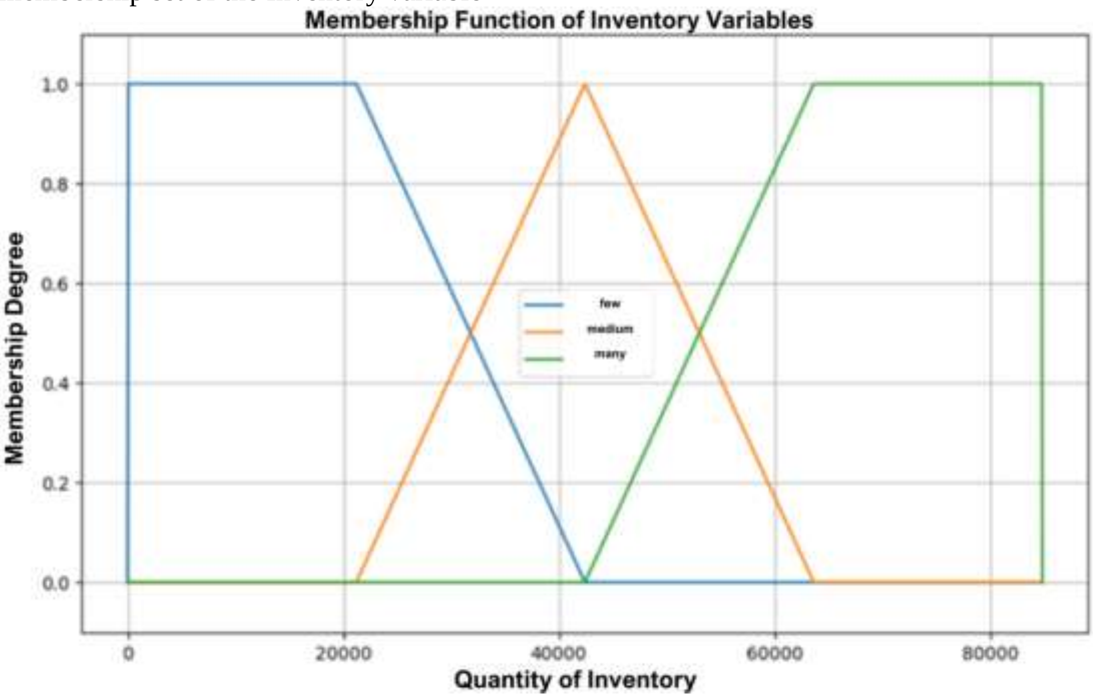

Fig 1 SetMembershipVariableInventory

Membership Functions:

$$\mu\text{Sedikit}[x] = \begin{cases} 1; & 0 \leq x \leq 21219 \\ \frac{42438 - x}{42438 - 21219}; & 21219 < x \leq 42438 \\ 0; & x > 42438 \end{cases}$$

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$$\mu\text{Sedang}[x] = \begin{cases} 0;\ x < 21219 \text{ atau } x > 63657 \\ \frac{x-21219}{42438-21219};\ 21219 \le x \le 42438 \\ \frac{63657-x}{63657-42438};\ 42438 < x \le 63657 \end{cases}$$

$$\mu\text{Banyak}[x] = \begin{cases} 0;\ x < 42438 \\ \frac{x-42438}{63657-42438};\ 5 \le x \le 63657 \\ 1;\ 63657 < x \le 84876 \end{cases}$$

Number of Requirements
Number of Needs is the number of drugs sold in a 1 year period. The following is the membership set for the variable number of needs.

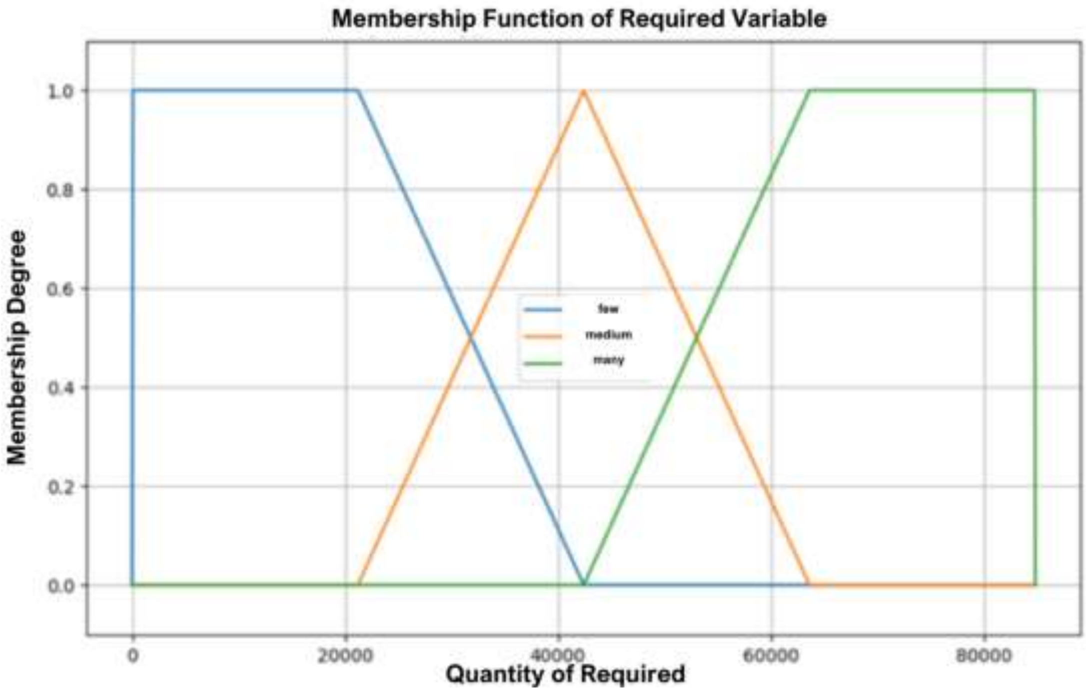

Fig 2 Set of Membership Variables Amount of Requirements

Membership Functions:

$$\mu\text{Sedikit}[x] = \begin{cases} 1;\ 0 \le x \le 21219 \\ \frac{42438-x}{42438-21219};\ 21219 < x \le 42438 \\ 0;\ x > 42438 \end{cases}$$

$$\mu\text{Sedang}[x] = \begin{cases} 0;\ x < 21219 \text{ atau } x > 63657 \\ \frac{x-21219}{42438-21219};\ 21219 \le x \le 42438 \\ \frac{63657-x}{63657-42438};\ 42438 < x \le 63657 \end{cases}$$

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$$\mu\text{Banyak}[x] = \begin{cases} 0;\ x < 42438 \\ \frac{x-42438}{63657-42438} & ;5 \le x \le 63657 \\ 1;\ 63657 < x \le 84876 \end{cases}$$

Fuzzy inference rules are created based on a combination of the 3 input variables used. For example, "If the inventory is small and the quantity needed is small and the remainder is small, then the prediction is small."Rules are designed to reflect various combinations of possible input values.In this research, rules will be created that can regulate all conditions that may occur. Because there are only 3 input variables, each of which has 3 set members, 27 rules are set to control all conditions that may occur.

Tabel 2*Rule* fuzzy

No	*Rule*
1	If the inventory is small and the quantity needed is small and the remainder is small then the prediction is small
2	If the inventory is small and the quantity needed is small and the remaining is moderate then the prediction is small
3	If the inventory is small and the quantity needed is small and the remainder is large, then the prediction is medium
4	If the inventory is small and the quantity needed is medium and the remainder is small, then the prediction is small
5	If the inventory is small and the number of needs is moderate and the remainder is moderate then the prediction is moderate

After going through the rule formation stage, the next step is to carry out a prediction process using the Tsukamoto fuzzy algorithm using input data from Inventory, Quantity Required and Remaining Stock of all types of medicines.

Application of the Fuzzy Tsukamoto Algorithm

After the value of Inventory, Quantity Required and Remaining Stock of each type of drug is entered, the Fuzzy Tsukamoto method is applied to calculate the output in the Prediction output.

Step 1: Fuzzyfication Process

Inventory Value refers to two sets, namely Medium and Large

$$\mathbf{\mu Medium[x]} = \frac{\mathbf{63657 - x}}{\mathbf{63657 - 42438}} = \frac{\mathbf{63657 - 58102}}{\mathbf{63657 - 42438}} = \mathbf{0.26}$$

$$\mu\text{A lot}[x] = \frac{x - 42438}{63657 - 42438} = \frac{58102 - 42438}{63657 - 42438} = 0.73$$

The Amount of Use value refers to two sets, namely Medium and Many

$$\mathbf{\mu Medium}[x] = \frac{63657 - x}{63657 - 42438} = \frac{63657 - 47982}{63657 - 42438} = 0.73$$

$$\mu\text{A lot}[x] = \frac{x - 42438}{63657 - 42438} = \frac{47982 - 42438}{63657 - 42438} = 0.26$$

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The Remaining Amount value pertains to one set, namely Little and µLittle[x] is 1 because the Remaining value is in the range 0≤x≤21219 according to the membership function.

Step 2: Inference Process

For the inference process, it is assumed that the input data model contains 4 rules.

[R1] If Inventory is Medium AND Amount of Usage is Medium AND Remaining is Medium THEN Prediction is Medium

$$\alpha_1 = \min(\boldsymbol{\mu Medium}[x]\,;\boldsymbol{\mu Medium}[x], \mu Slightly[x])$$

$$\alpha_1 = \min(0.26\,;\ 0.73; 1)$$

$$\alpha_1 = 0.26$$

$\mu Slightly[x] = \frac{42438-z}{42438-21219}$

$$\frac{42438-z}{42438-21219} = 0.26$$

$$42438 - z = 5516$$

$$z_1 = 36921$$

Step 3: Defuzzyfukation process

The firm z value is calculated using a weighted average, namely using the following equation.

$$z = \frac{\alpha_1(z_1) + \alpha_2(z_2) + \alpha_3(z_3) + \alpha_4(z_4)}{\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4}$$

$$z = \frac{0.26(36921) + 0.26(26735) + 0.73(57927) + 0.26(47954)}{0.26 + 0.26 + 0.73 + 0.26}$$

$$= \frac{71305}{1.51} = 47221$$

Based on the calculations that have been carried out, the predicted number of needs for the drug Acetylcysteine in 2023 is around 47221.By using the help of a system built using Python, the predicted values for all drugs for 2023 are obtained as follows.

Table 3 Comparison of Prediction Results

No	Medicine name	Needs 2023		
		Actual	Prediction	Difference (%)
1	Acetylcysteine	47982	47221	0.01586
2	Adalat Oros	14652	11826	0.192875
3	Amlodipin	43439	33031	0.2396
4	Asam Folat	24299	26093	0.07383
5	Lansoprazole	34617	38716	0.11841
6	Bisoprolol	38676	48983	0.266496
7	Calcium Lactate	32362	29232	0.096718
8	Candesartan	19349	23764	0.228177
9	Cavicur	25740	20773	0.192968
10	Diazepam	16841	13872	0.176296
11	Livron	44891	37927	0.155131
12	Mecobalamin	57805	66872	0.156855
13	Funar	12100	18632	0.539835
14	Allopurinol	31900	24642	0.227524
Average error				2.68%

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This research has implemented the Fuzzy Tsukamoto method to predict the number of medicines needed at Malahayati Islamic Hospital. Through this approach, we can describe a number of scenarios based on variables such as drug supplies, level of need, and remaining drugs available. By utilizing the principles of fuzzy logic, this research aims to provide recommendations for the optimal amount of medication according to conditions measured in a fuzzy manner.

The prediction results obtained from this research provide valuable insights for the management of drug supplies at Malahayati Islamic Hospital. By utilizing this approach, it is hoped that decision making regarding drug procurement can be more precise and efficient, reduce the risk of shortages of crucial drugs for patients, and optimize the management of health resources.

DISCUSSION

By comparing the predicted results with actual data, the difference between each value can be seen. Through this difference, the error value of the prediction process can be known. From a total of 14 types of predicted drugs, an average error of 2.68% was obtained. So it can be concluded that the prediction process carried out was very good because the error value was very small. After testing the prediction of the number of drug needs in 2023, we continued with the process of predicting the number of drug needs in 2024 using 2023 data. This research aims to develop a prediction system for the number of drug needs at Malahayati Hospital using a predictive approach based on drug sales data during 2023. The system to be developed will utilize historical data analysis methods from 14 types of drugs sold, with a focus on predicting the number of drug needs in in 2024. (Nurkasanah et al., 2022). The available data includes the amount of drug inventory, the amount needed and remaining drug sales in 2022 and 2023. The prediction process will use drug sales data in the form of the amount of inventory, the amount needed and remaining stock to build a prediction model that projects the amount of drug need in the year 2023. This approach will involve analyzing historical data and applying the Tsukamoto method to produce predictions of the amount needed for all drugs in the following year. The following is a data table that is used as a research reference

This research has implemented the Fuzzy Tsukamoto method to predict the amount of medicine needed at Malahayati Islamic Hospital. Through this approach, we can describe a number of scenarios based on variables such as drug supply, level of need, and remaining drugs available. By utilizing the principles of fuzzy logic, this research aims to provide recommendations for the optimal amount of medication according to conditions measured in a fuzzy manner (Hidayat et al., 2020). The prediction results obtained from this research provide valuable insights for the management of drug supplies at Malahayati Islamic Hospital. By utilizing this approach, it is hoped that decision making regarding drug procurement can be more precise and efficient, reduce the risk of shortages of crucial drugs for patients, and optimize the management of health resources.

CONCLUSION

After carrying out the prediction process on 14 types of drugs at Malahayati Hospital using Tsukamoto, the following conclusions were obtained.The Fuzzy Tsukamoto algorithm can be used to predict the number of needs for 14 types of medicine at Malahayati Hospital. The prediction process is carried out using 3 variables as prediction references, namely inventory, quantity needed and remaining stock.The prediction process begins with testing drug data in 2022 to predict the number of drug needs in 2023 before finally the 2023 drug data is used to predict the number of needs in 2024. The prediction testing process obtains an average error value of 2.68%

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REFERENCES

Dewanti, F. P., Setiyowati, S., & Harjanto, S. (2022). Prediksi Persediaan Obat Untuk Proses Penjualan Menggunakan Metode Decision Tree Pada Apotek. *Jurnal Teknologi Informasi Dan Komunikasi (TIKomSiN)*, *10*(1). https://doi.org/10.30646/tikomsin.v10i1.604

Fahirah, & Wulandari, L. (2020). The Implementation of Least Square Method on the Palm Shells Sales Forecasting Application. *International Journal of Information Engineering and Electronic Business*, *12*(5), 1–13. https://doi.org/10.5815/ijieeb.2020.05.01

Furqan, M., Sastia H Wibowo, S. Kom, M. K., & Dedy Abdullah, ST. M, E. (2016). Sistem Persediaan Obat Pada Puskesmas Menggunakan Metode Naive Bayes (Studi Kasus Puskesmas Talang Tinggi Seluma) Skripsi. Universits Muhammadiyah Bengkulu. *Universitas Muhamadiyah Bengkulu*, *18*(60), 1–8.

Hidayat, K., Efendi, J., & Faridz, R. (2020). Analisis Pengendalian Persediaan Bahan Baku Kerupuk Mentah Potato Dan Kentang Keriting Menggunakan Metode Economic Order Quantity (EOQ). *Performa: Media Ilmiah Teknik Industri*, *18*(2), 125–134. https://doi.org/10.20961/performa.18.2.35418

Numan, N., Kusumadewi, S., & Muzayyanah, N. (2020). Sistem Inferensi Fuzzy Untuk Membantu Diagnosis Penyakit Pneumonia Anak. *IT Journal Research and Development*, *5*(1), 53–62. https://doi.org/10.25299/itjrd.2020.vol5(1).5088

Nurkasanah, S., Prasetyo, A., & Bhanu Setyawan, M. (2022). Implementasi Logika Fuzzy untuk Prediksi Hasil Panen Padi dengan Metode Tsukamoto. *Jurnal Rekayasa Teknologi Informasi (JURTI)*. https://oipas.sentraki.umpo.ac.id/index.php/JRTK/article/download/5660/2299

Pinem, N. S., & Utomo, D. P. (2020). Implementasi Fuzzy Logic Dengan Infrensi Tsukamoto Untuk Prediksi Jumlah Kemasan Produksi (Studi Kasus : PT. Sinar Sosro Medan). *Pelita Informatika : Informasi Dan Informatika*, *9*(1), 56–60. https://ejurnal.stmik-budidarma.ac.id/index.php/pelita/article/download/2739/1848

Prabowo, Y. A., & Mandala Putra, L. E. U. (2022). Perancangan Hour Meter Berbasis Internet of Thing Menggunakan Logika Fuzzy. *Jurnal Informatika Dan Rekayasa Elektronik*, *5*(1), 53–61. https://doi.org/10.36595/jire.v5i1.513

Puspitasari, N., Prafanto, A., Ansyori, A., Wati, M., &Septiarini, A. (2022). Fuzzy Tsukamoto untuk Memprediksi Estimasi Persediaan Darah. *Journal MIND (Multimedia Artificial Intelligent Networking Database)*, *7*(2), 188–203. https://doi.org/10.26760/mindjournal.v7i2.188-203

Rodiana, K., Turnip, B., & Marbun, M. (2020). Sistem Pendukung Keputusan Penentuan Jumlah Pemesanan Obat Pada Apotek Dengan Metode Fuzzy Tsukamoto. *JOISIE Journal Of Information System And Informatics Engineering*, *4*(Desember), 139–146.

Salendah, J., Kalele, P., Tulenan, A., & ... (2022). Penentuan Beasiswa Dengan Metode Fuzzy Tsukamoto Berbasis Web Scholarship Determination Using Web Based Fuzzy Tsukamoto Method. *Proceeding Seminar …, (nama)*, 81–90. https://proceeding.unived.ac.id/index.php/snasikom/article/view/80%0Ahttps://proceeding.unived.ac.id/index.php/snasikom/article/download/80/70

Sari, H. U., Kartika, J., & Japa, A. (2019). Penerapan Fuzzy Inference System Pada Permintaan Darah Di Palang Merah Indonesia Pematangsiantar. *Prosiding Seminar Nasional Riset Information Science (SENARIS)*, *1*(September), 185. https://doi.org/10.30645/senaris.v1i0.22

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