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# Households' Willingness-to-Pay to Reduce the Use of Plastic Bags: Case Study in Viet Nam

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## Abstract

This study used the Binary Logistic regression model to estimate the willingness to pay (WTP) to reduce the use of plastic bags in the daily life of people in the Linh Nam ward. This study notes that households with higher incomes and higher levels of education tend to be more willing to pay. In addition, those who do not have access to information about the harmful effects of plastic bags and receive a higher proposed price often refuse to pay.

## Keywords

Binary Logistic Regression, Willingness to Pay, Plastic Bags

## 1. Introduction

In recent years, when the environmental pollution caused by plastic bags has become alarming, researchers in developed and developing countries have embarked on research to design policies to protect the appropriate environmental policies, even though improving ecological quality is seen as a luxury good for the poor [1]. Many researchers seek to quantify willingness to pay for public goods such as clean air or personal clean water by extracting information from property values [2]. However, one of the problems using the CVM method is that there are many errors in different interview methods [3].

Dunn [4] argues that people with high incomes often spend more money buying plastic bags than bringing recycled bags to use, even though these people's awareness is higher than low-income people's. The reason is they do not like the inconvenience. The research results of Akhtar *et al.* [5] have shown the relation-

ship between socio-economic factors and willingness to pay, especially income level, a variable that significantly influences willingness to pay. This conclusion is similar to N. V. Song *et al.* (2019) when the authors show that households with high incomes have higher WTP levels for water quality improvement programs [6].

Besides that, Yong Li and Bairong [7] emphasized the importance of awareness in reducing plastic bags. In addition, plastic ban policies have been effective when significantly changing consumer behavior. Research by T. T. T. Trang *et al.* (2019) [8] also confirms the role of perception on willingness to pay. The study confirms that people who are more aware of the benefits of treated wastewater have a higher willingness to pay for wastewater treatment.

Research by Patricia *et al.* [9] has given optimistic results on reducing plastic bag use. There are 80.7% of the total 367 people surveyed agree that they will reduce the use of plastic bags and change to other more environmentally friendly bags. Besides, research also shows that the plastic tax has not been highly effective because it is difficult to collect this tax. And that's why it is essential to increase people's awareness about environmental protection.

These are valuable studies that we can apply to Vietnam to examine the influence of socio-economic factors on reducing the use of plastic bags in daily life because Vietnam is currently a country with a high rate of pollution due to plastic waste. According to the Ministry of Industry and Trade, Vietnam has 1.8 million tons of plastic waste each year, including more than 30 billion plastic bags. It greatly affects the lives of people in all aspects.

In big cities, the consumption of plastic bags is often very high and shows no signs of slowing down. According to Yen [10], the willingness to pay for reducing the use of plastic bags in the daily life of people in Ninh Kieu District is still not high. Most interviewees chose to pay less than 500 VND/plastic bags. That's not a high number when compared to other countries. A study by Nattapat, Chanathip, and Jun [11] on estimates of willingness to pay for plastic bag waste management in Bangkok found that 60.2% of people (out of 108 people) are willing to pay for plastic bag waste management, and 39.8% disagree. And the results show that people in the study area are willing to pay 0.044 USD/plastic bag (Mean WTP) to manage nylon waste.

The highest consumption of plastic bags is in Hanoi. In Hanoi, nylon bags are still a convenient and cheap product used regularly in Hanoi city. Everywhere in the alleys, it is easy to see plastic bags. Linh Nam ward in Hoang Mai district, Hanoi city, is one of the localities with high consumption of plastic bags. On average, a household uses up to 1 kg of plastic bags per month. This number of nylon bags does not guarantee 100% that they will be collected and treated correctly. The amount of plastic bags indiscriminately discharged into the environment is still high because there are few public trash cans in Linh Nam ward. With the rapid and strong economic development, the apartment complexes gradually formed in Linh Nam ward will increase the number of goods consumed. Environmental issues, especially the reduc-

tion of plastic bags, will become a big problem—an urgent problem that needs to be solved.

There needs to be a study on reducing plastic bags in daily life. It can help design policies tailored to the study site. Therefore, this study aims to analyze people's opinions, estimate people's willingness to pay, identify influencing factors, and then provide a predictive model of willingness to pay to reduce the use of nylon bags in daily life. Determining willingness to pay for environmental issues has important informational significance for policymakers [12].

## 2. Methodology

The study used the Contingent Valuation Method (CVM) to build a market that does not yet exist for a certain type of goods or services. Then Mean WTP will be estimated from the Binary Logistic regression function. However, we need to make sure that all interviewees fully understand the information we convey. Otherwise, there will be errors in measuring willingness to pay [13].

### 2.1. Survey Design and Data Collection

With 6069 households in Linh Nam ward, the sample size reaching the 95% significance level is 375 households. It is calculated according to the formula of Yamane as follows [14]:

$$n = \frac{N}{1 + N \times e^2}$$

where: $N$ is the sample population.

$n$ is the number of samples needed to be investigated to ensure representativeness.

$e$ is the level of statistical significance (this study used $e = 0.05$).

Randomly select 375 households in 3 locations: Linh Nam Street, Nam Du Street, and Thuy Linh Street. Three adjacent streets all belong to Linh Nam ward.

### 2.2. Analysis of Fundamental Factors Affecting the Level of People's Willingness to Pay

The Binary Logistic regression function used in this study is as follows [15] [16]:

$$Y = \ln\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \beta_1 bid + \beta_i X_i$$

where: $X$ is a vector of socioeconomic factors such as age, gender, education, household size, and income.

$\beta(i = 0,1,2)$ are the estimated parameters.

The Odds Ratio: $\frac{P}{1-P}$.

$P$ is the probability that the respondent agrees to pay to reduce plastic bags in daily life. On the contrary, $(1-P)$ is the probability that respondents do not agree to pay to reduce the use of plastic bags in daily life.

The Binary Logistic regression equation is rewritten as follows:

$$Y = \ln(Odds) = \beta_0 + \beta_1 bid + \beta_i X_i$$

### 2.3. Parametric Approach to Estimate Willingness to Pay

The Mean WTP is estimated by using binary logistic model as follows [17]:

$$Y = \ln(Odds) = \beta_0 + \beta_1 bid + \beta_i X_i$$

We have:

$$\text{Mean WTP} = \frac{\beta_0 + \sum_1^n \beta_i X_i}{-\beta bid}$$

## 3. Results and Discussions

### 3.1. Result of Method Single-Bounded Dichotomous Choice

Based on DC1 model, 77.87% of the respondents are willing to pay to reduce plastic bags in daily life (Table 1). Moreover, the percentage of "Yes"-"No" responses indicates that the acceptance rate falls when the suggested bid gets higher. About 85.29% of people agree to pay at the bid of 50,000 VND. This ratio decreased to 78.49% at the bid of 60,000 VND. And the lowest rate is 69.57% at the proposal of 90,000 VND. This proves that the higher the bid, the more households tend to refuse to pay to reduce the use of plastic bags in daily life.

### 3.2. Model of Binary Logistic Regression and Its Parameters' Estimation

The Binary Logistic regression model was used to estimate the influence of the main parameters on the explanatory variable. The Omnibus fit test (Table 2) was performed before model estimation. The test result is Sig. < 0.05. It indicates the model's suitability.

Table 3 describes the variables in the model. It consists of 7 independent variables and one dependent variable.

Table 4 presents the output of the logistic regression model. This model estimates the proportion of respondents from individual categories who would be

Table 1. Probability of answering "Yes - No" of the households under model DC1.

| | **Yes** | | **No** | |
|---|---|---|---|---|
| Bid | No. | Percent (%) | No. | Percent (%) |
| 50.000 VNĐ | 87 | 85.29% | 15 | 14.71% |
| 60.000 VNĐ | 73 | 78.49% | 20 | 21.51% |
| 70.000 VNĐ | 68 | 77.27% | 20 | 22.73% |
| 90.000 VNĐ | 64 | 69.57% | 28 | 30.43% |
| **Total** | 292 | 77.87% | 83 | 22.13% |

Note: total percent of "yes" was calculated by dividing the number of households agreed to pay by the total number of households surveyed.

willing to pay a fee to reduce household use of plastic bags, *i.e.*, the odds that a variable "willing" will take on the value "Yes".

Household size and gender of the household head were not statistically significant due to the Sig. coefficient. > 0.05. We will remove these two variables from the model.

When we remove the two variables "household size" and "gender of the household head" from the model, the $\beta$ coefficients of the remaining variables do change, but not much.

**Table 2.** The Omnibus goodness of fit test.

| | Chi-square | df | Sig. |
|---|---|---|---|
| Model | 183.854 | 7 | 0.000 |

**Table 3.** Describe the variables in the model.

| Variable | Describe | Note |
|---|---|---|
| WTP | Willingness to pay of HH | No = 0<br>Yes = 1 |
| Age | Age of head of HH | Continuous variable |
| Gender | Gender of head of HH | Male = 1<br>Female = 0 |
| Nf | Size of HH | Continuous variable |
| Inc | Income of Interviewees | <7 million VND/month = 1<br>7 - 15 million VND/month = 2<br>15 - 25 million VND/month =3<br>>25 million VND/month = 4 |
| Edu | Education level of head of HH | Under high school = 1<br>High school = 2<br>Collge = 3<br>University/ above university = 4 |
| Cog | Probability to agree or disagree with the statement "people should sacrifice part of their income to protect the environment" | Yes = 1<br>No = 0 |
| P | Bid | 50 thousand VND/month = 1<br>60 thousand VND/month = 2<br>70 thousand VND/month = 3<br>90 thousand VND/month = 4 |

**Table 4.** The binary logistic regression output—explanatory variable: willingness to pay for a public good.

| | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| P | −0.579 | 0.177 | 10.656 | 1 | 0.001 | 0.56 |
| Inc | 3.459 | 0.591 | 34.284 | 1 | 0.000 | 31.792 |
| **Nf** | **−0.342** | **0.402** | **0.725** | **1** | **0.395** | **0.71** |
| Edu | 1.106 | 0.218 | 25.857 | 1 | 0.000 | 3.023 |
| Age | −1.079 | 0.252 | 18.33 | 1 | 0.000 | 0.34 |
| **Gender** | **0.812** | **0.443** | **3.359** | **1** | **0.067** | **2.253** |
| Cog | 1.875 | 0.927 | 4.091 | 1 | 0.043 | 6.52 |
| Constant | −5.933 | 2.571 | 5.326 | 1 | 0.021 | 0.003 |

### 3.3. Mean WTP and Factors Affecting People's Willingness to Pay to Reduce the Use of Plastic Bags in Daily Life

We used a parametric approach to estimate the interviewed households' mean WTP level. Specifically, this method will use the coefficients obtained from the Binary Logistic regression model in Table 5. The strength of this method is that it allows to combine and analyze the characteristics of the interviewees to calculate mean willingness to pay. The mean willingness to pay for reducing the use of plastic bags in daily life in Linh Nam ward is VND 67,221.89/month. It shows that respondents have a rather positive response to reducing plastic bags in daily life. In addition, it can be very effective to establish fundraising policies that fluctuate around willingness to pay. We need to determine how factors influence willingness to pay to develop the most effective policies. It is necessary to quantify the influencing factors.

In Table 5, the variable P has a coefficient of −0.577, which means that when the proposed price increases, the number of households that agree to reduce plastic bags will decrease. This conforms to the conclusions of Jin *et al*. [18] and Nasreen *et al*. [19]. The variable Inc has a coefficient of 3399, which proves that income is a very important variable affecting the "Yes" or "No" decision to pay for reducing the use of plastic bags. Construction policies that help reduce the use of plastic bags should be associated with policies to increase income. It will bring great benefits in ensuring social security. The Age variable has a coefficient of −1.178, showing that people in the older age group are more likely to refuse to pay for the reduction in plastic bag use. It may be because living habits and customs heavily influence their perception. We need to have appropriate policies to raise awareness of the elderly group, thereby stimulating them to reduce plastic bags in daily life. Education level is also an important variable affecting the "Yes" or "No" decision to pay for reducing the use of plastic bags in daily life. In this study, the variable Edu has a coefficient of 0.915, which means that as the level of education increases, the level of consent to pay for reducing the use of plastic bags in daily life also increases.

**Table 5.** Binary logistic regression output—explanatory variable: Willingness to pay for a public good (after removing two variables).

| | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| P | −0.577 | 0.175 | 10.859 | 1 | 0.001 | 0.561 |
| Inc | 3.399 | 0.551 | 38.02 | 1 | 0.000 | 29.923 |
| Edu | 0.915 | 0.189 | 23.486 | 1 | 0.000 | 2.497 |
| Age | −1.178 | 0.245 | 23.087 | 1 | 0.000 | 0.308 |
| Cog | 1.767 | 0.822 | 4.626 | 1 | 0.031 | 5.854 |
| Constant | −5.426 | 1.848 | 8.619 | 1 | 0.003 | 0.004 |

When giving the opinion "people should sacrifice part of their income to protect the environment", most respondents agreed with this view. Moreover, the percentage of households who agree with the given point of view also agree to pay the proposed price to reduce the use of plastic bags in daily life is 81.36%. It is consistent with the coefficient of the Cog variable when the coefficient 1.767 has a positive sign.

To better quantify the influence of the independent variables on the dependent variable, we assume that the probability that the household agrees to pay for reducing the use of plastic bags in their primary activities is 10%. Or $P_0$ = 10%. $P_i$ is the probability of willingness to pay to reduce the use of plastic bags in daily life when the variable $X_i$ fluctuates while other variables remain constant. We have:

$$P_i = \frac{P_0 e^{B_i}}{1 - P_0\left(1 - e^{B_i}\right)} = \frac{0.1 \times e^{B_i}}{1 - 0.1 \times \left(1 - e^{B_i}\right)}$$

Through Table 6, we see that income has the greatest influence on the probability of answering "Yes" to reducing the use of plastic bags in daily life. The proposed price has the lowest impact. The ranking of influencing factors is important to help develop suitable policies for the study area.

### 3.4. The Model Predicting the Probability of Answering "Yes" or "No" for Reducing the Use of Plastic Bags in Daily Life

One strong application of Binary Logistic regression is prediction. Predicting the probability of agreeing or disagreeing with reducing the use of plastic bags in daily life is necessary to estimate the effectiveness of the policy. The correct prediction for the whole model is 88%—calculated based on the Binary Logistic regression analysis results. To predict the probability of agreeing or disagreeing to pay for reducing the use of plastic bags in daily life, we use an equation as follows:

$$E\left(\frac{Y}{X}\right) = \frac{e^{\ln(odds)}}{1 + e^{(odds)}}$$

**Table 6.** Ranking the degree of influence of independent variables on the dependent variable.

| Variable | B | Exp(B) | Initial probability: 10% | Impact | Ranking |
|---|---|---|---|---|---|
| | | | Probability when the variable Xi fluctuates | | |
| P | −0.577 | 0.561 | 6% | −4% | 5 |
| Inc | 3.399 | 29.923 | 76.90% | 66.90% | 1 |
| Edu | 0.915 | 2.497 | 21.70% | 11.70% | 3 |
| Age | −1.178 | 0.308 | 3.30% | −6.70% | 4 |
| Cog | 1.767 | 5.854 | 39.40% | 29.40% | 2 |

where, $E\left(\frac{Y}{X}\right)$ is the probability that the dependent factor reaches the value 1 when the independent factors have a specific value.

$$\ln(odds) = \beta_0 + \beta_1 Gen + \beta_2 Age + \beta_3 Edu + \beta_4 Inc + \beta_5 N_f + \beta_6 Cog + \beta_7 P$$

We get:

$$\ln(odds) = -5.933 - 0.577P + 3.399Inc + 0.915Edu - 1.178Age + 1.767Cog$$

To make this clear, we can take the following example:

Mr. A lives in Linh Nam ward. This year he is 27 years old. He graduated from high school. Currently, he has an income of 10 million VND a month. He agrees with the view that "people should sacrifice part of their income to protect the environment". When he withdraws money for 60,000 VND/month, then the probability of answering "yes" is:

$$E\left(\frac{Y}{X}\right) = \frac{e^{-5.933-0.577\times2+3.399\times2+0.915\times2-1.178\times1+1.767\times2}}{1+e^{-5.933-0.577\times2+3.399\times2+0.915\times2-1.178\times1+1.767\times2}} = 0.993638 = 99.3638\%$$

The probability that Mr. A agrees to pay is 99.3638%, with a correct prediction of 88%.

## 4. Conclusions and Policy Recommendations

Research results show that people living in Linh Nam ward are aware of the harmful effects of using plastic bags. Nearly 61.3% of opinions said that the harmful effects of plastic bags directly affect human health. Only about 38.7% of the rest think that the harmful effects of plastic bags greatly affect the environment and natural resources. We need to continue to educate people about the harmful effects of using plastic bags. Policies should specifically target the elderly group when the analysis shows that they tend to refuse to pay to reduce the use of plastic bags.

On average, according to the DC1 model, about 77.87% of households are willing to pay to reduce the use of plastic bags in daily life. The mean willingness to pay for reducing the use of plastic bags in daily life in Linh Nam ward is VND

67,221.89/month. The policy of mobilizing capital for the construction of public works to reduce the use of plastic bags in daily life should revolve around this price. Suppose we want to increase the Mean WTP. In that case, more policies to improve people's incomes are needed because the results of this study have demonstrated that as income increases, the willingness to payments also increases.

Socio-economic characteristics greatly impact the probability of "Yes" or "No" to pay for reducing the use of plastic bags in daily life—especially factors such as income, age, awareness… The quantification of the influence on variables helps the proposed policies to support each other. For example, education policies can help reduce the use of plastic bags (education helps raise awareness and increase access to information about the environment).

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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