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ECONOMIC VALUATION OF HOUSEHOLD PREFERENCE FOR SOLID WASTE MANAGEMENT IN MALAYSIA: A CHOICE MODELING APPROACH*

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ABSTRACT

This study estimated the economic values of household preferences for improved solid waste management (SWM) service attributes in Malaysia. The Choice Model (CM) was employed on 859 randomly selected urban households in Kajang and Seremban areas. The study found that households were willing to pay a premium for improvements in the SWM system. More specifically, the study ascertains that households on average are willing to pay a charge of RM1.57 per month for a change in collection frequency - from 3 irregular times to either 3 scheduled times or 4 times per week, ceteris paribus; RM3.32 if waste disposal method was improved from control tipping to sanitary landfill, ceteris paribus; and RM2.48 if transportation mode was improved from a mix of compactor and open trucks to either compactor or a mix of compactor and covered trucks, ceteris paribus. The CM has also shown that households derive positive utility from the provisions of recycling facilities and compulsory kerbside recycling with an implicit price (willingness to pay) of about RM3.51 monthly. Results from the study can be used by service providers to identify any mismatch between what the public actually wants and are willing to pay for and the affordability of supply on the part of service providers.

ABSTRAK

Kajian ini menganggar nilai ekonomi permintaan isi rumah terhadap penambahbaikan dalam perkhidmatan pengurusan sisa pepejal perbandaran. Kajian menggunakan Model Pilihan yang melibatkan kaji selidik terhadap 859 responden di kawasan perbandaran Kajang dan Seremban. Kajian mendapati isi rumah berkesanggupan membayar premium bagi penambahbaikan dalam pengurusan sisa pepejal perbandaran. Secara spesifik, kajian mendapati isi rumah secara purata sanggup membayar sebanyak

RM1.57 sebulan bagi memperoleh peningkatan dalam kekerapan kutipan mingguan sampah daripada 3 kali tak menentu kepada 3 kali berjadual atau 4 kali seminggu; RM3.32 jika sampah dilupus dengan menggunakan kaedah sanitari daripada 'control tipping'; dan RM2.48 jika mod pengangkutan ditukar daripada campuran 'compactor' dan lori terbuka kepada 'compactor' sahaja atau campuran 'compactor' dan lori tertutup. Model yang diguna juga menunjukkan isi rumah memperoleh faedah ekonomi daripada pembekalan peralatan (tong kitar semula) untuk memudah pengasingan sampah-sampah di rumah serta arahan kitar semula mandatori dengan anggaran harga implisit atau kesanggupan membayar sebanyak RM3.51 sebulan. Dapatan kajian boleh digunakan oleh pembekal perkhidmatan untuk mengurangkan ketaksepadanan antara jenis perkhidmatan yang ingin dan mampu dibekal oleh pembekal dengan permintaan serta kesanggupan dan kemampuan membayar di pihak pengguna.

INTRODUCTION

Background and Problem Statement

Managing Municipal Solid Wastes (MSW) has become a major problem for local governments in Malaysia. In 1999, per capita MSW generation rates were estimated at 0.81 kg per day (The World Bank, 1999). These rates are expected to increase steadily as the economy grows.

In Malaysia, the local government authorities have been responsible for solid waste management services. However, over the years, various constraints in infrastructure, institutional setup, financial and technical resources, have led to inefficiency in management. These contrast to the increasing waste generation rates and environmental awareness among the general public. The privatisation process was thus initiated by the Malaysian government in 1996 with the aim of attaining an efficient management system to enhance environmental quality and encourage resource re-use and waste minimisation.

Before the privatisation program, the most common waste collection method was through household and communal bins and the wastes disposed in open dumps, normally without ground cover or control for leaching. It was reported that in 1990 (Mourato, 1999), there were 230 official dumping sites with less than two years of operating life. About half of these sites were open dumps. It was also reported that there were three times more unofficial dumping sites (Agamuthu, 2001). Control tipping has become an increasingly popular method of waste

disposal. It is regarded as the lowest quality method amongst the class of sanitary landfills.

The Malaysian government has of late increased its campaign to create public awareness on the importance of waste recycling and waste minimisation. It is estimated that only 3% of total solid wastes (SWs) generated nationwide are being recycled. Draft Concession Agreements between the government and the private waste service providers targeted 22% recycling, 8% composting, 17% incineration and 53% landfilling by 2020.

Currently, households in the privatised areas are required to place their waste bags in waste bins in front of their houses (kerbsides) and private collectors would collect the wastes twice - thrice a week. Payment for the collection services is currently made indirectly through the annual house assessment.

The local authorities set the tariff rate after consulting the private service providers. Therefore, households at this stage do not pay a separate payment for solid waste management fee and they are also not aware about the amount of tariff they are paying for the waste collection service. This, however, might change once the fully fledged privatisation process comes into being. Contractors may also wish to increase the quality of their services including substituting existing landfills with mostly sanitary landfills or incinerators, conventional open trucks with compactors or covered trucks. To offer these improved services, there may be a need to increase the service charge. Consumers may also be required to pay the service charge directly to contractors.

There are uncertainties in consumer awareness and attitude towards a number of waste management issues that may hinder the implementation of effective SW management options. A critical issue relates to consumer demand or willingness to pay (WTP) with the types of services characteristics and disposal options that the private service providers can offer. The experience of the privatisation project for sewerage services directly reflects this problem. A business group was awarded the privatisation concession for sewerage services in 1996. But the consortium was facing enormous difficulties in overcoming consumer reluctance to pay for the perceived (*unseen*) services even though the tariffs have been reduced several times since its inception.

Given the above background, this study addresses the following policy issues; (*What shall be the desirable future waste management programs, in terms of priorities over different service attributes and levels*). The major

service attributes that will be examined are: collection frequency, collection timing, mode of transportation, disposal options, and the provision of different type of containers to facilitate recycling or separation of waste at the household level.

Specifically, the objectives of this study are:

1. to elicit consumer marginal WTP for different service options – collection frequency, mode of transportation and the provision of facilities and containers to facilitate separation of waste at the source (kerbside recycling).
2. to rank the characteristics of service in order of importance to consumers – collection frequency, mode of transportation, recycling facilities, and disposal options.
3. to estimate the implicit price for each service attribute and the trade-offs among the attributes.

Rationale of Study and Policy Relevance

This study provides two important insights for public and private policy makers in terms of incorporation of demand-side information into the design of MSW management services/attributes and fee schedules.

This study will be of special interest to Malaysian regulators (Economic Planning Unit) of private concessions of MSW management as well as to the private waste collectors. This study derives estimates of the value of changes in individual attributes as well as changes in the aggregate level of service attributes. Therefore, the results from this study can be used to produce estimates of the value of multiple service alternatives or the total value of a SW management package. This information can be used in negotiating an appropriate tariff rate with the current private service providers as well as in the designing of future concession agreements and/or consideration of proposals by new private entities for new residential service areas.

An important contribution of this study is to minimise the problem of mismatch in terms of services that can be supplied by service providers (i.e, sanitary landfills vs open landfills options, less and regular vs more but irregular collection frequencies, conventional open trucks vs compactors, etc.) and what the public really wants and is willing to pay for. In short, knowledge obtained from this study will help match the affordability of supply and public WTP for waste services. To date, very few such studies have been conducted in Malaysia.

METHODOLOGY

An environmental valuation technique known as Choice modelling (CM) was employed in this study. The aim of CM was to identify marginal values for SWM attributes. This is to allow identification of a desirable SWM plan from the demand-side perspective.

The CM, like the Contingent Valuation (CV), is a class of stated preference technique but has the unique flexibility to evaluate both alternative management options and the marginal values of non-market attributes that may be difficult to identify using a typical CV study because of lack of variation. With CM, it is possible to estimate the value of the individual attributes that make up the environmental goods, such as increased waste collection frequency. The CM is also able to derive estimates of the value of changes in the aggregate level of non-market goods quality. The following section provides an overview of the background of CM.

Overview of CM

Many management decisions are concerned with changing attribute levels, rather than the losing or gaining of the environmental goods as a whole, of which the CV has the unique advantage. For the former, the CM has the unique strength. The CM is also able to derive estimates of the value of changes in the aggregate level of environmental quality. Therefore it can be used to produce estimates of the total value of multiple services or resource use alternatives. The main weakness of CM relative to CV is the added cognitive burden it imposes on respondents apart from its complexity in designing it correctly and its econometric estimation.

In CM questionnaires, respondents are posed with a series of choice sets, where each choice set usually contains three or more service or resource use options. Respondents are asked to choose their preferred option from each choice set. The options in each choice set contain common attributes, which can be at various levels. The combination of attribute levels for each option in each choice set is designed using experimental design techniques. Similar to a CV study, before the choice sets are presented to the respondents, there is a description of the study site, the research issues, the proposed policy changes, and its implications on attributes which are being modeled.

The theoretical basis of CM is random utility theory (RUT). Under RUT it is assumed that that the utility functions of goods can be broken down into two parts, deterministic and stochastic. Assume utility for

an option *i* which depends on environmental attributes (Z) and socio-economic characteristics (S).

$$U_{in} = V\,(Z_{in}\,,\, S_n\,) + e\,(Z_{in}\,\,,\, S_n) \tag{1}$$

The probability that individual *n* will choose option *i* over other option *j* is given by:

$$\text{Prob}\,(i/C) = \text{Prob}\,\{V_{in} + e_{\,in} > V_{jn} + e_{\,jn}\,;\, j \,\text{Œ}\, C\} \tag{2}$$

where C is the complete choice set. It is assumed that the error terms of the utility function are independently and identically distributed (IID). A consequence of this assumption is the property of independence of irrelevant alternatives (IIA). The IIA states that the probability of choosing one alternative over the other is entirely dependent on the utility of the respective alternatives. This property may be violated by the presence of close substitutes in the choice sets as well as heterogeneity in preferences.

The probability of choosing option *i* is given by:

$$\Pr(i) = \frac{\exp^{uv_i}}{\sum_{j \in C} \exp_{uv_j}} \tag{3}$$

where $V_i = V(Z_i, S)$, V_i is the utility function, Z_i is a vector of environmental goods, S is a vector of market goods and socio-economic characteristics, and m is a scale parameter, which is usually assumed to be equal to one (implying constant error variance). Equation (3) is estimated by means of a multi-nomial logit regression, which assumes that choices are consistent with the IIA property.

The most basic form of V_i is an additive structure, which includes the attributes from the choice sets only, eg:

$$V_i = C + Sb_kX \tag{4}$$

where *C* is an alternative specific constant (ASC), b is a coefficient and *X* are attributes from the sets. The effect of attributes in the choice sets are captured by the *X* variables while *C* represents the effect of systematic but unobserved factors that explains the respondent choices. Technically *C* reflects the differences in the error terms. In a multi-nomial logit (or nested logit) with *j* options it is possible to have *J-1* ASC.

It is possible to include socio-economic and environmental attitudinal variables into the utility functions by estimating the variables interactively, either with the ASC or with any of the attributes from a choice set. An added advantage of CM is its flexibility to incorporate simultaneously the importance of economic, social and environmental factors in a valuation project.

In this study the experimental design is constructed based on the compensating surplus (CS) welfare measure. It measures the change in income that would make an individual indifferent between the initial (lower environmental quality) and subsequent situations (higher environmental quality) assuming the individual has the right to the initial utility level. This change in income reflects the individual's WTP to obtain an improvement in environmental quality. Based on the indirect utility functions, the compensating surplus can be illustrated as follows:

$$V_0(S_i, Z_0, M) = V_0(S_i, Z_1, M\text{-}CS) \quad (5)$$

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

Using the results from the multinomial logit, the CS can be estimated by employing the following equation (Adamowicz, Louviere & Williams, 1994).

$$CS = -1/(b_M)\{\ln(S_i \exp^{V0}) - \ln(S_i \exp^{V1})\} \quad (6)$$

Following Boxall, Adamowicz, Swait, Williams, & Louviere (1996), and Morrison, Bennett and Blamey (1999), equation (6) is reduced to:

$$CS = \{-1/(|b_M|)\}(V_0 - V_1) \quad (7)$$

where b_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.

Questionnaire Design

Choice Model

As discussed earlier, in CM, respondents are presented with multiple choice sets, where each choice set usually contains three or more management options. Respondents are asked to choose their preferred option from each choice set. The options in each choice set contain

common attributes, which can be at various levels. The combination of attribute levels for each option in each choice set is designed using experimental design techniques. Before the choice sets are presented to the respondents, there is a description of the study site, the research issues, the proposed policy changes, and its implications on household budgets and the environmental attributes which are being modeled.

Three focus groups and a pre-test was employed to identify the non-market SW management attributes, the levels these attributes can take, to determine the appropriate format of the choice sets, and the levels of price tags for each choice set. These are critical for the success of a CM exercise. The first two focus groups (five to six people per group) solicited views from the general households (both house owners and renters) and the third from both public officials and private service providers. The pre-test utilised some 60 respondents in Bangi, a small university town within the Kajang Municipality.

The Choice sets followed the standard L^{MN} experimental design where only the main effects are modeled. A Choice Modelling exercise in Malaysia by Othman, Bennet and Blamey (2004) had shown that each respondent on average can take no more than 5 choice sets. In the focus groups, three MSW management alternatives (one baseline and the other two represent an improvement of MSW management plan) and six service attributes were constructed. The preliminary choice of attributes was made in consultation with a private SW service provider and researchers in the field. An example of the choice set is shown in Table 1.

If the above three management options were the only ones possible, which one would you prefer? If you choose the current option (Option 1), simply tick the first box as shown above.

The service attributes and levels that it takes for the two improved alternatives are as follows:

- Collection frequency – 3 levels; 3 times weekly but irregular, 3 times weekly but regular, 4 times weekly
- Free provision of multiple containers for separation of waste at source – 2 levels; separation at source not needed (baseline), respondents are required to separate waste at source - free multiple containers provided
- Time of collection – 3 levels; irregular time (baseline), afternoons only, evenings only

Table 1
An Illustration of a Choice Set Presented in the Focus Group Analysis

Implications	Option 1 (current management Option)	Option 2	Option 3
Collection frequency	Irregular - 3 times weekly	Alternate days (3 times weekly)	4 times weekly
Separation of waste at source by households	No separation at source needed	Yes – free containers and facilities provided	Yes - free containers and facilities provided
Time of waste collection	Irregular	Afternoon	Evening
Types of waste disposal methods	Open landfills	Sanitary	Incinerator
Mode of Transportation	Conventional trucks	Manually loaded compactor	Manually loaded compactor
Monthly charge	RM 15	RM 20	RM 25
	☑	☐	☐

- Types of waste disposal methods – 3 levels; open landfills (baseline), sanitary, incinerator
- Mode of transportation – 3 levels; conventional open trucks (baseline), manually loaded compactors, covered conventional trucks
- Monthly charge – 3 levels; RM15 (baseline), RM20, RM25

The baseline option considers the baseline levels only while the other two options can take on any orthogonal mix of levels including the baseline level. Five choice sets were deliberated during the focus group session.

We found that focus group participants were having extreme cognitive difficulty in determining their preferred choice. Most notably was the intransitivity of the levels. For instance some choice sets were given more improvements in the non-monetary attributes but was less on the monetary attribute. Note that in a CM, the mix of levels need not be transitive. For instance, a choice set which contains more environmental improvements need not necessarily be accompanied by a higher service charge. Each choice set is considered as a separate

option, independent of the baseline option, and any other option in the preceding choice sets.

We finally ended up with five attributes, dropping the Collection Time attribute as we thought that it would not be economically realistic for the service providers to commit to a fixed time in collecting wastes. The levels chosen were further refined to consider the actual realities in the chosen survey areas. The number of alternatives were also reduced to two to facilitate the decision-making process by respondents. The final attributes and levels are as follows:

- Collection frequency – 3 levels; 3 times weekly but irregular, 3 times weekly but regular, 4 times weekly
- Free provision of multiple containers for separation of waste at source – 2 levels; no separation at source needed (baseline), respondents are required to separate waste at source - free multiple containers provided
- Types of waste disposal methods – 2 levels; control tipping (baseline), sanitary
- Mode of transportation – 2 levels; mix of compactors and conventional open trucks (baseline), mix of conventional covered trucks and compactor
- Monthly charge – 4 levels; RM15 (baseline), RM20, RM25, RM30

All of the above attributes and levels can be applied practically to all municipalities in Malaysia except for Petaling Jaya and a few other areas where a formal framework for waste separation at source was already in existence. In terms of waste disposal methods, most municipalities are considering (*control tipping*) and sanitary landfill methods. Incineration as a disposal option was dropped, as private service providers indicated that it might not be feasible in the short-run, where land for landfills in Malaysia is still in abundance. On the mode of transportation, most municipalities and private service providers are utilising a mix of open trucks and compactors, as transfer of wastes normally involves two stages – firstly, from the households to a transfer site and secondly, from the site to the landfill area. Small conventional trucks are still needed due to infrastructural consideration - some municipality roads were not designed to withstand heavy vehicles. However, there is an understanding that the use of open trucks should be phased out. Therefore, the improved mode of transportation should well be a mix of compactors (manual or automatic) and conventional covered trucks. The range of monetary attribute (charge) reflects the WTP estimates of RM16 per month (Mourato, 1999) to obtain

an improvement in MSW management collection and disposal services. Unofficial information indicates that the current average level of charge is RM15 - some households would pay more and some less, as the charge is based on (*cross-subsidisation*).

Note that the CM in this study focuses on estimating the marginal benefits of MSW management improvements. Hence, in designing the choice sets, the precise quantum for the baseline monthly service charge is immaterial in identifying the incremental levels for the attribute. As long as the relativity of the levels with that of the baseline is preserved, the marginal values will not be affected significantly.

An orthogonal design guide was used to determine the mix of attribute levels for the choice sets. Only the main effects were considered. Fifteen choice sets were organized into three blocks of five choice sets each. An example of the final choice set is shown in Table 2.

Suppose Option 2 is the only possible alternative to the current waste management plan (Option 1). Do you prefer to choose Option 1 (collection frequency – 3 times weekly but irregular, etc.) or Option 2 (collection frequency – 3 times weekly and regular, multiple containers and facilities provided free of charge to facilitate separation of wastes at source, etc).

(Enumerator needs to forewarn the respondents that the waste service payment will be made directly to the service provider and it is to replace any waste fee that is implicit in the house assessment charge)

If Options 1, 2 and 3 were the only management options possible, which one would you prefer? (tick the box below your preferred option)

If the above two management options were the only ones possible, which one would you prefer? If you choose the current option (Option 1), simply tick the first box and if you choose the second option, tick the second box.

Note that from Table 2, it is clear that the design of choice sets resembles the dichotomous choice CV format where any one respondent is presented with a multiple resource allocation option, one at a time. The respondent has the choice to agree or disagree. If he/she agrees, it reflects his/her preference towards the proposed option over the baseline scenario or otherwise. Given the CM design and presenting it the way the dichotomous choice CV does, respondents find the choices more intuitive and less demanding cognitively. This is because

Table 2
An Example of the Actual Choice Set

Implications	Option 2 (current management Option)	Option 1 (proposed plan)
Collection frequency	3 times weekly, irregular	3 times weekly, regular
Separation of wastes at source by households	Separation at source not needed	Waste separation required, facilities and containers provided free
Disposal method	Control tipping – less environmentally friendly	Sanitary landfill – highly environmentally friendly
Mode of Transportation	Mix of conventional open trucks and compactor	Mix of covered trucks and compactor
Monthly charge	Average RM 15	RM 25
	☐	☐

respondents need only compare each choice set with the same baseline plan one at a time. In short this approach has the advantage of a CV in terms of easiness of response elicitation and the capability of a CM in modeling varying levels of resource allocation alternatives. The payment vehicle used in the CM was direct monthly payment to the service providers. It was assumed that households would need to pay for waste services directly to the service providers, the way they have been doing for other utilities. That way, households will be aware of how much they are actually paying exactly for waste services and it would also allow optimising behaviour should waste charges be based on a unit-based pricing system in the future.

The Study Areas and Sampling Strategy

Two study areas were selected for the study. First, the Kajang municipality area in the state of Selangor to represent one of the most fast developing municipalities in the country. It is located in the midst of the affluent Klang valley and in the vicinity of the country's futuristic Putra Jaya and Cyber Jaya. The area also includes Bangi, a small but affluent university town. The other is the Seremban municipality, the second largest city in the southern region. It is only 30 km south of Kajang town. While a significant number of Seremban residents work and commute in the Klang valley areas, Seremban is quite a mature and (*settled down*) city relative to Kajang.

For the Seremban area, 600 heads of household (or alternatively a working family member) (three blocks with about 200 respondents per block) stratified based on house types were sampled randomly. The residential areas representing Seremban municipality includes Taman Paroi Jaya, Taman Pertama, Taman Kelab Tuanku, Taman Panchor Jaya, Kampung Rumah KTM, and Taman Bukit Chedong. For the Kajang municipality, 300 respondents from residential areas - Taman Bukit, Taman Hijau and Bandar Baru Bangi were surveyed. For the Kajang area, each block of CM questionnaires was presented to some 100 respondents on average. The CM survey for both areas was completed between February – July 2001.

Prior to conducting the survey, the enumerators were given a series of training sessions by the researcher. The focus of training, which included a role-play exercise, was on how to obtain cooperation from respondents and hints on handling questions that might arise given the complexity of the CM (particularly the rationale for the intransitivity of the levels of attributes) survey as opposed to an ordinary socio-economic survey.

PROFILE ANALYSIS

Total valid respondents for Kajang and Seremban municipalities were 859. Of these, Malays comprised 62%, Chinese 19% and Indians and others, 19%. About 49% were females and 51% males. Mean age was 29 years. Respondents of age 35 years and above formed 30% of all respondents.

Most respondents (95%) did not employ maids. Only 5% reported to have at least one maid. Average number of household members who lived in the same house was 5.4 with some 52% having 3-5 family members. About 45% of the respondents reported having one or two members who were below 12 year of age while the mean was 1.1. About 47% of the respondents had two working members in the household while 21% and 17% reported to have 1 and 3, respectively. The mean number of working household members was 2.4.

About 66% of respondents lived in their own houses, 28% lived in rented houses, 3% in employer provided houses, and another 3% lived in friend-owned houses.

About 50% of respondents resided in either single or double-storey linked houses, 15% in single-storey semi detached houses, 11% in

double storey semi-detached houses, 7% in apartments, 8% in single storey bangalow houses, 5% in double-storey bangalows, and 4% in village houses, and 0.5% in condominiums.

About 54% of respondents had diploma level (college level) up to graduate level education. Most respondents had monthly income of RM2500 (22%), RM1500 (21%), RM3500 (17%), RM4,500 (11%) and RM500 (11%). Mean household income was RM3018 monthly.

Most respondents (91%) were not members of any environmental groups. Nevertheless, most respondents (82%) claimed that they were concerned about issues affecting the quality of MSW management. Only about 18% were not at all concerned. Maximum number of wastes generated per week was 15 bags by only one respondent. About 68% reported 3 - 7 large sized bags weekly. The mean number of bags generated was 4.6 weekly or 18.4 bags monthly.

The data revealed that about 96% of the respondents were concerned about the importance of waste reduction – 4% were unconcerned at all. Almost all respondents (99.8%) have heard about recycling in the media while about 67% have heard about a recycling program in their vicinity. Only 32% of all respondents often or to some extent separate or recycle their waste while a large 68% have never or very seldomly do so. Interestingly, almost all respondents (99%) claimed that recycling will benefit the environment.

MODEL RESULTS

In the CM analysis, two models were employed. The first model considers the basic SWM attributes only while the second model considers the basic attributes as well selected socio-economic and environmental attitudinal variables.

Overall, 56% of respondents favoured the improved plan over the baseline option. While the percentage of respondents favouring the improved plan decreased as monthly charge was raised, the percentage of respondents favouring the highest monthly bid was still substantially high. Specifically, 67% of respondents supported the improved plan when monthly charge was RM20, and 51% and 41% when monthly charge was raised to RM25 and RM30, respectively.

Baseline Model (Model 1)

This model follows the specification presented in Equation 4 :

V_i = f (COLLFREQ, SEPWASTE, WASDISPO, TRANSPTN, CHARGE)

V_i = ASC + b_1* COLLFREQ + b_2* SEPWASTE + b_3* WASDISPO + b_4* TRANSPTN + b_5* CHARGE

(i = 1, 2, ASC = 0 for V_i = 1)

The following are the definitions for the variables used:

Dependent variable

V_i = utility of individuals (*1 = choice of option, 0 = non choice*)

Influence of systematic factor

ASC = alternative Specific Constant for option 2 (*improved plan*)

Independent variables

COLLFREQ = frequency of weekly waste collection (*1 = improved plan- 3 times regular and 4 times irregular, 0 = baseline plan*)
SEPWASTE = separation of waste by household (*1 = improved plan, 0 = baseline plan*)
WASDISPO = waste disposal method (*1 = improved plan, 0 = baseline plan*)
TRANSPTN = transportation mode (*1 = improved plan, 0 = baseline plan*)
CHARGE = monthly charge

It is expected that all the improved non-monetary attributes will influence consumer utility positively. However, the monetary attribute (monthly charge) is expected to have a negative relation with utility.

CM With Socio-Economic Factors (Model 2)

This model considers several socio-economic and attitudinal factors.

V_i = f (COLLFREQ, SEPWASTE, WASDISPO, TRANSPTN, CHARGE, CONCERN, WASTEBAG, OPNSPACE, HOWORK, HOLIVING, RACE, MAID, SEPARATE, DKJG)

V_i = SC + b_1 * COLLFREQ + b_2*SEPWASTE + b_3 * WASDISPO + b_4*TRANSPTN + b_5 *CHARGE

$+ g_1$ ASC*CONCERN + g_2 ASC*WASTEBAG + g_3 ASC*OPNSPACE + g_4 ASC*HOWORK + g_5 ASC*HOLIVING + g_6 ASC*RACE + g_7 ASC*MAID + g_8 ASC*SEPARATE + g_8 ASC*DKJG

(i = 1, 2; ASC = 0 for $V_i = 1$)

The definitions for the various notations are given below:

Dependent variable

V_i = respondent's utility (*1 = choice of option, 0 = non choice*)

Influence of systematic factor

ASC = alternative specific constant for option 2

Independent variables

EDUCATE = highest education level (*1 = diploma level and above, 0 = others*)
CONCERN = concerns on general SWM issues (*1 = concerned, 0 = unconcerned*)
WASTEBAG= number of large bags of wastes generated weekly
OPNSPACE = area of yard or space (*square meter*)
HOLIVING = number of household members living together
HOWORK = number of working household members
MAID = number of household maid
SEPARATE = whether respondents practiced waste separation (*1 = often or at times, 0 = never*)
DKJG = area intercept dummy variable (1 = kajang municipality respondents, 0 = otherwise)

All coefficients for the non-monetary variables in the extended model are expected to be correlated positively with utility.

Results of the Basic Model

We employed the multi-nomial logistic regression on the CM specification. The results of the basic model are shown in Table 3.

Table 3
Results of the Basic Model

	Coeff.	Std.Err.	t-ratio	P-value
ASC	0.562	0.109	5.152	2.56E-07
COLLFREQ	0.147	0.064	2.283	0.022392
SEPWASTE	0.382	0.064	5.952	2.64E-09
WASDISPO	0.385	0.064	6.015	1.80E-09
TRANSPTN	0.263	0.064	4.096	4.19E-05
CHARGE	-0.105	0.007	-13.966	2.89E-15

Log likelihood function = -2797, RsqAdj = 0.06, No. of obs. = 4295

The sign of the coefficient for all non-monetary attributes was positive. This suggests that improvements in all the non-monetary attributes lead to positive utility among households.

The finding that the coefficient for SEPWASTE was positive is rather striking and thought provoking as it denotes that households derive positive utility by the provision of recycling facilities and the mandatory kerbside recycling of waste, *ceteris paribus*. The positive coefficient for SEPWASTE may be deduced as the net increase in utility (benefits) accrued to the average household should adequate recycling facilities are provided to facilitate kerbside waste recycling, *ceteris paribus*.

CM With Socio-Economic Characteristics

Table 4 depicts the results of the CM with socio-economic and attitudinal variables.

Results show that all socio-economic and attitudinal variables except SEPARATE were significant at least at the 5% level. All monetary and non-monetary attributes, like in the basic model, were also significant and yielded the expected signs.

It is worthy to note that the variables OPNSPCE and HOWORK which signify income and wealth of respondents were highly sigificant at the 1% level. The positive and significant coefficient for RACE suggest that the malays on average tend to support improvements in solid waste management regime relative to the non-malays.

The coeffient for WASTEBAG was negative and significant. This implies that those who are large producers of wastes would prefer the current or lower cost management regime. The coefficient for Kajang area

dummy (area intercept dummy – ASC*DKJG) was negative and significant. This indicates that the average respondents from Kajang area exhibit a lower level of marginal willingness to pay for improved solid waste management relative to that of Seremban.

From the results of the two models, it can be deduced conclusively that households support improvement in solid waste management plan, in terms of collection frequency, waste separation at source, disposal methods and mode of transportation.

Table 4
Results of CM with Socio-Economic and Attitudinal Variables

	Coeff.	Std.Err.	t-ratio	P-value
ASC	0.3741	0.2365	1.5818	0.1136
COLLFREQ	0.1960	0.0684	2.8629	0.0041
SEPWASTE	0.4257	0.0682	6.2350	4.52E-10
WASDISPO	0.4139	0.0678	6.0976	1.08E-09
TRANSPTN	0.3094	0.0683	4.5291	5.92E-06
CHARGE	-0.1246	0.0080	-15.4929	2.89E-15
ASC*CONCERN	0.5166	0.1692	3.0527	0.0022
ASC*WASTEBAG	-5.10E-02	1.39E-02	-3.6806	0.0002
ASC*OPNSPACE	0.0021	0.0004	5.2408	1.60E-07
ASC*HOWORK	0.1111	0.0296	3.7451	1.80E-04
ASC*HOLIVING	-0.0137	0.0210	-0.6541	5.13E-01
ASC*RACE	0.3234	0.0709	4.5615	5.08E-06
ASC*MAID	0.3033	0.1561	1.9423	5.21E-02
ASC*SEPARATE	0.0026	0.1082	0.0241	0.9807
ASC*DKJG	-1.5210	0.0789	-19.2681	2.89E-15

Log Likelihood function = -2544
RsqAdj= 0.14
No. of obs = 4295

Estimation of Implicit Prices

In this sub-section, the estimation of implicit prices for each attribute is undertaken. Implicit prices reflect the marginal rate of substitution (MRS) between each non-market attribute and the monetary attribute.

It is estimated by the coefficient for the non-market attribute divided by coefficient for the monetary attribute, i.e.:

$$MRS = \beta^{(NON\text{-}MARKET)} / \beta^{(MONETARY)}$$

Thus, implicit price reflects individual's WTP for the presence of an additional unit of non-market attribute, *ceteris paribus*. The estimation of implicit prices for each non-market attribute is shown below (Table 5):

Table 5
Estimation of Implicit Prices

Non market attribute	Basic model (RM) (Model 1)	Model with socio-economic factors (RM) (Model 2)
COLLFREQ	1.40	1.57
SEPWASTE	3.63	3.51
WASDISPO	3.67	3.32
TRANSPTN	2.50	2.48

The estimated implicit prices under the two models are found to be comparable.

Estimation of equilibrium values for the non-monetary attributes

It is also possible to identify the tradeoffs between the non-monetary attributes that will leave individuals on the same utility level. This involves the identification of a reference implicit price, then divide it by the implicit price of interest, i.e.:

$$\text{Equilibrium values} = \text{WTP}^{(\text{REFERRED ATTRIBUTE})} / \text{WTP}^{(\text{SEARCHED ATTRIBUTE})}$$

Based on the implicit price for WASDISPO, the estimation of the equilibrium values is shown below:

Table 6
Estimation of Equilibrium Values For the Non-Monetary Attributes

Non-monetary attribute	Basic Model	Model 2	Ranking of importance (Model 2)
COLLFREQ	0.38	0.47	4
SEPWASTE	0.99	1.06	1
WASDISPO	1.00	1.00	2
TRANSPTN	0.68	0.68	3

Since all the non-monetary attributes are indivisible, this analysis will only suggest the relative importance of each attribute to households. This implies that in terms of importance of attributes, SEPWASTE ranks top, followed by WASDISPO, TRANSPTN, and COLLFREQ.

Estimating the Value of a Program

The CM technique can be used to estimate the value of a programme, i.e. the compensating surplus (CS) for a given SWM package. This is done by employing Equation 7. Several management packages are considered and compared with that of the (*business as usual*) scenario (Option 1). Using the results of Model 2, the following eight improvement scenarios were considered for Kajang and Seremban municipality, separately. The marginal benefits for each scenario were calculated by substracting the prevailing waste charges from the calculated CS. Marginal benefits represent the estimated welfare gain that households derive from the improved management plan. In practical terms, it reflects the incremental waste charges that households are willing to pay in addition to the amount that they are currently paying for waste services.

Base line scenario
Collection frequency 3 times and irregular
Waste separation at source not mandatory
Waste disposal method – less environmentally friendly - "control tipping"
Transportation – mixed of open trucks and compactors

Scenario 1
Collection frequency 3 times weekly every alternate day
Waste separation at source not mandatory
Waste disposal method – sanitary landfill
Transportation mode – mixed of open trucks and compactors

Scenario 2
Collection frequency 3 times weekly and irregular
Waste separation at source mandatory
Waste disposal method - sanitary landfill
Transportation mode – mixed of open trucks and compactors

Scenario 3
Collection frequency 3 times weekly and irregular
Waste separation at source not mandatory
Waste disposal method - sanitary landfill
Transportation mode – mixed of open trucks and compactors

Scenario 4
Collection frequency 3 times weekly and irregular
Waste separation at source mandatory

Waste disposal method – control tipping
Transportation mode – mixed of open trucks and compactors

Scenario 5
Collection frequency 4 times weekly and irregular
Waste separation at source mandatory
Waste disposal method - sanitary landfill
Transportation mode – mixed of open trucks and compactors

Scenario 6
Collection frequency 3 times weekly and irregular
Waste separation at source mandatory
Waste disposal method – control tipping
Transportation mode – mixed of covered trucks and compactors

Scenario 7
Collection frequency 4 times weekly and irregular
Waste separation at source mandatory
Waste disposal method – sanitary landfill
Transportation mode – mixed of covered trucks and compactors

Scenario 8
Collection frequency 4 times weekly and irregular
Waste separation at source not mandatory
Waste disposal method – sanitary landfill
Transportation mode – mixed of covered trucks and compactors

The estimated marginal benefits (or marginal WTP) for each improved plan are presented in Table 7.

Table 7
Marginal WTP for Various MSW Management Plan

Management Plan	Kajang (RM)	Seremban (RM)
1	5	8
2	6	10
3	2.6	6.3
4	2.8	6.4
5	8	11
6	5	9
7	10	14
8	7	11

The results indicate that respondent marginal WTP increases as more SWM attributes are improved. If all attributes are improved (Plan 7)

the average households in Kajang and Seremban on average are willing to pay an additional monthly charge of RM10 and RM14 above the prevailing levels, respectively. As evidenced by the regression results earlier (negative coefficient for Kajang intercept dummy), the estimated marginal WTPs for Kajang area were lower relative to that of Seremban.

Given knowledge about household preference and WTP towards any SWM improvement, policy-makers will be able to match between household demand and the firm's affordability of supply. For instance, should service providers wish to improve the disposal method from control tipping to sanitary landfill while all others remain the same (Scenario 3), then the cost of service ought to be some level below or equal to the estimated household WTP (marginal WTP + current charges).

SUMMARY AND POLICY IMPLICATIONS

This aim of this study was to estimate the economic values of household preferences for improved solid waste management service attributes in Malaysia. The Choice Model (CM) was employed on 859 randomly selected urban households in Kajang and Seremban areas.

This study has obtained estimates of marginal values of improved SWM service attributes and households WTP for improved MSW management services. In general, households highly value improvements in SW management plan. Specifically, it has been determined that households are willing to pay a premium for improvement in collection frequency, waste disposal methods, and transportation mode attributes. To obtain all these improvements, the model suggests that households on average are willing to pay an additional monthly charge of RM10 and RM14 for Kajang and Seremban areas, respectively. More specifically, the model (Model 2) ascertains that the average households are willing to pay a charge of RM1.57 per month for a change in collection frequency - from 3 times irregular to either 3 times every alternate day or 4 times per week, *ceteris paribus;* RM3.32 if the waste disposal method was improved from control tipping to sanitary landfill, *ceteris paribus;* and RM2.48 if the transportation mode was improved from a mix of compactors and open trucks to either compactors or a mix of compactors and covered trucks, *ceteris paribus*.

The CM has also shown that households derive positive utility from the provisions of recycling facilities and compulsory kerbside recycling with an implicit price (willingness to pay) of about RM3.51 monthly.

In a related study (Othman, 2002), using a CV technique, it was observed that respondents were not willing to pay additional waste charges for non-voluntarily compliance of kerbside recycling, despite the provision of free recycling facilities by service providers. Further studies are clearly needed to gain a better understanding of such household behaviour.

This study has demonstrated empirically the demand perspectives of MSW management improvements. Results from the study can be used by service providers to identify any mismatch between what the public actually wants and are willing to pay for and the affordability of supply on the part of service providers. This way, an improved MSW management outcome will be identifiable. Although there may be some controversies with regard to the recycling attribute, the CM results may lend support for the imposition of some additional levy for the provision and maintenance of kerbside recycling facilities.

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