Fuzzy Logic Prediction of Dengue Hemorrhagic Fever Distribution in Pringsewu Region

Muhamad Muslihudin, Siti Mukodimah, Erma Dwiyani, Trisnawati, Wahidah Hashim, Andino Maseleno

Abstract: Dengue Hemorrhagic Fever (DHF) has been a public health problem in Indonesia for the past 47 years. Dengue hemorrhagic fever or dengue fever is an infection caused by the dengue virus, which is transmitted by the bite of the female Aedes aegipty or female Aedes albopictus. This study was conducted to predict the distributin of dengue hemorrhagic fever in pringsewu areas using fuzzy logic method. Fuzzy logic method was selected because it is able to select the best alternative from all available alternatives. In this study seven criteria were used as reference in predicting the distribution of dengue hemorrhagic fever in pre-pregnancy area such criteria as Population Density, air humidity, water sources, health facilities, sanitation, sewerage and trash cans. In addition to the criteria also used the weighting criteria to determine the best alternative and from the calculation obtained the highest score found in column d which means that the area or village with Indication as in column d was an area prone to the distribution of dengue fever, while the lowest score was in the column y which means that the area with Indication column y was the area with the least chance of risk of dengue hemorrhagic fever distribution.

Index Terms: ***Prediction, Dengue Hemorrhagic Fever, Fuzzy Logic, Pringsewu Area.***

I. INTRODUCTION

Dengue hemorrhagic fever or dengue fever is an infection caused by the dengue virus, which is transmitted by the bite of the female Aedes aegipty or female Aedes albopictus. Dengue virus consists of four types (strains), namely dengue type 1, 2, 3, and 4. Dengue virus causes interference with the capillary arteries and blood clotting system resulting in bleeding, it can cause death. Usually, dengue hemorrhagic fever is endemic when the season change from the rainy season to the dry season or vice versa.

Revised Manuscript Received on May 22, 2019.

Muhamad Muslihudin, Department of Information Systems, STMIK Pringsewu, Lampung, Indonesia. E-mail: muslihudinstmikpsw@gmail.com

Siti Mukodimah, Department of Information Systems, STMIK Pringsewu, Lampung, Indonesia.

Erma Dwiyana, Department of Information Systems, STMIK Pringsewu, Lampung, Indonesia.

Trisnawati, Department of Information Systems, STMIK Pringsewu, Lampung, Indonesia.

Wahidah Hashim, Institute of Informatics and Computing Energy, Universiti Tenaga Nasional, Malaysia.

Andino Maseleno, Institute of Informatics and Computing Energy, Universiti Tenaga Nasional, Malaysia. E-mail: andimaseleno@gmail.com

Aedes aegipty or Aedes albopictus mosquito is found in tropical and sub-tropical regions.

DHF has been a public health problem in Indonesia for the past 47 years. Since 1968 there had been an increase in the number of provinces and districts / cities from 2 provinces and 2 cities, it became 34 provinces and 436 (85%) districts / cities in 2015. There had also been an increase in the number of dengue cases from 1968 to 126,675 cases in in 2015. The increase and distribution of dengue case can be caused by high population mobility, urban development, climate change, changes in population density and distribution and other epidemiological factors[1]

The number of fluctuating DHF cases every year. Data from the Directorate of Prevention and Control of Vector and Zoonotic Diseases, Ministry of Health, Republic of Indonesia, in 2014 the number of patients reached 100,347. 907 of them died. In 2015, 129,650 sufferered and 1,071 died. Whereas in 2016 there were 202,314 sufferered and 1,593 died . In 2016, from January to May there were 17,877 cases, with 115 deaths. The morbidity or Incidence Rate (IR) in 34 provinces in 2015 reached 50.75 per 100 thousand residents, and IR in 2016 reached 78.85 per 100 thousand residents. This number is still higher than the national IR target of 49 per 100,000 residents[2].

Based on the research [3] done by researcher for ranking dengue hemorrhagic fever endemic area in Tanggamus district using the saw method. In this study several criteria were used such as Population Density, air humidity, clean water sources and available health facilities. In this study 10 sub-districts were used as an alternative, 2 of which received the highest scores and 5 sub-districts included in the area prone to dengue fever.

Based on the research [4] conducted on the relationship of environmental and community behavior factors with the presence of DHF vectors in the working area of health center in southern Denpasar. The study showed that environmental factors associated with the presence of DHF vectors like Population Density, population mobility, the existence of places of worship, the presence of ornamental plant pots, the presence of rainwater channels, and the existence of containers. Community behavior factors related to the presence of DHF vectors were actions and habits of hanging clothes. Research on the distribution of dengue hemorrhagic fever has also been carried out

Retrieval Number: H11020688S219/19©BEIESP

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

using applications as in the study [5]
This study was a study of the spread of dengue hemorhagic fever in Ambon city which was detected using backpropagation neural network applications. In addition to the backpropagation method, 82 data were used, 62 data as data and 20 test data such as average temperature data, rainfall, number of rainy days, Population Density and larva free numbers. From this study the best network architecture obtained from one hidden layer with the number of neurons as many as 25 neurons and the best training algorithm was by using a learning rate of 0.4 with MSE 0.0099. Thus, the Application of Artificial Neural Networks backpropagation method for the spread of DHF in Ambon City had a high degree of accuracy, which was equal to 90%.

Lampung Province as a result from the expansion of Tanggamus Regency, and was formed based on Law Number 48 of 2008 dated November 26, 2008 and was inaugurated on April 3, 2009 by the Minister of Home Affairs. Geographically, Pringsewu Regency is located between 104045'25 "- 10508'42" East Longitude (BT) and 508'10 "- 5034'27" South Latitude (LS), with an area of around 625 km2 or 62,500 Ha or only equivalent to 2% of the area of Lampung Province with a population density of 379,190 inhabitants, which has the possibility of the distribution of dengue hemorrhagic fever [6][7]

This study designed a system that can be used as an effort to predict the spread of dengue hemorrhagic fever in Pringsewu District using the fuzzy logic method based on predetermined criteria. The existence of this research was expected to help minimize the distribution of dengue hemorrhagic fever in Pringsewu District.

II. THEORETICAL BASE

2.1. Decision Support System

Decision Support System is an information system to help user for semi-structured decision-making processes to be more effective using analyst model and available data [8]. Decision support systems is information system that helps identify decision-making opportunity or provide information to help make decisions[9].

Three goals that must be achieved by a decision support system, namely, the system must be able to assist manager in making decisions to solve semi-structured problem, the system must be able to support manager rather than trying to replace them and the system must be able to improve the effectiveness of manager's decision making[10].

2.2. Dengue Hemorrhagic Fever

Dengue Hemorrhagic Fever (DHF) is an infectious disease caused by one of four different dengue viruses and is transmitted through mosquitoes, especially Aedes Aegypti and Aedes Albopictus which are found in the tropics and subtropics, including the history of Indonesia to the northern part of Australia. Indonesia is a tropical country that is very good for the growth of animals and plants. Indonesia is also a place for developing various diseases, especially diseases carried by vectors, namely pathogenic agent spreading organisms from host to host, such as mosquitoes which transmit diseases such as Dengue Hemorrhagic Fever. The incidence of dengue hemorrhagic fever in Indonesia tends to increase in the middle of the rainy season around January, and tends to fall from February to the end of the year.

The Indonesian Ministry of Health noted that the number of people with Dengue Hemorrhagic Fever (DHF) in Indonesia in January-February 2016 was 13,219 people with DHF with 137 deaths. The highest proportion of sufferers who experience DHF in Indonesia WAS in the group of children aged 5-14 years, reaching 42.72% and the second in the age range of 15-44 years, reaching 34.49%.

2.3 Fuzzy Method

Fuzzy logic was first introduced by Jan Lukasiewicz in the 1920s as a possible theory [11][12]. In 1965 Lotfi A. Zadeh, a professor from the University of California rediscovered, identified, promoted, and fought for fuzzy logic[13]. Professor Zadeh expanded the possibility of working space into a system of formal mathematical logic and a new concept to apply the term natural language to his research, "Fuzzy Sets". Fuzzy set theory is a mathematical framework used to present uncertainty, obscurity, inaccuracy, lack of information and partial truth [14][15], [16].
Fuzzy logic comes from fuzzy set. Unlike the strict set, where an object can be a member or not a member, the fuzzy set is a set whose membership is only partially [16].

III. RESEARCH METHOD

3.1 Data Collection Method

3.1.1 Observation

Observation is a method of collecting data through direct observation or a careful and direct review of the field or location of the study [17-21]. Through observation the author can see and observe directly and can gather information that might not be obtained during the interview [22-26]. By making observation author can see the conditions and problem that exist in field [27-32].

3.1.2 Literature Review

Literature review is the stage of data collection by collecting and studying various references to previous journals related to the problem to be studied [33-36].

3.2 Fuzzy Logic

Fuzzy set theory was introduced by Lothfi A. Zadeh in 1965. Zadeh stated a definition of a fuzzy set [37-39].

Fuzzy set is a collection of mathematical principle as illustration of knowledge based on membership degree rather than using low degree of classical binary logic [40-43]. A fuzzy set is a set that contains the degree of membership that varies in the set. These elements can also enter into other fuzzy sets in the same universe. Conventional sets can be written in mathematical form as follows .

$$\mu_A(x) = \begin{cases} 1, if\ x \in A \\ 0, if\ x \notin A \end{cases}$$

Fuzzy set is set that has fuzzy boundary. The basic idea of fuzzy set theory is that all elements are included in a fuzzy set with a certain degree of membership, which is not only true or false (0 or 1), but can be partially true or partly wrong to some degrees. This degree is usually taken from the real score in the interval [0,1]. The degree of fuzzy membership can be denoted as follows.

$$\mu_A(x) = \begin{cases} 1, if\ x \in A \\ 0, if\ x \notin A \\ 0 < \mu_A < 1, if\ x\ is\ partly\ in\ A \end{cases}$$

Fuzzy logic has a degree of membership in the range of 0 (zero) to 1 (one), different from the digital logic which only has two values, namely 1 (one) or 0 (zero). Fuzzy logic is used to translate a quantity that is expressed using language (linguistic). For example, the speed rate of a vehicle that is expressed slowly, rather quickly, quickly, and very quickly.

Membership function μ_A (x) maps object or attribute (x) to positive real numbers at intervals [0,1]. Because the characteristic of the mapping is like a function, it is called a membership function. A membership function μ_A (x) is characterized by mapping μ_A: (x) → [0,1], x ∈X where x is a real number that describes an object or attribute and x is a universe study and A is a subset of x.

The membership function is x element mapping of the universe of membership score using a form of theoretical function. Some fuzzy membership functions:

1. Liniear representation

The input mapping to the degree of membership is described as a straight line. There were 2 forms, namely linear up and down representation. On a rising representation curve, the set started at the dominant score that had a degree of membership [0] and moved right to the dominant with a higher degree of membership.

Membership function was :

$$\mu_A(x) = \begin{cases} 0; x \le a \\ \frac{x-a}{b-a}; a \le x \le b \\ 1; x \ge b \end{cases}$$

On the linear representation curve, the set started at the dominant score that had a degree of membership [1] and moved right toward the dominant with a lower degree of membership.

Membership function was :

$$\mu_A(x) = \begin{cases} \frac{b-x}{b-a}; a \le x \le b \\ 0; x \ge b \end{cases}$$

2. Triangle Curve Representation

Representation of triangle curve was combination between two lines (linear)

Membership function was :

$$\mu_A(x) = \begin{cases} 0; x \le a\ or\ x \ge c \\ \frac{x-a}{b-a}; a \le x \le b \\ \frac{c-x}{c-b}; b \le x \le c \end{cases}$$

3. Trapesium Trapezoid Curve Representation

The trapezoidal curve representation resembled a triangular shape, but had several points with a membership degree of 1.

Membership function was :

$$\mu_A(x) = \begin{cases} 0; x \le a\ or\ x \ge d \\ \frac{x-a}{b-a}; a \le x \le b \\ 1; b \le x \le c \\ \frac{d-x}{d-c}; c \le x \le d \end{cases}$$

4. Soldier form curve representation

Area that is located on the right and left side had not been changed, the are was used to terminate the variables of a fuzzy area. On the left shoulder the curve moved from true to false , and on the right side the curve moved from false to true.

In a study to predict the distribution of Dengue Hemorrhagic Fever in Pringsewu Area using the fuzzy logic method that required weighting criteria, weight score and alternatives tested using the village area as the sample.

a. Weight Criteria

The criteria of the predictions the spread of dengue fever in the fuzzy logic Pringsewu uses the method used to determine Criteria and weights for performing calculations that extend to the best alternative.

Table 1. Criteria Table

CRITERIA	CODE	WEIGHT
Population density	C1	20
Air humidity	C2	10
Water source	C3	10
Health facility	C4	15
Sewerage	C5	10
Sanitation	C6	20
Trash can	C7	15

IV. RESULTS AND DISCUSSION

4.1. Discussion

Prediction of the Dengue Hemorrhagic Fever distribution in Pringsewu Area using fuzzy logic method. The Villages predicted to be infected by Dengue Hemorrhagic Fever distribution were the villages with the lowest score. Where the lowest score obtained from each criterion that was the reference of the study considered to be a vulnerable area due to the spread of Dengue Hemorrhagic Fever. The membership score of Dengue Hemorrhagic Fever prone area to detect the distribution of Dengue Hemorrhagic Fever can be calculated in Pringsewu area as follows:

Population Density

$\mu(area)_{SR}[32.5] = \frac{60-32.5}{60-30} = 0.9167$

Retrieval Number: H11020688S219/19©BEIESP

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

$\mu(area)_R[62.5] = \frac{90-62.5}{90-60}$=0.9167

$\mu(area)_C[92.5] = \frac{120-92.5}{120-90}$=0.9167

$\mu(area)_T[110] = \frac{110-90}{120-90}$=0.6667

$\mu(area)_{ST}[140] = \frac{140-120}{150-120}$=0.6667

Air Humidity

$\mu(area)_{SR}[7.5] = \frac{15-7.5}{15-10}$=1.5

$\mu(area)_R[12.5] = \frac{20-12.5}{20-15}$=1.5

$\mu(area)_C[17.5] = \frac{25-17.5}{25-20}$=1.5

$\mu(area)_T[24] = \frac{24-20}{25-20}$=0.8

$\mu(area)_{ST}[29] = \frac{29-25}{30-25}$=0.8

Water Source

$\mu(area)_{SR}[7.5] = \frac{10-7.5}{10-5}$=0.5

$\mu(area)_R[12.5] = \frac{15-12.5}{15-10}$=0.5

$\mu(area)_C[17.5] = \frac{20-17.5}{20-15}$=0.5

$\mu(area)_{ST}[19] = \frac{19-15}{20-15}$=0.8

$\mu(area)_T[24] = \frac{24-20}{25-20}$=0.8

Health Facility

$\mu(area)_{SR}[4.5] = \frac{6-4.5}{6-3}$=0.5

$\mu(area)_R[7.5] = \frac{9-7.5}{9-6}$=0.5

$\mu(area)_C[10.5] = \frac{12-10.5}{12-9}$=0.5

$\mu(area)_T[11] = \frac{11-9}{12-9}$=0.6667

$\mu(area)_{ST}[14] = \frac{14-12}{15-12}$=0.6667

Sewerage

$\mu(area)_{SR}[3] = \frac{4-3}{4-2}$=0.5

$\mu(area)_R[5] = \frac{6-5}{6-4}$=0.5

$\mu(area)_C[7] = \frac{8-7}{8-6}$=0.5

$\mu(area)_T[7] = \frac{7-6}{8-6}$=0.5

$\mu(area)_{ST}[8] = \frac{9-8}{10-8}$=0.5

Sanitation

$\mu(area)_{SR}[3] = \frac{4-3}{4-2}$=0.5

$\mu(area)_R[5] = \frac{6-5}{6-4}$=0.5

$\mu(area)_C[7] = \frac{8-7}{8-6}$=0.5

$\mu(area)_T[7] = \frac{7-6}{8-6}$=0.5

$\mu(area)_{ST}[8] = \frac{9-8}{10-8}$=0.5

Trash Can

$\mu(area)_{SR}[7.5] = \frac{15-7.5}{15-10}$=1.5

$\mu(area)_R[12.5] = \frac{20-12.5}{20-15}$=1.5

$\mu(area)_C[17.5] = \frac{25-17.5}{25-20}$=1.5

$\mu(area)_T[24] = \frac{24-20}{25-20}$=0.8

$\mu(area)_{ST}[29] = \frac{29-25}{30-25}$=0.8

4.2 Inference

This stage is the determination of rules of fuzzy logic system, rules can be formed to express the relation between input and output. Each rule is an implementation, the operator used to connect the input rule is the operator and what describes the input-output is If-Then

a. **IF** Indication A area **[Very low indication]** and Indication B **[Very high indication]** and Population Density **[Very high population density] THEN** disease distribution risk **[Very high risk]**

b. **IF** Indication A area [**low indication]** and Indication B **[Very high indication]** and Population Density **[Very high population density] THEN** disease distribution risk **[high risk]**

c. **IF** Indication A area [**medium indication]** and Indication B **[medium indication]** and Population Density **[Very high population density] THEN** disease distribution risk **[medium risk]**

d. **IF** Indication A area **[high indication]** and Indication B

Published By:
Blue Eyes Intelligence Engineering & Sciences Publication

[low indication] and Population Density **[Very high population density] THEN** disease distribution risk **[low risk]**

e. IF Indication A area **[very low indication]** and Indication B **[Very high indication]** and Population Density **[Very high population density] THEN** disease distribution risk **[high risk]**

f. IF Indication A area **[very low indication]** and Indication B **[Very high indication]** and Population Density**[Very high population density] THEN** disease distribution risk **[high risk]**

g. IF Indication A area **[very low indication]** and Indication B **[Very high indication]** and Population Density**[high population density] THEN** disease distribution risk **[high risk]**

h. IF Indication A area **[medium indication]** and Indication B **[medium indication]** and Population Density**[high population density] THEN** disease distribution risk **[high risk]**

i. IF Indication A area **[high indication]** and Indication B **[low indication]** and Population Density**[high population density] THEN** disease distribution risk **[low risk]**

j. IF Indication A area **[very high indication]** and Indication B **[very low indication]** and Population Density**[high population density] THEN** disease distribution risk **[low risk]**

k. IF Indication A area **[very low indication]** and Indication B **[Very high indication]** and Population Density**[medium population density] THEN** disease distribution risk **[medium risk]**

l. IF Indication A area [**low indication]** and Indication B **[high indication]** and Population Density**[medium population density] THEN** disease distribution risk **[medium risk]**

m. IF Indication A area **[medium indication]** and Indication B **[medium indication]** and Population Density**[medium population density] THEN** disease distribution risk **[low risk]**

n. IF Indication A area **[high indication]** and Indication B **[low indication]** and Population Density**[medium population density] THEN** disease distribution risk **[low risk]**

o. IF Indication A area **[very high indication]** and Indication B **[Very low indication]** and Population Density**[medium population density] THEN** disease distribution risk **[medium risk]**

p. IF Indication A area **[very low indication]** and Indication B **[Very high indication]** and Population Density**[low population density] THEN** disease distribution risk **[medium risk]**

q. IF Indication A area [**low indication]** and Indication B **[high indication]** and Population Density **[low population density] THEN** disease distribution risk **[medium risk]**

r. IF Indication A area **[medium indication]** and Indication B **[medium indication]** and Population Density**[low population density] THEN** disease distribution risk **[low risk]**

s. IF Indication A area **[high indication]** and Indication B **[low indication]** and Population Density**[low population density] THEN** disease distribution risk **[low risk]**

t. IF Indication A area **[very high indication]** and Indication B **[Very low indication]** and Population Density**[low population density] THEN** disease distribution risk **[low risk]**

u. IF Indication A area **[very low indication]** and Indication B **[Very high indication]** and Population Density**[very low population density] THEN** disease distribution risk **[low risk]**

v. IF Indication A area [**low indication]** and Indication B **[high indication]** and Population Density**[very low population density] THEN** disease distribution risk **[high risk]**

w. IF Indication A area **[medium indication]** and Indication B **[medium indication]** and Population Density**[very low population density] THEN** disease distribution risk **[very low risk]**

x. IF Indication A area **[high indication]** and Indication B **[low indication]** and Population Density **[very low population density] THEN** disease distribution risk **[low risk]**

y. IF Indication A area **[very high indication]** and Indication B **[Very low indication]** and Population Density**[medium population density] THEN** disease distribution risk **[low risk]**

4.3 Defuzzification

This stage is also called input and process affirmation stage. This assertion is a blurred set obtained from the momposition between blurred rules, for which the output obtained is a number in the weight of the blurred set.

$$Z_a = \frac{166.505}{5.2667} = 31.61467$$

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Retrieval Number: H11020688S219/19©BEIESP

$Z_b = \frac{167.505}{5.2667}$ =31.80454

$Z_c = \frac{178.005}{5.6667}$ =31.41246

$Z_d = \frac{165.5054}{5.1334}$ =32.24089

$Z_e = \frac{157.5055}{5.1334}$ =30.68249

$Z_f = \frac{153.5041}{5.1334}$ =29.90300

$Z_g = \frac{149.5042}{5.1334}$ =29.1238

$Z_h = \frac{145.5043}{5.1334}$ =28.34462

$Z_i = \frac{145.5044}{5.1334}$ =28.34464

$Z_j = \frac{137.5054}{5.1334}$ =26.78624

$Z_k = \frac{156.0031}{5.3834}$ =28.97854

$Z_l = \frac{152.0032}{5.3834}$ =28.23553

$Z_m = \frac{148.0033}{5.3834}$ =27.49253

$Z_n = \frac{148.0034}{5.3834}$ =27.49255

$Z_o = \frac{140.0035}{5.3834}$ =26,00652

$Z_p = \frac{128.5021}{5.3834}$ =23.87006

$Z_q = \frac{124.5022}{5.3834}$ =23.12705

$Z_r = \frac{120.5023}{5.3834}$ =22.38405

$Z_s = \frac{120.5024}{5.3834}$ =22.38406

$Z_t = \frac{112.5025}{5.3834}$ =20.89803

$Z_u = \frac{101.0011}{5.3834}$ =18.76158

$Z_v = \frac{97.0012}{5.3834}$ =18.01857

$Z_w = \frac{93.0013}{5.3834}$ =17.27556

$Z_x = \frac{93.0014}{5.3834}$ =17.27558

$Z_y = \frac{85.0015}{5.3834}$ =15.78955

From calculation above, it can be seen in the following table 2 :

Table 2. Total Score and Ranking

No	Total Score	RANK
A	31.61467332	3
B	31.80454554	2
C	31.41246228	4
D	32.24089298	1
E	30.68249114	5
F	29.90300775	6
g	29.12381657	7
h	28.34462539	10
i	28.34464487	9
j	26.78624304	14
k	28.97854516	8
l	28.23553888	11
m	27.4925326	13
n	27.49255118	12
o	26.00652004	15
p	23.87006353	16
q	23.12705725	17
r	22.38405097	19
s	22.38406955	18
t	20.89803841	20
u	18.7615819	21
v	18.01857562	22
w	17.27556934	24
x	17.27558792	23
y	15.78955679	25

From the table above, it can be seen that the highest score was found in column d, it means region or village with indication such as in column d was prone area to the distribution of Dengue Hemorrhagic Fever, while the lowest score was in column y, which mean that regions with column y was region with a small risk of Dengue Hemorrhagic Fever distribution.

V. CONCLUSION AND SUGGESTION

5.1 Conclusion

From this study it can be concluded that Fuzzy Logic method can be used to predict the spread of Dengue Hemorrhagic Fever in Pringsewu District by using several criteria for Population Density, Air Humidity, Water Sources, Health Facilities, sewerage, Sanitation, and Trash.

5.2 Suggestion

In this study authors only used seven criteria. As for suggestions for future research, this research can still be developed again by means of adding criteria, changing the weight score of criteria or by using other methods

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

and developing into expert system in application form.

REFERENCES

1. Ministry of Health Republic of Indonesia, "Infodatin: Situs DBD di Indonesia." p. 9, 2016.
2. "data fluktuatif," *www.kemenkes.go.id*. 2017.
3. M. Muslihudin and F. Noviarti, Tri, "Sistem Pengambilan Keputusan Perankingan Wilayah Endemik Demam Berdarah Di Kabupaten Tanggamus," *SEMNASTEKNOMEDIA*, vol. 6, no. 1, pp. 12–17, 2018.
4. I. G. Suyasa, N. A. Putra, and I. W. R. Aryanta, "HUbungan Faktor Lingkungan dan Perilaku Masyarakat dengan Keberadaan Vektor Demam Berdarah Dengue (DBD) di Wilayah Kerja Puskesmas I Denpasar Selatan," *Ecotrophic*, vol. 3, no. 1, pp. 1–6, 2007.
5. Y. A. Lesnussa, L. J. Sinay, and M. R. Idah, "Aplikasi Jaringan Saraf Tiruan Backpropagation untuk Penyebaran Penyakit Demam Berdarah Dengue (DBD) di Kota Ambon," vol. 13, no. 2, pp. 63–72, 2017.
6. Pemkab pringsewu Lampung, "Sejarah Kabupaten Pringsewu," 2015.
7. BPBD Kabupaten Pringsewu Lampung, "Kabupaten Pringsewu," no. April 2009, pp. 3–4, 2015.
8. R. Irviani, I. Dinulhaq, D. Irawan, R. Renaldo, Kasmi, and A. Maseleno, "Areas Prone of the Bad Nutrition based Multi Attribute Decision Making with Fuzzy Simple Additive Weighting for Optimal Analysis," *Int. J. Pure Appl. Math.*, vol. 118, no. 7 Special Issue, 2018.
9. E. Turban, J. E. Aronson, and T.-P. Liang, "Decision Support Systems and Intelligent Systems," *Decis. Support Syst. Intell. Syst.*, vol. 7, p. 867, 2007.
10. E. Turban, R. Sharda, and D. Delen, *Decision Support and Business Intelligence Systems. Chapter 6 Artificial Neural Networks for Data Mining*, vol. 8th. 2007.
11. S. Kusumadewi, S. Hartati, A. Harjoko, and Retantyo Wardoyo, "Fuzzy Multi Attribute Decision Making (FUZZY MADM)," *Ed. Pertama Cetakan Pertama. Graha Ilmu. Yogyakarta.*, 2006.
12. A. Maseleno, M. M. Hasan, N. Tuah, and C. R. Tabbu, "Fuzzy Logic and Mathematical Theory of Evidence to Detect the Risk of Disease Spreading of Highly Pathogenic Avian Influenza H5N1," *Procedia Comput. Sci.*, vol. 57, no. Icrtc, pp. 348–357, 2015.
13. M. Muslihudin, R. Wanti, K. Shankar, and M. Ilayaraja, "Prediction of Layer Chicken Disease using Fuzzy Analytical Hierarcy Process," *Int. J. Eng. Technol.*, vol. 7, no. 26, pp. 90–94, 2018.
14. I. P. B. Krisnawan, I. K. G. D. Putra, and I. P. A. Bayupati, "Sistem Pakar Diagnosa Penyakit Kulit dan Kelamin dengan Metode Certainty Factor dan Fuzzy Logic," *Merpati*, vol. 2, no. 3, pp. 351–360, 2014.
15. L. A. Zadeh, "Fuzzy logic," *Computer (Long. Beach. Calif).*, vol. 21, no. 4, pp. 83–93, 1988.
16. R. E. Bellman and L. A. Zadeh, "Decision-Making in a Fuzzy Environment," *Manage. Sci.*, 1970.
17. Mulung, B.R., Maseleno, A., Proposed SMART Traffic signal control in Brunei Darussalam, Telkomnika, Vol. 15, No. 2, 2015, pp. 1-7.
18. Maseleno, A., Tang, A.Y.C., Mahmoud, M.A., Othman, M., Saputra, S., Muslihudin, M., Fuzzy AHP method to determine headache types based on symptoms, Investigacion Clinica, Vol. 58, 2017.
19. Muslihudin, M., Susanti, T.S., Maseleno, A., The priority of rural road development using fuzzy logic based simple additive weighting, Int. J. Pure Appl. Math, Vol. 118, No. 8, 2018, pp. 9-16.
20. Kurniasih, D., Jasmi, K.A., Basiron, B., Huda, M., Maseleno, A., The uses of fuzzy logic method for finding agriculture and livestock value of potential village, International Journal of Engineering & Technology (UAE), Vol. 7, No. 3, 2018, pp. 1091-1095.
21. Maseleno, A., Fauzi, Nungsiyati, Noviarti, T., Muslihudin, M., Irviani, R., Optimal dengue endemic region prediction using fuzzy simple additive weighting based algorithm, International Journal of Pure and Applied Mathematics, Vol. 118, No. 7, 2018, pp. 472-477.
22. Mukodimah, S., Mulihudin, M., Andoyo, A., Hartati, S., Maseleno, A., Fuzzy simple additive weighting and its application to toddler healthy food, Int. J. Pure Appl. Math, Vol. 118, No. 7, 2018, pp. 1-7.
23. Oktafianto, Akbar, M.R.A., Fitrian, Y., Zulkifli, Sodikin, Wulandari, Maseleno, A., Dismisall working relationship using Analytical Hierarchy Process Method, Int. J. Pure Appl. Math, Vol. 118, No. 7, 2018, pp. 177-183.
24. Susilowati, T., Anggraeni, E.Y., Fauzi, Andewi, W., Handayi, Y., Maseleno, A., Using profile matching method to employess position movement, International Journal of Pure and Applied Mathematics, Vol. 118, No. 7, 2018, pp. 415-422.
25. Irviani, R., Dinulhaq, I., Irawan, D., Renaldo, R., Maseleno, A., Areas prone of the bad nutrition based multi attribute decision making with fuzzy simple additive weighting for optimal analysis, Int. J. Pure Appl. Math, Vol. 118, No. 7, 2018, pp. 589-596.
26. Muslihudin, M., Latif, A., Ipnuwati, S., Wati, R., Maseleno, A., A solution to competency test expertise of engineering motorcycles using simple additive weighting approach, Int J. Pure Appl. Math, Vol. 118, No. 7, 2018, pp. 261-267.
27. Surendar, A., Samavatian, V., Maseleno, A., Ibatova, A.Z., Samavatian, M., Effect of solder layer thickness of thermo-mechanical reliability of a power electronic system, Journal of Material Science: Materials in Electronics, Springer, September 2018, Volume 29, Issue 17, pp.

Retrieval Number: H11020688S219/19©BEIESP

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

15249-15258.
28. Samavatian, M., Ilyashenko, L.K., Surendar, A., Maseleno, A., Samavatian, V., Effect of System Design on Fatigue Life of Solder Joints in BGA Packages Under Vibration at Random Frequencies, Journal of Electronic Materials, November 2018, Volume 47, Issue 11, pp. 6781-6790.
29. Surendar, A., Bozorgian, A., Maseleno, A., Ilyashenko, L.K., Najafi, M., Oxidation of Toxic Gases via Ge-B36N36 and Ge-C72 Nanocages as Potential Calaysts, Inorganic Chemistry Communications, Elsevier, Vol. 96, October 2018, pp. 206-210.
30. Motlagh, A.H., Klyuev, S.V., Surendar, A., Ibatova, A.Z., Maseleno, A., Catalytic Gasification of Oil Sludge with Calcined Dolomite, Petroleum Science and Technology, Taylor and Francis, pp. 1-5, 2018.
31. Namdarian, A., Tabrizi, A.G., Maseleno, A., Mohammadi, A., Mossavifard, S.E., One step synthesis of rGO-Ni3S2 nano-cubes composite for high-performance supercapacitor electrodes, International Journal of Hydrogen Energy, Elsevier, vol. 43, Issue 37, 13 September 2018, pp.17780-17787.
32. Javanshir, I., Maseleno, A., Tasoujian, S., Oveisi, M., Optimization of suspension system of heavy off-road vehicle for stability enhancement using integrated anti-roll bar and coiling spring mechanism, Journal of Central South University, September 2018, Volume 25, Issue 9, pp 2289–2298.
33. Huda, M., Maseleno, A., Jasmi, K.A., Mustari, I., Basiron, B., Strengthening interaction from direct to virtual basis: insights from ethical and professional empowerment, International Journal of Applied Engineering Research, Vol.12, No. 17, 2017, pp. 6901-6909.
34. Huda, M., Maseleno, A., Atmotiyoso, P., Siregar, M., Ahmad, R., Jasmi, K.A., Muhamad, N.H.N, Mustari, I.M., Basiron, B., Big Data Emerging Technology: Insights into Innovative Environment for Online Learning Resources, International Journal of Emerging Technologies in Learning, Vol. 13, No. 1, 2017, pp. 23-36.
35. Huda, M., Maseleno, A., Teh, K.S.M., Don, A.G., Basiron, B., Jasmi, K.A., Mustari, M.I., Nasir, B.M., Ahmad, R., Understanding Modern Learning Environment (MLE) in Big Data Era, International Journal of Emerging Technologies in Learning (iJET),Vol. 13, No. 5, 2018, pp. 71-85. Maseleno, A., Tang, A.Y.C., Mahmoud, M.A., Othman, M., Shankar, K., Big Data and E-Learning in Education, International Journal of Computer Science and Network Security, Vol. 18, No. 5, pp. 171-174.
36. Shankar, K., Lakshmanaprabu, S.K., Gupta, D., Maseleno, A., De Albuquerque, V.H.C., Optimal feature-basedmulti-kernel SVM approach for thyroid disease classification, The Journal of Supercomputing, Springer, Vol. 74, no. 259, 2018, pp. 1-16.
37. Abadi, S. Huda, M., Basiron, B, Ihwani, S.S., Jasmi, K.A., Hehsan, A., Safar, J., Mohamed, A.K., Embong, W.H.W., Mohamad, A.M., Noor, S.S.M., Novita, D., Maseleno, A., Irviani, R., Idris, M., Muslihudin, M., Implementation of Fuzzy Analytical Hierarchy Process on Notebook Selection, International Journal of Engineering and Technology (UAE), Vol. 7, No. 2.26, 2018, pp. 102-108.
38. Abadi, S., Huda, M., Jasmi, K.A., Noor, S.S.M., Safar, J., Mohamed, A.K., Embong, W.H.W., Mohamad, A.M., Hehsan, A., Basiron, B., Ihwani, S.S., Maseleno, A., Muslihudin, M., Satria, F., Irawan, D., Hartati, S., Determination of the Best Quail Eggs using Simple Additive Weighting, International Journal of Engineering and Technology (UAE), Vol. 7, No. 2.27, 2018, pp. 225-230.
39. Anggraeni, E.Y., Huda, M., Maseleno, A., Safar, J., Jasmi, K.A., Mohamed, A.K., Hehsan, A., Basiron, B., Ihwani, S.S., Embong, W.H.W., Mohamad, A.M., Noor, S.S.M., Fauzi, A.N., Wijaya, D.A., Poverty Level Grouping using SAW Method, International Journal of Engineering and Technology (UAE), Vol. 7, No. 2.27, 2018, pp. 218-224.
40. Ristiani, Pardimin, Teh, K.S.M., Fauzi, A., Hananto, A.L., Huda, M., Muslihudin, M., Shankar, K., Maseleno, A., Decision Support System Model for Selection of Best Formula Milk for toddlers using Fuzzy Multiple Attribute Decision Making, Journal of Advanced Research in Dynamical and Control Systems, Vol. 10, 02-Special Issue, 2018.
41. Hamid, A., Sudrajat, A., Kawangit, R.M., Don, A.G., Huda, M., Jalal, B., Akbar, W., Onn, A., Maseleno, A., Determining basic food quality using SAW, International Journal of Engineering and Technology(UAE), Vol. 7, No. 4, pp. 3548-3555, 2018.
42. Fauzi, Huda, M., Teh, K.S.M., Haron, Z., Ripin, M.N., Hehsan, A., Abas, H., Rafiq, M., Irawan, J., Abadi, S., Maseleno, A., The Design of Fuzzy Expert System Implementation for Analyzing Transmissible Disease of Human, International Journal of Pharmaceutical Research, Vol. 10, Issue 4, 2018.
43. Abadi, S., Huda, M., Teh, K.S.M., Haron, Z., Ripin, M.N., Hehsan, A., Sarip, S., Hehsan, M.R., Amrullah, M., Maseleno, A., Hazard Level of Vehicle Smoke by Fuzzy Multiple Attribute Decision Making with Simple Additive Weighting Method, International Journal of Pharmaceutical Research, Vol. 10, Issue 4, 2018.

Retrieval Number: H11020688S219/19©BEIESP

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication