Solid Waste Disposal: A Choice Experiment Experience in Malaysia

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Increasing generation of solid waste requires better quality disposal options in Malaysia. Control tipping is the most commonly used complemented by sanitary landfill and incineration. This study estimates the non-market values of improved waste disposal services and also ranking them using choice experiment. River water quality is the most concerned followed by psychological fear, air pollution and land use. Socio-economic background and distance factor influence the types of compensating surpluses. These conclude the importance of perception, influenced by socio-economic background, the presence of the Not-In-My-Backyard syndrome and that sanitary landfill is more preferred.

Keywords: Solid waste disposal; willingness-to-pay; choice experiment

JEL codes: Q51, Q53

1. Introduction and Problem Statement

Solid waste disposal, an integral and final part of the solid waste management process, discards solid wastes which are by-products of human and animal activities. Municipal solid waste in Malaysia which comprises mainly of garbage, plastics, bottle or glass, paper, metals and fabric are getting more complex and sophisticated in their compositions.

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The amount of these solid waste has been increasing in the recent years due to the country's population and robust economic growth, averaging 1.7 kg per day per person (Kathirvakle et al., 2003) as compared to 0.7 kg in 1987 (Jusoh, 2002). These SW can be disposed by various methods like landfilling, incineration, composting and recycling.

Although the solid waste management process may seem to be straightforward, managing solid waste management and disposal has become a major global problem for many governments, Malaysia included, due to unstructured management plans and higher awareness of public health, and better education.

Currently in Malaysia, most wastes are disposed into poorly managed control tipping with little or no pollution protection measures. This traditional disposal method is land dominance and its poor maintenance creates visual disamenities. Malaysians pay a fee for the collection and disposal services of the traditional method indirectly through the annual housing assessment but the exact value is unknown to the households.

With the use of sanitary landfill and incineration, improvements on the unsatisfactory disposal services employed by the solid waste management contractors are expected. However, to obtain such improvements, a higher payment through the same payment vehicle is also likewise anticipated.

There are uncertainties in public awareness and attitudes towards the solid waste disposal issues, especially with respect to incineration and poorly managed sanitary landfills in the country, that may hinder the implementation of effective solid waste disposal services put forward in the revamped bills; Solid Waste and Public Cleansing Management Bill 2007 and the Solid Waste and Public Management Corporation Bill 2007. The concern relates to public demand or willingness to pay for the service characteristics of preferred disposal technologies that the contracted service providers can offer.

Given the said background, this study addresses the following policy issues; *What shall be the desirable future solid waste and disposal management plans defined by their service attributes and levels from the perspectives of consumers or households?*

1.1. *Objectives*

The objectives of this study are: (1) To perform an economic study on the household demand for municipal solid waste disposal service improvements in Malaysia, with households as the unit of analysis as they are direct users of the solid waste disposal facilities, (2) To estimate the implicit prices (trade-offs between money and improvements in those disposal service attributes) of *psychological fear, land use, air pollution and river water quality*, (3) To rank these services attributes according to their importance, and (4) To identify the influence of distance factor in determining the economic value of disposal services.

1.2. *Definition of terms*

Psychological fear relates to the public uncertainties and uneasiness of knowing a disposal method is to be employed and independent of other externalities, *Land use* is the land space for disposal facility construction (possibly attained through deforestation), *Air pollution* is the dust particulate matter (PM_{10}) concentration in the ambient air when the disposal method is in use, *River water quality* is referred to the river quality measured and categorized by the Water Quality Index according to the suitability of consumption by human, animals or irrigation, *Distance factor* is referred to the space between the current and proposed disposal facility site respectively, and the residential areas, and *Additional payment* is the additional monthly SWM charge to enjoy quality-improved facilities. *Exchange rate* is Malaysian Ringgit (MYR) 3.52 for US Dollar (USD) 1.00 as of 28 August 2009.

1.3. *Rationale of study and policy relevance*

This study provides important demand-side information for policy makers to form the solid waste disposal services based on the defined attributes levels and additional monthly solid waste management charge which the public is willing to pay for those improved service quality.

The results of this study will be of interest to Malaysian solid waste regulators such like the National Solid Waste Management Department and the Solid Waste Management Corporation. This information can also be used to write the future concession agreements between the government and service providers.

2. Theoretical Framework and Choice Experiment

Choice experiment, an economic and environmental valuation technique which uses a surrogate market by directly eliciting consumers' preferences and willing to pay for some proposed market conditions which offer potential improvements or avoid potential damages, is employed to elicit and estimate the values for meeting the objectives of this study. Choice experiment 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.

Louviere (1981) pioneered the choice experiment application to model the choices of Australian transport and telecommunication. However, this application has broadened its influence into the field of environmental economics and valuation. It has been developed and employed, among others, in the works of Adamowicz, Louviere and Williams (1994), Adamowicz et al. (1998), Rolfe, Bennett and Louviere (2002), Jamal (2002, 2006) and Jamal et al. (2004), which follow the choice experiment procedure starting with the selection of attributes to assignment of levels, choice of experimental design, construction of choice sets, measurement of preferences and until the final stage of estimation procedure (Hanley et al., 2001).

Choice experiment rests on random utility theory (RUT) which assumes that the utility of any goods or services consist both the deterministic and stochastic part. Choice experiment can be designed to resemble real market choice situations with multiple choices which may include the none or competing multiple choice options. Utility for option *i* depends on environmental attributes (Z) and socioeconomic characteristics (S) can be expressed as:

$$U_{in} = V\,(Z_{in}\,,\, S_n) + \varepsilon\,(Z_{in}\,,\, S_n)$$

and the probability that individual *n* will choose option *i* over other option *j* is given as:

$$\text{Prob}\,(i/C) = \text{Prob}\,\{V_{in} + \varepsilon_{in} > V_{jn} + \varepsilon_{jn}\,;\, j \in C\}$$

where C is the complete choice set. The error terms of the utility function are assumed independent and identically distributed (IID) with the property of independence of irrelevant alternatives (IIA). This property states that the probability of choosing an alternative is dependent on the utility of respective options.

The probability of choosing option *i* is expressed as:

$$P(i) = \frac{\exp^{\mu V_i}}{\sum_{j \in C} \exp^{\mu V_j}}$$

where,

$$V(i) = V_i = V(Z_i\,,\, S)$$

with V_i as the utility function, Z_i as a vector of environmental goods, S as vector of market goods and socioeconomic characteristics and μ as a scale parameter, assumed to be 1, implying constant error variance. This probability is estimated using multinomial logit regression, assuming choices are consistent with the independent and identically distributed property.

The utility function, V_i is an additive structure encompassing attributes only from the choice sets;

$$V_i = C + \sum \beta_k Z_{ik}$$

where C is an alternative specific constant (ASC), β is the coefficient and Z are attributes. The effect of attributes in the choice set will be reflected by the Z variables while the ASC captures any systematic variations in choice observations that are associated with an alternative that are not explained either by the attribute variation or respondents' observed socio-economic characteristics. There will be k-1 ASCs, in a multinomial logit of k number of options.

It is also possible to put in the environmental attitudinal and socioeconomic variables into the utility functions by estimating the variables interactively, either with ASC or any attributes from a choice set, e.g.

$$V_i = ASC + \sum_n \gamma_n ASC * S_n + \sum \beta_k Z_k + \sum_{kn} \delta_n^* Z_k$$

where S_n indicates the socio-economic or environmental attitudinal variables for the n^{th} individual.

If the IID assumption is violated, a nested logit estimation procedure is appropriate (Jamal et al., 2004). Nested logit explains respondents' choices by way of a step-wise process that can be depicted as a decision tree. This allows for correlations among error terms within subsets of alternatives in each branch of the decision tree. In a two-level nested logit mode, the probability of an individual choosing the h^{th} alternative in class r(P_{hr}) is represented as:

$$P_{hr} = P(h|r)P(r)$$

where P(h|r) is the probability of the individual choosing the h^{th} alternative conditional on choosing the r^{th} class of outcome, and P(r) is the probability that the individual chooses the r^{th} class. Following Kling and Thompson (1996):

$$P_i(h \mid r) = \frac{\exp[V_{ihr} / \alpha_r]}{\exp[I_r]}$$

$$P_{ir} = \frac{\exp[\alpha_r I_r]}{\sum_{k=1}^{R} \exp[\alpha_k I_k]}$$

where $I_r = \log [\Sigma_{i=1 \text{ to } Jr} \exp (V_{ir} / \alpha_r)]$ is referred to as the inclusive value. This is a measure of the expected maximum utility from the alternatives associated with the r^{th} class of alternatives. The coefficient of inclusive value α_r measures substitutability across alternatives.

In this study the experimental design is constructed based on the compensating surplus measure. It measures the change in income that would an individual indifferent between the initial (lower solid waste disposal quality) and subsequent situations (improved solid waste disposal quality) assuming the individual has the right to the initial level of utility. The change in income shows the individual's willing to pay to obtain an improvement in environmental (solid waste disposal) quality.

The compensating surplus can be derived from the following based on the indirect utility functions:

$$V_0(G_i, Z_0, M) = V_0(G_i, Z_1, M - CS)$$

where M is income, Z_0 and Z_1 represent different levels of an environmental attribute, and G_i represents other marketed goods.

Using the results from the multinomial logit, the compensating surplus (CpS) can be estimated by employing the following equation (Adamowicz et al., 1994):

$$CpS = -1 / (\beta_M)\{\ln(\textstyle\sum_i \exp^{V0}) - \ln(\sum_i \exp^{V1})\}$$

Following Boxall et al. (1996) and Morrison, Bennett and Blamey (1999), the equation above can be reduced to:

$$CpS = \{-1 / (\mid \beta_M \mid)\} (V_0 - V_1)$$

where β_M is the coefficient of the monetary attribute and is defined as the marginal utility of income, and V_0 and V_1 represent initial and subsequent states, respectively.

Kling and Thompson (1996) and Choi and Moon (1997) show the modifications required for compensating surplus in a nested logit procedure. A two-level nested logit model,

compensating surplus for a change from the initial state of $W_c(V_0)$ to the subsequent state of $W_c(V_1)$ is given as:

$$CpS = W_c(V_0) - W_c(V_1)$$

where

$$W_c = \frac{1}{\lambda} \ln \left\{ \sum_{r=1}^{R} \left[\sum_{hr \in Cr} \exp\left(\frac{Vr}{1-\alpha r}\right) \right]^{(1-\alpha r)} \right\}$$

where λ = the marginal utility of income, r = random utilities from r = 1,…., R (max) addictively separable subsets of alternatives and that of the random components of the random utilities belonging to the same separable subset of the alternatives, h = the alternatives with r random utilities, C = the choice set of alternatives with r random utilities, and α_r = similarity parameter applicable to the alternatives within the separable nest C_r. Choi & Moon (1997) offers the details of the derivation.

3. Choice Experiment Implementation

Choice experiment elicits the consumers' willingness to pay through questionnaire surveys where respondents are posed with a series of six to eight very similar types of questions. These questions are in the form of choice sets with three or more service or resource use options.

The choice set design and procedure of experimental design have been used to form those choice sets with the aid of SAS 9.0 statistical software. A choice set shows several options defined by different levels of similar services attributes and can be formed in an *orthogonal and balanced pattern* using the experimental design.

Before the choice sets are determined, in order to select the feasible attributes and their levels that characterize the disposal services befitting this study, several focus group discussions and intense literature search have been implemented. The outcome of the implementation with

the defined services attributes and levels for the waste disposal services is shown in Table 3.1 below.

Table 1. Attribute definition and levels

Attribute	*Definition*	*Attribute levels*		
		Existing CT[1]	*Alternatives*	
			SLF	*INC*
Psychological fear	Uncertainties and uneasiness knowing a disposal method is employed	High	Negligible Low	Low High
Land use	Land space for disposal facility construction	Average 13 ha	25 ha *(2X more)* 90 ha *(7X more)*	16 ha *(1.25X more)* 20 ha *(1.5X more)*
Air pollution	Dust particulate matter (PM_{10}) concentration in the ambient air when the disposal method is in use	Average 46µg/m^3	Unchanged 5% lower *(43.7µg/m^3)* 10% lower *(41.4µg/m^3)*	Unchanged 5% higher *(48.3µg/m^3)* 10% higher *(50.6µg/m^3)*
River water quality	River water quality (Water Quality Index according to usability[2])	Polluted	Slightly Polluted Clean	
Additional monthly charge	Additional monthly indirect SWMD payment	None	MYR 4.00 MYR 8.00	

1. *CT= Control tipping, SLF= Sanitary landfill, INC=Incineration.*
2. *Polluted (Water suitable only for non-human use like irrigation and washing), Slightly polluted (Water suitable for domestic and recreational use) and Clean (Water suitable for all uses).*

3.1. *Study areas*

In designing the choice sets, which follow the standard L^{MN} experimental design where only the main effects are modeled, the impact zones which is the distance factors are incorporated. There are three levels of distances known as PROEX (the ratio of distance between the proposed to the existing disposal sites from the respondents' residential areas, in km), identified by the selected

study areas of Broga, Semenyih and Cheras. All these areas are located in the state of Selangor Darul Ehsan as shown in Table 2.

Table 2. Impact zones (PROEX)

Residential area	*Existing facility km away*	*Proposed facility km away*
Broga	20	1
Semenyih	16	5
Cheras	10	20

Broga town has been selected due to its location proposed to site both the sanitary landfill and incinerator planned by the government. The proposed sites are about 1 km away from central Broga. However, the plan for the construction of an incinerator was scrapped. The other towns identified are Semenyih and Cheras. Semenyih is a small but an affluent university town. Cheras is one of the most fast developing and dense township in the state of Selangor. Hulu Langat about 10 km from centre Cheras runs a control tipping where most of the SW from these towns is disposed. Broga is the town identified to build proposed disposal facilities while Hulu Langat is the existing site of the traditional disposal method. Semenyih is about half-way between these two towns and this allows modeling work capturing the distance factor or impact zones.

A choice experiment exercise in Malaysia (Jamal, 2000) has shown that Malaysian on the average cannot take more than 5 choice sets in a survey session. Table 3 shows a sample of one of the final choice sets used in the study.

Table 3. A sample choice set

	Existing facility 10 km away	*Proposed alternative 20 km away*	
Attributes	*Control tipping (Existing facility)*	*Sanitary landfill*	*Incineration*
Psychological fear	High	Negligible	Low

Land use	Average 13 ha	90 ha (7 times more)	20 ha (1.5 times more)
Air pollution (PM_{10} concentration)	$46\mu g/m^3$	Unchanged	10% higher
River water quality	Polluted	Clean	Slightly Polluted
Additional monthly charge	No additional payment	Additional MYR8.00	Additional MYR4.00
Please check your chosen option			

The payment vehicle used in this choice experiment experience is the current indirect additional monthly solid waste management payment through the housing annual assessment since improvement in waste disposal services is a natural extension of the entire process.

3.2. *Sampling strategy*

A total of 450 head of households who are users of the solid waste disposal services have been interviewed in the vicinities of the three selected areas with about 20 percent from Broga and 40 percent each from Semenyih and Cheras respectively. This sample size is comfortable for use in surveys on environmental valuation studies in the Malaysian context taking into consideration the high survey cost and budget constraints. Broga is a small town and naturally the maximum achievable households are smaller than the other two townships.

The survey took two months to complete in early 2008 with the employment of 12 enumerators moving around the residential areas within the vicinity of Broga, Semenyih and Cheras. Prior to conducting the survey, the enumerators attended trainings conducted by the researcher. They were briefed on the choice experiment procedure, the idea of economic valuation, the types of solid waste disposal technologies and the background of the study, and

also included are role-play exercises to expose the enumerators to the ways in obtaining cooperation from the respondents.

They were also made aware of possible biases (like strategic and starting-point bias) during interviews and ways to minimize them. They were informed in several occasions to remind the respondents that opting an improved alternative would mean lowering their disposal income as an extra payment would be required. This was to ensure that the respondents state a willingness to pay which is within their budget. The enumerators were taken for a brief tour to familiarize the areas of the study sites and also meet the village heads to seek their help in getting respondents to cooperate in the survey.

4. Profile Analyses

The respondents interviewed were either head of households (48 percent) or spouse of the head of household (52 percent). Of the total sample interviewed, the Chinese again made up the largest race composition of the survey with 72.4 percent, followed by the Malays (19.8 percent) and Indians (7.3 percent). The race composition of the study is made up of more Chinese, instead of the Malay, unlike reflected in the population. The main justification of this occurrence is the Chinese are residing in the more accessible urban areas of the study sites, than the Malay (and also Indian), which make it easier for the surveys to be conducted on Chinese households. However, this does not undermine the contribution of the other ethnic groups in the survey exercises as the percentages of non-Chinese ethnic groups are not overly low.

The composition of male (47.3 percent) and female (52.7 percent) respondents was quiet balanced in the areas of study with a mean age of 43.7 years old (median is very similar with mean age). The residents were keener to know where the rubbish they generate would be disposed as indicated by a high percentage of 73.1 percent of “yes” answer to the question.

However, a lower number of respondents (5.6 percent) were members of an environmental organization.

Majority of the respondents completed their primary school education (19.8 percent) and about 37.6 percent of them received at least a diploma or tertiary qualifications which includes bachelor, master and doctoral degrees. A mere four percent of the respondents did not receive any formal education, implying a high literacy rate of the sample.

Most of the respondents were private sector workers (32.5 percent), followed by government servant (23.3 percent), and running own businesses made up of 21.3 percent of the profile. Of the private workers and government servants' profile, 48.1 percent were categorized under the management and professional groups. This is about two-fold of the generic form sample as the majority of them were workers of private sectors.

The mode of the household income was class interval of MYR2,001 – MYR3,000 (20.4 percent). Only 9.1 percent of them earned less than MYR1,000 per household per month while a mere 2.4 percent earned more than MYR10,000. With this monthly household income distribution, the profile was expected to show relatively high ownership of house resided by the respondents (80 percent) as the house prices are lower in the study areas compared to other major towns in Selangor Darul Ehsan. Minority of them (20 percent) either rent or stayed in properties belonging to their parents. The average number of households was five persons (23.6 percent) and the maximum number of residents in a household in the sample was 15 persons (0.2 percent). Majority of these households did not have any children staying with them (46 percent), about 21.8 percent had one child and seven kids were the highest number in any one household (0.2 percent).

Analysis of the responses to the choice sets found that 34 percent opted for baseline i.e. Control tipping. The higher number of respondents opting for improvement in label form is

expected as respondents knew the actual proposed solid waste disposal technology. There is also a difference between the percentages of respondents opting for Sanitary landfill (52 percent) and Incineration (14 percent), indicating a strong choice for sanitary landfill as the more preferred solid waste disposal options.

Since the study incorporates impact zones, it will be interesting to study if the respondents' choices of disposal facilities vary according to changes in PROEX (impact zones). A cross-tabulation (Table 4) between the respondents' choices of disposal facilities defined by the choice sets and the PROEX (impact zones factor), aids the explanation of the trend of respondents' choices based on their residential location to the proposed and existing disposal sites.

Table 4. Cross-tabulation of public choice option and PROEX

Choice option	*PROEX*			*Total respondents 100%*
	Broga (1:20)	*Semenyih (5:16)*	*Cheras (20:10)*	
Control tipping	6%	8%	10%	34%
Sanitary landfill	15%	17%	19%	52%
Incineration	3%	4%	7%	14%

As PROEX increases, the votes for sanitary landfill (from 15 to 17 and to 19 percent) and incineration (from 3 to 4 and to 7 percent) as the alternate disposal options are increasing. However, it can also be observed that among the three disposal options, incineration is the least preferred option in every PROEX. For instance, 4 percent of the total label treatment sample opted incineration as compared to 8 percent for control tipping and 17 percent for sanitary landfill in Semenyih.

5. Model Results

In the choice model analysis, multinomial logit (MNL) models are regressed. The first model is a basic specification which shows the importance of the attributes in explaining the respondents' choice for the three different solid waste disposal options.

The second model is extended to incorporate the socio-economic and environmental attitudinal variables. The inclusion of these variables helps to correct the heterogeneity in preferences and provides an estimate of the effects of the change in any attributes on the probability that the improved or base option will be chosen.

Nested logit models are excluded as the two MNL regressions do not violate the independently and identically distributed (IID) assumptions and hence the parameter estimates are unbiased.

5.1. *MNL basic model*

There are three indirect utility functions derived from the MNL models, each representing the respective resource use option:

- Control tipping, which is the baseline or status quo
- Sanitary landfill and Incineration, which are the improvement plans with better environmental attributes relative to Control tipping (nothing changes and as usual), respectively.

The utility of each of the functions is determined by the attribute levels in the choice sets and its function is stipulated below:

$$V_i = C_0 + \beta_1 * PSYF + \beta_2 * LAND + \beta_3 * AIRP + \beta_4 * RWQL + \beta_5 * ADPY$$

for $i = 1, 2, 3$ and $C_0 = 1$ for $V_i = 1$

C_0	Alternative specific constant (ASC) taking the value of one (1) for baseline option and zero (0) for improved options

PSYF	Psychological fear
LAND	Land use
AIRP	Air pollution
RWQL	River water quality
ADPY	Additional monthly SWM charge/payment

With $C_0 = 1$ for $V_i = 1$, it would mean that when there is a choice for control tipping, i.e. the baseline, the utility will be 1 and hence the ASC captures the status quo. Consumers will attain higher utility level with control tipping when ASC takes a positive value. Otherwise, when it takes a negative value, the improved options, i.e. sanitary landfill or incineration will give higher utility level. An ASC (C_0) represents the mean of a collection of random effects due to, example, unobserved variables, once effects associated with all the other variables have been taken into account (Brownstone, Bunch & Train, 2000).

In the basic model, the baseline gives higher utility level to the consumers than the improved plans. All the attributes, are found to be significant at 1 percent level and all have the *a priori* expected signs. The negative coefficient signs for the monetary payment attributes signify that respondents are not ready to pay higher charges for any improved options that would burden their budgets. The Hausman-McFadden tests (1984) indicate that the estimation of the baseline model does not violate the IID assumptions at the 1 percent level.

5.2. *MNL extended model*

This model assumes that several socio-economic and environmental attitudinal variables influence the respondents' preference and behaviour. It is specified as:

$$\begin{aligned} V_i = {} & C_0 + \gamma_1 C_0 * PROEX + \gamma_2 C_0 * AGE + \gamma_3 C_0 * RESD + \gamma_4 C_0 * KIDS + \gamma_5 C_0 * RACE \\ & + \gamma_6 C_0 * GDR + \gamma_7 C_0 * CARE + \gamma_8 C_0 * MBR + \gamma_9 C_0 * OWNHSE + \gamma_{10} C_0 * QUAL \\ & + \gamma_{11} C_0 * HHINC + \gamma_{12} C_0 * STPROF + \gamma_{13} C_0 * TYPROF + \gamma_{14} C_0 * DEMO \\ & + \beta_1 * PSYF + \beta_2 * LAND + \beta_3 * AIRP + \beta_4 * RWQL + \beta_5 * ADPY \end{aligned}$$

for i = 1, 2 and 3, and $C_0 = 1$ for $V_i = 1$.

PROEX	Distance ratio of proposed site to existing site of SWD facility from respondents' residence
AGE	Age of respondents
RESD	Number of residents residing in the respondents' house
KIDS	Number of kids below age of ten (10 yo) residing in respondents' house
RACE	Dummy variable (DV) equaling one (1) if respondent is a Malay
GDR	DV = 1 for Male
CARE	DV = 1 for respondents who care where the SW they generate would be disposed
MBR	DV = 1 for respondents who are members of any environmental related organizations
OWNHSE	DV = 1 for respondents who are residing in their own properties
QUAL	DV = 1 for respondents who attain academic qualifications above higher secondary schooling
HHINC	DV = 1 for respondents whose household income is below MYR 3,000.00 per month
STPROF	DV = 1 for respondents who are government servants
TYPROF	DV = 1 for respondents who are categorized as professionals and management related personnel
DEMO	DV = 1 for respondents who would support peaceful street demonstrations to stop construction of harmful SWD facility

It is interesting to find that in the extended model, the improved options give higher utility than the baseline as shown by the negative ASC. In this second model, the socio-economic and attitudinal variables are modeled through the interactions of the variables with the alternative specific constant, C_0. These interactions serve to capture the influence of those variables on the probability for a respondent to opt for status quo. For instance, the interaction between ASC and age would show the effect of the variable on the probability that a respondent would choose control tipping, since the ASC captures the status quo as explained earlier. A positive partial coefficient of the interaction between ASC and a variable will mean that the said variable would influence a higher chance of respondents to opt for baseline. Otherwise, a negative partial coefficient would mean higher probability of going for improved options.

All the attributes are highly significant in the extended as in the basic model. However, only about half of the socio-economic variables tested like PROEX, age, care and household

income are significant and interestingly all their partial coefficients take negative values which mean favouring the improved options. The reason for limited variables being significant in this case can be explained by the virtue that when a solid waste disposal technology is vividly named, for example sanitary landfill or incineration, less socio-economic and attitudinal variables would be influential in one's decision to choosing the preferred solid waste disposal option. Commonly regardless of one's race, qualification, status of house ownership or profession, if an option is perceived to be bad (as it may be in the case of incineration due to lack of awareness) it would be bad to all.

The negative sign of PROEX shows that as the ratio of the distance between one's house and proposed, to existing site for solid waste disposal facility decreases, one is more likely to choose the improved options, as they are believed to be safer technologies. Age with a positive coefficient would show higher willingness to pay for improved options by younger respondents. This is probably due to the higher ability to earn by the younger generation than the senior citizens, as supported by the significant household income interaction with ASC. Similar to the baseline model, the extended model passes the Hausman-McFadden tests as well. Table 5 shows the MNL results.

Table 5. Results of MNL models

Variables	*Basic model*	*Extended model*
C_0	0.8406*** (0.2873)	-1.0542** (0.5677)
C_0PROEX		-0.2762*** (0.0618)
C_0AGE		0.0459*** (0.0055)
C_0RESD		0.0411 (0.0302)
C_0KIDS		-0.0270 (0.0467)
C_0RACE		-0.0547 (0.0977)
C_0GENDER		0.1724* (0.0990)
C_0CARE		-0.3075*** (0.1100)
C_0MBR		-0.4727** (0.2419)
C_0OWNHSE		0.0400 (0.1300)
C_0QUAL		-0.0512 (0.0387)

C_0HHINC		-0.0591** (0.0242)
C_0STPROF		0.0458 (0.0646)
C_0TYPROF		0.1242*** (0.0305)
C_0DEMO		-0.1048* (0.0595)
PSYF	0.2562*** (0.0685)	0.2641*** (0.0706)
LAND	-0.1861*** (0.0520)	-0.1784*** (0.0533)
AIRP	0.2856*** (0.0386)	0.2956*** (0.0398)
RWQY	0.4200*** (0.0716)	0.4502*** (0.0738)
ADPY	-0.1173*** (0.0179)	-0.1242*** (0.0184)
Log-likelihood	*-2,190.13*	*-2,053.62*
Rsq Adj	*0.11*	*0.17*
Iterations completed	*5*	*5*
Observations	*2,250*	*2,250*

Note: Parentheses indicate the standard errors of the respective coefficients.
*Significant at 10 percent, **Significant at 5 percent, ***Significant at 1 percent

5.3. *Implicit prices*

Implicit prices show the marginal rates of substitution (MRS) between each of the identified attributes (which are non-monetary) and the monetary attribute. These values are obtained as the ratio of the coefficients of the attributes concerned and of the monetary attribute. Implicit price of an attribute reflects the respondents' willingness to pay for an additional unit of that attribute to be present, ceteris paribus. The implicit prices of the attributes estimated by the two econometric models do not differ significantly as shown in Table 6. Consistent with these indifferent estimates, Jamal et al. (2004) notes that heterogeneity of respondents' preferences has little effect on the estimates of implicit prices.

Table 6. Estimates of implicit prices (MYR)

Attribute	*MNL Basic Model*	*MNL Extended Model*
PSYF	2.18	2.12
LAND	1.59	1.44
AIRP	2.43	2.38
RWQL	3.58	3.63

5.4. *Equilibrium values and ranking*

The four non-monetary attributes can be ranked by computing the equilibrium values (EqV) using their respective implicit prices as shown in Table 7. These values would help to identify the tradeoffs between the non-monetary attributes that will leave the individuals on the initial utility level. Firstly, a reference implicit price has to be identified and then dividing it with the implicit price of interest:

$$EqV = WTP^{(\text{Reference attribute})} / WTP^{(\text{Interest attribute})}$$

Table 7. Estimation of equilibrium values

Attribute	*MNL Basic Model*	*MNL Extended Model*	*Ranking of importance*
PSYF	1.00	1.00	3
LAND	1.38	1.48	4
AIRP	0.90	0.89	2
RWQL	0.61	0.59	1

Based on the MNL basic model and following the work of Jamal (2006), the equilibrium values can be interpreted conceptually as; the utility derived by the households on average as a result of a unit improvement in psychological fear (PSYF), ceteris paribus is equivalent to the utility derived by 1.38 unit improvements in land use (LAND), 0.90 unit improvements in air pollution (AIRP) and 0.61 unit improvements in river water quality (RWQL).

RWQL is ranked the most important non-monetary attribute and LAND least important. The findings show that the public cares very much the quality of river water probably due to the several river contamination cases in Selangor Darul Ehsan and the published reports that 70 percent of the rivers in the country are polluted. LAND captures the least attention and this may be due to the abundant amount of land in the country, indicating the willingness of the public to sacrifice land for better and more environmental friendly disposal options.

5.5. *Compensating surpluses*

Following the framework of this study, the compensating surplus should be the welfare measure of the solid waste disposal improvement. Compensating surplus is the amount of money an individual is willing to pay to attain the improvement and which leaves him/her just as well off as if there were no improvement and requiring no payment.

Adopting the attribute levels for the sanitary landfill and incineration from choice sets generated by the experimental design, the compensating surplus for both the alternative disposal options are computed. The options are defined by the near best attribute levels for each of the technology. It is observed that when socio-demographics and attitudinal variables are not considered, the respondents are willing to pay a sum of MYR26.14 for a sanitary landfill which is characterized by the following attribute levels. An extra payment of MYR24.55 is estimated for an incinerator to replace the current control tipping. However, when the socioeconomic and attitudinal factors are reflected on, surprisingly all the willingness to pay change into willingness to accept compensation. These are evident when the willingness to pay for the said sanitary landfill and incineration change to willing to accept (MYR24.04) and (MYR25.48) respectively as shown in Table 8. The results can be anticipated from the MNL models.

Table 8: Compensating surplus comparison based on best practices choice sets

Attribute	*Sanitary landfill*	*Incineration*
PSYF	Low	Low
LAND	25 ha	20 ha
AIRP	Decrease 10%	Decrease 10%
RWQL	Clean	Clean
CpS (MYR): Basic Model	26.14	24.55
Extended Model	(24.04)	(25.48)

Note: Compensating surplus (CpS) values in parentheses are willing to pay compensation

These outcomes may suggest the need for public consultation to better understand the socioeconomic background of the community before any waste disposal projects are planned and proposed to avoid disagreements that may lead to court proceedings like the cases of incinerator constructions in the town of Puchong and Broga respectively.

A further study on these unexpected findings, found that distance factor in terms of PROEX, plays an important role in the determination of the economic value of the waste disposal services. For instance, a sanitary landfill and an incineration with their respective attribute levels as presented below fetch willingness to accept but change into willingness to pay after a certain PROEX level. The sanitary landfill and incinerator take the features which are comparable to the proposed Broga Sanitary Landfill and Broga Incinerator.

Table 9. PROEX and change in compensating surplus

Attribute	*Sanitary landfill*	*Incineration*
PSYF	Negligible	High
LAND	90 ha	20 ha
AIRP	Unchanged	Increase 10%
RWQL	Clean	Slightly polluted
PROEX	*CpS (MYR)*	
10	(1.79)	-
11	0.55	-
12	2.90	-
17	-	(0.89)
18	-	1.45
19	-	3.80

Note: CpS in parentheses show willingness to accept compensation

The compensating surplus sanitary landfill will become positive when PROEX value goes beyond 10 but 17 for the incinerator. This would mean that the public is willingness to pay for sanitary landfill if the proposed disposal site is 10 times further than the existing site from their residence and 17 times of such for incineration if the proposed disposal facilities carry features of

the two proposed Broga projects. Other combinations of sanitary landfill and incineration attribute levels can also be used to compute their respective compensating surplus for solid waste management policy use. Although the estimation of the compensating surplus may arguably be incomprehensive, it at least opens avenues for further researches.

6. Conclusion and Policy Implications

With more access to education and borderless information, the demand for more improved solid waste management and disposal 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. Nevertheless, the findings of this study envision shedding some lights to the policy makers and relevant authorities to provide more public-receptive waste disposal services in due course.

The implicit prices may suggest that (1) with adequate awareness, education and knowledge, people will learn to adapt and accept new technologies, (2) proper and efficient land use is appreciated and people are keen to replace the current control tipping with sanitary landfill, (3) if the government proceeds with the implementation of incineration in the country, more cautious steps have to be taken to ensure minimal negative externalities to the public, and (4) if the government can safely guarantee that river would be kept unpolluted by sanitary landfill and incineration, implementing them in the country could be possible.

This study also reveal several crucial and interesting behaviours of the Malaysian public regarding the solid waste disposal issues, (1) the perception of the public, commonly nurtured by their socio-economic background and, distance factor have great impacts on the choice of disposal options, (2) the Not-In-My-Backyard (NIMBY) syndrome is still by and large present in the society, (3) the public demands transparency and open consultations with the government on

issues related to SWD facilities, and (4) sanitary landfill is better received than incineration by the society as the alternative to control tipping.

These findings may supply some direction in strategizing government policies related to solid waste management and disposal that are implementable and acceptable by all stakeholders in the country. The strong NIMBY syndrome and willingness to accept sanitary landfill at the expense of more land use identified in this study suggest that the authorities have to relook at the procedures on location choice to site the disposal facilities and that these sites should be further away from townships. However, the transportation costs have to be factored in as well in order to make the site location a feasible one for the waste disposal service providers at the same time. The study also reveals some form of labeling effect where the public chooses to shy away from incineration than sanitary landfill. Hence, the authorities may have to use more greener or neutral names for disposal technologies that might be brought into the country in the future.

With the study reveals that river water quality is one of the utmost crucial attribute that the public would pay attention, it is implied that the government should further enhance on the implementation of the River Water Quality Management Information System (RWQMIS) by the Naitonal Water Resources Council (1998) and to allocate bigger budgets for river water rehabilitation projects throughout the country.

The results of the study show high influence of perception and distance factor on the public choice pattern for waste disposal options. These propose that the government should have more open consultations with the public to understand their perspectives and needs before attempting to announce any solid waste management and disposal policies. It is also shown that the authorities have to be more transparent in the future proposed waste disposal technology in order to convinced the public of their advantages but not leaving the public to guess and presume the negativities due to lack of knowledge and access to information. With the distance factor, the

government can devise a more comprehensive waste fees system that is based on social equity, which shall compensate the made worse-off and charge higher fees on those who are made better-off by any proposed waste disposal options and sites.

This study of non-market valuation of solid waste disposal options has illustrated that choice experiment can be successfully applied in developing countries, like Malaysia, on solid waste related issues, with careful construction of choice sets, questions and effective data collection. As highlighted by Jamal et al. (2004), close consultations with stakeholders through focus group discussion are critical to understanding the nature of the environmental problems, selection of attributes and levels which are the main crusts of the choice experiment design. The training of enumerators is also important to ensure unbiased data collection in the survey process.

In closing, the choice experiment application can be used to value a range of resource use scenarios in solid waste management and disposal. The estimates derived from this study can be aggregated to determine the total non-market value accrued to the wider community for each solid waste disposal 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 the Ministry of Housing and Local Government can identify a solid waste disposal plan that yields the greatest net benefit to the Malaysian society.

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