SinkrOn
JURNAL & PENELITIAN TEKNIK INFORMATIKA
Journal Publications & Informatics Engineering Research
Volume 3, Number 2, April 2019
DOI : https://doi.org/10.33395/sinkron.v3i1.10014
e-ISSN : 2541-2019
p-ISSN : 2541-044X

Monitoring patient health based on medical records using fuzzy logic method

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Abstract. The Fuzzy Logic concept was first introduced as a way of processing data by allowing the use of partial set membership compared to the crisp set membership or non-membership. Along with the development of computer technology, the concept of fuzzy logic is increasingly needed by people, because this concept is able to provide information needed in the decision making process. This study aims to analyze and design intelligent systems to monitor the health development of inpatients. The method used is the Fuzzy Logic method. This method will predict the level (degree) of health of each patient based on the amount of drug use and the duration of diagnosis process. The tools used to analyze and design the system are Unified Modeling Language. The results of this research are monitoring the health development of patients using the Fuzzy Logic method.

Keywords: Fuzzy Tsukamoto, patient health monitoring, medical records

1. INTRODUCTION

In almost every aspect of life, humans are always faced with several choices. Making the right decisions will be very influential in our lives going forward. Artificial Intelligence is one of the fields of computer science that uses computers so that they can behave intelligently like humans. Computer Science is developing software and hardware to be able to imitate the actions of humans. Artificial intelligence can solve problems by using computers to solve complex problems by following human reasoning processes [1].

Research in the field of health and pharmacy has been carried out before, such as research on the design of an integrated service post information system at the Surabaya-based Web City Health Office [2] which produces a Posyandu information system that provides convenience in running information systems (user friendly) and convenience and speed in making Posyandu reports. Research on System Strategy and Information Technology Planning at Rs. Damian Lewoleba With Ward And Peppard's Approach [3] which discusses the application of technologies such as networks, databases, and platforms. Other research on Productivity Using Nurse Working Time in Inpatient Installation of Ahmad Yani Hospital Pekanbaru [4] which produced information in the form of nurses' productive work time ie 42.4% (i.e. 19.6% direct activities and indirect nursing activities 22.8 %) and non-productive 57.6%, so it can be concluded that the productivity of the use of nurse's work time is not optimal and is more dominated by non-productive activities such as: talking outside the main tasks, watching TV, using gadgets or going out for other activities. However, some of these studies do not discuss the development of patient health.

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Research on the fuzzy logic method has also been carried out by several previous researchers, such as research on Fuzzy Logic Analysis Determining the Selection of Honda Motors with the Mamdani Method [5], obtaining information that the process of Matlab Beat motor shows 23.3% and defuzzification results of manual Beat motorbike shows 24,049%, the process from Matlab motor Vario shows 79.4% and the defuzzification result of manual Vario motor count shows 83.88%, the process from Supra motor matlab shows 23.2% and the defuzzification result of manual Supra motor shows 21.049%. so this result shows the Vario motorbike to be bought. Other research concerning the Application of Fuzzy Logic Method to Evaluate Nurse Service Performance (Case Study: RSIA Siti Hawa Padang) [6] who obtained information that the fuzzy logic method for evaluating nurse performance in hospitals, according to the desired results and fuzzy logic methods can be used to nurse performance assessment.

To solve the problems faced in several previous studies, then in this study Fuzzy Logic algorithm will be used to analyze and monitor the health development of patients. The Fuzzy Logic concept was first introduced by Prof. Lotfi Zadeh from the University of California at Berkeley in 1965, and presented not as a control methodology, but as a way of processing data by allowing the use of partial set membership compared to the crisp set membership or non-membership. Along with the development of computer technology, the concept of fuzzy logic is increasingly needed by people, because this concept is able to provide information needed in the decision making process.

With the design of the system, it is expected to benefit the hospital, especially regarding monitoring the health development of patients at the hospital. This eventually became a challenge for the author to make a study into a research entitled **Monitoring the development of patient health based on medical records using the fuzzy logic algorithm**.

2. RESEARCH METHODOLOGY

2.1 Smart System

Smart systems are AI programs (Artificial Intelligence) or artificial intelligence that combine the knowledge base with inference machines. This is a part of high-level specialization software or high level language. Intelligent systems can adopt a small part of the level of human intelligence, among others, the ability to be trained, recalling conditions that have been experienced, processing data to provide appropriate action according to what has been taught, and the ability to absorb the expertise of an expert through commands written in a certain programming language.

2.2 Fuzzy Logic Method

Fuzzy Logic is an appropriate way to map an input space into an output space. The starting point of the modern concept of uncertainty is the paper made by Lofti A Zadeh (1972), where Zadeh introduced a theory that has objects from fuzzy sets that have limits that are not precise and membership in fuzzy sets, and not in the form of true logic (true) or false, but expressed in degrees.

Fuzzy logic is an increase of Boolean logic that deals with partial concepts of truth. When classical logic states that everything can be expressed in binary terms (0 or 1, black or white, yes or no) fuzzy logic replaces Boolean truth with a level of truth. The set of fuzzy logic was first introduced by Lotfi A. Zadeh in 1965 as a mathematical way to represent linguistic uncertainty. Based on the concept of fuzzy logic, factors and criteria can be classified without binding restrictions. Fuzzy logic is very useful for resolving high problems in various fields which usually contain degrees of uncertainty. The theory of set fuzzy logic was developed by Professor Lofti A. Zadeh in 1965. He argues that right and wrong logic of conventional Boolean logic cannot overcome the problem of gradation in the real world. To overcome this infinite gradation problem, Zadeh developed a fuzzy set. Unlike boolean logic, fuzzy logic has continuous value. Fuzzy is expressed in degrees of membership and degrees of truth. Therefore something can be said to be partially true and partly wrong at the same time. Based on the above, fuzzy logic can be used to model a mathematical problem, where the mathematical concepts underlying fuzzy reasoning are very simple and easy to understand.

Logic is only a small part of the capacity of the human mind for a reason. Logic can be a means to force us to conclude the right answer, but it cannot by itself be responsible for our creativity or for our ability to remember. In other words, logic can help us arrange words to make clear sentences, but cannot help us determine what sentences to use in various contexts. Consider the top part of nineteenth century mathematics Lewis Carroll in the Classic Through the Looking Glass. How high can we see the logical context in this fictional character's discourse? Logic for humans is a quantitative way to develop a reasoning process that can be replicated and

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manipulated with mathematics. Interest in logic is the study of truth in logical propositions, in the classic logic of this truth is binary - propositions are true or false. From this perspective, fuzzy logic is a method for formalizing human capacity right reasoning, or approximate reasoning. reasoning like this is a human ability to reason less and judge under uncertainty. in fuzzy logic all truths are only partial or approximate. In this case, this reason has also been called reasoning interpolation, where the process of interpolating between extreme binary from right and wrong is represented by the ability of fuzzy logic to summarize partial truths. [16]

2.3 Fuzzy Tsukamoto Method

"Fuzzy Inference System is a computational framework based on fuzzy set theory, fuzzy rules in the form of IF-THEN, and fuzzy reasoning".

Broadly speaking, block diagrams are fuzzy inference processes as below (Figure 1).

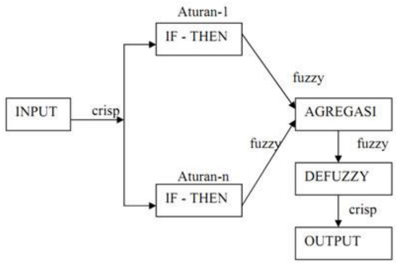

Figure 1. Block Diagram of Fuzzy Inference System

Fuzzy inference systems accept crisp input. This input is then sent to the knowledge base containing n fuzzy rules in the IF-THEN form. Fire strength will be searched for in each rule. If the number of rules is more than one, then all rules will be aggregated. Furthermore, the results of the aggregation will be defuzzy to get the crisp value as the system output.

Block diagram of the inference process using the Tsukamoto method as below (Figure 2).

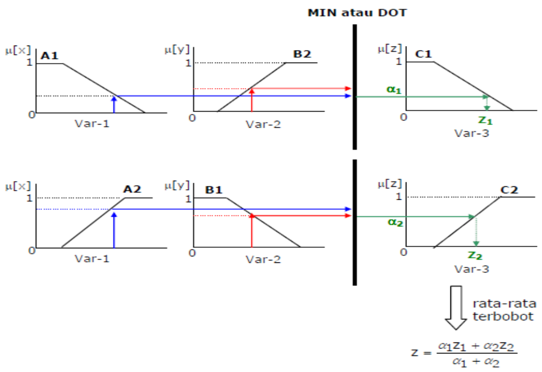

Figure 2. Inference Process Block Diagram Using Tsukamoto Method

Basically, the Tsukamoto method applies monotonous reasoning to each rule. In monotonous reasoning, the system has only one rule, in the Tsukamoto method, the system consists of several rules. Because it uses the basic concept of monotonous reasoning, in the Tsukamoto method, every consequence of IF-THEN rules must be represented by a fuzzy set with a monotonous membership function. The output of the inference results from each rule is given explicitly (crisp) based on α-predicate (fire strength). The process of aggregation between rules is done, and the final results are obtained by using defuzzy with the concept of weighted averages. Suppose there are input variables, namely x and y, and one output variable, z. The variable x is divided into 2 sets, namely A1 and A2, the y variable is divided into 2 sets as well, namely B1 and B2, while the output variable Z is divided into 2 sets, namely C1 and C2. Of course the set C1 and C2 must be a monotonous set. 2 rules are given as follows:

IF x is A1 and y is B2 THEN z is C1
IF x is A2 and y is B2 THEN z is C1

2.4 Data Analysis

Analysis is an activity that starts from the initial process in learning and evaluating a form of problem that exists. The distribution of analysis, namely analysis of input documents, process analysis, and analysis of output documents.

The data sources used in this study are patient data and patient disease diagnosis data from one of the private hospitals in 2016.

The data obtained from hospitals in 2016 after passing the data selection process for this study are as follows:

a. Patient Data
Patient data was obtained from patient registration in 2016. These patient data consisted of patient attributes_id, age_group and gender. The patient data used can be seen in the table below:

Table 1. Patient Data Pasien for 2016 Year

Patient_ID	Age Group	Gender
P1	Lansia	Perempuan
P2	Lansia	Perempuan
P3	Lansia	Perempuan

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P4	Dewasa	Laki-Laki
P5	Lansia	Laki-Laki
…		
P65535	Dewasa	Laki-Laki

b. Diagnosis Master Data

This Diagnosis Master Data consists of the types of illnesses suffered by patients based on the doctor's diagnosis obtained from the patient's medical record in 2016. Diagnosis data consists of the diagnosis_code attribute, diagnosis name. The diagnostic data used can be seen in the table below:

Table 2. Diagnosis Table for 2016 Year

Diagnosis_Name
Pra Hipertensi
Hipertensi1
Hipertensi2
Hipotensi

c. Diagnosis Data based on Age and Gender

Diagnosis data based on age and gender is obtained from the patient's disease diagnosis data and the age and sex of patients diagnosed with the disease. Diagnosis data consists of diagnostic attributes, code, diagnosis, name, group, name, gender. The diagnostic data used can be seen in the table below:

Table 3. Diagnosis Table Based on Age and Gender

Patient	Age (old)	Gender (P/L)	Blood Pressure (mmHg)	Item
1	44	L	80	dewasa, laki-laki, hipotensi
2	79	P	135	lansia, perempuan, prahipertensi
3	43	P	145	dewasa, perempuan, hipertensi1
4	51	L	143	dewasa, laki-laki, hepertensi1
5	60	L	149	dewasa, laki-laki, hipertensi1
6	55	L	161	dewasa, laki-laki, hipertensi2
7	35	P	163	dewasa, perempuan, hipertensi2
8	50	L	166	dewasa, laki-laki, hipertensi2
9	74	P	74	lansia, perempuan, hipotensi
10	33	L	135	dewasa, laki-laki, prahipertensi
11	40	L	170	dewasa, laki-laki, hipetensi2
12	49	L	134	dewasa, laki-laki, hipertensi1
13	57	P	83	dewasa, perempuan, hipotensi
14	56	P	84	dewasa, perempuan, hipotensi
15	45	P	142	dewasa, perempuan, hipertensi2
16	71	L	146	lansia, laki-laki, hipertensi1
17	67	L	136	lansia, laki-laki, prahipertensi
18	78	L	75	lansia, laki-laki, hipotensi
19	62	L	144	lansia, laki-laki, hipertensi1
20	59	L	135	dewasa, laki-laki, prahipertensi
21	52	L	159	dewasa, laki-laki, hipertensi1
22	72	L	83	lansia, laki-laki, hipotensi
23	78	L	133	lansia, laki-laki, prahipertensi

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24	68	L	95	lansia, laki-laki, normal
...	...	...	...	...

Table 4. Diagnosis Table based on Age, Gender, Duration of Diagnosis and Tension

Patient	Age (Old)	Gender (P/L)	Item
35	69	L	lansia, laki-laki, sedang, lemah
36	87	P	lansia, perempuan, sedang, normal
37	69	P	lansia, perempuan, sedang, normal
38	50	L	dewasa, laki-laki, cepat, normal
39	51	P	dewasa, perempuan, lama, normal
40	47	L	dewasa, laki-laki, sedang, lemah
41	49	L	dewasa, laki-laki, sedang, normal
42	59	P	dewasa, perempuan, sedang, normal
43	64	P	lansia, perempuan, sedang, normal
44	59	L	dewasa, laki-laki, sedang, normal
45	75	L	lansia, laki-laki, sedang, lemah
46	57	P	dewasa, perempuan, sedang, normal
47	64	P	lansia, perempuan, lama, normal
48	63	L	lansia, laki-laki, cepat, normal
49	63	P	lansia, perempuan, sedang, normal
50	59	P	dewasa, perempuan, lama, lemah
51	73	L	lansia, laki-laki, sedang, normal
52	47	L	dewasa, laki-laku, sedang, normal
53	75	L	lansia, laki-laki, sedang, normal
54	60	P	dewasa, perempuan, sedang, normal
55	53	L	dewasa, laki-laki, sedang, normal
56	56	P	dewasa, perempuan, sedang, normal
57	54	P	dewasa, perempuan, cepat, normal
58	63	L	lansia, laki-laki, sedang, normal
59	72	P	lansia, perempuan, sedang, normal
60	75	P	lansia, perempuan, lama, normal
61	57	P	dewasa, perempuan, cepat, normal
62	53	P	dewasa, perempuan, sedang, lemah
63	66	P	lansia, perempuan, cepat, normal
64	63	P	lansia, perempuan, sedang, lemah
65	53	P	dewasa, perempuan, sedang, lemah
66	37	L	dewasa, laki-laki, cepat, normal
67	63	L	lansia, laki-laki, cepat, normal
68	75	P	lansia, perempuan, cepat, normal
69	69	L	lansia, laki-laki, cepat, normal
70	72	L	lansia, laki-laki, sedang, lemah
71	60	L	dewasa, laki-laki, sedang, lemah
72	35	L	dewasa, laki-laki, sedang, lemah
73	57	L	dewasa, laki-laki, sedang, normal
74	57	L	dewasa, laki-laki, cepat, normal
75	63	L	lansia, laki-laki, cepat, normal
76	55	L	dewasa, laki-laki, sedang, normal
77	71	L	lansia, laki-laki, sedang, normal
78	77	P	lansia, perempuan, cepat, normal
79	58	L	dewasa, laki-laki, sedang, lemah
80	78	P	lansia, perempuan,

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			sedang, lemah
81	71	P	lansia, perempuan, cepat, normal
82	42	P	dewasa, perempuan, sedang, normal
83	47	P	dewasa, perempuan, cepat, normal
...	...	...	...

The process of grouping age based on the age range into the age group will use the data set as shown in the following table:

Table 5. Age Group Table

No.	Age Group	Age
1	Anak-Anak	≤ 14 thn
2	Remaja	15-24 thn
3	Dewasa	25-60 thn
4	Lansia	> 60 thn

2.5 Data Transformation

Medical data used in this study will be transformed first so that it is suitable for the data mining process.

Table 6. Transformation Data Table

Atribut	Nilai
Kelompok Umur	Anak-Anak, Remaja, Dewasa, Lansia
Jenis Kelamin	1 = Laki-laki, 0 = Perempuan

2.6 Data Representation

Data variables used in the information retrieval process are diagnosis, age group and gender. Examples of data used in this study are shown in the following table:

Table 7. Data Clustering Result for Man

Patient	Age (Old)	Gender (P/L)	Blood Pressure (mmHg)	Item
1	44	L	80	dewasa, laki-laki, hipotensi
4	51	L	143	dewasa, laki-laki, hepertensi1
5	60	L	149	dewasa, laki-laki, hipertensi1
6	55	L	161	dewasa, laki-laki, hipertensi2
8	50	L	166	dewasa, laki-laki, hipertensi2
10	33	L	135	dewasa, laki-laki, prahipertensi
11	40	L	170	dewasa, laki-laki, hipetensi2
12	49	L	134	dewasa, laki-laki, hipertensi1
16	71	L	146	lansia, laki-laki, hipertensi1
17	67	L	136	lansia, laki-laki, prahipertensi
18	78	L	75	lansia, laki-laki, hipotensi
19	62	L	144	lansia, laki-laki, hipertensi1
20	59	L	135	dewasa, laki-laki, prahipertensi
21	52	L	159	dewasa, laki-laki, hipertensi1
22	72	L	83	lansia, laki-laki, hipotensi
23	78	L	133	lansia, laki-laki, prahipertensi
24	68	L	95	lansia, laki-laki, normal
25	63	L	135	lansia, laki-laki, prahipertensi
28	48	L	79	dewasa, laki-laki, hipotensi
32	67	L	142	lansia, laki-laki, hipertensi1
...	...	...	...	...

Table 8. Clustering Result for Elderly Age

Patient	Age (Old)	Gender (P/L)	Blood Pressure (mmHg)	Item
16	71	L	146	lansia, laki-

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				laki, hipertensi1
17	67	L	136	lansia, laki-laki, prahipertensi
18	78	L	75	lansia, laki-laki, hipotensi
22	72	L	83	lansia, laki-laki, hipotensi
23	78	L	133	lansia, laki-laki, prahipertensi
24	68	L	95	lansia, laki-laki, normal

2.7 Design of Monitoring System of Patient Health Development Based on Medical Record Using Fuzzy Logic Algorithm

The process of monitoring the health development of inpatients has two fuzzy functions or sets involved in it, namely:

a. Drug Usage Variable

Drug Use Variables have 3 fuzzy sets namely low, medium, high, as shown in figure below:

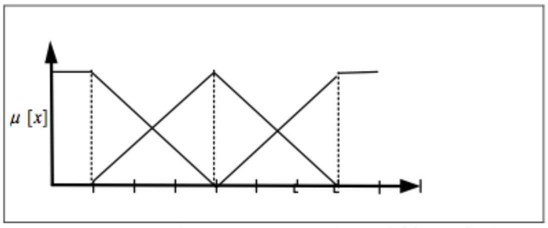

Figure 3. Drug Usave Variable Diagram

The low set uses the linear membership function approach down the left shoulder, the high set is the linear membership function approach up the right shoulder, while the set is using a triangular membership function approach. The following form of curve is the default curve of several factors that influence the use of drugs and their sets.

Membership Function :

$$\mu_{PakaiObatRENDAH}[x] = \begin{cases} 1, & x \le 5 \\ \dfrac{15-x}{15-5}, & 5 \le x \le 10 \\ 0, & x \ge 10 \end{cases}$$

$$\mu_{PakaiObatSEDANG}[x] = \begin{cases} 0, & x \le 5\, atau \quad x \ge 15 \\ \dfrac{x-5}{10-5}, & 5 \le x \le 10 \\ \dfrac{15-x}{15-10}, & 10 \le x \le 15 \end{cases}$$

$$\mu_{PakaiObatTINGGI}[x] = \begin{cases} 0, & x \le 10 \\ \dfrac{x-10}{15-10}, & 10 \le x \le 15 \\ 1, & x \ge 15 \end{cases}$$

P.S.: Numbers in the membership function formula for drug use represent the number of drug items used per day.

b. Treatment Duration Variable

The treatment duration variable has 3 fuzzy sets, namely: low, medium, high, as shown in figure below:

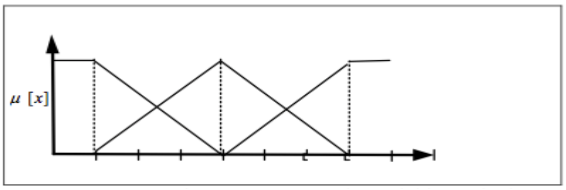

Figure 4. Treatment Duration Variable Diagram

The low set uses the linear membership function approach down the left shoulder, the high set uses membership the linear membership function approach rises the right shoulder, while the set is using a triangular membership function approach. The following form of curve is the default curve of several factors that influence the length of the diagnosis and its sets.

Membership Function:

$$\mu_{LamaDiagnosaRENDAH}[x] = \begin{cases} 1, & x \le 4 \\ \dfrac{12-x}{12-4}, & 4 \le x \le 12 \\ 0, & x \ge 12 \end{cases}$$

$$\mu_{LamaDiagnosaSEDANG}[x] = \begin{cases} 0, & x \le 4\, atau \quad x \ge 20 \\ \dfrac{x-4}{12-4}, & 4 \le x \le 12 \\ \dfrac{20-x}{20-12}, & 12 \le x \le 20 \end{cases}$$

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$$\mu_{LamaDiagnosaTINGGI}[x] = \begin{cases} 0, & x \le 12 \\ \dfrac{x-12}{20-12}, & 12 \le x \le 20 \\ 1, & x \ge 20 \end{cases}$$

P.S.: Numbers in the duration treatment variable membership function represents the length of treatment in units of days.

Rule contains rules that apply to all events (combinations). This process functions to find a fuzzy output value from fuzzy input. The process is as follows: A fuzzy input value derived from the fuzzyfication process is then entered into a rule that has been made to be made into a fuzzy output. Following are the rules that will be used for fuzzy calculations:

[R1] IF Pemakaian obatTINGGI And Lama diagnosaTINGGITHEN
Kesehatan TIDAK MEMBAIK;
[R2] IF Pemakaian obatTINGGI And Lama diagnosa SEDANGTHEN
Kesehatan TIDAK MEMBAIK;
[R3] IF Pemakaian obatTINGGI And Lama diagnosa RENDAHTHEN
Kesehatan TIDAK MEMBAIK;
[R4] IF Pemakaian obat SEDANG And Lama diagnosa TINGGI THEN
Kesehatan TIDAK MEMBAIK;
[R5] IF Pemakaian obat SEDANG And Lama diagnosaSEDANG THEN
Kesehatan TIDAK MEMBAIK;
[R6] IF Pemakaian obatSEDANG And Lama diagnosaRENDAH THEN
Kesehatan MEMBAIK;
[R7] IF Pemakaian obat RENDAH And Lama diagnosaTINGGI THEN
Kesehatan MEMBAIK;
[R8] IF Pemakaian obat RENDAH And Lama diagnosa SEDANGTHEN
Kesehatan MEMBAIK;
[R9] IF Pemakaian obat RENDAH And Lama diagnosa RENDAH
THEN Kesehatan MEMBAIK;

Data clustering results that describe the relationship between length of treatment and patient tension can be seen in the following figure:

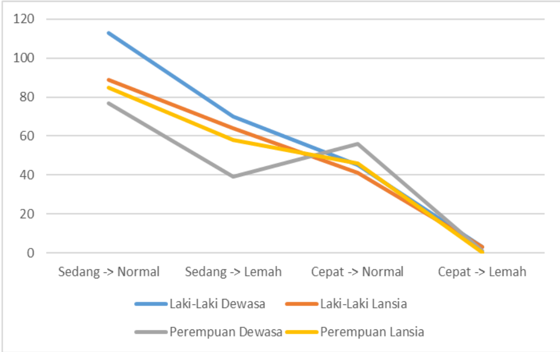

Figure 5. Comparison Chart of Clustering Result Data for Treatment Duration and Patient Tension

From the results of the clustering data obtained above, information can be obtained that if the duration of treatment is fast then the possibility of patient tension is weak, the percentage is very small. So that it can be said that if the duration of treatment is fast, then it is likely that the patient's tension is normal.

Data clustering results that describe the relationship between length of treatment and patient tension by grouping by patient sex can be seen in the following figure:

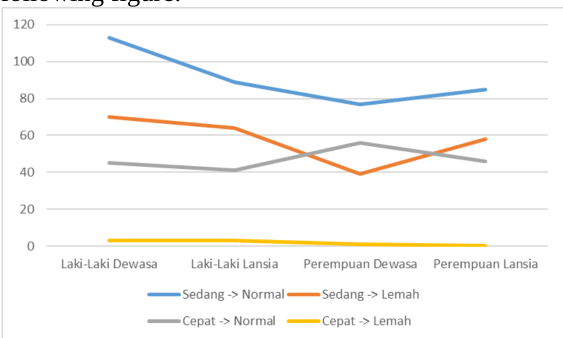

Figure 6. Comparsion Chart of Clustering Result Data for Treatment Duration and Patient Tension with Grouping Based on Patient Gender

From the results of the clustering data obtained above, information can be obtained that adult women have the highest recovery process success. In other words, it can be said that the process of caring for female patients has a higher success rate compared to male patients.

Meanwhile, the results of clustering that describe the relationship between gender and patient tension can be seen in the following figure:

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DOI : https://doi.org/10.33395/sinkron.v3i1.10014
e-ISSN : 2541-2019
p-ISSN : 2541-044X

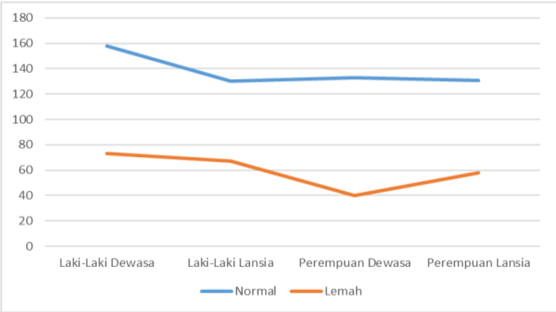

Figure 7. Comparison Chart of Clustering Result Data for Gender and Patient Tension

From the results of the clustering data obtained above, information can be obtained that the number of male patients whose weakness is far more than female patients. Meanwhile, the number of adult female patients whose weaknesses are the least.

Examples of the calculation of the value of µ for the number of drug use as many as 13 items and the length of treatment for 7 days can be seen in the following table:

Table 9. Computation Result µ on Treatment Duration and Drugs Usage Variable

		DRUGS USAGE		
TREATMENT DURATION		Rendah: 0	Sedang: 0,4	Tinggi: 0,6
	Rendah: 0,625	0	0,4	0,6
	Sedang: 0,375	0	0,375	0,375
	Tinggi: 0	0	0	0

2.8 Workflow Process Anlysis of Fuzzy Tsukamoto Method

The working procedure stages of the Fuzzy Tsukamoto method in analyzing patient health can be described as shown in the following flowchart image:

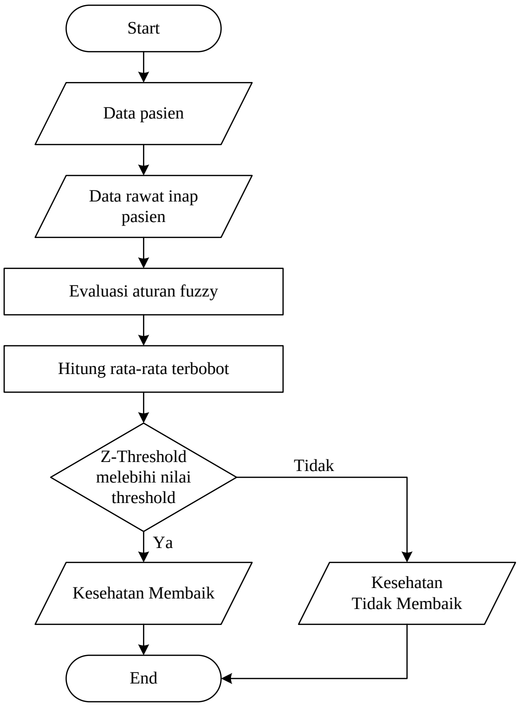

Figure 8. Flowchart Diagram of Fuzzy Tsukamoto Method

The process needs several data as input such as patient data and patient treatment record data. The data will be evaluated by using fuzzy rules and then it's checked whether the health condition is better or not.

2.9 Diagram

System work process design is used to show user interaction with the system made so that it can be known that the framework of this system is intended to know the outline of the system form that will be design. In the framework of this system framework, auxiliary tool use a use case diagram, as seen in Figure 7.

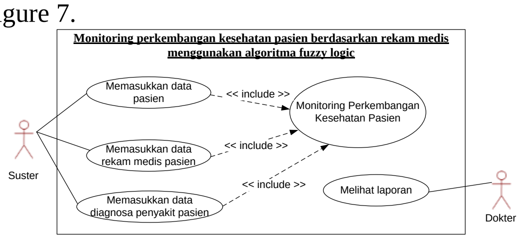

Figure 9. Use Case Diagram of Sytem

As shown ini figure 9, there are several process in system such as input patient data, input patient treatment record, input patient desease diagnosis, monitoring patient health improvement and showing report.

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Activity Diagram design of system could be seen as figure below:

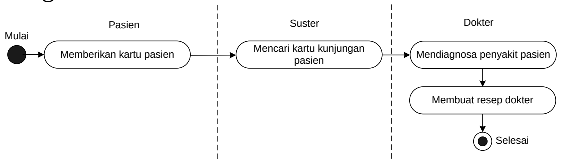

Figure 10. Activity Diagram of Proposed System

The medical record process starts with the patient giving the patient card to the nurse. After that, the nurse will look for a patient visit card. After the patient's turn, the patient will notify the complaint about the illness he has suffered to the doctor. After that, the doctor will diagnose the disease suffered by the patient and open a doctor's prescription to the patient.

3. IMPLEMENTATION

Display input from software includes:

1. Drugs Master, which could be used as a place for filling, changing and deleting drug data, as shown in figure 11.

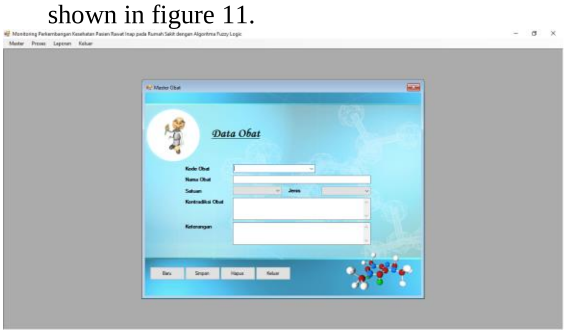

Figure 11. Drugs Master Form Display

2. Patient Master, which could be used as a place for filling, changing and deleting patient data, as shown in figure 12.

Figure 12. Patient Master Form Display

3. Desease Master, which could be used as a place for filling, changing and deleting desease data, as shown in figure 13.

Figure 13. Desease Master Form Display

4. Health Development Monitoring Process, which serves to display the patient's health development results, as shown in figure 14.

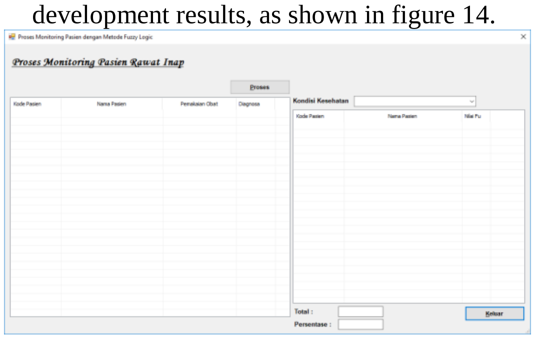

Figure 14. Health Development Monitoring Form Display

Based on the results of tests conducted on the system designed, it can be summarized in table form as follows:

Table 10. Monitoring Results of Patient Health Development

Health Condition	Patient Amount	
	Real Condition	System Monitoring Result
Improve	256	202
Started to Improve	125	154
Not Improve	20	42
Get Worse	5	8

The process of testing the accuracy of the monitoring results obtained by the system will use the Confusion Matrix method as shown in the following description:

	Predicted: NO	Predicted: YES
Actual: NO	TN: 25	FP: 0
Actual: YES	FN: 25	TP: 356

Result achieved:

Accuracy: (TP + TN) / Total_data = (356 + 25) / 406 = 381 / 406 = 0.938 (= 93.8 %)

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Error Rate: (FP + FN) / Total_data = (0 + 25) / 406 = 25 / 406 = 0.062 (= 6.2 %)

4. CONCLUSIONS

After completing the design process of monitoring inpatient applications, some conclusions can be drawn such as the application is able to predict the number of patients whose condition is healthy, has improved or is still sick by using the Fuzzy Logic method and based on the results of the tests carried out, the information achieved is the accuracy of the application of the fuzzy logic method to the health monitoring process of patients in hospitals was 93.8%, so the fuzzy logic method is suitable to be applied in the health monitoring process of patients.

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