Valuing Environmental Impact and Willingness to Pay for Improved Air Quality: Evidence from Patimban Port Project, Subang, Indonesia

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Abstract. The influence of the Patimban port's construction can be seen in the cost of land and houses nearby, as well as environmental issues like air pollution, which is getting worse due to the traffic of project material vehicles. This study aims to assess the environmental impact on the property price around the project and determine the willingness to pay for improved air quality. The finding showed that property and the neighborhood characteristics, and the ambient of air quality of SO2 has negatif and significant impact on residential property price. About 55.6 percent of the respondents were willing to pay a lump sum of money for improved air quality. Age, income, years of schooling, the distance to Patimban Port project, the history of respiratory disease and health cost had favorable and significant effects. This study contributes to the literature by highlighting the environmental impact of the project on the property price and the participation of people to improve the air pollution in the area prone to polluted.

Keywords: Hedonic Price, Contingent Valuation Method, Air Pollution, Implicit Price, Willingness To Pay

1 Introduction

The increased public awareness about environmental issues has increased the frequency of research in the subject of environmental economics. Due to the excessive emissions from industrial and other resources, air pollution has reportedly gotten worse and has a greater negative impact on human health as a result of the swiftly developing global economy [1-3]. According to a recent study, air pollution not only has a deleterious effect on chronic diseases of the cardiovascular and respiratory systems but also hastens their development [4]. Air pollution has been linked to premature mortality and morbidity, according to various national and international studies conducted in recent years [1-3]. These studies put the onus on the local government to lessen the amount of air pollution brought on by industrial growth and weigh the advantages and disadvantages of doing so [4].

Patimban Port is a development project carried out by the Indonesian government through the Directorate General of Sea Transportation (DGST) in collaboration with the Japan International Cooperation Agency (JICA). Patimban Port will be established as the second largest international port after Tanjung Priok. The construction of the Patimban port will certainly have negative impacts including the large number of conversions of agricultural land so that many farmers lose their agricultural land and fishermen who lose their fish catch due to sea reclamation. Another impact of the construction of the Patimban port is regarding environmental problems such as air pollution which is increasing due to the traffic of project material vehicles and the price of land and housing around the Patimban port. The amount of pollution that occurs around the Patimban port project will damage the quality of the environment and the residences of local residents. Decreased air quality due to pollution from port project development activities and polluted water quality can affect the value of land and existing buildings.

The absence of a market for clean air benefits, as there is for other environmental assets, makes it difficult to evaluate their value. Due to this, environmental economics has created two different methods for estimating the value of these assets: revealed preferences and asserted preferences. The primary distinction between them is that the first makes use of a real market while the second is based on a fictitious market. Both attempt to determine the willingness to receive as a kind of compensation for worse conditions or the willingness to pay (WTP) for environmental quality improvements.

The methods used in the stated preference procedures, which are based on surveys, include Contingent Valuation, Choice Experiments, Structural Equations, and Delphi. The most popular of them is the Contingent Valuation, created by Hanemann [5]. Hedonic prices and travel costs are two of the methods used to determine preferences (HP). Environmental products including woods, parks, and lakes are evaluated using travel costs. The value is assessed using the number of visits and the cost of travel. We choose the hedonic pricing technique in this study because it has the benefit of using actual market prices rather than hypothetical prices. When it comes to air pollution, HP studies employ information from the housing market and include the degree of pollution or the distance to industrial areas as one of the features. It is anticipated that properties in areas exposed to more environmental contamination will cost less than those in less polluted areas.

The notion of Willingness to Pay (WTP) is established in order to gauge public enthusiasm for improving environmental conditions [6]. When respondents are questioned about their willingness to pay for an unmarketable

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good, their WTP is an intention. The respondents are often chosen consumers since WTP has been utilized extensively in the early stages of economic markets to help enterprises build an effective pricing strategy [7]. The market for clean air and water has since begun to use WTP, according to some researchers [8]. Consumers were not the only group that responded; other groups were also included. The fundamental objective of WTP was to close the gap between social economics and the environment. Numerous research on WTP-related air quality have been carried out throughout the world, including in the United States, Bangkok, Mexico, and certain countries in northern Europe [9–11]. In India, Kumar conducted study that demonstrated how respondents' WTP might be strongly impacted by their health situation [12]. To further understand the relationships between demographics and residents' WTP in China, some research has been done [13], including several recent studies in Nanchang [14,15]. According to a recent questionnaire survey, over 95% of Nanchang University students said that improving air quality required government financing and effort as well as the responsibility and obligation of every person [16]. These studies have demonstrated that respondents strongly believe that local air quality can be improved. Jiangxi province's capital, Nanchang, is predicted to have a population of 5.29 million [17]. The studies which valuing environmental impact of port project in Indonesia are still inconclusive. To fill this gap, this study aims to show the adverse effects of air pollution externalities on housing price. This study is also measuring the willingness to pay (WTP) for improved air quality due to the project of Patimban Port Subang, Indonesia and determine the factors influence to the WTP for improved air quality.

2 Research Method

2.1. Study site

This study was conducted in Subang Regency, precisely in several villages in Pusakanagara District. Research where the Patimban port project is located.

Figure 1. Patimban Port Proect in Subang, Indonesia

This study is located in several villages which are affected by air pollution due to the construction of the Patimban Port project.

Table 1. Summary of ambient air research tests around Patimban Port

No	Location	Parameter	Unit	Result	
				1st test	2nd test
1	Pusakanagara District Office	Sulflur Dioksida (SO_2)	µg/Nm^3	4	14
		Nitrogen Dioksida (NO_2)	µg/Nm^3	12	4
2	Roadside Patimban-Kalentambo Village	Sulflur Dioksida (SO_2)	µg/Nm^3	7	12
		Nitrogen Dioksida (NO_2)	µg/Nm^3	17	20
3	Patimban seaside	Sulflur Dioksida (SO_2)	µg/Nm^3	4	7
		Nitrogen Dioksida (NO_2)	µg/Nm^3	13	13
4	Kotasari Village Settlement	Sulflur Dioksida (SO_2)	µg/Nm^3	10	20
		Nitrogen Dioksida (NO_2)	µg/Nm^3	10	11

2.2. Sampling method

In this survey study, the stratified cluster sampling approach was used, and six villages in Pusakanagara District, Subang Regency were chosen. These villages including Patimban Village, Kalentambo Village, Kotasari Village, Trungtum Village, Ciawitali Village and Pusakaratu Village. After that, 45 respondent fro each villages were chosen randomly. A sample size of 270 people was intended by Isaac and Michele sampling method. A face-to-face interview method was used in this study because in-person interviews were thought to be preferable to mail or telephone surveys for obtaining contingent values [28] and because varying educational levels of respondents were taken into account. The interview was done between December 2020 and February 2021.

2.3. Survey design and administration

In this work, we surveyed people in the study site to discovered the property prices and the factor influence these prices. We also evaluated WTP for improved air quality due to the Patimban Port project. If respondents are prepared to pay more for better air quality, they must analyze their preferences and treat air quality as a hypothetical good. In the contingent valuation method, the questionnaire's content was modified based on the findings of a pre-test survey with a sample size of 20 respondents.

Table 2. Descriptive statistics of the survey participants (n = 270).

Variable	Mean	Std. Deviation
AGE	46.00	10.906
SEX	.53	.500
INCOME	2.27	.986
EDUCATION	10.79	3.173
PROPPRICE	363490814.81	213489397.869
LANDSQ	160.07	92.101
BUILDINGSQ	121.54	57.961
ROOM	2.94	.875
DISPROJECT	2689.00	1567.232
DISSCHOOL	936.07	398.943
DISMARKET	4226.85	2322.140
POLLUTION	12.46	4.547
ILLNESS	.53	.500
HEALTHCOST	48759.26	87030.938
WTP	.56	.498

All survey participants were requested to fill out the following information: a) for hedonic price method (HPM) analysis, we need information of independent variables including characteristics of property (i.e. land square, building square, number of rooms), characteristics of neigborhood (i.e. distance to project, distance to school, distance to market), and characteristic of environment (i.e. SO_2 pollution), and property price as dependent variable; b) for contingent valuation method (CVM), weed information of sociodemographic characteristics (i.e. age, gender, educational attainment), property characteristics (i.e. land square, distance to project, distance to school, distance to market); health status characteristics (i.e. history of illness, health cost), and WTP for improved air quality as dependent variable by asking, "Are you willing to spend a particular amount of money per month to enhance the current ambient air quality to a level such as nature reserves, beautiful areas, etc.."

2.4. Data analysis

2.4.1. Hedonic Price Method (HPM)

By incorporating an air pollution variable into the hedonic model, this study expands on previous research that deals with pollution features. HPM has been effectively used by several researchers to examine how changes in housing values are influenced by air pollution. The researcher is able to evaluate the potential impact of each attribute on the cost of the property under study thanks to HPM. Property and neighborhood characteristics, and also air pollution indicator (as the environment characteristic) are the factors that have an impact on property prices, as shown in Table 3. Equation (1) illustrates the functional form of the model's HPM-based explanation of property price:

$$PPRICE = f\,(PROP, NEIGH, ENVT) \quad (1)$$

Where *PPRICE* represents the property price. Meanwhile, *PROP, NEIGH, ENVT* represent the attributes of property, neighbourhood, and environment respectively of the property.

Table 3. The definitions of explanatory variables in HPM

Categories	Variable	Definition
	Dependent variable	
Property price	PPRICE	Price of residential property (IDR)
	Independent variable	
Property characteristics	LANDSQ	Land square (m^2)
	BUILDINGSQ	Building square (m^2)
	ROOM	Number of rooms (unit)
Neighborhood characteristics	DISPROJECT	Land square (m^2)
	DISSCHOOL	Years as farmers (years)
	DISMARKET	
Environment characteristic	POLLUTION	Parameter of air quality of SO2 (ppm)

Rosen's [18] two-step approach is the basis for the second stage of HPM. The second stage approach, builds on the knowledge gained in the first stage to create a set of exclusion criteria that may be used to determine the marginal willingness to pay [19]. The subsequent step in the second stage is to estimate the implicit price of improved air quality for each observation, which is the responsiveness of the house price function with respect to the air pollution attributes, in accordance with some studies [20-22].

In this stage, the implicit price obtained from Equation (2) is regressed against the air pollution attributes (such as SO^2 ambient) and sociodemographic variables [21,23,24] also claim that respondents' sociodemographic attributes, such as income, age, gender, and educational background, also influence their willingness to pay.

Equation (2) is hence the definition of the study's final log-linear equation:

$$PPRICE_i = \beta_0 + \beta_1 LANDSQ_I + \beta_2 BUILDINGSQ_1 + \beta_3 ROOM_I + \beta_4 DISPROJECT_I + \beta_5 DISSCHOOL_I + \beta_6 DISMARKET_I + \beta_7 POLLUTION_I + e \quad (2)$$

The partial derivatives of this function with respect to air quality have marginal price implications. That price is the Marginal Willingness to Pay for choosing a home with improved air quality, and everything else remains the same. The implicit price is estimated as follows:

$$Implicit\ Price = PPRICE\left(\frac{1}{SO_2}\right) x\beta_7 \quad (3)$$

2.4.2. Contingent Valuation Method (CVM)

In order to determine the relationship between explanatory factors and peoples' willingness to pay for improved air quality, we used a logistic regression [25]. The dependent variable of the model is the people's willingness, where 1 indicates agreement and 0 disagreement. The independent variables of the model are the sociodemographic, property, and health characteristics (Table 3).

The logistic regression model:

$$WTP_i = Ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 AGE_I + \beta_2 GENDER_1 + \beta_3 INCOME_I + \beta_4 EDUCATION_I + \beta_5 LANDSQ_I + \beta_6 DISPROJECT_I + \beta_7 DISSCHOOL_I + \beta_8 DISMARKET_I + \beta_9 ILLNESS_I + \beta_{10} HEALTHCOST_I + e \quad (4)$$

P is the probability of 1, 0 is a constant, n is the regression coefficient, and X_n are the variables that affect WTP. The definition of variables was displayed in Table 4.

Table 4. The definitions of explanatory variables in CVM

Categories	Variables	Definition
	Dependent variable	
Willingness to Pay	WTP	Support for monthly payment for improved air quality (1 : yes ; 0 :no)
	Independent variable	

Categories	Variables	Definition
Sociodemographic characteristics	AGE	Age of respondent (year)
	GENDER	Gender of respondent (1: male; 0: female)
	INCOME	Income of respondent per month (IDR)
	EDUCATION	Years of schooling of the respondent (years)
Property characteristics	LANDSQUARE	Land square (m^2)
	DISPROJECT	Distance to project (m)
	DISSCHOOL	Distance to school (m)
	DISMARKET	Distance to market (m)
Health characteristics	ILLNESS	History of respiratory disease (1: yes, 0: no)
	HEALTHCOST	Medical expenses for the treatment of respiratory diseases (IDR)

3 Result and Discussion

3.1. Hedonic Price Method Analysis

In Table 5, the study's findings are displayed. At the 99 percent confidence level, the majority of the explanatory variables employed in the analysis are statistically significant and have the predicted sign. Among the property characteristics, the factors of land square, building square, and number of rooms all significantly and favorably impacted the residential property values. The residential property prices increase as land area increases. The residential property rises as building size increases. The price of a residential property increases with the number of rooms as well.

Of the neighborhood characteristics, distance to Patimban Port project and distance to the school had a negative and significant impact. The nearer residential property to the Patimban Port project, the higher residential property price. The nearer school, the higher residential property price. Meanwhile, distance to market had no significant impact. The environment characteristic i.e. the ambient of air quality of SO2 has significant impact on residential property price.

Table 5. The regression result of HPM

Variable	Coefficient	Stand. error
(Constant)	18.932	.088
LANDSQUARE	.003***	.000
BUILDINGSQ	.001***	.000
ROOM	.087***	.022
DISPROJECT	-8.083E-5***	.000
DISSCHOOL	-7.302E-5**	.000
DISMARKET	1.135E-5	.000
POLLUTION	-.008***	.004
F stat	115.660	
Adjusted R^2	.749	

Dependent variable: ln property price.
* significant at α = 10%.
** significant at α = 5%.
*** significant at α = 1%.

The calculation of implicit price represents an empirically implementable measure of consumer's willingness to pay for improved air quality due to the Patimban Port project. The implicit price can be calculated by using the formula as in Equation (3):

$$Implicit\ Price = 363490814.81\left(\frac{1}{12.46}\right)x0.008 = 233{,}380.94$$

For methods to prevent losses in residential property value due to air pollution problems, respondents provided an implicit price total of IDR 233,400. By dividing the overall implicit price by the quantity of

respondents, one can derive an estimate of the individual amount. The implicit cost to each respondent of reducing air pollution in their neighborhood is typically around IDR 1000.

3.2. Contingent Valuation Method Analysis

The study results showed that 55.6 percent (*n*=150) of the respondents were willing to pay a lump sum of money for improved air quality and the remaining 44.4 percent (n=120) were not willing to do so (see Table 6).

Table 6. Willingness to pay for improved air quality

WTP	Frequency	Percent
0	120	44.4
1	150	55.6
Total	270	100.0

Age, income, years of schooling were sociodemographic indicators that had favorable and significant effects, whereas gender had no such effects (see Table 7). People support improved air quality more as they age. Their willingness to participate increases with the higher income. Additionally, people are more inclined to join if they are longer years of schooling.

Table 7. The regression result of CVM

Variable	Odds ratio	Stand. error
Constant	.092	1.361
AGE	1.040**	.018
GENDER	.665	.367
INCOME	1.958***	.205
EDUCATION	1.252***	.071
LANDSQUARE	1.001	.002
DISPROJECT	.999***	.000
DISSCHOOL	.999**	.000
DISMARKET	1.000	.000
ILLNESS	4.824***	.375
HEALTHCOST	1.000**	.000
Nagelkerke R Square	.535	

Dependent variable: support for improved air quality.
* significant at α = 10%.
** significant at α = 5%.
*** significant at α = 1%.

The distance to Patimban Port project was one of the aspects of property that somewhat influenced how supportive people were of improved air quality. People are more likely to participate the nearer the project is. The encouragement for improving is stronger for people with nearer school. Of the health characteristics, the history of respiratory disease and health cost has a positive and significant impact. People who have history of respiratory disease willing to participate more than people who never have the disease. Additionally, the more expensive the medical expenses for the treatment of respiratory diseases, the higher their willingness to participate.

4 Conclusion

This study uses the hedonic price method (HPM) to estimate the effect of air pollution due to Patimban Port project on property price in area around the port. This study was also determine the WTP for improved air quality using the contingent valuation method (CVM). We surveyed people in several villages in Pusakanagara District which are affected by air pollution due to the construction of the Patimban Port project. The finding showed that among the property characteristics, the factors of land square, building square, and number of rooms all significantly and favorably impacted the residential property values. Of the neighborhood characteristics, distance to Patimban Port project and distance to the school had a negative and significant impact. The environment characteristic i.e. the ambient of air quality of SO2 has negatif and significant impact on residential property price.

This study also determined the willingness to pay (WTP) for improved air quality. The study results showed that 55.6 percent of the respondents were willing to pay a lump sum of money for improved air quality. Age, income, years of schooling had favorable and significant effects, whereas gender had no such effects. The distance to Patimban Port project was one of the aspects of property that somewhat influenced how supportive people were of improved air quality. The history of respiratory disease and health cost has a positive and significant impact.

These result have implications for public policy at the local level. In order to protect public health, local government might consider ordinances restricting or banning the emission by project or they could erode a tax base if they drive away too may activities. The alternative solution by providing subsidies to household for purchasing pollution control equipment. Ideally, this measure could be partly self-financing, as a cleaner environment would result in slightly higher property values, and thus increased property tax revenue. For further study, it would be useful to survey the health status of people residing in the area affected by air pollution in order to assess the health risks they are facing and the researcher can use the health production function to examine the impact of the air pollution due the the Patimban Port project.

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