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Judul Prosiding Ilmiah (Artikel) : Mamdani Fuzzy Inference System (FIS) for Early Diagnosis of Diabetes Mellitus (DM) and Calorie Needs
Penulis Prosiding Ilmiah : Humaidillah Kurniadi Wardana, Imamatul Ummah, Lina Arifah Fitriyah,
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a. Nama Prosiding : Proceedings of the International Joint Conference on Science and Engineering (IJCSE 2020)
b. Volume : 196
c. Halaman : 387-394
d. Penerbit : Atlantis Press Advances in Engineering Research
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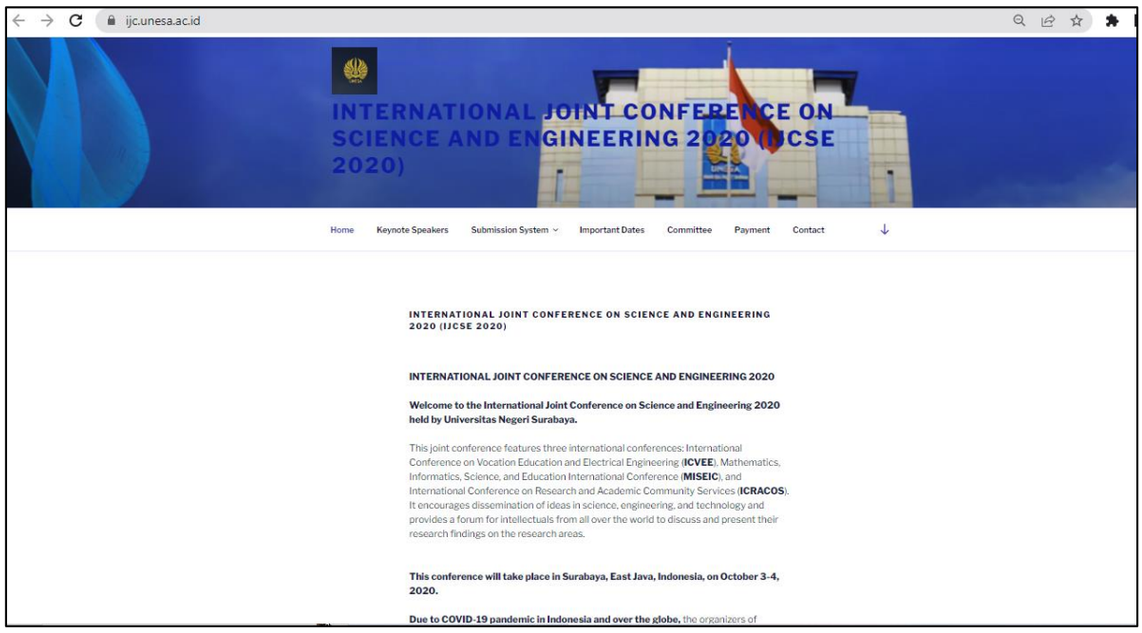

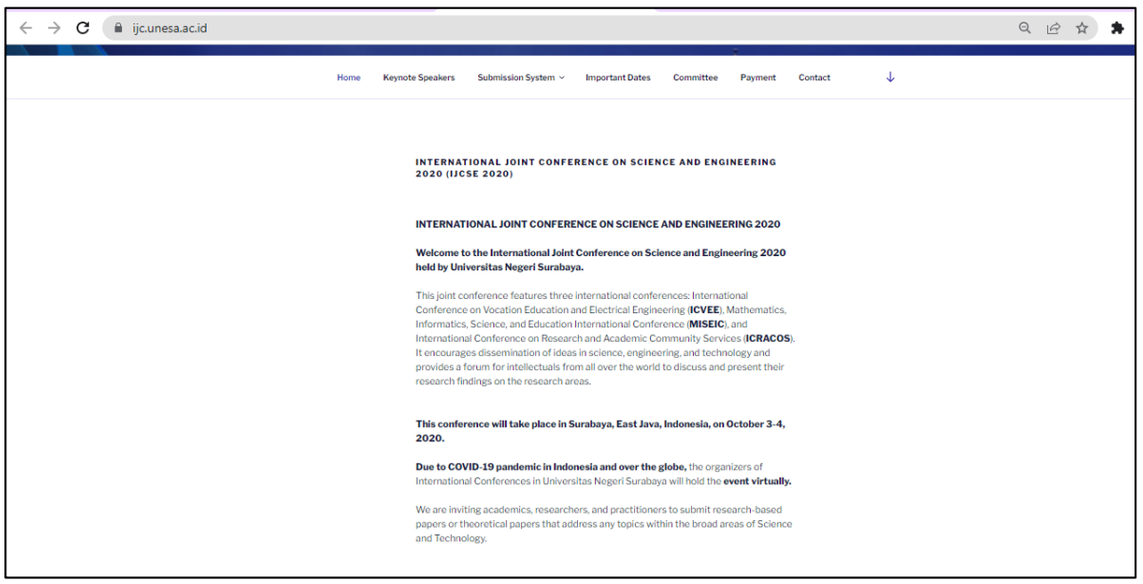


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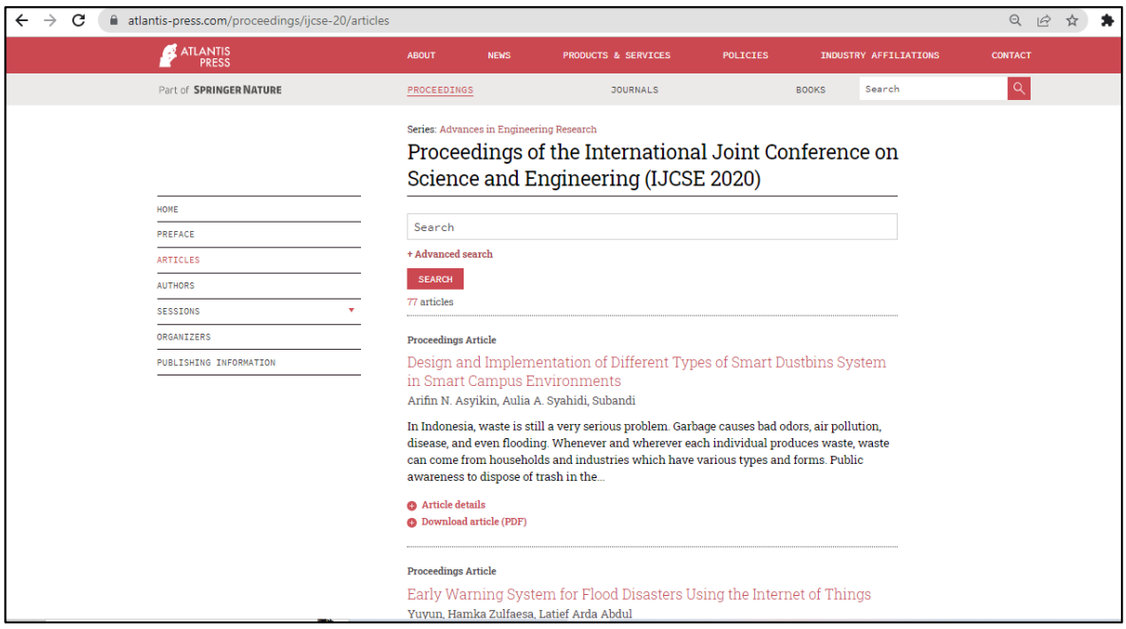
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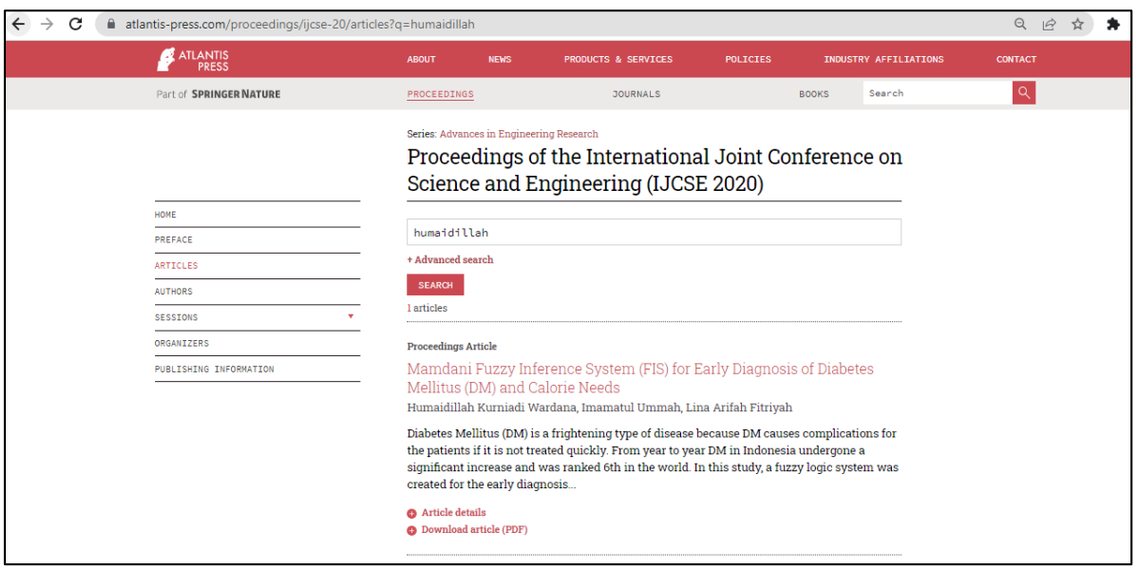
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Diabetes Mellitus (DM) is a frightening type of disease because DM causes complications for the patients if it is not treated quickly. From year to year DM in Indonesia undergone a significant increase and was ranked 6th in the world. In this study, a fuzzy logic system was created for the early diagnosis...
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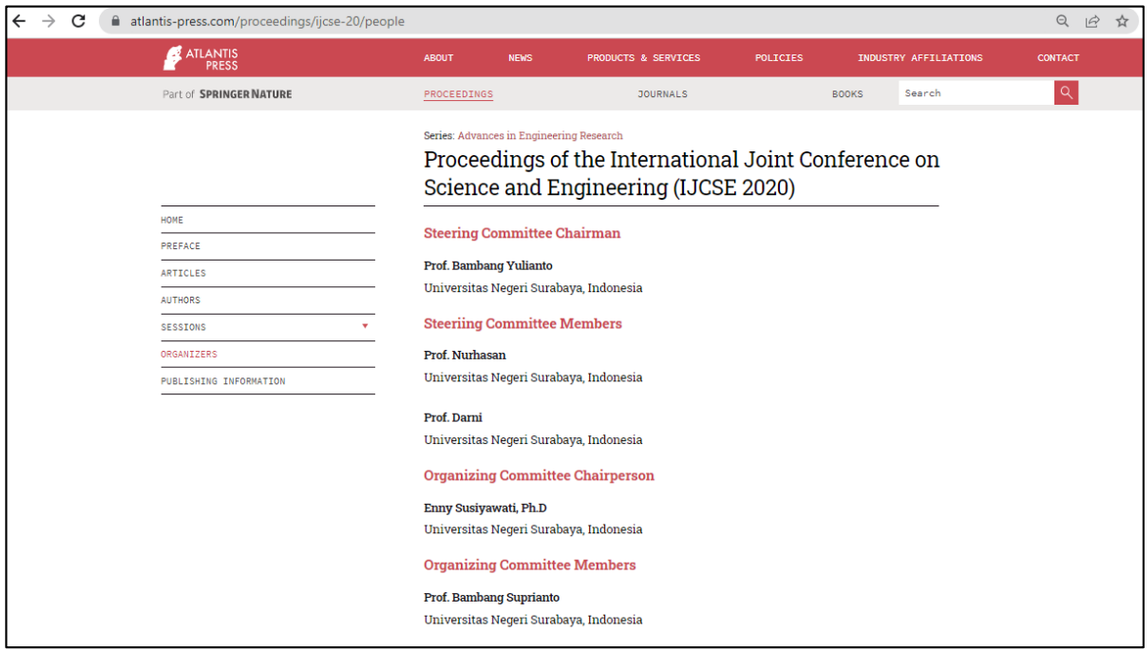
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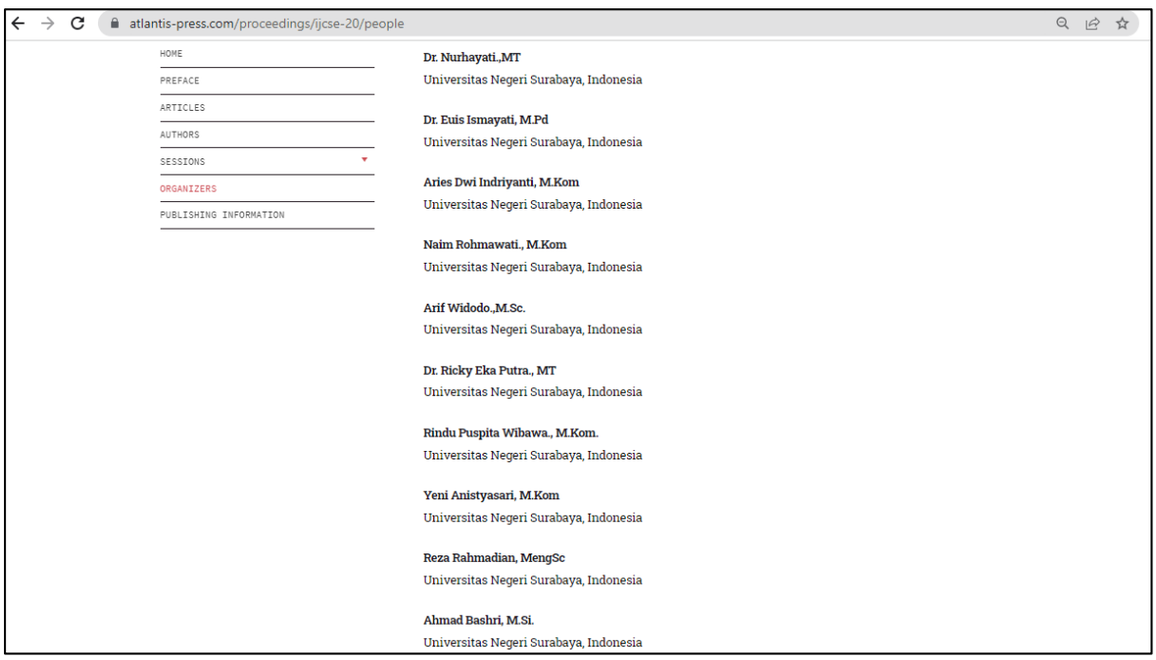
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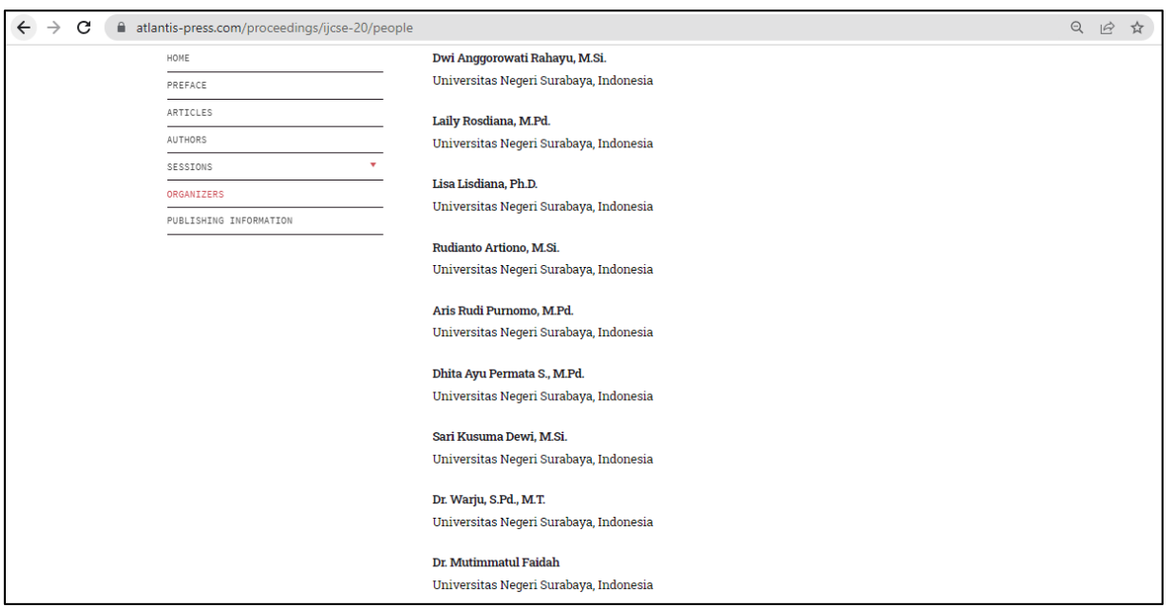
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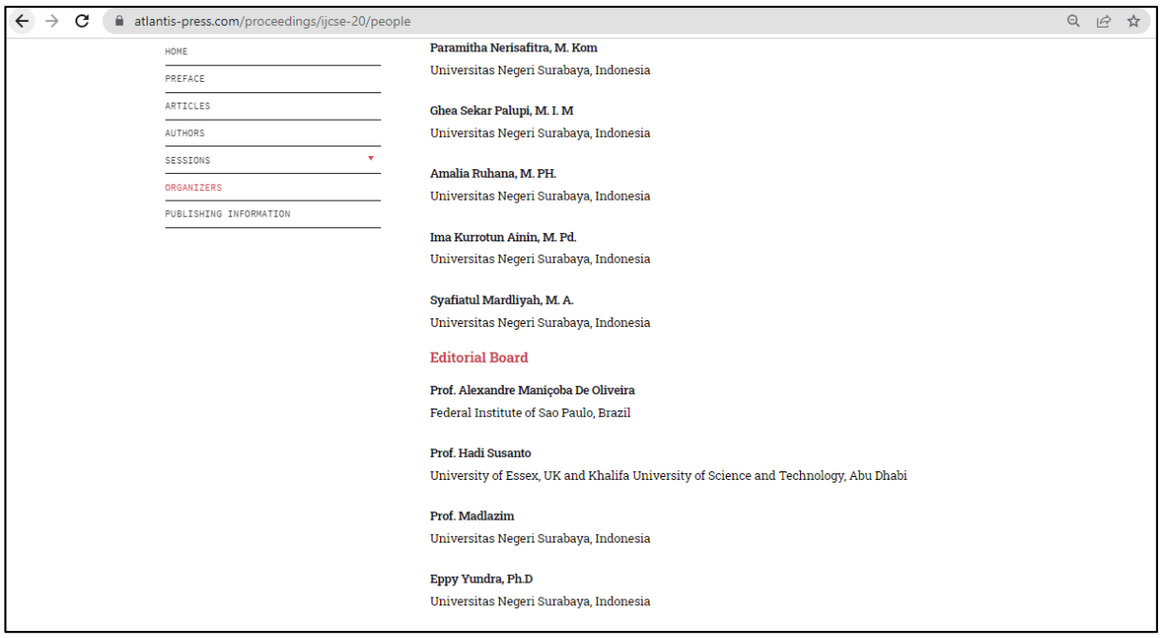

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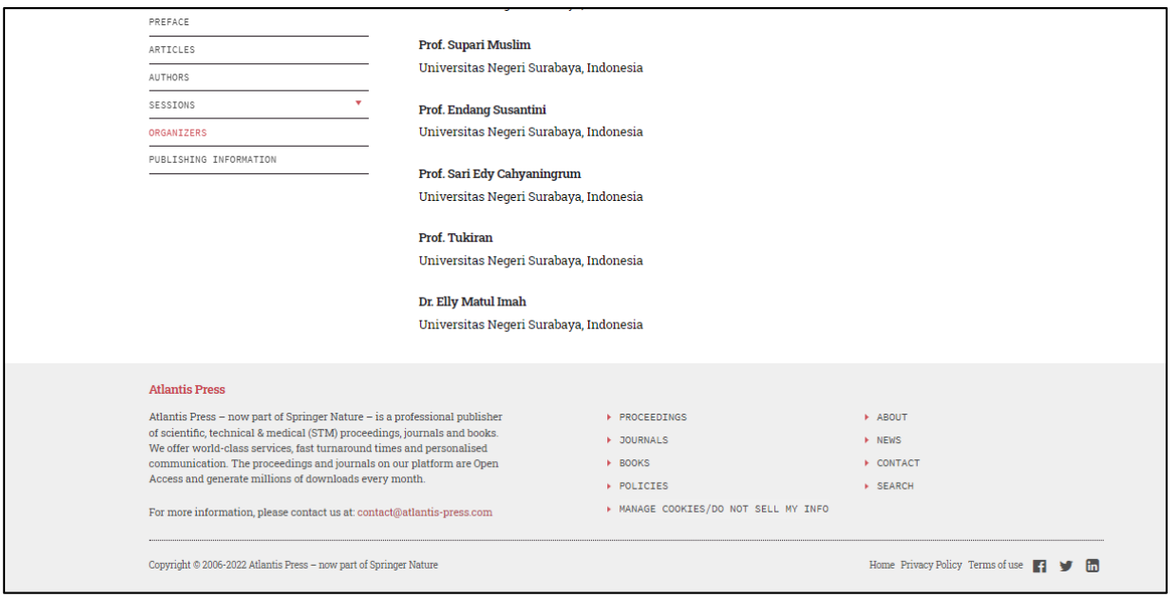

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Mamdani Fuzzy Inference System (FIS) for Early Diagnosis of Diabetes Mellitus (DM) and Calorie Needs
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Available Online 24 November 2020.
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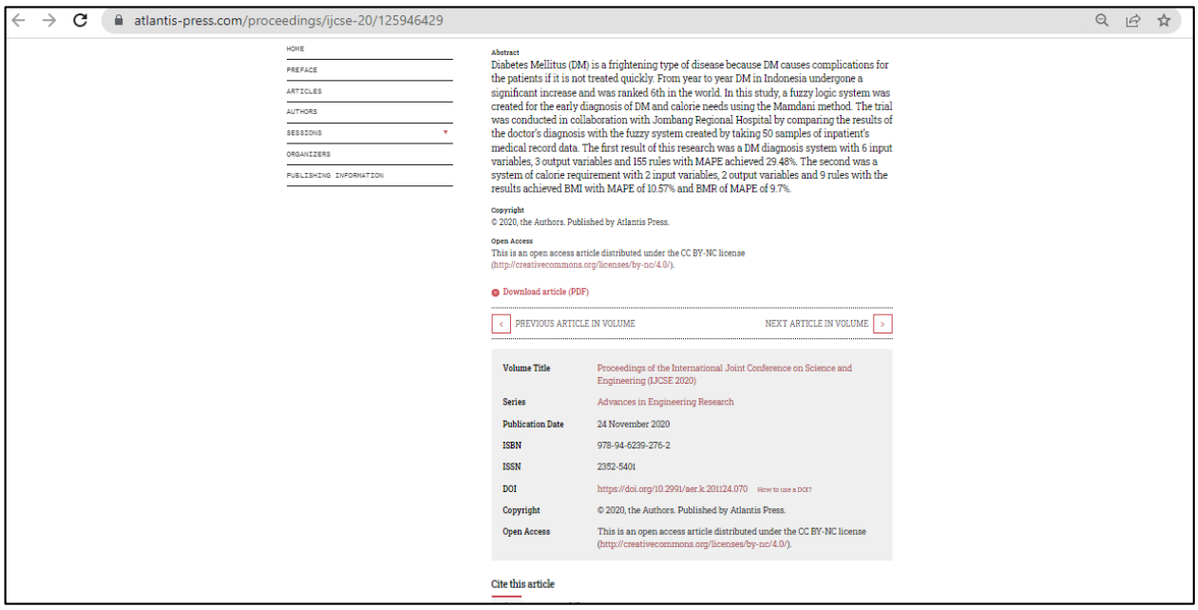
https://doi.org/10.2991/aer.k.201124.070 How to use a DOI?
Keywords
FIS, Mamdani, Diabetes Mellitus, Calorie
Abstract
Diabetes Mellitus (DM) is a frightening type of disease because DM causes complications for the patients if it is not treated quickly. From year to year DM in Indonesia undergone a significant increase and was ranked 6th in the world. In this study, a fuzzy logic system was created for the early diagnosis of DM and calorie needs using the Mamdani method. The trial was conducted in collaboration with Jombang Regional Hospital by comparing the results of the doctor's diagnosis with the fuzzy system created by taking 50 samples of inpatient's medical record data. The first result of this research was a DM diagnosis system with 6 input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Mamdani Fuzzy Inference System (FIS) for Early Diagnosis of Diabetes Mellitus (DM) and Calorie Needs

Humaidillah Kurniadi Wardana[1,*], Imamatul Ummah[1], Lina Arifah Fitriyah[1]

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[*] *Corresponding author. Email: bhindere.adi3@gmail.com*

ABSTRACT
Diabetes Mellitus (DM) is a frightening type of disease because DM causes complications for the patients if it is not treated quickly. From year to year DM in Indonesia undergone a significant increase and was ranked 6th in the world. In this study, a fuzzy logic system was created for the early diagnosis of DM and calorie needs using the Mamdani method. The trial was conducted in collaboration with Jombang Regional Hospital by comparing the results of the doctor's diagnosis with the fuzzy system created by taking 50 samples of inpatient's medical record data. The first result of this research was a DM diagnosis system with 6 input variables, 3 output variables and 155 rules with MAPE achieved 29.48%. The second was a system of calorie requirement with 2 input variables, 2 output variables and 9 rules with the results achieved BMI with MAPE of 10.57% and BMR of MAPE of 9.7%.

Keywords: *FIS, Mamdani, Diabetes Mellitus, Calorie*

1. INTRODUCTION

Diabetes Mellitus (DM) comes from the Latin word, Diabetes meaning to drain and Mellitus meaning sweet. This disease arises due to metabolic disorders in the body so that blood sugar levels increase (hyperglycemia). Metabolic disorders occur if the pancreas cannot produce enough insulin as what the body needs [1], [2]. The hormone insulin has the function of maintaining blood sugar levels to remain balanced so that the metabolic processes of carbohydrates, fats, and proteins are converted into energy needed by the human body.

The development of DM in Indonesia from year to year has increased. According to the Atlas International Diabetes Federation (IDF) report in 2017 the DM epidemic in Indonesia was ranked sixth in the world after China, India, America, Brazil, and Mexico with DM at the age of 20-79 years of 10.3 million people. Furthermore, the Basic Health Research (Riskesdas) report in 2018 DM sufferers in Indonesia increased up to 8.5% when it is compared to 2013 which was 6.9%.

One of the ways to maintain the health of people with DM is by maintaining dietary habit through a healthy diet [3]. Dietary habit are managed by considering calorie need in a day [4]. The number of calories needed by the body affects the energy needed to do daily activities. Energy needs of each person is different because it is influenced by factors of age, gender, activity and body condition of a person.

DM cannot be cured completely. DM treatment is only used to control or manage blood sugar levels in the body to remain normal. Therefore, we need a method to control and provide early diagnostic information about DM. One of them is by using Fuzzy Inference System (FIS). Fuzzy system is very suitable to be applied in helping to make decisions quickly and well because it is easily understood and practical.

Some researches that have been done by utilizing the fuzzy system were determining the risk level of DM with the Sugeno method which input variables consisted of fasting blood sugar, fasting plasma blood sugar, sleeping plasma sugar, 2 hour PP blood sugar, HbA1c levels, HDL levels, triglyceride levels and insulin levels [5], DM diagnosis using Mamdani and Sugeno methods [6], DM detection using fuzzy hierarchical models [7], using Mamdani method for DM disease detection with input variables consisting of age, weight, blood pressure [8], prediction and classification of DM using the adaptive neuro FIS application [9], using the Sugeno method in determining the type of DM with input variables consisting of age, insulin levels and body weight [10]. Based on the description above, the researchers had a purpose to apply Mamdani method to diagnose early DM and the calorie needs needed by sufferers of this disease.

The results of the study were expected to be used as an information system in making decision in the early selection of DM disease.

2. METHOD

Some basic and supporting theories used in this study are:

2.1. Diabetes Mellitus (DM)

DM occurs due to metabolism disturbance because pancreas cannot produce the hormone insulin effectively. The purpose of the pancreas to produce the hormone insulin to control blood sugar levels in the body remains balanced. There are two types of DM namely [11]:

1) Type I (Depending on Insulin)

It is characterized by failure to produce partial or total insulin by pancreatic bet cells. The cause of this factor is still unclear, but several viruses, autoimmune diseases, and genetic factors can be the causes. Children and adults can suffer DM of type 1. The treatment is by giving insulin injections to control blood sugar levels.

2) Type II (Not Depending on Insulin)

It is characterized by insulin resistance when the hormone insulin is produced in an ineffective amount. This DM is cuased by strong genetic and obesity and usually experienced by adults. DM of type 2 is treated by diet and exercise and the use of diabetes medications.

2.2. Mamdani Fuzzy Inference System (FIS)

The Mamdani method was introduced by Ebrahim Mamdani in 1975, often called the max-min method [12]. To produce an output, four stages need to be passed namely:

1) Fuzzyfication

Formation of input and output variables in the form of crips so that it becomes a fuzzy set.

2) Function of Implications

The function used in this case is min (minimum).

3) Composition of Rules

What is done is the rule with the max (maximum) method. This method is obtained from the maximum value, then used to modify the fuzzy area and apply to the output with the OR (union) operator. The resulted output contains fuzzy set which is a reflection of the contribution of each proportion. The formulation is written as follows:

$$\mu_{sf}(x_i) = \max(\mu_{sf}(x_i), \mu_{kf}(x_i)) \quad (1)$$

with:

$\mu_{sf}(x_i)$ = fuzzy solution member values up to the i-th rule;

$\mu_{kf}(x_i)$ = fuzzy consequent member values up to the i rule;

4) Defuzzy

The defuzzyfication process input contains a set of fuzzy rule compositions while the output is a number in the origin area of the fuzzy membership. So if it is given a certain range of fuzzy set, the crisp value must be taken as output. The method used in this stage is the centroid method (composite moment). The centroid method is a crisp solution obtained from the central point (z *) of the fuzzy region

$$z^* = \frac{\int_z z\mu(z)dz}{\int_z \mu(z)dz} \text{ for continuous variables or} \quad (2)$$

$$z^* = \frac{\sum_{f=1}^{n} z_j \mu(z_j)}{\sum_{f=1}^{n} \mu(z_j)} \text{ for discrete variables} \quad (3)$$

2.3. Calories Needs

Calorie needs needed by people with DM are related to the food consumed every day. Foods that are consumed as what the body needs are balanced foods between nutrients, carbohydrates, proteins, fats, vitamins and minerals. Here are some types of diets and the number of calories for people with DM [13].

Table 1. DM Diet Type

Diet Type	Energy (Kalori)	Carbohydrate (g)	Protein (g)	Fat (g)
I	1100	172	43	30
II	1300	192	45	35
III	1500	235	51.5	36.5
IV	1700	275	55.5	36.5
V	1900	299	60	48
VI	2100	319	62	53
VII	2300	369	73	59
VIII	2500	396	80	62

Explanation:

1) Types of Diet I to III

It is given to people with fat DM and very fat (obese) DM.

2) Types of Diet IV to V

It is provided for people with DM without complications or normal weight.

3) Types of Diet VI to VIII

It is given to people with thin, very thin, and complicated diabetes.

The calculation of the number of calories needed for people with DM is also related to the Mass Body Index (BMI) which is calculated using the BMI formula:

$$BMI = \frac{Body\_Mass(Kg)}{Height(m)} \times Height(m) \quad (4)$$

2.3. Research Stages By Using Fuzzy Mamdani Method

The stages of fuzzy research using the Mamdani method are described in the following flowchart as in Figure 1.

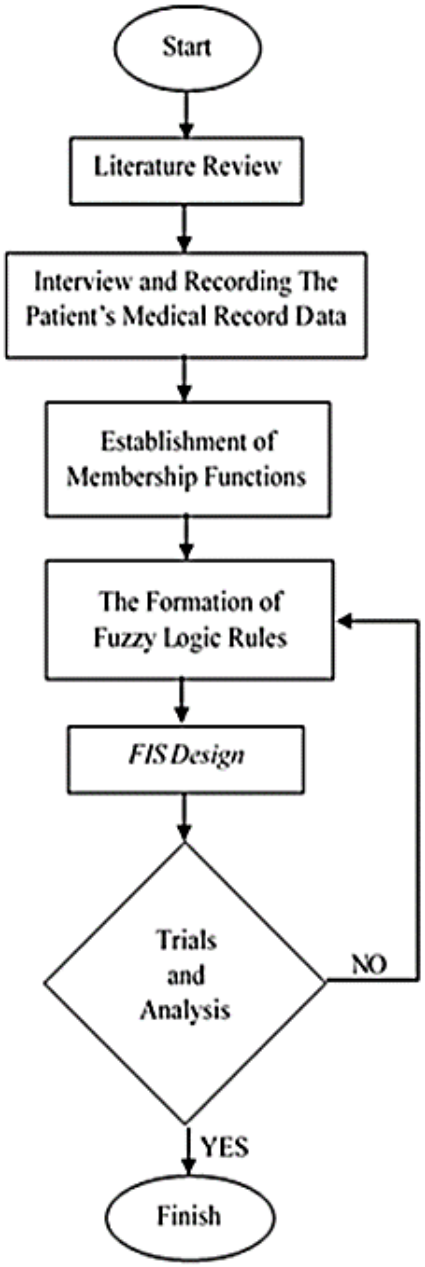


Figure 1 Research Flow Diagram

Based on Figure 1. The stages of research consist of:

- Literature review

The initial stage is to collect various information about DM disease from journal articles, books, internet and other various sources.

- Interviewing and Writing the Data of Patients' Medical Record

Direct interviews were conducted with doctors and nutritionists at a Jombang regional hospital to find out firsthand DM disease and continued to the data retrieval in the form of patients' medical record data related to DM variables.

- Establishment of Membership Functions

The formation of membership functions in the logic of the two fuzzy systems that will be made in this study are: the first system consists of 7 inputs and 3 outputs. Input variables consist of: systole, dystol, glucose, total cholesterol, HDL levels, LDL levels, triglycerides. Output variables are normal, prediabetes, and diabetes. The detailed fuzzy process can be described as follows:

1) Blood Pressure

Table 2. Blood Pressure (mmHg)

Range		Fuzzy Set
Systole	Diastole	
100-120	20-80	Normal
115-145	75-95	Prehypertension
140-160	90-100	Hypertension State I
155-240	95-140	Hypertension State II

2) Glucose at a Time

Table 3. Glucose at a Time (mg/dl)

Range	Fuzzy Set
100-200	Normal
200-300	Diabetes

3) Total Cholesterol

Table 4. Cholesterol Total (mg/dl)

Range	Fuzzy Set
100-200	Normal
190-250	Rather High

240-300	High

4) HDL Levels

Table 5. HDL Levels (mg/dl)

Range	Fuzzy Set
20-50	Low
45-65	Normal
60-80	High

5) LDL Levels

Table 6. LDL Levels (mg/dl)

Range	Fuzzy Set
50-100	Optimal
90-135	Near Optimal
130-160	High Boundary Line
155-195	High
190-210	Very High

6) Triglycerides

Table 7. Triglycerides (mg/dl)

Range	Fuzzy Set
50-150	Normal
145-205	Rather High
200-500	High
495-600	Very High

The second system is to determine the calories needed by people with DM. The membership function consists of 2 input variables namely body weight and height as well as output variables namely BMI and BMR. The detailed fuzzy process can be described as follows:

1) Body's Weight

Table 8. Body Mass (kg)

Range	Fuzzy Set
25-50	Thin
38-60	Normal
58-80	Fat

2) Height

Table 9. Height (meter)

Range	Fuzzy Set
1.20-1.45	Short
1.40-1.65	Normal
1.60-1.85	High

- Establishment of Fuzzy Logic Rules

Fuzzy logic rules are arranged based on a combination of fuzzy sets of each input variable.

- FIS Design

Making the application of function implications, composition of rules, and defusion is a step to interfere with fuzzy systems in a case sample.

- Trial and Analysis

The trial was conducted in collaboration with Jombang Regional Hospital by comparing the results of the doctor's diagnosis with the fuzzy system created by taking 50 samples of inpatient's medical record data. Analysis is made by using the Mean Absolute Percent Error (MAPE) method. The calculation of MAPE is as follows:

$$MAPE = \frac{\frac{\sum_{t=1}^{n} \left| Y_t - \bar{Y}_t \right|}{Y_t} \times 100}{n} \quad (5)$$

with:

Y_t = actual data

$\bar{Y}_t$ = predictive data

n = sum of data

3. RESULT AND DISCUSSION

This research consisted of 2 fuzzy systems, in which the first system diagnoses diabetes, prediabet, and normal and the second system determines the calories needed by using the Mamdani fuzzy method. The results of each system were as follows.

3.1. Diagnosis of Diabetes Mellitus (DM)

In the first system, the inputs used to build a fuzzy system for diagnosing diabetes mellitus are systole, diastole, glucose, total cholesterol, HDL, LDL and triglyceria. The fuzzyfication stage in this system forms the range and fuzzy sets of each input and output using a shoulder curve. The results of the membership function of the input variable at each set of fuzzy sets are as follows.

1) Blood Pressure

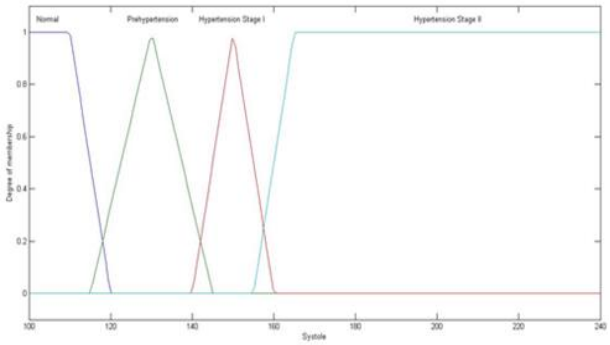


Figure 2 Membership of Systole

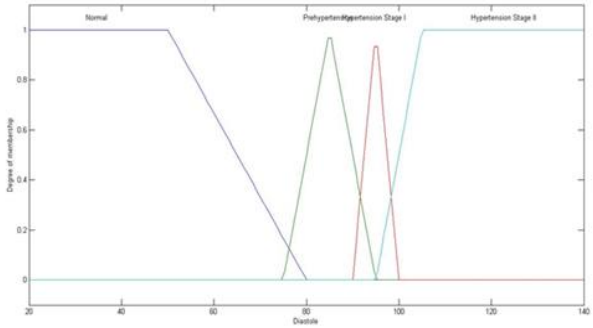


Figure 3 Membership of Diastole

2) Glucose at a Time

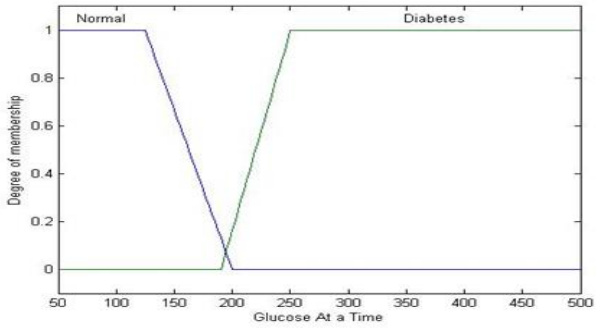


Figure 4 Timing Glucose Membership

3) Total Cholesterol

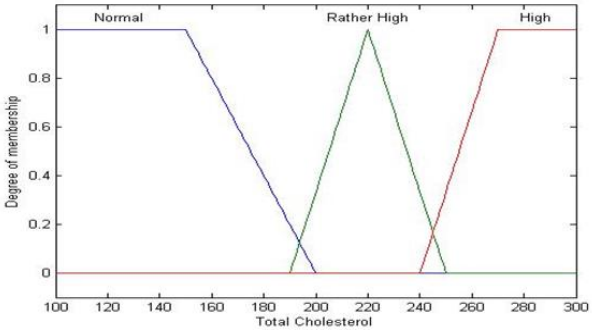


Figure 5 Total Cholesterol Membership

4) HDL Levels

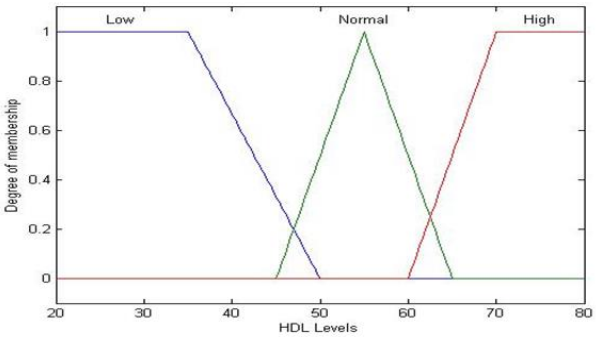


Figure 6 Membership of HDL Levels

5) LDL Levels

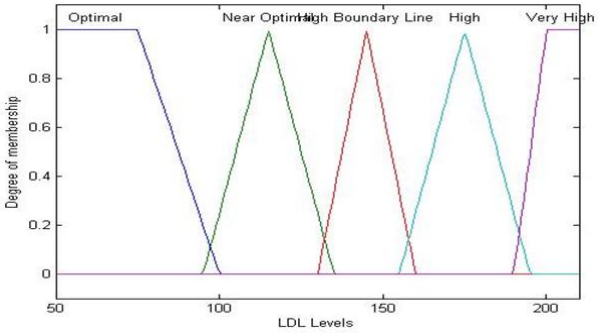


Figure 7 Membership of LDL Levels

6) Triglycerides

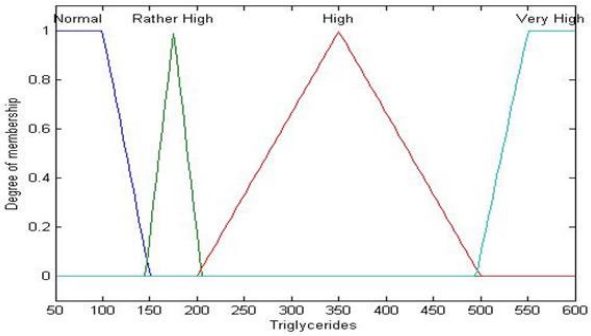


Figure 8 Triglyceride Membership

While the output in this system was divided into 3 fuzzy sets, namely normal, prediabetes and diabetes. Fuzzy sets of DM output formed as follows:

Table 10. Output DM

Range	Fuzzy Set
50-100	Normal
95-125	Prediabetes
120-200	Diabetes

The inference stage in this system is 155 rules. So that the diabetes mellitus system was formed with 7 inputs, 1 output and 155 rules as shown in Figure 9 below.

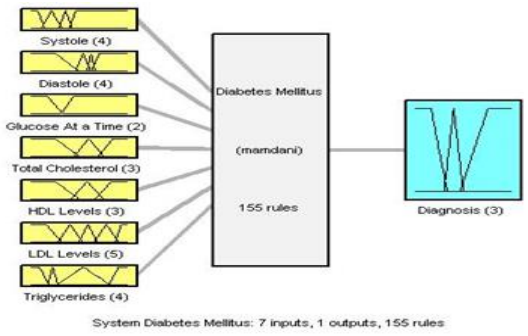


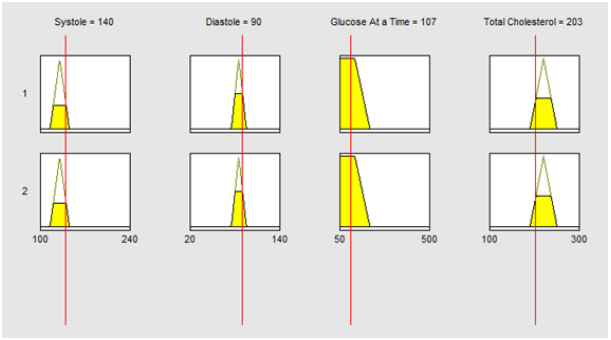
Figure 9 DM Diagnosis System

The results of the analysis of 50 data obtained from Jombang Regional Hospital with a fuzzy system using MAPE were 29.48%. For example if blood pressure was 140/90 mmHg, glucose at 107 mg / dl, total cholesterol 203 mg / dl, HDL 44 mg / dl, LDL 140 mg / dl and triglyceria 94 mg / dl., then the rule formed was:

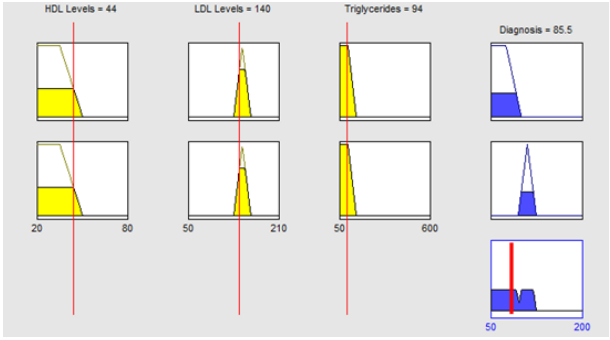
R27 If systole prehypertension and diastole prehypertension and glucose when normal and total cholesterol are rather high and HDL is low and LDL is in high borderline and triglyceria is normal, then the diagnosis is normal

R27 If systole prehypertension and diastol prehypertension and glucose at time are normal and total cholesterol is rather high and HDL is low and LDL is in high boundary and triglyceria is normal, then the diagnosis is prediabetes.

Based on the results of the DM fuzzy diagnoss system obtained 85.5 which meant normal, while according to data from Jombang Regional Hospital 98 whose meaning was that it was normal. The difference of results of the system from the data obtained was only 12.5 but both showed normal diagnoses. The results of the DM diagnosis system based on fuzzy system can be seen in Figure 10.



(a)



(b)

Figure 10 (a), (b) Results of DM Diagnosis by Using Fuzzy System

3.2. Calories Needs

This second system was to determine the calories needed. This study used two outputs namely BMI and BMR, in the forms of inputs of weight and height. This kind of system was the same as the first system also using shoulder curves. It had two inputs, two outputs and 9 fuzzy IMT and BMR system rules as shown in Figure 13 below. The results of the input variables of membership function at each fuzzy set are as follows.

1) Weight

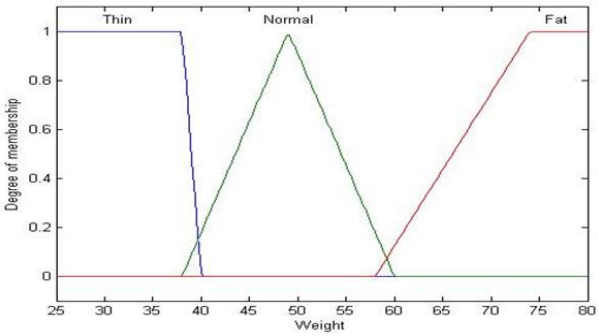


Figure 11 Membership of Weight

2) Height

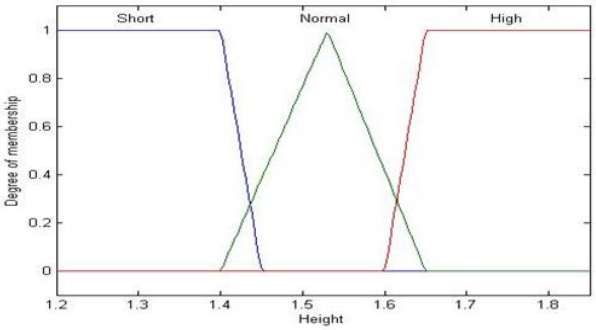


Figure 12 Membership of Height

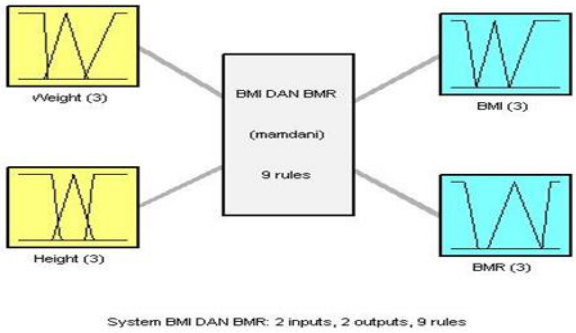


Figure 13 IMT and BMR System with 2 Inputs, 2 Outputs and 9 Rules

For instance, if you weigh was 53 kg and your height was 1.63 m., so the formed rule was

R5 If the weight and height are normal, BMI and BMR are normal

R8 If your weight is normal and you are tall, BMI and BMR are normal

Fuzzy sets of IMT output formed as follows:

Table 11. Output IMT

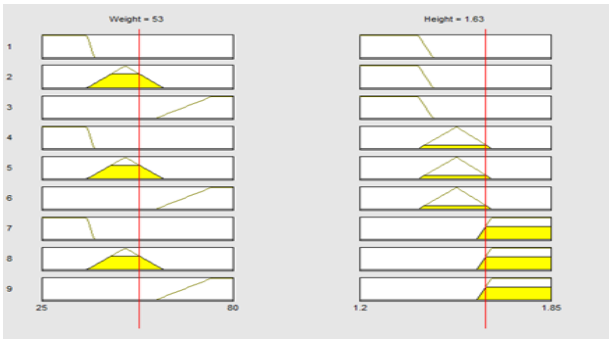
Range	Fuzzy Set
15-18.5	Thun
18.5-23	Normal
23-30	Fat

Fuzzy sets of BMR output formed as follows:

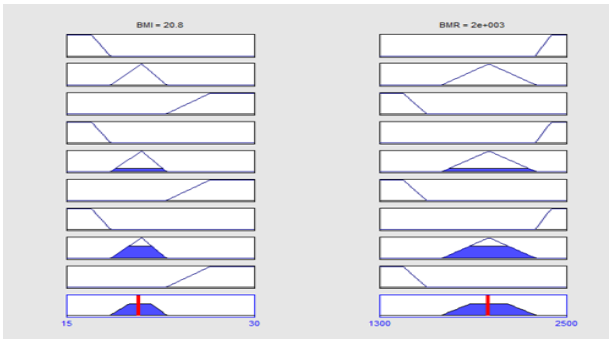
Table 12. Output BMR

Range	Fuzzy Set
1500-1600	Fat
1700-2300	Normal
2300-2500	Thin

Based on the results of the fuzzy IMT and BMR system in Figure 12, the BMI of 20.8 kg/m2 was normal so that the required BMR was 2000 calories. Whereas, according to the formula, IMT of 19.94 means normal and the required BMR was around 1700 to 2100 calories. The difference of the fuzzy system results from those of the system with the formula is only 0.86 and both of them show the normal BMI with the appropriate BMR.



(a)



(b)

Figure 14 (a), (b) Results of IMT and BMR with Fuzzy Systems

Correlation between calorie requirements and DM according to the description of Table 1. Suppose the type of diet I to diet III was given to people with DM fat and very fat (obese) required calories of 1100 to 1500 calories.

4. CONCLUSION

Based on the results and discussion of this study, it could be concluded that an application in the health field had been made, namely early diagnosis of DM using the Fuzzy Mamdani method and calorie needs. The DM diagnosis system consisted of 6 input variables: blood pressure, glucose time, total cholesterol, HDL, LDL, triglycerides and 3 output variables: normal, prediabetes and diabetes by producing 155 rules with a MAPE of 29.48%. The calorie need system comprised of 2 input variables: body weight, and height and 2 output variables: BMI with MAPE of 10.57% and BMR of MAPE of 9.7% by producing 9 rules.

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REFERENCES

[1] Ade Eviyanti, Hindarto, and Sumarno, "Sitem Pakar Diagnosa Dini Penyakit Diabetes," Jurnal Saintek, vol. 12, pg. 1-6, Juni 2015.

[2] A. Shaheen, W.A. Khan, "Intelegent Decision Support System in Diabetic eHealth Care From the Persepctive of Elders," Thesis Ronneby: Department of School of computing Bleking Institute of Technology Soft Center.

[3] G.W. Krisnanti dkk, "Aplikasi Perhitungan Kalori harian Pemderita DM Menggunakan Metode FIS Tsukamoto," Tugas Akhir: Program Studi Informatika Universitas Brawijaya, 2013.

[4] Askandar Tjokroprawiro, "Garis Besar Makan dan Pola Hidup sebagai Pendukung Terapi Diabetes mellitus," Kongres Nasional III AsDi, 11-13 oktober, 2012.

[5] Huzaimah, S. Musdalifa, A. Hendra, and I.W. Sudarsana, "penentuan Tingkat Resiko Penyakit Diabetes Mellitus dengan Metode Sugeno di RSUD UNDATA proponsi Sulawesi Tengah," JIMT, vol.9, pg 65-74, 1 juni 2012.

[6] Jimmy Singla, "Comparative Study of Mamdani-Type and Sugeno-Type Fuzzy Inference Systems fod Diagnosisi of Diabetes," ICACEA-IEEE Ghaziabad India, pp. 517-522, 2015.

[7] Rian Budi Lukmanto, Irwansyah E, "The Early Detection of Diabetes Mellitus (DM) Using Fuzzy Hierarchical Model," Procedia Computer Science-ScienceDirect,vol.59, pp. 312-319, 2015.

[8] Slamet Riyadhi, "Uji Coba Metode Mamdani Untuk Deteksi Penyakit Diabetes di RSUD Dr. H. Soemarno Sosroatmojo, Kuala Kupas," Jurnal INTEKNA, vol.1, pg. 70-77, mei 2013.

[9] Oana Geman, I. Chiuchisa, R.T. Toderean, "Application of Adaptive Neuro-Fuzzy Inference System for Diabetes Classification and Prediction," EHB-IEEE, pp. 639-642, 22-24 Juni, 2017.

[10] Rico Andrial, "Fuzzy Logic Modelling Metode Sugeno Pada Penentuan TipeDiabetes Melitus Menggunakan Matlab," Jurnal Ilmiah Informatika (JIF). vol. 6, no.1, 2018. ISSN (Prin) 2337-8379. ISSN (Online) 2615-1049.

[11] J.M. Gibney J.M dkk, "Gizi Kesehatan Masyarakat," Jakarta: Buku Kedokteran EGC. 2009.

[12] Sri Kusumadewi dkk, "Aplikasi Logika Fuzzy untuk Pendukung Keputusan," Yogyakarta: Graha ilmu, 2010.

[13] Beny Irawan and S. Achmady, "Pola Diet Pada Penderita Diabetes Melitus Menggunakan Metode Fuzzy Inferensi Sistem," Seminar Nasional Literasi Sistem:USU, pg. 381-384, ISBN: 979-458-762-1, 2014.