Estrogenic Waste Conservation in Bengawan Solo Sub-Watershed: Application of Contingent Valuation Method

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Abstract. This study aims to determine the number of people willing to pay (WTP) for clean water using the Contingent Valuation Method (CVM). The sub-watersheds are located on the Pucang Sawit, Pepe, Premulung, and Kalianyar rivers. The data were random collected through interviews using questionnaires. The primary data consisted of four types, namely socioeconomic, perceptions of the environment and clean water, conservation of polluted water and simulations. The calculation of WTP with the CVM approach was carried out in 4 stages, including creating a hypothetical market, obtaining the WTP value, using an analytical model with dummy variables, and data analysis. The data analysis includes descriptive, regression, model significance, coefficient of determination (R2), and partial test. The results showed that 69.2% of respondents chose the 3rd simulation, with the willingness to plant 20 clumps of portulaca plants, to clean 50 litres of water for IDR 300,000. Based on the partial test, the variables that significantly affect WTP were the monthly expense, number of family members, gender, participation in environmental activities, and willingness to pay for water conservation. The contribution of this study is to be able to determine the WTP of a water conservation activity polluted in another area.

1. Introduction
Water is an essential natural resource in human life, socioeconomic development of society, households, industry, tourism, and culture [3]. Furthermore, clean water help in the survival and improvement of human welfare. An area develops rapidly when there is the availability of water to meet the domestic needs of the community [13]. The Bengawan Solo Sub-watershed is a source of drinking water and raw material for the Regional Drinking Water Company Surakarta city. However, there has been increasing pollution of estrogenic waste from the environment in this region, both from domestic, industrial, and agricultural by-products. The worse the water quality of the Bengawan Solo Sub-watershed, the more polluted the raw material used by the government company.

Presently, the increasing environmental damage has not received attention, leading to more devastation [20]. Therefore, efforts from various parties are needed to carry out environmental conservation to build an efficient and environmentally sound economic system. A clean environment ensures the resilience of industries that rely on productive natural resources. When the environment is damaged due to economic activities, it causes a decrease in the production rate. In the economic concept,
pollution is an externality that occurs when one or more individuals experience or suffer losses in welfare. However, at a certain level, economic activities can still overcome the problem of pollution by using waste cleaning technology [26].

This study examines economic valuation with the CVM approach to determine the number of people willing to pay bills (WTP) for clean water. The clean water in question is obtained from post-conservation estrogenic waste-free raw material based on the Portulaca plant's biological agents. The CVM respondents live around the Bengawan Solo sub-watershed, namely the Pepe, Kalianyar, Puchong Sawit, and Premulung rivers. This is an exploratory study with random sampling [24]. The CVM approach analyzed the respondents' WTP value and the water conservation efforts around the Bengawan Solo Sub-watershed. The data were collected from the 2019 clean, consolidated document of the Surakarta City Population and Civil Registry Office.

2. Method

This study was conducted in September 2020 in 4 villages around Bengawan Solo Sub-watershed in the city of Surakarta. The primary data used were obtained from the respondents' questionnaires. A total of 12,599 respondents from 4 villages were taken as a sample, namely Gilingan, Pucangsawit, Kestalan, and Laweyan, each with 6565, 4368, 975, and 691 families, respectively. Slovin's formula was used to determine the number of samples as follows:

\[
n = \frac{N}{(1 + N \cdot (e)^2)}
\]  

Where:
\(n\) = the number of samples
\(N\) = Total Population
\(e\) = Error Tolerance Limit

Then the number of samples is as follows:

\[
n = \frac{12,599}{(1 + 12,599 \times (0.1)^2)} = \frac{12,599}{126,99} = 99
\]  

Based on the slovin formula, the respondents for each village are as follows:

1. Gilingan Village  = 6.565 x 99/12.599 = 51.6 rounded to 52
2. Pucang sawit Village  = 4.368 x 99/12.599= 34
3. Kestalan Village  = 975 x 99/12.599= 7.6 rounded to 8
4. Laweyan Village  = 691 x 99/12.599= 5.38 rounded to 5

Based on the above calculation, the number of respondents in each village was at least 125 people.

The study method is a method of obtaining and analyzing data according to a specific purpose. The collected data were then analyzed using a dummy model, descriptive, and analysis. After several stages of analysis, the result is presented in a precise representation.

The calculation of WTP with the CVM approach has four stages: making a hypothetical market, obtaining the WTP value, using an analytical model with dummy variables, and data analysis. The first step involves creating a hypothetical market for the community around the Bengawan Solo Sub-watershed. Furthermore, the hypothetical market is stated in a questionnaire that provides clear information on the community’s current condition and asks questions based on the willingness to pay for maintaining the sustainability of the sub-watershed. The implementation of CVM is divided into six stages of work, namely, building a hypothetical market, generating a bid value, estimating the average WTP, assessing the bid curve, data aggregation, and evaluation [29].
3. Results and discussion

3.1. Hypothetical market

The Bengawan Solo Sub-watershed is a source of drinking water and raw material for the Regional Drinking Water Company in Surakarta. Therefore, the addition of chemicals in drinking water treatment increases [17]. The Bengawan Solo sub-watershed in Central Java is polluted by household, industrial and agricultural waste. The waste results from the disposal from the economic activity and production that is no longer needed. The contaminated river is caused by EDC (Endocrine Disrupting Compound) or SPH (Hormone Disrupting Compounds) factors above the quality standard. When people aspire to a healthy and pollution-free environment, then there must be willing to pay for it. This is considered as the economic value lost due to pollution. Therefore, efforts from various parties are needed to carry out environmental conservation to build an efficient and environmentally sound economic system.

3.2. Analysis with Dummy Variables

The problem often faced in this analysis is independent variables with non-metric or nominal size scales. When the independent variable is nominal, it is declared a dummy in the regression model by assigning a code of 1 or 0 [11]. The data obtained from the respondents' answers on a nominal scale are the gender variable, marital status, activity participation, pollution knowledge, clean water need, and conservation fee willingness dummy. This study uses willingness to pay (Y) as the dependent variable and the dummies of gender (X1), marital status (X2), activity participation (X3), pollution knowledge (X4), clean water need (X5), willingness to pay for conservation (X6), water resources (X7), presence of plants (X8), young people (X9), pay for conservation (X10), and not worry (X11). The method of assigning a dummy code uses a category indicated by the number 1 or 0. Therefore, the gender variable is coded 1 for males and 0 for females. The marital status variable is coded as 1 for married and 0 for unmarrieds. The multiple regression model used is as follows:

\[ WTP = \alpha + \beta_1 DJK + \beta_2 DSP + \beta_3 DKK + \beta_4 DPP + \beta_5 DAB + \beta_6 DKB + \beta_7 SA + \beta_8 KT + \beta_9 AM (2) \]

\[ + \beta_{10} BK + 1\beta_{11} TK + \varepsilon \]

Where:
- WTP = Willingness to pay
- DJK = Gender dummy
- DSP = Marital status dummy
- DKK = Participation activities dummy
- AM = Young people
- DPP = Pollution knowledge dummy
- DKB = Willingness to pay for conservation
- SA = Water resources
- KT = Presence of plants
- BK = Pay for conservation
- \alpha = Constant
- \varepsilon = Error
- \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}, \beta_{11} = Regression coefficient

3.3. Descriptive Analysis

The respondents were 133 living in four locations of the Bengawan Solo Sub-watershed. The majority of the 85% were married, and 15% were unmarried. The education level of the respondents was 20.3% elementary school, 15.6% junior high school, 46.6% high school, and 16.5% college (Diploma and Bachelor). The personal spending range per month was IDR 600,000 - 10,000,000. Based on the survey, the respondents' gender was 66% male and 34% female. A total of 12.8% respondents were self-employed, 5.4% were civil servants/Indonesian National Army/Police, 18% were housewives, and 63.16% were employees. Among the 133 respondents, some participated in
environmental activities, such as conservation and maintaining water from pollution by incurring costs.

3.4. Regression analysis
Following the regression analysis of WTP for clean water, free of estrogenic waste after conservation based on biological agents.

Table 1. The multinomial logistic regression analysis of WTP

| No. | WTP value (IDR) | Number (person) | Percentage |
|-----|-----------------|-----------------|------------|
| 1.  | 300,000         | 92              | 68.2       |
| 2.  | 225,000         | 21              | 15.8       |
| 3.  | 150,000         | 20              | 15.0       |

Source: Study results, 2020

Based on table 1, the multinomial logistic regression data results showed that 68.2% of the respondents chose the 3rd simulation, i.e., the willingness to plant 20 clumps of portulaca to clean 50 litres of water for IDR 300,000. As much as 15.8% chose the second simulation, i.e., the willingness to plant 15 clumps of portulaca with the ability to clean 37.5 litres of water for IDR 225,000. Meanwhile, the remaining 15% chose the first simulation, i.e., the willingness to plant ten clumps of portulaca with the ability to clean 25 litres of water for IDR 150,000.

3.5. Model Significance Test
The significance test of the model is used to determine the relationship of parameters in the regression model.

Table 2. Table of model significance test

| Model       | -2 Log likelihood | Chi-square | df | Sig. |
|-------------|-------------------|------------|----|------|
| Intercept   | 221.125           | 89.802     |    |      |
| final only  | 131.323           |            | 52 | .001 |

Based on table 2, the Sig value from model significance test was 0.001, i.e., there was at least one independent variable that statistically and significantly affected the dependent, because the P-value < α; (0.001 <0.05).

3.6. The Coefficient of Determination Test ($R^2$)
The test was used to quantify the model's ability to illustrate the dependent variable [11]. The value of the coefficient of determination was between zero and one. The greater the value of $R^2$ or close to the number 1, the greater the ability of the independent variable to influence the dependent.

Table 3. Results of the Coefficient of Determination

| Pseudo R square | Cox and Snell | Nagelkerke | Mc Fadden |
|-----------------|---------------|------------|-----------|
|                 | .491          | .606       | .406      |
Based on table 3, the Nagelkerke value from the pseudo R2 of 0.606 was observed, i.e., the variability of the dependent variable, which was explained by the independent was 60.6% or 30%; other factors outside the model expressed the rest.

### 3.7 The Partial Test

This test is used to measure the effect of each independent variable individually on the dependent. Based on the partial test, five dependent variables significantly affect the independent because of the p-value <0.05. They are monthly expenses, number of family members, gender, participation in environmental activities, and WTP for water conservation. The research in Eldoret Kenya and the government based on the decline in water quality in the area exacerbated by the project's lack of lifespan and years of conservational efforts. The factors associated with WTP were closely related to individual characteristics, risk perception, and trust in the government [31]. Meanwhile in the research, there are five dependent variables significantly affect

#### 3.7.1. Effect of monthly expense variable

The monthly expense variable has a significant value of 0.000, smaller than the implied level $\alpha = 0.05$ or 0.000 <0.05. This indicates that the monthly expenses variable has a significant effect on the willingness to pay. The community's monthly expenses range from IDR 600,000 - 10,000,000. The more respondents spend, the greater the value of the WTP chosen.

Expense per month in a research showed a positive relationship with WTP. Therefore, increasing a person's monthly expense increases the WTP towards the rise in waste disposal services [4]. The level of respondent's expense dramatically influences the total of the WTP value, indicating that the community is willing to pay. The research conducted on health insurance participants by observing the respondents' average expense positively impact the ability to pay health insurance premiums. This shows that the greater the expense, the higher the willingness to pay the WTP [30].

#### 3.7.2. The Effect of the number of family members

The variable number of family members has a significance value of 0.011, smaller than the implied level $\alpha = 0.05$ or 0.011 < 0.05. This indicates that the variable number of family members has a significant effect on the WTP. The number of family members ranges from 1-7 people. The more the family members, the greater the value of the WTP accepted. The value of WTP is different because the more of number household members, the greater the tendency of the respondent to pay [5].

The research on environmental services in the Sekampung watershed showed that the highest WTP value has six people, while the lowest is only two. The variable number of the dependents increases the WTP value of water-using farmers. In a research showed a positive effect between the number of household members and willingness to pay [14]. The greater the number of household members, the higher the tendency of the respondent to pay. An analyzed the willingness to pay (WTP) and faxing the factors that influence it at Vocational High Schools in Semarang City [27].

#### 3.7.3. Effect of gender

The gender variable has a significance value of 0.044, smaller than the implied level $\alpha = 0.05$ or 0.044 < 0.05. This indicates that the gender variable affects the determination of WTP. The gender of the respondents consisted of 66% male and 34% female. Man dominate this study because they have more roles in the issues outside the home and the surrounding environment, while women take care of the house. In a study conducted that woman tend to be more consumptive [28].

The research on visitation to the Gunung Gede Pangrango national park showed that household income and gender are significant factors affecting the number of entry fees they are willing to pay. Furthermore, binary logit regression was used to analyze visitor WTP probability for entry fees in GPNP. The model estimation involves the socioeconomic characteristics of visitors, such as age, gender, marital status, residential area, and income level. This analysis was also used to examine significant
differences in socioeconomic variables and provide more information about the independents that affect the willingness to pay [19].

3.7.4. Effect of participation in environmental activities
The variable participation in environmental activities has a significance value of 0.014, smaller than the implied level $\alpha = 0.05$ or $0.014 < 0.05$. This indicates that the variable participation in environmental activities affects the determination of WTP. Among the 133 respondents, 80% participated in environmental activities, such as conservation and keeping water from being polluted by incurring the costs.

The presence or absence of activity in the Code River affects the willingness to pay for improving the quality of the water [22]. The household's head, wetland and agricultural income, and previous experience of participating in conservation activities positively affect the household's willingness to pay. This study investigated local people's willingness to pay for community-based conservation activities and the variables that affect it in the Ghodaghodi Lake Complex, Nepal [15].

3.7.5. Effect of willingness to pay for water conservation
The variable of willingness to pay for water conservation has a significance value of 0.042, which is smaller than the implied level $\alpha = 0.05$ or $0.042 < 0.05$. This indicates that the variable of willingness to pay for water conservation affects the determination of WTP. Among the 133 respondents, a total of 67% indicated a WTP for water conservation polluted by estrogenic waste. The study of the WTP in the Karanganyar Regency showed that the average value of willingness to pay for organic rice in this regency is IDR 15,367 per kilogram. Factors that affect the value of WTP are income, trust, health awareness, age, and environmental awareness. The factor that has a dominant influence on the value of willingness to pay for organic rice is income [21].

4. Conclusion
Economic valuation with the CVM approach was conducted to determine the number of people willing to pay the WTP bill to conserve water exposed to estrogenic waste. The CVM respondents include the Bengawan Solo sub-watershed location residents, namely the Pepe, Kalianyar, Pucang Sawit, and Premulung rivers. There were three types of simulations of river water conservation, contaminated with estrogenic waste and purslane (*Portulaca sp*) to reduce estrogenic waste pollution. A total of 68.2% of respondents chose the 3rd simulation, i.e., the willingness to plant 20 clumps of portulaca, with the ability to clean 50 litres of water for IDR 300,000. The partial test showed that five factors affected the determination of WTP, namely monthly expense, number of family members, gender, participation in environmental activities, and willingness to pay for water conservation. The results of this study can be used as a reference for calculating the WTP for polluted water conservation activities in other areas.

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