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FUZZY INFERENCE SYSTEM OF TSUKAMOTO METHOD IN DECISION MAKING ON DETERMINATION OF INSURANCE PREMIUM AMOUNT FOR DUE DAMAGES OF FLOOD NATURAL DISASTER

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ABSTRACT

Floods often cause loss of buildings damage for people in the Citarum river basin. Community chooses insurance for recovery and protection against buildings damage. Insurance companies need to determine the amount of premium which is feasible and affordable by the community. This paper analyzes the fuzzy inference system (FIS) of Tsukamoto method in determining the amount of insurance premium. For the determination of the premium, the variables used include income, expenses and residence zones. The amount of premium is determined using the FIS of the Tsukamoto method. From the analysis, the average amount of premium is IDR 11,041.00 per month for community in Bojongsoang zone and IDR 11,321.00 per month for community in Baleendah zone. The amount of this premium is quite feasible and affordable by community in the two zones.

Keywords: Citarum River; buildings damage; protection; income; expenses; zone.

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1. INTRODUCTION

Kabupaten Bandung is the prone flood area in which located in the lowlands of Bandung basin and some part of the area is located on the riverside of Citarum. A plenty of land has converted from the farm and absorbent areas into the settlement or forest to seasonal agriculture which leading to the high sedimentation and flooding occurrence.

Flood disaster impacted on the huge loss for the people of the region [1]. Until now, there has been no effective way to avoid flooding and get out of the problem but the community can take some protective measures against personal safety as well as assets owned. Insurance is one form of risk management that is effective enough to tackle the losses of floods [2-3]. In general, flood insurance risks applying the risk system in percentage to be a responsibility of the property owner insured [4]. While, the amount of premiums applied in flood insurance is determined by the condition of the insured property area and some other factors [5].

To determine the required amount of the premium, such a decision support system is needed. One decision support system that can be used is Fuzzy Inference System (FIS) from Tsukamoto method [6]. According to [7-8], Tsukamoto method is consequent upon every form of IF-Then rules and should be represented by a fuzzy set with monotonous membership function. As a result, the output of each inference rule is given strictly (crisp) based on α-predicate (fire strength) [6]. The final results are obtained by using weighted mean.

Tsukamoto method had been applied to a research concerning on the Fuzzy Inference System of Tsukamoto method on the determination of decision maker of insurance flood premium [9]. The location of this research is in the Citarum watershed Kecamatan Bojongsoang and Baleendah, Kabupaten Bandung, West Java, Indonesia. The purpose of this research is to determine the flood insurance premium, which are reasonable and affordable for the people living in the two regions.

2. METHODOLOGY

2.1. Materials

The data used in this research is primary and secondary data. The obtained primary data is the condition of the population on the interviews with official government and Kecamatan

Bojongsoang and Baleendah. In the meantime, the secondary data of Kecamatan Baleendah that focused on the population is obtained from the Summary of the Report Population 2016. Data from the Central Statistics Agency (BPS) Kabupaten Bandung is in the form of Publication of Kecamatan Bojongsoang in number 2016, Kecamatan Baleendah in number 2016 [1], the Gross Regional Domestic Product (GDP) in 2008 of Kabupaten Bandung. The data obtained from BPS Indonesia includes, publication of Wage Statistics in August 2016, and Executive Summary of National Expenses and Consumption in Indonesia. The division of flood zones is obtained from Kabupaten Bandung Flood Risk Map, which was made by the Regional Disaster Management Agency (BPBD) Kabupaten Bandung. The data of premium rate is obtained from an insurance company that has been serving the flood insurance program in Kabupaten Bandung.

2.2. Methods

2.2.1. Fuzzy Inference System (FIS) of Tsukamoto Method

Generally, there are three steps to determine the amount of premiums to be paid by residents of Kecamatan Bojongsoang and Baleendah by using Fuzzy Inference System (FIS) of Tsukamoto method namely the define of fuzzy variable (fuzzification), inferences and determination of output crisp (defuzzification).

2.2.1.1. Defining of Membership Fuzzy Variable Set

In this study, there are four defined fuzzy variables namely income variable, outcome variable, flood zone variable and premium variable. From each of these variables, the membership value of fuzzy sets need to be found by using membership functions of fuzzy set by observing the minimum and maximum values of each variable.

2.2.1.2. Income, Outcome and Premium Variable

Income variable is the earning variable or monthly salary earned by the citizens of Kecamatan Bojongsoang and Baleendah. While, the outcome variable is the expenditure per month and the premium variable is the premium to be paid per month to the insurance company. Those can be divided into three fuzzy sets namely low (L), medium (M) and high (H) [10]. The low and high set are using linear curve, while the medium and is using triangle curve.

Function of flood zone variable fuzzy sets membership follows the following equations [9, 11]:

$$«_L(a^{²}) = \begin{cases} 1; & a^{²} \le a^{²}_{\min} \\ \dfrac{a^{²}_{\max} - a^{²}}{a^{²}_{\max} - a^{²}_{\min}}; & a^{²}_{\min} \le a^{²} \le a^{²}_{\max} \\ 0; & a^{²} \ge a^{²}_{\max} \end{cases} \quad (1)$$

$$«_M(a^{²}) = \begin{cases} 1; & a^{²} = a^{²}_t \\ \dfrac{a^{²} - a^{²}_{\min}}{a^{²}_t - a^{²}_{\min}}; & a^{²}_{\min} \le a^{²} \le a^{²}_t \\ \dfrac{a^{²}_{\max} - a^{²}}{a^{²}_{\max} - a_t}; & a^{²}_t \le a^{²} \le a^{²}_{\max} \\ 0; & a^{²} \le a^{²}_{\min} \text{ atau } a^{²} \ge a^{²}_{\max} \end{cases} \quad (2)$$

$$«_H(a^{²}) = \begin{cases} 0; & a^{²} \le a^{²}_{\min} \\ \dfrac{a^{²} - a^{²}_{\min}}{a^{²}_{\max} - a^{²}_{\min}}; & a^{²}_{\min} \le a^{²} \le a^{²}_{\max} \\ 1; & a^{²} \ge a^{²}_{\max} \end{cases} \quad (3)$$

with $«_{¶}(a^{²})$ is the fuzzy membership function set where $¶ = \{L, M, H\}$ and $a^{²}$ is the amount of financial type where $² = \{\text{Income}, \text{Consumtion}, \text{Premium}\}$.

2.2.1.3. Flood Zone Variable

Flood Zone Variable is the location of residents of Kecamatan Bojongsoang and Baleendah resides based on the height of flood puddles. Flood Zone Variable is divided into 4 memberships of fuzzy sets: low (L), medium (M), high (H) and very high (V) [10]. The low and very high set are using linear curve, while the medium and high curve are using triangle curve. Function of flood zone variable fuzzy sets membership follows the following equations [9, 11]:

$$«_L(z) = \begin{cases} 1; & z \le z_{\min} \\ \dfrac{z_{\max} - z}{z_{\max} - z_{\min}}; & z_{\min} \le z \le z_{\max} \\ 0; & z \ge z_{\max} \end{cases} \quad (4)$$

$$\text{«}_M(z)=\begin{cases}1; & z=z_{h_1}\\ \dfrac{z-z_{\min}}{z_{h_1}-z_{\min}}; & z_{\min}\le z\le z_{h_1}\\ \dfrac{z_{h_2}-z}{z_{h_2}-z_{h_1}}; & z_{h_1}\le z\le z_{h_2}\\ 0; & z\le z_{\min} \text{ atau } z\ge z_{h_2}\end{cases} \tag{5}$$

$$\text{«}_H(z)=\begin{cases}1; & z=z_{h_3}\\ \dfrac{z-z_{h_2}}{z_{h_3}-z_{h_2}}; & z_{h_2}\le z\le z_{h_3}\\ \dfrac{z_{\max}-z}{z_{\max}-z_{h_3}}; & z_{h_3}\le z\le z_{\max}\\ 0; & z\le z_{h_2} \text{ atau } z\ge z_{\max}\end{cases} \tag{6}$$

$$\text{«}_V(z)=\begin{cases}0; & z\le z_{\min}\\ \dfrac{z-z_{\min}}{z_{\max}-z_{\min}}; & z_{\min}\le z\le z_{\max}\\ 1; & z\ge z_{\max}\end{cases} \tag{7}$$

with $\text{«}_s(z)$ is a function of fuzzy sets membership, where $s=\{L,M,H,V\}$, z is the value of flood zone and h_i is the height of zone level i.

2.2.2. The Inference Determination

Based on the definition of the four variables namely income, expenses, flood zone and premium if combined can form 36 basis of rules as follows [12]:

Rule [R1]. IF the income is low AND the outcome is low AND the zone is low THEN the premium is low.

$$\sim_1=\text{«}_L(a^{Inc})\cap\text{«}_L(a^{Con})\cap\text{«}_L(z)=\min\{\text{«}_L(a^{Inc}),\ \text{«}_L(a^{Con}),\ \text{«}_L(z)\} \tag{8}$$

Rule [R2]. IF the income is low AND the outcome is low AND the zone is medium THEN the premium is low.

$$\sim_2=\text{«}_L(a^{Inc})\cap\text{«}_L(a^{Con})\cap\text{«}_M(z)=\min\{\text{«}_L(a^{Inc}),\ \text{«}_L(a^{Con}),\ \text{«}_M(z)\} \tag{9}$$

Rule [R3]. IF the income is low AND the outcome is low AND the zone is high THEN the premium is medium.

$$\sim_3=\text{«}_L(a^{Inc})\cap\text{«}_L(a^{Con})\cap\text{«}_H(z)=\min\{\text{«}_L(a^{Inc}),\ \text{«}_L(a^{Con}),\ \text{«}_H(z)\} \tag{10}$$

Rule [R4]. IF the income is low AND the outcome is low AND the zone is very high THEN the premium is medium.

$$\sim_4 = «_L(a^{Inc}) \cap «_L(a^{Con}) \cap «_V(z) = \min\{«_L(a^{Inc}),\ «_L(a^{Con}),\ «_V(z)\} \qquad (11)$$

In determining the value of $\sim_5$ to $\sim_{36}$, the same way is performed follows Equation (8) to (11) that is by finding the minimum value of income variable, outcome variable and zone variable. After the membership degree is obtained, the next step is to find the value a_i^2 for ² = premi that is the results of rule of each inferences by Equation (1) to (3).

Low Premium. From Equation (1), if we take:

$$\sim_i = \frac{a^2_{\max} - a^2_i}{a^2_{\max} - a^2_{\min}}$$

thus, the following equation a_i^2 is obtained:

$$a^2_i = a^2_{\max} - \sim_i \left(a^2_{\max} - a^2_{\min}\right) \qquad (12)$$

Medium Premium. From Equation (2), if we take:

$$\sim_i = \frac{a^2_i - a^2_{\min}}{a^2_t - a^2_{\min}} \qquad (13)$$

and

$$\sim_i = \frac{a^2_{\max} - a^2_i}{a^2_{\max} - a^2_t} \qquad (14)$$

Further, by substituting Equation (14) to (13), it is obtained that:

$$\frac{a^2_{\max} - a^2_i}{a^2_{\max} - a^2_t} = \frac{a^2_i - a^2_{\min}}{a^2_t - a^2_{\min}}$$

Thus, the following equation a_i^2 is obtained:

$$a^2_i = a^2_t \qquad (15)$$

The High Premium. From Equation (3), if one taken:

$$\sim_i = \frac{a^2_i - a^2_{\min}}{a^2_{\max} - a^2_{\min}},$$

then, the following equation a_i^2 is obtained:

$$a_i^2 = a_{\min}^2 + \sim_i \left(a_{\max}^2 - a_{\min}^2\right) \tag{16}$$

2.2.3. The Determination of Output Crisp

After the degree of antecedent of all fuzzy set membership of each variable are obtained, the output crisp of each premium which should be paid by insurer can be determined by using Equation (17) as follows [7, 12]:

$$D = (\sum_{i=1}^{36} \sim_i d_i) / (\sum_{i=1}^{36} \sim_i) \tag{17}$$

Furthermore, the formula mentioned above is used in calculation to determine the following premium amount.

3. RESULTS

3.1. Defining the Membership of Fuzzy Variable Set

In defining the membership of fuzzy variables set, the input variables are divided into two variables, i.e. data variable of one specified period and data variable of current time. Variable of one specified period is the income data, outcome data, flood zone data and the premium data which has only maximum and minimum in one period of time. While the current data variable is the input value correspond to the condition of decision makers.

3.1.1. The Income Variable

The scope of discussion of income variable is between IDR400,000.00 to IDR8,162,017.00, with the median value of IDR4,281,009.00, thus by referring to equation (1), if a^{Inc} is the income variable, thus, the obtained fuzzy set membership of income variable are as follows:

$$\ll_L (a^{Inc}) = \begin{cases} 1; & a^{Inc} \leq 400000 \\ \dfrac{8162017 - a^{Inc}}{8162017 - 400000}; & 400000 \leq a^{Inc} \leq 8162017 \\ 0; & a^{Inc} \geq 8162017 \end{cases} \tag{18}$$

$$\ll_M(a^{Inc}) = \begin{cases} 0; & a^{Inc} \le 400000 \quad \text{or} \quad a^{Inc} \ge 8162017 \\ \dfrac{a^{Inc} - 400000}{4281009 - 400000}; & 400000 \le a^{Inc} \le 4281009 \\ 1; & a^{Inc} = 4281009 \\ \dfrac{8162017 - a^{Inc}}{8162017 - 4281009}; & 4281009 \le a^{Inc} \le 8162017 \end{cases} \quad (19)$$

$$\ll_H(a^{Inc}) = \begin{cases} 0; & a^{Inc} \le 400000 \\ \dfrac{a^{Inc} - 400000}{8162017 - 400000}; & 400000 \le a^{Inc} \le 8162017 \\ 1; & a^{Inc} \ge 8162017 \end{cases} \quad (20)$$

The average income of Kecamatan Bojongsoang residents in 2016 is IDR2,801,129.00 per month, thus the obtained degree of membership of low income set is 0.6907, middle income is 0.6187 and high income is 0.3093. While, the average of income of Kecamatan Baleendah residents in 2016 is IDR1,373,940.00 per month. Referring to Equation (1), if a^{Con} is the outcome variable, then the obtained degree of membership of low income set is 0.8745, the medium income is 0.2510 and the high income is 0.1255.

3.1.2. The Outcome Variable

The scope of discussion of output variable are between IDR187,786.00 to IDR2,603,242.00 with median of outcome value amounted to IDR1,395,514.00. Thus, the obtained fuzzy set memberships of outcome variable are as follows:

$$\ll_L(a^{Con}) = \begin{cases} 1; & a^{Con} \le 187786 \\ \dfrac{2603242 - a^{Con}}{2603242 - 187786}; & 187786 \le a^{Con} \le 2603242 \\ 0; & a^{Con} \ge 2603242 \end{cases} \quad (21)$$

$$\ll_M(a^{Con}) = \begin{cases} 0; & a^{Con} \le 187786 \text{ or } a^{Con} \ge 2603242 \\ \dfrac{a^{Con} - 187786}{1395514 - 187786}; & 187786 \le a^{Con} \le 1395514 \\ 1; & a^{Con} = 1395514 \\ \dfrac{2603242 - b}{2603242 - 1395514}; & 1395514 \le a^{Con} \le 2603242 \end{cases} \quad (22)$$

$$\ll_H(a^{Con}) = \begin{cases} 0; & a^{Con} \le 187786 \\ \dfrac{a^{Con} - 187786}{2603242 - 187786}; & 187786 \le a^{Con} \le 2603242 \\ 1; & a^{Con} \ge 2603242 \end{cases} \quad (23)$$

The average outcome of Kecamatan Bojongsoang residents in 2016 is IDR1,168,131.00 per month, thus the obtained degree of membership of low outcome is 0.5941, middle outcome is 0.8117 and high outcome is 0.4059. While the average of outcome of Kecamatan Baleendah residents in 2016 is IDR711,266.00 per month. Thus, the obtained degree of membership of low outcome is 0.7833, middle outcome is 0.4334 and high outcome is 0.2167.

3.1.3. Flood Zone Variable

Variable of flood zone illustrates the living condition of Kecamatan Bojongsoang residents and Baleendah correspond to the height of water when the flood occurs. The scope of discussion of flood zone variable is between 0 cm to 150 cm with the median of 75 cm. Referring to Equation (2) the obtained fuzzy set memberships of flood zone variable is:

$$\mu_L(z) = \begin{cases} 1; & z \le 0 \\ \dfrac{150 - z}{150 - 0}; & 0 \le z \le 150 \\ 0; & z \ge 150 \end{cases} \tag{24}$$

$$\mu_M(z) = \begin{cases} 0; & z \le 0 \text{ or } z \ge 75 \\ \dfrac{z - 0}{37.5 - 0}; & 0 \le z \le 37.5 \\ 1; & z = 37.5 \\ \dfrac{75 - z}{75 - 37.5}; & 37.5 \le z \le 75 \end{cases} \tag{25}$$

$$\mu_H(z) = \begin{cases} 0; & z \le 75 \text{ or } z \ge 150 \\ \dfrac{z - 75}{112.5 - 75}; & 75 \le z \le 112.5 \\ 1; & z = 112.5 \\ \dfrac{150 - z}{150 - 112.5}; & 112.5 \le z \le 150 \end{cases} \tag{26}$$

$$\mu_V(z) = \begin{cases} 0; & z \le 0 \\ \dfrac{z - 0}{150 - 0}; & 0 \le z \le 150 \\ 1; & z \ge 150 \end{cases} \tag{27}$$

The average height of flood in the residence of Kecamatan Bojongsoang in 2016 is 80 cm. Thus, the obtained degree of membership of low zone set is 0.4667, medium zone is 0, high zone is 0.1333 and very high zone is 0.5333. While, the average of flood height in the residence of Kecamatan Baleendah resident in 2016 is 135 cm. Therefore, the obtained degree of membership of low zone set is 0.1, medium zone is 0, high zone is 0.4 and very high zone is 0.9.

3.1.4. The Premium Variable

The premium variable is an ouput in this study. The scope of the premium variable amounted between IDR3,000.00 to IDR18,000.00 with the premium median value of IDR10,500.00. Referring to Equation (1), if $a^{\Pr e}$ represented a premium variable, then the premium variable membership sets are as follows:

$$\ll_L (a^{\Pr e}) = \begin{cases} 1; & a^{\Pr e} < 3000 \\ \dfrac{18000 - a^{\Pr e}}{18000 - 3000}; & 3000 \le a^{\Pr e} < 18000 \\ 0; & a^{\Pr e} \ge 18000 \end{cases} \tag{28}$$

$$\ll_M (a^{\Pr e}) = \begin{cases} 0; & a^{\Pr e} \le 3000 \text{ or } a^{\Pr e} \ge 18000 \\ \dfrac{a^{\Pr e} - 3000}{10500 - 3000}; & 3000 \le a^{\Pr e} \le 10500 \\ 1; & a^{\Pr e} = 10500 \\ \dfrac{18000 - d}{18000 - 10500}; & 10500 \le a^{\Pr e} \le 18000 \end{cases} \tag{29}$$

$$\ll_H (a^{\Pr e}) = \begin{cases} 0; & a^{\Pr e} \le 3000 \\ \dfrac{a^{\Pr e} - 3000}{18000 - 3000}; & 3000 \le a^{\Pr e} \le 18000 \\ 1; & a^{\Pr e} \ge 18000 \end{cases} \tag{30}$$

Based on the membership functions of fuzzy sets given in Equation (18) to (30), the obtained degree of membership of fuzzy sets for all variables are as given in Table 1.

Table 1. Degree of membership of fuzzy set

No	Variable	Set	Degree of Membership	Note
1	Income	Low	0.6907	Kecamatan Bojongsoang
2			0.8745	Kecamatan Baleendah
3		Medium	0.6187	Kecamatan Bojongsoang
4			0.2510	Kecamatan Baleendah
5		High	0.3093	Kecamatan Bojongsoang
6			0.1255	Kecamatan Baleendah
7	Outcome	Low	0.5941	Kecamatan Bojongsoang
8			0.7833	Kecamatan Baleendah
9		Medium	0.8117	Kecamatan Bojongsoang

10	Zone	High	0.4334	Kecamatan Baleendah
11			0.4059	Kecamatan Bojongsoang
12			0.2167	Kecamatan Baleendah
13		Low	0.4667	Kecamatan Bojongsoang
14			0.1000	Kecamatan Baleendah
15		Medium	0	Kecamatan Bojongsoang
16			0	Kecamatan Baleendah
17		High	0.1333	Kecamatan Bojongsoang
18			0.4000	Kecamatan Baleendah
19		Very High	0.5333	Kecamatan Bojongsoang
20			0.9000	Kecamatan Baleendah

3.2. Determination of Inferences

Based on the results in Table 1, the next step is to determine the antecedent degree of membership for all the fuzzy rules as a base of fuzzy rule. Combination of four variables can form 36 fuzzy rule bases. Under the rule of base [R1], IF the income is low AND the outcome is low AND the zone is low, THEN the premium is low.

3.2.1. Kecamatan Bojongsoang (Bo)

Referring to Equation (8), the value of $\sim_1$ can be obtained as follows:

$$\sim_1(Bo) = \min\{\ll_L(2502796),\ \ll_L(1168131),\ \ll_L(80)\} = \min\{0.6907,\ 0.5941,\ 0.4667\}$$

$$= 0.4667$$

Based on the membership function of low premium set in *fuzzy* rules [R1], the value $a_1^{\Pr e}$ obtained by using Equation (8) is as follows:

$$a_1^{\Pr e}(Bo) = 18000 - 0.4667(18000 - 3000) = 10999.5$$

3.2.2. Kecamatan Baleendah (Ba)

Referring to Equation (8), the value of $\sim_1$ can be obtained as follows:

$$\sim_1(Ba) = \min\{\ll_L(1373.940),\ \ll_L(711266),\ \ll_L(135)\} = \min\{0.8745,\ 0.8117,\ 0.1\} = 0.1$$

Based on the membership function of low premium set in *fuzzy* rules [R1], the value a_1^{Pre} obtained by using Equation (8) is as follows:

$$a_1^{Pre}(Ba) = 18000 - 0.1(18000 - 3000) = 16500$$

Under the base rule [R2], IF the income is low AND the outcome is low AND in the medium zone, THEN the premium is low.

3.2.3. Kecamatan Bojongsoang (*Bo*)

Referring to Equation (9), the value of $\sim_2$ can be obtained as follows:

$$\sim_2(Bo) = \min\{\ll_L(2.801.129),\ \ll_L(1.168.131),\ \ll_M(80)\} = \min\{0.6907,\ 0,\ 0.5941,\ 0\}$$

$$= 0$$

Based on the membership function of low premium set in *fuzzy* rules [R2], the value a_2^{Pre} obtained by using Equation (9) is as follows:

$$a_2^{Pre}(Bo) = 18.000 - 0(18.000 - 3.000) = 18.000$$

3.2.4. Kecamatan Baleendah (*Ba*)

Referring to Equation (9), the value of $\sim_2$ can be obtained as follows:

$$\sim_2(Ba) = \min\{\ll_L(1.373.940),\ \ll_L(711.266),\ \ll_M(135)\} = \min\{1.690,\ 0,\ 43340\} = 0$$

Based on the membership function of low premium set in *fuzzy* rules [R2], the value a_2^{Pre} obtained by using Equation (9) is as follows:

$$a_2^{Pre}(Ba) = 18.000 - 0(18.000 - 3.000) = 18.000$$

Further, for the fuzzy rule of base [R3] and so on can be obtained by the same way using fuzzy [13] rule of base such as [R1] and [R2].

4. DISCUSSION

According to the reported data, the main livelihood of Kecamatan Bojongsoang and Baleendah residents are agriculture (plantation, farming, fishing and so on), trader, laborers (peasants, building, industrial, etc.), employee of civil government, military, employers and

service provider. The scope of income variable are in the range between IDR400,000.00 to IDR8,162,017.00 with median of IDR4,281,009.00. It is also known that the area of Kecamatan Bojongsoang had GDP per capita of IDR12,199,585.00 in 2007. While, for the area of Kecamatan Baleendah had GDP per capita of IDR6,260,259.00 in 2007. The rate of GDP per capita is 11.92% per year for Kecamatan Bojongsoang and 11.29% per year for Kecamatan Baleendah.

Beside income, the others things that describes the condition of residents is the outcome. According to [10], people's outcome can be divided into four classes; i.e. lower class, lower middle class, upper middle class and upper class.

a. The lower class people are people who have a low purchasing level or their outcome less than IDR700.000,00. per month. This people of lower class generally have non-permanent job and their income is not stable.

b. The lower middle class are the people that already have a stable job and income. Their outcome is about IDR700,000.00 to IDR1,500,000.00 per month.

c. The upper class is the people that have outcome are about IDR1,500,000.00 to IDR3,000,000.00 per month. People of this class generally have a permanent job.

d. The upper class is the people with outcome greater than IDR3,000,000.00 per month. The income is not just obtained from one job only.

Based on the reported data, in order to define the variable expenditure, the outcome per capita in West Java Province, ranges between IDR187,786.00 to IDR2,603,242.00 with the median of expenditure is IDR1,395,514.00.

Based on the income variable, expenses variable, zone and flood insurance premium cost, the decision maker to determine amount of premium which is reasonable and reachable is performed by Fuzzy Inference System (FIS) of Tsukamoto method. Based on the results of analysis, it is obtained that the residents of Kecamatan Bojongsoang have to pay the amount of premium of IDR11,041.00 per month. While, the residents of Kecamatan Baleendah have to pay premium amount of IDR11,321.00 per month.

5. CONCLUSION

In this paper, the Fuzzy Inference System Method Tsukamoto has been analyzed concerning to the decision maker of flood insurance premium determination. In conclusion, during 2016, the residents of Kecamatan Bojongsoang had an average income of IDR2,801,129.00 per month, with an expenses average of IDR1,168,131.00 per month. While, the residents of Kecamatan Baleendah had an average income of IDR1,373,940.00 per month with an average expenses of IDR711,266.00 per month. The Zone of Kecamatan Bojongsoang and Baleendah located respectively in the high flooding zone and at high latitude. In 2016 the average of flood height was 80 cm and 135 cm. According to the average income, expenses and flood [14-15] zones, a reasonable premium paid by every household respectively IDR11,041.00 per month for Kecamatan Bojongsoang residents and IDR11,321.00 per month for Kecamatan Baleendah resident. The amount of premium is about 0.4% of income per month only, thus quite affordable for residents in these two sub-districts.

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