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# Household Demand for Solid Waste Disposal Options in Malaysia

Pek Chuen-Khee and Jamal Othman

**Abstract**—This paper estimates the economic values of household preference for enhanced solid waste disposal services in Malaysia. The contingent valuation (CV) method estimates an average additional monthly willingness-to-pay (WTP) in solid waste management charges of €0.77 to 0.80 for improved waste disposal services quality. The finding of a slightly higher WTP from the generic CV question than that of label-specific, further reveals a higher WTP for sanitary landfill, at €0.90, than incineration, at €0.63. This suggests that sanitary landfill is a more preferred alternative. The logistic regression estimation procedure reveals that household's concern of where their rubbish is disposed, age, ownership of house, household income and format of CV question are significant factors in influencing WTP.

**Keywords**—contingent valuation, logistic regression, solid waste disposal, willingness-to-pay.

## I. INTRODUCTION

MUNICIPAL solid waste (MSW) in Malaysia has been increasing by about 60 percent per day per person compared to 20 years ago due to the population and robust economic growth the country is enjoying. Thus, managing solid waste management and disposal (SWMD) has become a critical problem for the government due to unstructured management plans and higher awareness of public health and better education.

Currently most wastes are disposed into poorly managed control tipping with little or no pollution protection measures. This conventional disposal method is land dominance with poor maintenance and the payment for the use of it is currently made indirectly through the annual housing assessment fee and unknown to the households.

It is widely expected with the use of sanitary landfill and incineration significant progresses would result. However, to obtain such improvements, a higher payment is anticipated.

There are uncertainties in public awareness and attitudes towards the solid waste disposal (SWD) issues and these concerns relate to the public demand or WTP for the service characteristics of various better disposal technologies that are offered.

Given the said background, what shall the most desirable

SWD options, defined by service characteristics like psychological fear, land use, water pollution and air pollution, have?

This paper intends to estimate and compare the mean WTP for two alternative disposal methods, representing improved options with better levels of service characteristics, alongside the current disposal method, both in the generic and labeled format. The generic options are 'Existing facility' vis-à-vis 'Proposed alternatives' and the labeled options are 'Control tipping' vis-à-vis 'Sanitary landfill' and 'Incineration'. The WTP is interpreted as the additional monthly solid waste management (SWM) payment that the public pays for improved services quality and identifying the factors influencing the probability of this payment is also part of the objective of this paper.

The findings of this paper may provide important demand-side information for policy makers such like the National Solid Waste Management Department and the Solid Waste Management Corporation to implement improved SWD services and write future concession agreements between the government and SWM service providers.

In terms of methodological issue, this study may help to identify if realism matters in public choices. Realism would mean the way information of the disposal options is relayed to the respondents. In this case it would mean the way the SWD options are labeled.

## II. METHODOLOGY

### A. Contingent Valuation as the Measurement Method

Contingent valuation (CV) is an economic and environmental valuation technique which uses a surrogate market by directly eliciting consumers' preferences and WTP for some proposed market conditions which offer potential improvements or avoid potential damages. It is grouped under the family of non-market environmental valuation stated preference technique, which aims to quantify the environmental goods or services of non-market attributes (e.g. improved waste disposal technology or water sanitation) into monetary or market values. CV elicits the maximum WTP of individual respondent to obtain improvement or avoid damages on environmental goods and services in a hypothetical market [1, 2].

The CV technique has been widely used to estimate WTP

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due to its flexibility in application, allowing it to value almost everything. It can even value goods and services with no observable behavior but are easily understood and identified by respondents. Its direct approach of eliciting the WTP to obtain improvement or abstain from degradation of environmental goods and services provides defensible estimates and are easy to analyze and describe. CV is famously used to value total economic value, including the use and non-use values of an environmental good or service.

Although CV has been widely used in economic valuation, critiques are skeptical of its ability to accurately and adequately measure the WTP for any environmental goods or services [3]. However, the CV results can be reliable if the recommendations reported by The National Oceanic and Atmospheric Administration's (NOAA) Panel, are closely followed. The validity and accuracy of CV can be further enhanced by respondents' familiarity with the issues at hand and interviewed by well-trained interviewers [4]. This paper follows those conditions as closely as possible to ensure reliability of the findings.

#### *B. The Proposed Policy*

The CV questionnaire was designed to elicit the value of the proposed policy of improved SWD options. The respondents are asked their WTP for the enhanced disposal services, defined by services attributes of psychological fear, land use, water pollution and air pollution, at their respective levels. The existing facility is compared with improved alternatives and respondents are asked for their WTP if they agree to such improvements. These SWD options are labeled in a generic vis-à-vis label-specific format.

The government plans to replace the current control tipping with best practices like sanitary landfill and incineration. This concurs well with the Way Forward of the national SWM policies, aiming to upgrade the service quality in the country after a long delay. Several amendments and new laws are drafted, passed and implemented to allow more efficient management processes to ensure a more environmental-friendly and healthier SWM.

#### *C. Sampling and Survey Methods*

A total of 873 households were interviewed in Broga, Semenyih and Cheras. This sample size is comfortable for use in surveys on environmental valuation studies in the Malaysian context as shown in the works of Jamal [5, 6] and Jamal et al. [7]. The survey was conducted on head of households, normally the 'father' but in the absence of this person, the 'mother' is interviewed. Otherwise, the household will be skipped.

The finalization of the questionnaires is done after a pre-test and a pilot study. These served to check and ensure if the attributes were understood and acceptable to the public. After taking into consideration the comments from these exercises, improvements were made on the questionnaires before were used in the actual survey.

The survey was conducted by face-to-face interviewing as

the other methods such like mail or telephone interviews could not allow the interviewers to explain the actual issue in detailed and clearly to the interviewees. Face-to-face interview is expected to obtain more accurate and complete responses. The average time to complete the questionnaires was about 30 to 45 minutes.

The interviewers were properly trained through mock interviews and brought to the survey sites to understand the surroundings and have had several discussion sessions with the head of villages or representatives before the actual surveys were administered. The interview sessions were done more efficiently and co-operatively between the respondents and interviewers as prior notices were given by their head of villages or representatives about the survey. This allowed the respondents to search for more information on SWD and understand them or at least make them aware of this issue.

#### *D. Questionnaires as the Survey Instrument*

Following the work of Jamal [5], some innovations to present the environmental market to help respondents better understand the improved SWD services were applied into the traditional open-ended CV format question. Before the CV questions were presented to the respondents, a description of the current SWD service in terms of the services attributes and its implication on the environment and the payment to obtain the services were explained. The respondents were asked introductory questions like 'are they concerned about where their rubbish is disposed' and 'are they member of any environmental organizations'. They were also asked to rank their concern, based on importance, on a series of environmental issues like landslides, air pollution, SWM, deforestation and etc.

Next, the improved SWD services were presented in terms of the affected attributes that will be enhanced and respondents were asked of their WTP if they agree to the stated improvements. Depending on the improved services i.e. to proposed alternatives in the generic format or, either to sanitary landfill or incineration in the label format, the affected attributes changes differently.

The CV questions for the generic format (improved SWD denoted as proposed alternative) is shown in Figure 1, while the same for label format is shown in Figure 2 (with sanitary landfill as the improved SWD), and Figure 3 (with incineration as the improved SWD). Notice the differences in the attribute levels for the generic 'proposed alternative' and, label 'sanitary landfill' and 'incineration'. These differences are to cater for the different SWD options in terms of their technologies and impact on the services characteristics.

Following the key WTP questions, socio-demographic information about the household was recorded. These include asking questions like their age, gender, income, qualification, type of profession and ownership of the house they are residing.

Suppose a proposed alternative to the existing facility results in the following improvements, please state your WTP to utilize them.

Your choice of the proposed method would mean higher payment of assessment fee, reflecting a higher waste collection and disposal charge to obtain the improvements below. As usual, this additional charge will be paid indirectly through the assessment fee.

The distances of the existing and proposed facility from your house respectively are indicated.

Attributes	Existing facility	Proposed alternative
Psychological fear	High	Low
Air pollution	46 $\mu\text{g}/\text{m}^3$	Lower by 10% (to 41.5 $\mu\text{g}/\text{m}^3$ , nearer to 10-year lowest)
Water quality	Polluted	Clean
Land use	13 hectares (on average and with no facilities)	20 ha (1.5 times more) to accommodate complementary facilities (eg. waste storage) too
Additional monthly charge	No additional payment	<b>WTP (additional payment):</b> _____

Fig. 1 CV question for generic format (proposed alternative as improvement)

[..... as in Fig. 1]

Attributes	Existing facility	Proposed sanitary landfill
Psychological fear	High	Low
Air pollution	46 $\mu\text{g}/\text{m}^3$	Lower by 10% (to 41.5 $\mu\text{g}/\text{m}^3$ , nearer to 10-year lowest)
River water quality	Polluted	Clean
Land use	13 hectares (on average and with no facilities)	25 ha (2 times more) to accommodate complementary facilities (eg. waste storage) too
Additional monthly charge	No additional payment	<b>WTP (additional payment):</b> _____

Fig. 2 CV question for label format (sanitary landfill as improvement)

[..... as in Fig. 1]

Attributes	Existing facility	Proposed incinerator
Psychological fear	High	Low
Air pollution	46 $\mu\text{g}/\text{m}^3$	Unchanged
Water quality	Polluted	Clean
Land use	13 hectares (on average and with no facilities)	20 ha (1.5 times more) to accommodate complementary facilities (eg. waste storage) too
Additional monthly charge	No additional payment	<b>WTP (additional payment):</b> _____

Fig.3: CV question for label format (incineration as improvement)

E. Elicitation Method and Payment Vehicle

The open-ended CV format is used in this study and it allows respondents the full autonomy to state their maximum WTP. Enumerators are warned not to influence the respondents in choosing the values of WTP to minimize “starting-point” bias. The respondents were told explicitly that if they decided to choose the improved plan, they would need to pay the additional SWM service fee paid indirectly to the service provider, like the current practice through the annual house assessment. They were also being informed that agreeing to pay the extra cost would mean reducing their disposal income.

The respondents were asked of their maximum WTP. Since respondents are unaware of the actual amount they pay for the SWM services, as it is paid indirectly through the house assessment, “anchoring bias” is minimized [5]. If the respondents opted for the current services, it is assumed that they are happy with the status quo and were only willing to continue paying the unknown amount, i.e. no additional payment. A positive WTP would mean a “Yes” in agreeing to pay for better services quality, while a “No” would mean otherwise.

It is recognized that the open-ended CV would put pressures on the respondents to state their WTP and this gives rise to high level of protest bids [4]. However, to minimize this concern, enumerators were told to give sufficient time and space for the respondents to think carefully of their WTP.

F. Concerns of using CV

CV respondents may not be familiar with the environmental goods posed to them for WTP elicitation. This information bias would influence their stating of the true monetary values. Besides, these respondents may have just revealed their opinions on the scenario given to them than expressing value for the good. Respondents may state agreement to WTP to show their support for environmental protection in terms of preservation and conservation, but not the monetary values they give to the environmental good itself. CV is posed with several issues of biases. Hypothetical bias occurs when the

actual payments by the respondents are lower than the hypothetical values pledged [8]. The choice of payment vehicles like taxes, annual house assessment or even direct debit from respondents' credit cards may minimize this bias as they would have to honor the value they pledged.

Strategic bias occurs when CV respondents supply biased answers in order to influence some outcomes in line with their personal agenda. In this study of SWD options, respondents who disagree with employment of incineration would indicate higher WTP to support proposed improvements that can be obtained through usage of sanitary landfill.

### III. LOGISTIC REGRESSION

After analyzing the WTP from the survey findings by computing the simple mean and median, the logistic regression (LR) is used to study the probability of agreeing to pay for improved services by alternative SWD options, as predicted by some explanatory variables.

LR is based on a linear model for the natural logarithm of the odds (known as log-odds) in favor of  $Y=1$ :

$$\begin{aligned} \text{Log}_e \left[ \frac{P(Y=1|X_1, \dots, X_p)}{1-P(Y=1|X_1, \dots, X_p)} \right] &= \text{Log}_e \left[ \frac{\pi}{1-\pi} \right] \\ &= \alpha + \beta_1 X_1 + \dots + \beta_p X_p = \alpha + \sum_{j=1}^p \beta_j X_j \end{aligned}$$

$\pi$  is a conditional probability of the form  $P(Y=1|X_1, \dots, X_p)$ . That is, it is assumed that "success" is more or less likely depending on combinations of values of the predictor variables. The log-odd, as defined above, is also known as the logit transformation of  $\pi$  and the analytical approach described here is sometimes known as logit analysis.

The logistic function takes the form of:

$$P(Y=1|X_1, \dots, X_p) = \frac{e^{\alpha + \sum_{j=1}^p \beta_j X_j}}{1 + e^{\alpha + \sum_{j=1}^p \beta_j X_j}}$$

which can also be transformed into:

$$P(Y=1|X_1, \dots, X_p) = \frac{1}{1 + e^{-\alpha - \sum_{j=1}^p \beta_j X_j}}$$

The non-response probability is:

$$P(Y=0|X_1, \dots, X_p) = 1 - P(Y=1|X_1, \dots, X_p) = \frac{1}{1 + e^{\alpha + \sum_{j=1}^p \beta_j X_j}}$$

The dependent variable is the response towards the WTP

such like 'Yes' (=1) if the respondents state a positive WTP and 'No' (=0) when they are not WTP any amount. The independent variables employed to predict the probability of WTP are the concern of where the rubbish is disposed, age, ownership of house, household income, format of the CV question and an interaction term between age and household income.

Using the set of predictors, the LR equation for the log-odds in favour of WTP is estimated to be:

$$\log \left[ \frac{p_i}{1-p_i} \right] = b_0 + b_i \times X_i$$

with the partial coefficients,  $b_i$ , informing the change to log odds of agreeing to pay for better SWD options.

### IV. RESULTS

#### A. WTP Responses and Findings

Some descriptive statistics of the respondents are shown in Table I for a better understanding of the sample interviewed whose mean WTP are computed, based on the entire sample, and CV question format, i.e. generic and label, for further analysis and discussions.

TABLE I  
SOME DESCRIPTIVE STATISTICS OF RESPONDENTS

Variable	Average
Age	43.8
Household monthly income	€ 455 – 682
Qualification	Lower secondary school
Gender	Male
House ownership	Owner

The respondents ranked air pollution as the most concerned environmental issues followed by air pollution from the introductory questions. It is interesting to note that SWM is ranked third among the eight environmental issues. At the bottom of the list are noise pollution and extinction of wild animals and plants. Table II shows the ranking of the environmental concerns with their respective mean values. The lower mean indicates a more concerned environmental issue from a scale of 1 to 8.

TABLE II  
RANKING OF THE ENVIRONMENTAL ISSUES

Environmental Issues	Mean
Water pollution	2.16
Air pollution	2.32
Solid waste management	3.77
Deforestation	4.19
Landslides	5.61
Preservation of wetlands	5.81
Noise pollution	6.00
Extinction of wild animals and plants	6.13

The responses to the WTP has been analyzed and show that 575 (66 percent) agreed to pay for improved services quality in the SWD methods while 298 (34 percent) disagree to the payment. A further check was done to determine the reasons for the non-responses to WTP. It may mean a protest bid, indicating that the public are not willing to pay any extra cost for the improvement due to reasons like disagreeing with the proposed plan or refused to give a value of WTP, or a genuine zero WTP where the respondents favors improvement but could not afford to pay.

In most CV studies, protest bids are excluded from the computation of the mean WTP as they are not indicative of the respondents' 'true' values. However, in this study due to the nature of the good, i.e. SWD methods, which its usage is directly contributed by everyone, whether one likes the proposed plan or not, and WTP or otherwise, it is suggested that protest bids are included into the estimation of mean WTP as well to reflect a truer picture of the case. Genuine zero WTP are included into the computation as well as they reflect the 'true' values of the respondents. Table III analyzes the zero WTP according to their reasons.

TABLE III  
ANALYSIS OF ZERO WTP

Reasons	%
The current facility is still feasible	8
Distance of the proposed disposal site	15
Did not bother to state WTP	24
Support but could not afford to pay any money	4
Support but could not afford to pay the proposed amount	1
Support but it is the responsibility of the government	48

The mean WTP of the survey shows that on average, people are WTP between €0.77 to 0.80 for improved SWD options. The generic CV question format generates a slightly higher WTP as compared to label format, with the latter averaging a WTP of €0.83, and the former with €0.77. This may suggest that the public wants change but wary of the alternative options like sanitary landfill and incineration. A deeper investigation reveals that incineration has a lower mean WTP of €0.63 as compared to sanitary landfill at €0.90. This trend of WTP may suggest that whilst the public agrees to pay for better services quality of disposal methods, they are more comfortable and confident with sanitary landfill, whose mean and median are rather similar, suggesting a normal distribution of the WTP.

Table IV shows the various mean and median WTP. The mean WTP values are all significant at 1 percent level, allowing a generalization to the bigger population.

TABLE IV  
SAMPLE MEAN AND MEDIAN WTP (€)

WTP	Entire	Generic	Label	Sanitary landfill	Incineration
Mean	0.80 (24.8)*	0.83 (17.3)*	0.77 (17.8)*	0.90 (14.3)*	0.63 (11.0)*
SD	0.95	0.99	0.92	0.95	0.86
Lower 95%	0.74	0.74	0.69	0.78	0.52
Upper 95%	0.86	0.93	0.85	1.03	0.75
Median	0.68	0.68	0.68	0.91	0.46

Figures in parentheses show the respective t-values.  
\* denotes significant at 1 percent level

### B. Estimation Results and Discussions

The logistic regression results in Table V show that all the explanatory variables, with the Wald-test values shown, are significant in explaining the WTP.

TABLE V  
ESTIMATION RESULTS FROM LR MODEL

Variable	B	SE	Wald	Sig	Exp(B)
Concern	.436	.157	7.703	.006	1.547
Age	-.019	.010	3.288	.070	.981
Hse	.392	.185	4.476	.034	1.480
HInc	1.569	.630	6.208	.013	4.802
CVformat	-.275	.151	3.335	.068	.760
AgeHInc	-.032	.013	5.658	.017	.969
Constant	.937	.541	3.000	.083	2.552

Respondents who are concern about where their rubbish is disposed have a 1.55 times higher chances of WTP than those who do not have the concern. This finding concurs well with the general observation that people who care for the environment are WTP for 'green' shopping bags in the country. On average the retail prices of such bags are between €1.00 to 2.00. The odds of an older individual WTP for better services quality of SWD methods is about two percent less than that of a younger individual with each year of age. For a ten year difference, the probability of older public to WTP is 17.5% less than the younger individual. This may suggests that older people are more skeptical of the new technologies and also that they have lower income to pay for higher fees for SWM services.

The status of house ownership influences the WTP with those owning a house having a 1.48 times more likely WTP than those leasing their residences. This generally shows that the public is more wary of the disposal options if they are permanently staying in a residence. Leasing a house would mean a temporary stay as one can move to elsewhere if the place is receiving negative externalities from SWM related issues. A check on the household income reveals that the middle income group is 4.8 times more likely to pay extra for better services than the lower and upper income groups. This result is very encouraging as most Malaysians are middle income earners and this would mean having a large group of the public who are WTP for better SWD services quality. This higher WTP of the group may show the uprising of the more

learned public who are more aware of environmental concerns than the lower income group, normally with lower educational qualifications. The higher income group is acknowledged but they make up a relatively small percentage of the survey.

The outcome for the CV format shows that respondents interviewed using the label-specific CV questions are 24 percent less likely to WTP than those who were interviewed with generic CV questions. This suggests strongly that labeling effect is present and the public's choice for SWD options is influenced by the manner the disposal options are named. A generic way of labeling the options like 'proposed option' with no specific technological names garners a higher WTP than when they are specifically labeled with their technological names like sanitary landfill and incineration. This finding blends well with the survey WTP as the WTP using generic CV question is higher than that of label form. This may imply that the public is uncertain of the externalities of sanitary landfill and incineration, though the mean WTP for the former option is higher than the latter.

The interaction term of age and household income shows that when the two factors are considered simultaneously, there is a lower probability of WTP. Comparing this result with that of age and household income individually, it can be concluded that age is a more dominating factor than household income when WTP is concerned. This may indirectly propose that the Malaysian public is cautious about their spending even though they are earning for a better lifestyle in their older ages.

## V. POLICY IMPLICATIONS AND CONCLUSION

With more access to education and borderless information, the demand for more improved SWD services in the country has increased through the years. However, mismatches between the demand and supply of these services in terms of quality and efficiency are still prevalent. It is the objective of this study to identify these gaps by providing some demand-driven perspectives of SWD management improvements using the non-market valuation techniques.

The survey WTP of proposed improved SWD plans have been presented and some interesting findings would be reinforced, followed by discussions on the policy implications.

The findings reveal that careful thoughts over the naming of a waste disposal technology is needed and more transparent information has to be channeled to the learned public before making public announcements of the proposed alternatives. This concurs to the idea that realism matters in public choices. There were several occasions in the country where the public overtly protest the initiative of the government to build incinerators in several proposed spots. All these initiatives were eventually called-off after the Courts ruled in favor of the public.

The public is more receptive of sanitary landfill than incineration due to reasons like the former is more environmental-friendly and poses less health hazards. Though incineration may possess alike properties as that of sanitary landfill, the ill perception of incineration maintains high in the

country. This may suggest either to replace the current control tipping with more sanitary landfills. Otherwise, more detailed information of incineration has to be channeled to the public to educate them about the benefits of this option instead of stereo-typing it as a health threat disposal method. Alternatively, the regulators may need to replace it with a more acceptable name that may ease the possible misconception of the technology.

The education and awareness of the public on any alternatives are very crucial as people will only accept something novel to them if they have access to detailed specification of the technology. These awareness creations can start from as young as the school children and to the retired generation.

The WTP estimated gives a general idea of the demand of the public for any improved SWD services. This helps the regulators to work closely with the SWM service providers to strategize on the best possible service quality and options that may equilibrate the market for waste disposal.

This study has used contingent valuation method for analyzing and measuring the SWD services quality in the country. It has been shown that CV can be successfully applied in developing countries, like Malaysia, on solid waste related issues, with careful construction of CV questions and effective data collection. The close consultations with stakeholders through FGD are critical to understanding the nature of the environmental problems and selection of attributes. The training of enumerators is also important to ensure unbiased data collection in the survey process [7].

The CV application can be used to value a range of resource use scenarios in SWD. The estimates derived from this study can be aggregated to determine the total non-market value accrued to the wider community for each SWD improvement options. By weighing up these values along with the market values of benefits and costs for the available improved options, the policy makers especially the local government and Ministry of Housing and Local Governments can identify a SWD plan that yields the greatest net benefit for the Malaysian society.

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