Measuring the Level of Ability to Pay Flood Insurance Premiums and the Factors that Influence it by Using the Contingent Valuation Method

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Abstract

One of the efforts to alleviate the risk of loss of building damage due to flooding of the Citarum River is by buying insurance. But not all people in the Citarum watershed are able to buy flood insurance. In this paper aims at identifying, mapping of flood-prone areas and flood mitigation. It is assumed that there are eight variables that affect the ability to purchase flood insurance, including: income level, education level, respondent's age, number of family members, perception of damage impact, distance of house to river, elaboration of buildings by road, and experience of flood frequency. Measurement analysis is done using the Contingent Valuation Method approach, and uses multiple linear regression models. Based on the results of the analysis shows that the variables of income, age, level of education, and number of family members significantly influence the ability to buy flood insurance. This is expected to be a consideration for insurance companies, to determine flood insurance premium rates in the Citarum river basin, to be affordable by many people.

Keywords:

Flood insurance, building damage, insurance premiums, Contingent Valuation Method, multiple linear regression models.

1. Introduction

Floods often afflict communities in a number of Citarum river basins during the rainy season. Not only property, not infrequently floods also damage and cause harm to motorized vehicles (Bachrudin et al., 2018). However, not many people understand that insurance protection can guarantee the risk of flooding of customer assets. Nevertheless, the main thing is education and knowledge of the importance of flood insurance protection for homes & vehicles (Sidi et al., 2017a; 2017b; Sukono et al, 2018). In fact, not only protecting the customer's property and motorized vehicles, insurance that guarantees the risk of flooding is an extension of the main guarantee that can guarantee the risk of customer property contents. Customers can transfer flood risk into a flood risk protection product, in this case a property insurance company or home insurance with the benefits of flood expansion. This product guarantees customer assets from the threat of flooding (Shang et al., 2012; Sidi et al., 2018; Sukono et al., 2017). This flood expansion guarantee can also guarantee the contents of buildings or property, including items in the building if they are listed in the policy when the insurance is registered. However, as an insurance customer, must be willing to spend more to pay premiums for the risks of the disaster. Even though it is more expensive, it is important to remember that the benefits of protection that customers will get will be maximized (Joseph et al., 2015; Markantonis and Bithas, 2010; Nairobi. 2012). The problem is, not all people are able to buy insurance protection that can guarantee the risk of flooding of customer assets. Many factors influence the community not being able to buy flood insurance to protect themselves from various possible losses that can arise at any time. Therefore, this issue is considered important for research (Bon et al, 2018; Markantonis et al., 2012).

Rusminah and Gravitiani (2012), have conducted research to identify, map flood-prone areas in the former residency of Surakarta, and conduct flood mitigation analysis. The analytical tool used is the Geographic Information System and contingent valuation methods, by calculating the amount of willingness to pay (WTP) to reduce the risk of flood disasters and the factors that influence the PAPs. The objects studied were farmers in the Bengawan Solo river basin in Klaten, Sukoharjo, Karanganyar and Sragen regencies. The results showed that the variables of income, age, education and number of family members had a significant influence on willingness to pay, carried out flood mitigation actions. Shang et al. (2012), has conducted a study to test public awareness about the value of river networks, and determine people's attitudes towards current conditions in Shanghai. Using logistic regression analysis based on the contingent valuation method (CVM) to calculate the total benefits, and measuring the socio-economic factors that affect the public willing to pay (WTP) mitigation costs. The study shows that people in Shanghai have a high level of awareness of the value of the river network, but the level of satisfaction is low with the government's actions to overcome the current conditions in Shanghai. This study also illustrates that the majority of respondents are willing to pay for the protection of river networks. It should also be considered that the length of stay in Shanghai, the distance from the house to the nearest river, and the number of bids are important factors affecting the respondent's WTP.

Based on the description above, the paper intends to measure the level of insurance and premium factors that influence it by using the Contingent Valuation Method (CVM). The object of the research object was the people who lived in the area affected by the flood of the Citarum river in Bandung Indonesia. This object was chosen because the Citarum river basin is flooded every year, and causes damage to buildings. The aim is to measure the level of willingness to pay (WTP) in order to reduce the risk of flood disasters and the factors that influence the WTP.

2. Methodology

This study uses a survey method to the community, especially those living in four sub-districts: Baleendah, Dayeuhkolot, Bojongsoang, and Banjaran, Bandung Regency, West Java, Indonesia. The study area was chosen because of the four sub-districts: Baleendah, Dayeuhkolot, Bojongsoang, and Banjaran, Bandung Regency, because every year the floods were always affected the most, as a result of the overflow of the Citarum river. The method used to obtain primary data is a survey with direct interview techniques, and is assisted using a questionnaire. Whereas secondary data is obtained from the Bandung District Disaster Management Agency (BPBD), and an insurance company operating in the area of Bandung Regency.

2.1 Determination of the number of samples and research design

The population as the object of this study were people who lived in four sub-districts: Baleendah, Dayeuhkolot, Bojongsoang, and Banjaran, Bandung Regency, which were affected by the Citarum river flood. Determination of the number of samples used in the analysis is done using Slovin as follows (Rusminah and Gravitiani, 2012):

$$n = \frac{N}{1 + Ne^2}, \quad (1)$$

where n is the number of samples needed, N is the number of population, and e is a critical value or error limit which is usually set at 10%.

The research design was carried out using the Contingent Valuation Method (CVM) which used survey techniques. So this technique is called contingent valuation survey method, which is done by giving a list of questions to the respondent. The list of questions given must be filled by the head of the household, because the family income variable and the maximum pay ability level (WTP) are very important variables of validity. However, it is possible for certain conditions to be filled by representatives not by the head of the household (Ozdemir, 2000; Pek et al., 2010).

2.2 Multiple linear regression model

To determine how much the independent variables that affect the level of ability to pay for flood insurance as an effort to mitigate the program, carried out using multiple linear regression models. The multiple linear regression model in general can be stated as follows (Sukono et al., 2016):

$$Y = b_0 + b_1 X_1 + b_2 X_2 + ... + b_k X_k + e. \quad (2)$$

Where Y dependent variable (regression), X independent variable (regressor), b_0 intercept parameters (constants), b_1, b_2, ..., b_k is the coefficient (slope) parameter, and e residual. Multiple linear regression equation (2), has an estimator equation which is stated as follows:

$$\hat{Y} = b_0 + b_1 X_1 + b_2 X_2 + ... + b_k X_k. \quad (3)$$

2.3 The estimation method of multiple linear regression parameters

This section discusses the multiple regression parameters estimation method in general. Using the matrix equation approach, multiple linear regression equation (3) can be stated as follows:

$$\mathbf{Y} = \mathbf{XB} + \mathbf{e}. \quad (4)$$

Where:

$$\mathbf{Y} = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix};\ \mathbf{X} = \begin{bmatrix} 1 & X_{12} & X_{13} & \cdots & X_{1k} \\ 1 & X_{22} & X_{23} & \cdots & X_{2k} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & X_{n2} & X_{n3} & \cdots & X_{nk} \end{bmatrix};\ \mathbf{B} = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{bmatrix};\ \mathbf{e} = \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_n \end{bmatrix},$$

where $\mathbf{Y}$ matrix of ($n \times 1$), $\mathbf{X}$ matrix of ($n \times k$), $\mathbf{B}$ matrix of ($k \times 1$), and $\mathbf{e}$ matrix of ($k \times 1$).

To obtain the matrix parameter estimator value $\mathbf{B}$, the amount of residual squared must be minimized, namely:

$$\text{Minimization } \sum e_i^2 = \mathbf{e}^T \mathbf{e} = (\mathbf{Y} - \mathbf{XB})^T (\mathbf{Y} - \mathbf{XB}). \quad (5)$$

Where $\mathbf{e}^T = (\mathbf{Y} - \mathbf{XB})^T$ transpose of $\mathbf{e}$. Because $\mathbf{B}^T \mathbf{X}^T \mathbf{Y}$ is scalar, hence the same as the transpose, that is $\mathbf{Y}^T \mathbf{XB}$. For the minimizing process, equation (5) is obtained as follows:

$$\frac{\partial \sum e_i^2}{\partial \mathbf{B}} = -2\mathbf{X}^T \mathbf{Y} + 2\mathbf{X}^T \mathbf{XB} = 0. \quad (6)$$

From equation (6) the parameter estimator can be obtained:

$$B = (\mathbf{X}^T \mathbf{X})^{-1} \mathbf{X}^T \mathbf{Y}. \quad (7)$$

Where $(\mathbf{X}^T \mathbf{X})^{-1}$ is the inverse of $(\mathbf{X}^T \mathbf{X})$. This approach can be used if $(\mathbf{X}^T \mathbf{X})$ have inverse (Sukono et al., 2016).

2.4 Goodnes of fit test

The goodness of fit test is intended to ensure that the model is able to describe the actual data. Goodness of fit testing of parameter estimators is carried out using individual significance test, simultaneous significance test, residual normality assumption test, and determination coefficient test.

- *Test for individual significance*

Individual significance tests are intended to test each parameter β_i ($i = 0,1,2,...,k$), where $\beta_i \in \{ b_0, b_1, b_2,..., b_k \}$ from equation (2), in influencing the dependent variable. To test parameters β_i, the hypothesis is $H_0: \beta_i = 0$ and $H_1: \beta_i \neq 0$. Testing is done using statistic t_{stat}, with equation:

$$t_{Stat} = \frac{\beta_i}{SE(\beta_i)}, \tag{8}$$

where $SE(\beta_i)$ is a standard error of parameters β_i.

Reject the hypothesis H_0 when $|t_{Stat}| > |t_{(n-2,\frac{1}{2}\alpha)}|$, or $\Pr[t_{Stat}] < \alpha$, where $t_{(n-2,\frac{1}{2}\alpha)}$ critical value of distribution -t with a level of significance $100(1-\alpha)\%$ and n the number of data (Sukono et al., 2016; Sukono et al., 2014).

- *Simultaneous significance test*

Simultaneous significance test is intended to test together parameters β_i ($i = 0,1,2,...,n$), where $\beta_i \in \{ b_0, b_1, b_2,..., b_k \}$ from equation (2), in influencing the dependent variable. The hypothesis is $H_0: b_0 = b_1 = b_2 = ... = b_k = 0$ and $H_1: \exists\ b_0 \neq b_1 \neq b_2 \neq ... \neq b_k \neq 0$. Testing is done using statistic F, dengan persamaan:

$$F_{stat} = \frac{\text{MS}_{\text{Reg}}}{\text{MS}_{\text{Error}}}, \tag{9}$$

where MS_{Reg} mean square due to regression, and MS_{Error} mean square due to residual variation.

Reject the hypothesis H_0 when $F_{Stat} > F_{(1,n-2,1-\alpha)}$, or $\Pr[F_{Stat}] < \alpha$, where $F_{(1,n-2,1-\alpha)}$ critical value of distribution F with a significance level of $100(1-\alpha)\%$, and n the number of data (Sukono et al., 2016; Sukono et al., 2014).

- *Uji normalitas residual*

The normality test is intended to determine that the residual data is normally spread. Normality test can be done using Kolmogorov-Smirnov (KS) statistics. The hypothesis is H_0: data is normally distributed, and H_1: data is not normally distributed. Testing is done by determining the residual standard deviation by using the equation:

$$S_{e_i} = \sqrt{\frac{\sum_{i=1}^{n}(e_i - \bar{e})^2}{n-1}}. \tag{10}$$

Transform values e_i become z_i with the equation $z_i = (e_i - \bar{e}) / Se_i$. Determination of probability values $P(z_i)$ performed using a standard normal distribution table. Whereas probability $S(z_i)$ determined using the equation $S(z_i) = randl(z_i)/n$. Furthermore, the absolute difference value is calculated $|S(z_i) - P(z_i)|$. Kolmogorov-Smirnov statistic KS_{Stat} determined using the equation:

$$KS_{Stat} = \max\{|S(z_i) - P(z_i)|\}. \tag{11}$$

Determine the critical value of statistic $KS_{(\alpha,n-1)}$, at the level of significance $\alpha = 0.05$. The test criteria are reject H_0 when $KS_{Stat} > KS_{(\alpha,n-1)}$ (Saputra et al., 2018; Sukono et al., 2014).

- *The coefficient of determination*

According to Sukono et al. (2016) and Sukono et al. (2014), the coefficient of determination R^2 is to measure how much the diversity of independent variables is to the dependent variable, based on the strength of the relationship.

So the coefficient of determination is the ability or influence of the independent variable X_i ($i = 1,2,...,k$)in influencing the dependent variable Y. The coefficient of determination R^2 determined using the equation:

$$R^2 = \frac{\sum_{i=1}^{n}(\hat{Y}_i - \overline{Y})^2}{\sum_{i=1}^{n}(Y_i - \overline{Y})^2}. \quad (12)$$

The value of the coefficient of determination is between 0 and 1. A small determination value close to 0 means that the variation of the independent variable is very weak, and the value that approaches 1 means that the variation of the independent variable gives all the information needed to predict the dependent variable.

2.5 Valuasi nilai kerugian

Citarum river floods that often occur can cause damage to buildings, so as to cause losses. The magnitude of the losses resulting from the Citarum river flood disaster can be estimated for the value of damage to buildings, and can be calculated using the equation:

$$\Delta Q_x = f(A \times \Delta P_t), \quad (13)$$

where Δ is declaring change, Q_x is the value of the building, $\boldsymbol{A}$ is the area of the building that is flooded, and P_t price per square meter of land and building (Rusminah and Gravitiani, 2012).

The steps to determine the loss of each building are as follows: (i) assessing the value of damage to buildings due to flooding; (ii) calculate the building area of each family; and (iii) estimating the average loss suffered by each building.

3. Result and Analysis

3.1 Areas prone to flooding

High intensity rain that often occurs, often resulting in flooding in some areas in Bandung Regency, West Java. Data obtained from the Bandung District Disaster Management Agency (BPBD), flooding occurred in four sub-districts: Dayeuhkolot, Baleendah, Bojongsoang and Banjaran, are as follows:

- Dayeuhkolot District floods occur in 10 villages in two villages including Dayeuhkolot Village and Citerup Village with Water Levels of 10-100 cm.
- Baleendah Subdistrict floods occur in town of Cigosol RW 09, village of Andir with Water Levels of 50-80 cm.
- Bojong Soang Sub-district floods occurred in Bojong Soang Village, Cijagra RW 09 and 10 Villages with Water Levels 20-70 cm
- Banjaran District floods occur in the Village of Kamasan RW 07 with Water Levels of 60-100 cm.

3.2 Analysis of the effects of flood disaster mitigation

Flood disaster mitigation analysis is carried out with the aim to determine how much the independent variables influence the level of ability to buy flood insurance as the dependent variable. In this study there is one dependent variable and eight independent variables, which are defined as follows:

Y : willingness to buy flood insurance as a mitigation effort;
X_1 : the average family income received by respondents each month;
X_2 : usia responden pada saat dilakukan wawancara;
X_3 : education level of respondents currently do interviews;
X_4 : the number of family members who are dependent on the respondent;
X_5 : perception of the impact of building damage due to flooding of the Citarum River;
X_6 : jarak tempat tinggal dengan aliran sungai Citarum;
X_7 : the average height of flood inundation in the respondent's residence;
X_8 : intensity of flooding in one year.

Citarum river flood mitigation analysis is carried out using multiple linear regression model which refers to equation (2), and parameter estimation is done by referring to equation (7). While the goodness of fit test is carried out by referring to equations (8), (9), (11), and (12). Both for parameter estimation and goodness of fit test, all is done with the help of Minitab 16 software, the results of which can be summarized in Table 1 below.

Table 1. Arameter estimation results of multiple linear regression using OLS

Variables	Coefficients	t-Count	Probability
Constant	-3256271	-1.893479	0.091214
X_1	0.793251	11.65638	0.000000
X_2	62124.87	3.426843	0.000002
X_3	290962.91	2.124232	0.000102
X_4	-199074,32	-1.992432	0.000000
X_5	280721,90	1.089726	0.070351
X_6	-56.36843	-0.321067	0.000310
X_7	-4832,476	-1.296059	0.004051
X_8	-253876,21	-1.573702	0.060305

Based on the results of the analysis presented in Table 1, if a 95% significance level is determined or a rejection rate of 5%, that the variable coefficients X_1, X_2, X_3, X_4, X_6, and X_7 significantly affect the variable Y, because it has the value Prob(t_{stat}) <5%. Overall the multiple linear regression model produces F_{stat} = 26.110653 with Prob(F_{stat}) = 0.00000. While the critical value of the statistics is $F_{(7,148;0.05)}$ = 2.40, it is clear that F_{stat} > $F_{(7,148;0.05)}$, which means the linear regression model is significant. The residual distribution of the regression is also normally distributed with an average of 0.00023 and variance of 0.826131. It is also shown that the relationship between the independent variable and the dependent variable is relatively strong, ie the coefficient of determination is R^2 = 0.67.

3.3 Analysis of the ability to buy flood insurance

Analysis of the ability to buy flood insurance as an effort to mitigate building damage is based on the results of a questionnaire assisted with interview techniques. The number of respondents was determined using equation (1), which in this study determined 150 respondents. Based on interviews with 150 respondents, the maximum level of ability to buy flood insurance can be summarized in Table 2. The following.

Table 2. Maximum ability level to buy flood insurance (W)

No	Maximum (IDR)	Number of Resnpondence	Percentage (%)
1	$0 < W \leq 250{,}000$	21	14.00
2	$250{,}000 < W \leq 750{,}000$	36	24.00
3	$750{,}000 < W \leq 1{,}000{,}000$	31	21.00
4	$1{,}000{,}000 < W \leq 1{,}250{,}000$	7	4.67
5	$1{,}250{,}000 < W \leq 1{,}500{,}000$	11	7.33
6	$1{,}500{,}000 < W \leq 1{,}750{,}000$	2	1.33
7	$1{,}750{,}000 < W \leq 2{,}000{,}000$	9	6.00
8	$2{,}000{,}000 < W \leq 2{,}250{,}000$	3	2.00
9	$2{,}250{,}000 < W \leq 2{,}500{,}000$	5	3.33
10	$2{,}500{,}000 < W \leq 2{,}750{,}000$	23	15.33
11	$2{,}750{,}000 < W \leq 10{,}000{,}000$	2	1.33
	Total	150	100

Observing Table 2, it appears that the average community living in vulnerable areas is affected by the flood of the Citarum river, the ability to buy flood insurance is very low. They have a surrender to the threat of flooding, which is likely to cause damage to the building where they live. This is due to the socioeconomic factors that influence it.

3.4 Valuation of loss value

Citarum river floods that often occur can cause harm to people living in vulnerable areas. The amount of loss caused by the Citarum river flood disaster can be determined based on changes in the sale value of land and buildings. To determine the magnitude of losses due to flooding of the Citarum river can be done by using equation (13). The steps are as follows:

a) Losses damage to buildings
Based on the results of the questionnaire, which was assisted by interview techniques for 150 respondents, obtained data that the loss of building damage in each flood event can be summarized in Table 3.

Table 3. Losses damage to buildings (L)

No	Losses damage to buildings (IDR)	Number of Respondence	Percntage (%)
1	$0 < L \leq$ 1,000,000	31	20.67
2	1,000,000 $< L \leq$ 2,000,000	39	26.00
3	2,000,000 $< L \leq$ 3,000,000	23	15.33
4	3,000,000 $< L \leq$ 4,000,000	12	8.00
5	4,000,000 $< L \leq$ 5,000,000	7	4.67
6	5,000,000 $< L \leq$ 6,000,000	9	6.00
7	6,000,000 $< L \leq$ 7,000,000	5	3.33
8	7,000,000 $< L \leq$ 8,000,000	7	4.67
9	8,000,000 $< L \leq$ 9,000,000	8	5.33
10	9,000,000 $< L \leq$ 10,000,000	7	4.67
11	10,000,000 $< L \leq$ 50,000,000	2	1.33
	Total	150	100

Paying attention to the results of the questionnaire presented in Table 3, shows that on average the people living in vulnerable areas affected by the Citarum river flood are significant losses in the event of a flood. The highest amount of loss can reach IDR 50,000,000.00, and the smallest loss can reach IDR 1,000,000.00.

b) Ownership of building area (A)
The building area of respondents living in vulnerable areas was affected by the Citarum river flood, from 150 respondents on average had a building area between 0.25 $< A \leq$ 0.50 times 200 square meters. The smallest building area reaches 60 meters per square meter, and the largest building area reaches 500 square meters. The ownership of the building area of 150 respondents can be summarized in Table 4.

Table 4. Ownership of building area per 200 square meters (A)

No	Building area (200 m^2)	Number of Respondence	Percntage (%)
1	$A \leq 0.25$	26	17.33
2	0.25 $< A \leq$ 0.50	35	23.33
3	0.50 $< A \leq$ 0.75	21	14.00
4	0.75 $< A \leq$ 1.00	25	16.67
5	1.00 $< A \leq$ 1.25	23	15.33
7	1.25 $< A \leq$ 1.50	7	4.67
8	1.50 $< A \leq$ 1.75	4	2.67
9	1.75 $< A \leq$ 2.00	3	2.00
10	2.00 $< A \leq$ 2.25	4	2.67
11	2.25 $< A \leq$ 2.50	2	1.33
12	Total	150	100

Ownership of a building area of less than 0.25x200 or less than 50 square meters, is generally included in the category of people who cannot afford it. So that generally do not have the ability to buy flood insurance.

c) Percentage rate of loss after flood
The percentage of the loss rate after the flood disaster, from 150 respondents living in flood-prone areas can be summarized in Table 5.

Table 5. Percentage of post-flood loss rates (ρ)

No	Persentase kerugian (%)	Number of Respondence	Percntage (%)
1	$0 < \rho \leq 25$	9	6
2	$25 < \rho \leq 50$	113	75.33
3	$50 < \rho \leq 75$	24	16
4	$75 < \rho \leq 100$	4	2.67
	Total	150	100

Based on the results in Table 5, it appears that the average respondent experienced a loss of building damage due to the flood of the Citarum river ranging from $25 < \rho \leq 50$ percent or as many as 113 people. As many as 24 people experienced losses ranging from $50 < \rho \leq 75$ percent, and as many as 4 people experienced losses ranging from $75 < \rho \leq 100$ percent. The remaining 9 people experienced losses ranging from $0 < \rho \leq 25$ percent.

4. Conclusion

This paper has discussed about measuring the level of insurance and the factors that influence it by using the Contingent Valuation Method (CVM). Based on the results of the discussion it can be concluded that the variables: family income; age of respondent; last level of education, number of family members; perception of damage to buildings; distance of residence with the Citarum river; high flood inundation; and flood intensity, can affect the level of ability to buy flood insurance. However, of the eight explanatory variables that are significantly influential are the variables: family income; age of respondent; last level of education, number of family members; distance of residence with the Citarum river; and high flood inundation. Based on questionnaire results on 150 respondents, it appears that the average community living in vulnerable areas is affected by the Citarum river flood, the ability to buy flood insurance is very low. The loss experienced by 150 respondents at the highest reaches IDR 50,000,000.00, and the smallest loss reaches IDR 1,000,000.00. The ownership of the building area of 150 respondents on average ranges from 0.25 to 0.50 times 200 square meters. The percentage of the level of damage to the building damage due to the flood of the Citarum river, from 150 respondents on average ranged from 25-50 percent. So that the results of this study can be used as a consideration in making a policy of selling flood insurance products.

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