A FRAMEWORK TO ESTIMATE THE WILLINGNESS TO PAY OF HOUSEHOLD FOR AIRQUALITY IMPROVEMENT: A CASE STUDY IN KLANG VALLEY, MALAYSIA

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Abstract: The main objective of this study is to estimate the willingness to pay (WTP) of the household for improving the air quality in Klang Valley, Malaysia as a result of implementation of two types of transport hypothetical policy options. Survey method will be conducted to estimate how much the household in Klang Valley would value lowering the health risks associated with poor air quality. The popular method, contingent valuation method (CVM) has been used to estimate WTP for avoiding the ill health episodes due to air pollution or to improve the air quality in Klang Valley. The survey results will be analyzed using Binary Logit Model. This study is expected to minimize the problem of mismatch in terms of services that can be supplied by government and what the public really wants and is willing to pay for.

Keywords: Air quality improvement, Contingent valuation, Willingness to pay.

INTRODUCTION

Urbanization and the economic growth together determine the steps forward of transport sector in the concerned cities especially in Klang Valley, Malaysia (East Asia and Pacific Region, 2006). Transport service industry increasingly serves as a prerequisite in continuing and developing the productivity of other sectors in the society. Furthermore, it is closely connected with current lifestyles. Meantime, the transportation sector is responsible for a large portion of energy consumption in Malaysia and the highway sector is the largest part of transportation fuel consumption. Transport sector accounts for 40.5 per cent of the total final commercial energy demand in 2005 [1]. As a consequence, there is a conflict between energy use and the attempt to trim down the greenhouse gas (GHG) emissions. Transport sector is emitting the pollutions more than the industrial, agricultural sector and opened burning in Malaysia. Transportation is the fastest growing source of CO_2 emissions. This condition would deteriorate the ambient atmospheric conditions in big cities in Malaysia [2]. The atmosphere system has changed considerably due to the expanding use of fossil fuels and pollutant emissions from transportation sector in Malaysia [3].

PM_{10} exceeds the Malaysian air quality guideline in Petaling Jaya, Gombak, Kelang, Kajang and Kuala Lumpur. It would be affecting human health in this area. Respiratory diseases are among the highest ranked diseases suffered by Malaysian citizens. The elderly and the children are the most victims of the effects of the Particulate Matter [4,5]. As a result, local and national governments increasingly require information of costs and benefits associated with ambient levels of pollution to support them in improving standards and imposing pollution control measures.

This study intends to estimate the WTP for two improved alternative hypothetical options, and then the WTP obtained from two alternative options would be compared. WTP is extra money is being paid by the household for having improved air quality in Klang Valley, Malaysia. Further, it would try to identify the factors influencing the probability of WTP.

This study would help to minimize the problem of mismatch in terms of services that can be supplied by government and what the public really wants and is willing to pay for. To date, no such study has been conducted in Malaysia as such this study provides two important insights for policy-makers that affects public and private sector; (1) Incorporation of demand-side information into the design of air quality improvement attributes, and (2) Development of programs to increase respondent's participation for air quality improvement projects.

MATERIALS AND METHODS

Theoretical Framework of CVM for Air Quality Improvement in Klang Valley, Malaysia

The theoretical framework of CVM model has been developed based on the theory of Cropper et al., Alberini et al. and Cropper and Freeman [6,7,8]. According to them, the utility function of an individual is decided by good consumed (X), leisure time (L), individual's characteristics (Z), and the individual's health status (S) during a year. In this model individual's health status refers to the number of sick days due to the respiratory diseases which are caused due to air pollution. It is simplified in Eq.(1) as;

$$U = U(X, L, Z, S) \qquad (1)$$

The health status or number of sick days of an individual depends on some biological factors, environmental quality, mitigation activities and some socio-economic factors. In this model, we considered the biological factors as constant. Environmental quality refers to the air quality which depends on the concentration of different air pollutants. In Klang Valley, the concentration of PM_{10} is above the standard level. So, it is considered that the concentration of PM_{10} is affecting the air quality in Klang Valley and indirectly affecting the heath status of the individuals. The mitigation activities are also the important factors to determine the individual's health status. It is shown in the Eq. (2)

$$S = S(Q, M, Z) \qquad (2)$$

Where Q is the concentration of PM_{10}, M is mitigation activities and Z is the socio-economic factors. Here, mitigation activities refer to the individual's demand for medicines, hospitalization, pathological tests, doctor's consultation, visits to doctor's clinic and health insurance cost. Socio-economic factors include individual's age, level of education, employment, gender, income levels, work place environment, transport, residence envirnment, smoking, and access to healthcare services. The expenditure function can be written in the Eq. (3) as;

$$e = (p_x, w, p_m, Q, M, Z- \bar{U}) = \{\min p_x x + p_m M - (Y_{NW} + w(T - L - S(Q, M, Z))\}$$

$$\text{Subject to } U(X, L, Z, S) \geq \bar{U} \qquad (3)$$

Where, p_x is the price of good x consumed, w refers the wage rate, p_m shows the price of mitigation activities, Y_{NW} is non-wage income, T is total time available and $\bar{U}$ represents the average utility of the respondents. For the convenience, the expenditure function omits the Y_{NW} non-wage income and T, total time available. Air quality improvement can raise the individual's utility levels indirectly by reducing the numbers of illness days and increasing leisure time.

The current study assumes that the willingness to pay to for the air pollution reduction from Q^0 to Q^1 is defined by the following equation and it implies that willingness to pay to improve the air quality should differ with income, prices, individual characteristics, the concentration of PM_{10}, sick days due to respiratory sickness and average utility of the respondents. In this study, the experimental design will be constructed based on the compensating surplus (CS) welfare measure. It will measure the change in expenditure that would make an individual indifferent between the initial (lower air quality) and subsequent situations (higher air quality) assuming the individual has the right to the initial utility level. This change in expenditure will reflect the individual's WTP to obtain an improvement in air quality. Based on the indirect utility functions, the compensating surplus can be illustrated as follows in the Eq.(4):

$$CS = e(p_x, w, p_m, Q^0, M^0, Z - \bar{U}) - e(p_x, w, p_m, Q^1, M^1, Z - \bar{U}) \qquad (4)$$

Table 1: An Illustration of a CVM Question

Implications	Base line (Current practice)	Improved Option
Sick Days(Number of Days) per month	6	4
Mitigation expenditures(MYR) per month	50	5% reduction
Concentration of PM_{10} (µg/m^3)	50	5% reduction
Increase in Household Assessment tax(MYR) (Annually)	Based on house price	0.1% increase

Contingent Valuation Method as an Instrument

CVM conveys the preferences directly by a response, is a technique of state preference method. This technique has the capability to confine the non-values of environmental goods, estimate the wide range of commodities which are not traded in the markets. CVM is an approach to elicit the preference for public goods by asking people about their willingness to pay to bear a financial impose in order to achieve some potential environmental improvement or to avoid some potential harm, upon the particular hypothetical markets. The respondents would be asked their choices environmental quality settings or changes along with a cost to their household of the options while circumventing the absence of a real market for them [9,10].

Proposed Alternative Options

In the CVM study, Compensating Surplus will be employed to measure the welfare changes due to implimentation of new policy in Malaysia, i.e., WTP to gain an improvement of air quality improvement policy(Q^1) relative to the current policy(Q^0). The attributes which are expected to be affected by the air pollution, will be to be improved (Q_1) followed that of the CVM, i.e:

Option 1

(a) A change in 6 sick days to 4 sick days (b) 5% reduction in mitigation expenditure from its current level (c) 5% reduction in the concentration of PM_{10}

Option 2

(a) A change in 6 sick days to 2 sick days (b) 10% reduction in mitigation expenditure from its current level (c) 10% reduction in the concentration of PM_{10}

The above levels of attributes were determined after the discussion made with expert groups such as medical doctors, research fellows, and enviornmental officers.

Questionnaire as a Tool of Survey

The household respondents will be given the description of the current air quality, the health impact of air pollution, mitigation expenditures and the policies to improve the air quality in Klang Valley, before the CVM questions will be presented to the respondents. The improved option plan will be then presented. The respondents will be told clearly that if they decide to vote for the improved plan, they have to pay the increase in annual household assessment tax directly to the government from their pocket for the certain period. Respondents who will vote for the improved plan will be further asked to reveal their maximum monthly WTP (dichotomous choice format) to obtain the improvement of the air quality. On the other hand, respondents who will pick for the current management plan will not be asked any WTP question. The Table 1 shows the CV questionnaire which will be used in the study. The respondents who agreed to pay for the improved air qulity option will be asked, suppose the new improved air quality management option is the only possible alternative to the current air quality managaement, whether they prefer to choose current air quality management option or the improved air quality management option.

Likewise, the air quality improved possible alternative option 2 to the current air quality managaement plan will be presented seperately to the respondents in this study.

The questionnaire has seven components. In part one, the impact of air pollution will be described to the respondent, and the respondents will be asked about their experiences of air pollution in the Klang Valley and will be asked to rank attributes from the most to the least dangerous.

Table 2: The Independent and Dependent Variables

Variables	Definition	Expected Sign
Dependent Variable		
Willingness to Pay	Dummy to represent willingness to pay '1' and not willingness to pay '0'	
Independent Variables		
Gender	Dummy to represent male '1' and female '0'	+/-
Age	In years	+/-
Family members	Numbers	+
Income	Household monthly income (1000RM[a]/ month)	+
Consciousness about air quality management	Dummy to represent conscious about air quality management '1' and not conscious about air quality management '0'	+
Ressperetary Illness	Ressperetary illnesses such as Fever, sneezing, cough, asthma, chest discomfort, running nose & sore throat, , and eye irritation disease are taken as dummy variables. It takes the value 1 if an individual or any of his family members has a particular disease; otherwise it takes the value of 0.	+
Sickdays due to respiratary	In days	+
Mitigation expenditure	In MYR/month	+/-
Bid(WTP value)	Annual Household Assessment Tax (MYR/year)	+/-
Work Place Environment	This variable stands for non-professional jobs, which includes individuals having non-professional jobs in factories, roadside shops, hawkers, waste collectors etc. This variable depicts work place environment. It takes value 1 if a person has a non-professional job and 0 otherwise.	+
Concentration of PM_{10}	$\mu g/m^3$	+
Residence	If the respondent stay in higly polluted area It takes the value 3, If the respondent stay in medium polluted area It takes the value 2, If the respondent stay in low polluted area It takes the value 1; otherwise it takes the value of 0.	+
Transportation	If the respondent uses walk It takes the value 3, If the respondent uses own vehicle It takes the value 2, If the respondent uses public transport It takes the value 1; otherwise it takes the value of 0.	+/-

In part two, the respondents will be asked whether they experience any ill health episodes related to air pollution such as cough, sneezing, fever, running nose, eye irritation, stay away from the work, and the daily length of time spent outdoors during the last three months. Then they will be presented the health impact of air pollution, part three will be about the causes of ill health episodes, and part four is about the policies to be implemented as a remedy for reducing those causes to the respondents using three show cards. The households who will opt for the current management project will not be asked any WTP question. The households who decide to vote for the improved project, they will be asked to reveal their WTP (dichotomous choice method) to obtain the improvement. It would be in part five. In part six, some questions will be asked to the respondent to validate their answer. In part seven, the respondents' socio-economic will be gathered such as their occupation, level of education, monthly household consumption, ethnic, and number of children and smoking habits.

Survey and Sampling Design

The on-side survey will be utilized in Klang Valley and 600 respondents will be selected from six urban areas; Shah Alam, Kuala- Lumpur, and Kajang are highly air polluted areas, Petaling Jaya and Klang are the medium air polluted area and Batu Muda is low polluted area within Klang Valley region. The reasons for selecting the above mentioned metropolitan cities are, its economic development is extremely growing fast at 11.2% per annum and are recognized as unhealthy air quality region by the department of environment [2]. The survey will choose the households rather than the individuals as response unit in WTP questions to avoid the over estimation of aggregate willingness to pay [11]. The survey will be administered by means of a 30-minute face-to-face interview, which will be taken place at the respondent's household.

Empirical Model of CVM

For the CVM, the binary logit model will be used in this study to estimate the WTP of the respondents to improve the air quality in Klang Valley. The Maximum Likelihood (ML) method will be employed to estimate the parameters in logistic regression model. The likelihood ratio index will be measured as an indicator of goodness of fit for the logistic regression model. As such, the model assesses the relationship between various factors and the households' willingness to pay for improved air quality management. The dependent variable is designed as a dichotomous dummy because of assuming whether the respondent is willing to pay or not. The model is presented in the Eq.(5).

$$LogP_i/(1-P_i) = Z_i = \beta_0 + \beta_i X_i + e \qquad (5)$$

Where,

P_i = 1 if the respondent is willing to pay for improved air quality management

P_i = 0 for otherwise

X_i = Independent variables

β_0 = Constant term

β_i = Coefficient of independent variables

e = The error or disturbance term

i = 1,2,3,…..n

Results from the logit equations will be used to demonstrate the relationship between socio-economic variable, environmental attitudes and mean WTP. Mean WTP will be calculated by assuming no negative values for air quality improvement in Klang Valley by using the equation suggested by Hanemann [12]. It is illustrted in Eq.(6).

$$E(WTP) = \left(\frac{1}{\beta_1}\right)^* \ln\left(1+\exp^{\beta_0}\right) \qquad (6)$$

The dependent variable in these two models is willingness to pay of the respondent to improve the air quality in Klang Valley. The independent variables of these two models are age, number of family members, education, income and conscious about air quality, health experience and job environment. Most of the variables will be derived from the survey, in which it is considered relevant from theoretical point of view and included as independent variables. The details of independent and dependent variables which will be used in the model are shown in Table 2.

More income, consciousness about air quality management, ressperetary illness, many sickdays due to respiratary are expected to have the direct relationshp with willingness to pay for air quality improvement in Klang Valley Malaysia. The old people are not willing to pay for air quality improvement because they may think that they are old and the future plans might not bring benifits for them . The professonal job respondents would be willing to pay more than the non- profossonal respondents. People who are staying in high polluted area, are willing to pay more than the people from low polluted area. The relationship between WTP and gender**,** family members, Mitigation expenditure, Bid(WTP value), residence and transportation can be negative or possitive.

CONCLUSION

The air pollution is given more stress the policy makers, due to their greatest impacts on health and agriculture, visibility, global weather, and man-made material. Mobiles sources are the major root for air pollution in Malaysia. The increasing importance given to the valuation of intangible good during last decades has given rise to the development of numerous valuation methods to place the monetary value for environmental goods. The CM method has become increasingly popular in recent years to estimate the value of non-market goods among others. However, time, resources constrain and the lacks of expert bodies in the environmental valuation methods are the main barriers in developing countries. It is potential for designing and validating the CVM survey on economic evaluation methods. This study would provide two important insights for policy-makers that affect public and private sector: (1) Incorporation of demand-side information into the design of air quality improvement attributes, and (2) Development of programs to increase respondent's participation for air quality improvement projects. And it is hoped that the knowledge obtained from this study will help match the affordability of supply and public demand for air quality improvement programs and to evaluation of any program that impacts upon the ill-health episodes experienced in a population.

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