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Original Research Article

Household Preferences for Food Waste Management System

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Abstract: Improper waste management has received remarkable attention from the stakeholders due to its negative impacts. Due to the increase in population, the waste generated in Malaysia also is increasing. Currently, landfilling is the main method of disposal. Considering a few issues related to this approach such as the landfills have reached its capacity, environmental pollution, as well as the bad condition of the landfill; alternative measure to manage the waste, is crucial. Food waste can be utilized for other uses such as converting into fertilizer, electricity generation as well as the alternative for fuel. However, to implement such a program, innovative measures for appropriate management of the food waste collection are required. To encourage the participation of households in food waste management, determining the preferred attributes by the household is crucial. Therefore, this study attempts to determine the household preferences for food waste management system in Malaysia as well as their willingness to pay for the food waste management system. The discrete choice experiment was used to accomplish the objectives of the study. The findings from this study suggested that the frequency and time of food waste collection are among the preferred attributes for food waste management system. The result also suggested that the willingness to pay for food waste management significantly varies by income and age of the respondents. Thus, it is suggested that if the government decides to come out with food waste management program, frequency and pick up time of the food waste are among important attributes that need to be considered.

Keywords: food waste; discrete choice experiment; willingness to pay; waste management; household

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1. Introduction

According to the World Bank report (2018), 2.01 billion tons of solid waste was generated in 2016. It is estimated that this value will be increased to 3.40 billion tons in 2050 as the population is expected to rise to 9 billion (World Bank, 2018). The rapid growth in population, economic development, rapid urbanization, industrialization as well as changes in community lifestyle are among the factors that lead to the raising amount of solid waste generated (Zhang *et al*., 2015; Srivastava *et al*., 2014; Guerrero *et al.*, 2013; Manaf *et al*., 2009). Improper waste management has received remarkable attention from the stakeholders due to its negative impacts (Jereme *et al.*, 2016).

The management of waste is a critical issue for some developing countries especially in Asia (Subhan *et al.*, 2014). Malaysia is a developing country with significant economic development after its independence. However, due to the increase in population, the food waste generated in the country also is growing. Food waste heavily contributes towards municipal solid wastes in Malaysian. Malaysians generally generate 38,000 tons of waste per day and from this amount, 15,000 tons are food waste (SWCorp, 2018). The food waste produced by Malaysia is able to feed around 2.2 million people (Poverty Pollution Persecution, 2019).

According to the National Solid Waste Management Department (2013), food waste contributed the highest composition of waste with 44.5%, followed by plastics (13.2%), diapers (12.1%), papers (8.5%) and garden waste (5.8%). According to Nadzri (2013), food wastage makes up 50% of the overall municipal solid waste in Malaysia and 70% of them are being dumped at the landfills. As of 2018, Malaysia has 170 waste disposal sites and it was reported that only 14 had ‘sanitary landfill’ status (Poverty Pollution Persecution, 2019). The household was reported as the main contributor to food waste with 8,745 tons of food waste generated per day (Jereme *et al*., 2016).

Currently, landfilling is the main approach to dispose of waste in Malaysia (Abd Ghafar, 2017). The dependency on landfills as a waste disposal approach is expected to raise the production of greenhouse gas (GHG), which could lead to environmental pollution (Abd Ghafar, 2017). Furthermore, it was reported that the landfills in the country were also in bad condition and operated without appropriate protecting actions (Ismail & Manaf, 2013). The capacity of the landfills that have reached their size is another issue that has raised concern

(Moh & Manaf, 2014). Considering the problems mentioned above, an alternative measure is required to combat the rising trend of waste generation.

According to Nadzri (2013), proper management of food waste is considered limited and is still under-developed in Malaysia. Despite many kinds of efforts and initiatives taken by the government, the participation rate is still low (Moh & Manaf, 2014). There are limited studies done to determine the preferred food waste management attributes, as well as the household evaluation on food waste, attributes management system in Malaysia. The improvement in the food waste management system requires additional cost. However, there are limited information about the extent to the households value the environmental goods and services that can impact the environment in Malaysia. Policy makers generally require information about the value of benefits for the improvements and the extent to which new policies or programs are supported in communities (Benyam *et al.*, 2020). Thus, these, later on, can be compared to the costs of different food waste management system. The willingness to pay also reflects household awareness about the detrimental effects of improper waste management on the communities (Subhan *et al*., 2014). This valuation will provide useful information for future implementation of voluntary or mandatory food waste management system.

While knowing the right portion of food required is important to minimize the food waste, food waste recycling program also might be another measure to manage the waste. Food waste is possible to be converted into useful resources such as compost or fertilizer. Food waste also can be utilized for electricity generation as well as for alternative fuel (National Solid Waste Management Department, 2012). However, to implement such a program, innovative measures for appropriate management of the food waste collection are required. A clear food waste management system in Malaysia is still under develop. According to literature, the participation rate of the household in the proper food waste management system is still low (Moh & Manaf, 2014). The cooperation by the household as the main contributor to food waste generation is important to ensure the success of the food waste management system. Understanding community preferences are also an important element in the food waste management system to increase the participation rate of the household. This can be done by determining the attributes of the food waste collection program preferred by the households. This process is crucial before developing any kind of food waste management system or program. Therefore, this study attempted to provide a hypothetical scenario for food waste management system in Malaysia. The objective of this

study is to determine the household preferences for food waste management system in Malaysia as well as their willingness to pay for the food waste management system. The discrete choice experiment was used to accomplish the objectives of the study. A discrete choice experiment is a stated preference method in which the respondents are asked to select one of several options based on their preferences. This approach is often used to compare the costs and benefits of policy changes before the implementation of the program or policy (DEFRA 2007). This approach is suitable to value a good or service which does not have a pre-determined market price such as food waste collection (Ndau & Tilley, 2018).

2. Literature Review

Discrete choice experiments have been used in various settings to determine the respondents' preference for specific attributes of product or service. This approach also has been widely used for environmental valuation (Rakotonarivo *et al*., 2016). A discrete choice experiment is a stated preference method in which the respondents are asked to select one of several options based on their preferences. This technique offers a good valuation approach, especially for environmental goods. This approach also becomes widely used for non-market valuation (Adamowicz, 2004). It also has been widely used to evaluate the household preferences and willingness to pay for waste management and recycling (Akil *et al*., 2015; Boyer 2006; Rai *et al*., 2019; Yuan *et al*., 2015; Yuan & Yabe, 2015). This section, therefore, attempts to determine the relevant food waste management attributes that have been considered from previous studies. Most of the waste management studies considered food waste as part of solid waste (Ku *et al*., 2009; Ndau & Tilley, 2018; Akil *et al*., 2015). According to Benyam *et al*. (2020), solid waste management options are also relevant in explaining householders' interest to reduce food waste. There are limited numbers of studies that focus solely on food waste management attributes since most of them considering food waste as part of solid waste. Thus, the relevant attributes of waste management from previous studies have been reviewed to get some insight, in terms of possible attributes that the household is willing to pay for the improvement in the waste management system or service.

Several attributes have been used by previous studies to evaluate the willingness to pay off the households towards waste management service. Among them were frequency of collection and fee subscription (Boyer, 2006; Ku *et al*., 2009; Hazra *et al*., 2013; Ndau & Tilley, 2018; Rai *et al*., 2019; Akil *et al*., 2015). Boyer (2006) found that the households in Stillwater, Oklahoma were willing to pay more for a higher frequency of waste collection. A similar finding was found by Hazra *et al*. (2013) in which the household was willing to pay

for frequent collection of waste in India. Similarly, Akil *et al*. (2015) suggested that households were willing to pay a higher price for improvements in the collection frequency of waste in Malaysia.

Providing recycling containers is among the important factors that can encourage or motivate the households to sort out their waste (Rai *et al*., 2019; Keramitsoglou *et al*., 2018; Ting *et al*., 2016; Moh & Manaf, 2014; Suttibak *et al*., 2008). In terms of willingness to pay for the recycle bin, Hazra *et al*. (2013) found that the respondents were willing to pay more for the covered bin. In addition to the bin, Keramitsoglou *et al*. (2018) suggested that environmental messages must be printed on the bins to encourage the participation of the respondents in waste management. Providing recycling bins at appropriate places within the household areas also is a good approach to encourage waste separation at source (Moh & Manaf, 2014).

Considering the importance of the shortest distance between the container and the household, Yuan & Yabe (2015) conducted a study that focuses on placing bins for kitchen waste in front of individual apartment buildings. The choice experiment was used, and the selected attributes were collection frequency, collection time, incentives, and education. They found that households preferred the evening collection relative to morning selection. On the other hand, Yuan *et al*. (2015) has utilized the latent class model to determine the households' preferences for the attributes of household kitchen waste source separation service. They found that the young, highly educated and have more kitchen waste separation experiences households preferred the evening collection of waste.

Further studies have shown that socio-demographic factors can influence household willingness to pay for waste management. For instance, Boyer (2006) found the higher income households were more willing to pay for recycling services in Stillwater, Oklahoma. Similarly, Hazra *et al.* (2013) and Akil *et al*. (2015) found that high-income households were willing to pay more for waste management in India and Malaysia, respectively. In addition to income, age, gender, educational status, distance from the dumpsite, and satisfaction with the existing service for solid waste were among other factors that can influence willingness to pay for waste management (Mulat *et al.*, 2019). They also found that there was an inverse relationship between age and willingness to pay for waste management in which the younger people were willing to pay more for waste management than older people. In contrast, Akil *et al*. (2015) found that the elderly was more interested in waste management as compared

to younger people. Those households with higher education were willing to pay more for waste management (Song *et al,* 2016).

3. Methodology

3.1 Survey Design

A self-administered survey was conducted to the household in Klang Valley and 400 respondents have completed the survey. The survey was comprised of two sections. The first section consisted of the discrete choice experiment questions, in which respondents were requested to choose their preferred waste management system given different levels of service attributes and subscription fees. In the second section, the respondents were asked about their demographic and household information.

Table 1 presents the attributes and the attribute levels which were used to construct the survey options. Four attributes considered in this study were frequency of collection per week, the usage of a specific bin for storing food waste, the time of collection for food waste, and the price. Since there were three attributes varied at three levels and one attribute varied at two levels, there were 18 possible combinations ($3^3 \times 2^1$).

Table 1. Attributes and the attribute levels.

Attribute	Level	Description
Frequency of collection per week	Everyday	Pickup truck collects food waste twice a week from the household area
	Three times per week	Pickup truck collects food waste twice a week from the household area
	Two times per week	Pickup truck collects food waste twice a week from the household area
Specific bin for food waste	Yes	Each household has a specific bin allocated for food waste
	No	Each household does not have a specific bin allocated for food waste
Pickup time of the food waste	Morning	Pickup truck collects food waste in the morning
	Afternoon	Pickup truck collects food waste in the afternoon
	Evening	Pickup truck collects food waste in the evening

Price	RM 30	Subscription fee per month
	RM 20	Subscription fee per month
	RM 15	Subscription fee per month

The choice sets were created such that the respondents could choose between two waste management service options (A and B) and one option opting out of food waste management service, i.e., the "not willing to pay" option (Option C). The respondents were asked to compare the three alternatives (Option A, B, and C) simultaneously and choose one of them in which the one that they preferred the most. Table 2 provides an example of one of the randomly assigned choice sets.

Example 1: Below you will find three scenarios being considered for food waste management service. Please choose ONE option from choices A, B, or C.

Table 2. Example of choice set.

Option	**A**	**B**	**C**
Frequency of collection	Three times per week	Two times per week	Neither A nor B is preferred
Specific bin for food waste	No	Yes	
Pickup time of the food waste	Afternoon	Evening	
Price (RM/month)	RM 15	R M30	
I would choose…		X	

3.2 Model Development

Given a set of choices, each respondent faced 18 choice sets. The model assumed respondents are facing i=1, 2, N faced discrete choices between several alternatives. A random utility function may be defined by a deterministic V_{ji} and stochastic ε_{ji} component:

$$U_{ji}=V_{ji} + \varepsilon_{ji} \quad (1)$$

where U_{ji} is the j^{th} respondent's utility of selecting option i which are either option A, B or C V_{ji} is the systematic portion of the utility function which is determined by attributes of the

alternative *i* and the respondents-specific characteristics, and ε_{ji} is a stochastic element. The probability of a respondent chooses alternative *i* is given by

$$\text{Prob}\{V_{ji}+\varepsilon_{ji}\geq V_{jk}+\varepsilon_{jk};\text{for all } k\neq i\} \quad (2)$$

where *i* is the choice set for respondents *j*, i.e., I_j= {option A, option B, option C, etc.} If the ε_{ji} are independently and identically distributed across the I alternatives and N individuals with a type I extreme value distribution (e.g., $F(\varepsilon_{ji})=\exp(-\exp(-\varepsilon_{ji}))$), the probability of respondents *j* choosing alternative *i* is:

$$\text{Prob\{i is chosen\}}= \frac{e^{V_{ji}}}{\sum_{k=1}^{I} e^{V_{jk}}} \quad (3)$$

And the log-likelihood function is;

$$\log L= \sum_{j=j}^{N}\sum_{i=1}^{J} d_{ji} \log(\text{Prob }\{\text{i is chosen}\}) \quad (4)$$

where d_{ji} is a dummy variable that takes the value of 1 for a particular alternative that was chosen. The following utility function will be used to estimate the utility of the respondents

$$V_{ji}=\beta_0+\beta_1\text{Frequency}+\beta_2\text{Specific bin}+\beta_3\text{Pick up time}+\beta_4\text{price}+\varepsilon_{ji} \quad (5)$$

where Frequency refers to the frequency of pickup trucks pick up the food waste per week, Specific bin refers to each household has a specific bin allocated for food waste,*pick up time* refers to the time pick up truck collects food waste and *price* refers to the subscription fee per month. The β coefficients represent the parameters to be estimated, and β_0 is the alternative-specific constant, which captures the effect of a respondent's selection of option C on utility compared to options A and B in the sample. The conditional logit was performed to estimate the model. The coefficients obtained from equation (5) further will be used to calculate the willingness to pay using equation (6) below.

$$\text{WTP}= -\frac{B_k}{B4} \quad (6)$$

where *Bk* refers to coefficient of kth attribute and *B4 refers to* coefficient of price. Equation (5) refers to the basic model without interaction terms. The effects of other factors like demographics and other characteristics of the respondent can affect the willingness to pay for

waste management system. These characteristics can be included as interaction terms (Hanley *et al.*, 2001). Dummy variables have been generated for four age groups (Age2029 = 1 if a respondent is between 20 to 29, otherwise Age2029 = 0; Age3039 = 1 if a respondent is between 30 to 39, otherwise Age3039 = 0; Age4049 = 1 if a respondent is between 40 to 49, otherwise Age4049 = 0; Age over50 = 1 if a respondent is over 50, otherwise Age over50 = 0); three education groups (Edu_Low = 1 if a respondent has primary education, otherwise Edu_Low = 0; Edu_Med = 1 if a respondent has secondary education, otherwise Edu_Med = 0; Edu_High = 1 if a respondent has tertiary education, otherwise Edu_High = 0); gender (Gender_male = 1 if a respondent is male, otherwise Gender = 0). According to the Department of Statistics Malaysia (2019), the range of income for three income groups is as follows; B40 is less than RM 4849, M 40 is between RM 4850 to RM 10,959 and T20 is greater than RM 10,960. After considering the distribution of the data and these three classifications of income, the income has been categorized into three groups namely low, medium, and high income. Dummy variables have been generated for three income groups (Inc_Low = 1 if monthly respondent's income is less than RM 4000, otherwise Inc_Low = 0; Inc_Med = 1 if monthly respondent's income is in between RM 4001 and RM 9000, otherwise Inc_Med = 0; Inc_High = 1 if monthly respondent's income is more than RM 9000, otherwise Inc_ High = 0). Then, the interaction terms of these dummy variables with independent variables have been added to the original specification equation. The interaction model can be specified as follows:

$$V_{ij} = \beta_{ij}\mathbf{X} + \alpha(\mathbf{X_{ij}} \times \mathbf{Age}) + \alpha(\mathbf{X_{ij}} \times \mathbf{Education\ Level}) + \alpha(\mathbf{X_{ij}} \times \mathbf{Income}) + \alpha(\mathbf{X_{ij}} \times \mathbf{Gender}) \quad (7)$$

where **X** is a vector of variables specified in equation (5). β and α refer to the coefficient to be estimated. **Age** is a vector of age of the respondents which is separated into 4 categories that were coded as 1 if individual is in that age category group and 0 otherwise. The age category for 31–40 was used as a base. **Education level** is a vector of education level of the respondents which is separated into three variables that were coded as 1 if individual is in that income category group and 0 otherwise. The secondary education level category was used as a base. **Income** is a vector of households' income which is separated into three variables that were coded as 1 if individual is in that income category group and 0 otherwise. The low-income category was used as a base. **Gender** is dummy variable of gender and female was used as a base. A conditional logit model was used to estimate equations (5) and (7). The bootstrapping procedure followed by Krinsky and Robb (1986) was used in to calculate the standard error.

4. Results and Discussions

A total of 400 respondents completed the discrete-choice questions. Table 3 presents the socio-demographic profiles of these respondents. The majority of respondents were between 20–30 years old (47%), followed by 31–40 years old (29.5%), 41–50 years old (20%), and greater than 50 years old (3.5%). Of 400 respondents, 55% were female and 45% were male. As presented in Table 3 majority of the respondents were Malay (40%), followed by Chinese (36%), Indians (11%), Bumiputera from Sabah and Sarawak (28%), and other (6%). In terms of marital status, the majority of respondents were married (60%), followed by single (39%) and divorced (1%). 99% of the respondents had at least secondary education levels. In terms of employment status, 39% of them were from the government and private sector, followed by respondents with home duties (14%), unemployed or currently looking for a job (6%), and retirees (1%). The majority of respondents had a monthly income less than RM 4000 per month (70%), followed by RM 4001–9000 (25%) and greater than RM 9000 (5%).

Table 3. Socio-demographic profiles of the respondents.

Socio-Demographic profiles		**Frequency (*n*)**	**Percentage (%)**
Group of age (years old)	20–30	188	47
	31–40	118	29.5
	41–50	80	20
	>50	14	3.5
Gender	Male	179	45
	Female	221	55
Ethnic	Malay	160	40.0
	Chinese	144	36.0
	Indian	44	11.0
	Bumiputera Sabah dan Sarawak	28	7.0
	Others	24	6.0
Marital status	Single	157	39.25
	Married	239	59.75
	Divorced	4	1.0
Eucation	Primary Education	1	0.25
	Secondary Education	202	50.5
	Tertiary Education	197	49.25

Socio-Demographic profiles		Frequency (*n*)	Percentage (%)
Employment	Government sector	155	38.75
	Private sector	157	39.25
	Full time student	3	0.75
	Unemployed	23	5.75
	Home Duties	56	14.0
	Retiree	6	1.5
Income (RM/month)	<4000	281	70.25
	4001–9000	98	24.5
	>9001	21	5.25
Household number	1–3	186	46.5
	4–6	168	42.0
	7–9	39	9.75
	> 9	7	1.75
Total		**400**	**100**

The results from conditional logit model were reported in Table 4. For the basic model, frequency of collection, use of specific bin and pick up time of food waste were statistically significant at 5% level, while price was statistically significant at 1% level. All the coefficient showed the expected sign except for use of a specific bin which had a negative coefficient. A positive and significant coefficient indicated that the respondents were more likely to choose an alternative with that scenario. The negative sign for price coefficient indicated that the level of household utility decreases with the increase of the subscription fees for the waste management system. The alternative specific constant for the status quo was statistically significant and negative, indicating a specific preference against the status quo. This suggested that, on average, respondents for this study were significantly likely to choose any option (A or B) that proposed changes in the food waste management system. The highest coefficient was 1.3771 indicated that frequency of collection (everyday) was the most preferred food waste management attribute by the household followed by frequency of collection (thrice per week) (0.3453), pick up time (morning) (0.3304) and pick up time (evening) (0.11947). The positive sign for frequency of collection (thrice per week), frequency of collection (everyday), pick up time (morning), and pick up time (evening) implied that households had greater preferences to select the options that have those attributes. The conditional logit results indicated that the household's preference for the food waste to be collected frequently. It is proven by the positive sign of coefficient for frequency

of collection (everyday) and frequency of collection (thrice per week) suggesting that household preferred for the food waste to be collected every day and three times a week rather than 2 times in a week. This finding was consistent with previous studies in which they found that most households would prefer frequent collection of waste (Boyer, 2006; Hazra *et al*., 2013; Rai *et al.*, 2019). The result also suggested that the respondents preferred the food waste collection to be done in the morning and evening over the afternoon. In contrast, the negative sign for use a specific bin suggested that respondents did not prefer a specific bin solely for the use of storing food waste. The coefficients for the attributes and the price attributes were then used to calculate the willingness to pay.

Table 4. Conditional logit estimates for food waste management system.

Variable	Conditional logit estimates
Alternative Specific Constant	-4.4386*
	(0.9569)
Frequency of collection (Thrice per week)	0.3453**
	(0.04285)
Frequency of collection (Everyday)	1.3771**
	(0.0448)
Use of Specific Bin	-0.1802**
	(0.0365)
Pick up time (Morning)	0.3304**
	(0.0443)
Pick up time (Evening)	0.1947**
	(0.0459)
Price	-0.0926***
	(0.0029)
Log likelihood	-9314

Number of Observation = 21,600

Notes: Standard errors are in parentheses.

***Statistically significant at the 0.01 level

**Statistically significant at the 0.05 level

*Statistically significant at the 0.10 level

Table 5 below presents the willingness to pay for food waste management attributes. In discrete choice experiment, the willingness to pay is derived as the ratio of two random variables. The standard error obtained from Krinsky-Robb parametric bootstrap method was used to determine the confidence intervals of willingness to pay. The findings showed that

the respondents in this study were willing to pay RM 14.87 more for collection of food waste on a daily basis relative to collection of food waste twice per week. Besides that, the respondents were also willing to pay RM 3.73 more for collection of food waste thrice a week relative to collection of food waste twice per week. In contrast, the result indicated that the household was not willing to pay for a specific bin to store for food waste. This can be shown by negative sign of willingness to pay. This suggested that they were only willing to accept using a specific bin to store food waste, if they were being paid of RM 1.72.

A possible reason for this could be because respondents undergo social dilemmas where responding to the benefits of social conflicts with their own narrow self-interest. (Thøgersen, 2007). The author further explained that it is more convenient to dispose one's household waste in the same garbage bin rather than separate it at the source. The result also suggested that the respondents are willing to pay RM 3.56 and RM 2.10 more to have the food waste to be collected in the morning and evening respectively relative to the afternoon.

Table 5. Marginal willingness to pay for food waste management attributes.

	Marginal Willingness to Pay (RM/month)	**Standard Error[1]**
Frequency of collection (thrice)	3.73	0.4656
Frequency of collection (everyday)	14.87	0.6468
Usage of Specific bin for food waste storage	-1.95	0.3899
Pick up time (morning)	3.56	0.4773
Pick up time (evening)	2.10	0.4951

Note: [1]Corresponding standard errors are estimated following the Krinsky-Robb parametric bootstrap method with STATA 15 software.

In interactions model, the socio-demographic variables were interacted with the other attribute levels to estimate how marginal willingness to pay differs by social-demographic factors. Table 6 below presents the significant interaction variables in the interaction model. It was found that the household preferences varied by socio-demographic variables such as age and income. For example, compared to the household who were in between 31 to 40, the household who were in between 20 to 30 years old were more likely to choose options with frequent collection of food waste (everyday) and the pick-up time in the morning. In terms of income, similar finding was reported in which the results showed that the middle-income

household were more likely to choose options with frequent collection of food waste (everyday) and the pick-up time in the morning. In order to calculate the willingness to pay for the interaction model the following formula was used wtp=- ((βk+βx))/ βp where βk equals to coefficient of kth attribute, βx equals to coefficient of xth interacted category and βp is coefficient of price.

Table 6. Conditional logit estimates for interaction model.

Variable	Conditional logit estimates
Alternative Specific Constant	-3.4699*** (0.0920)
Frequency of collection (Thrice per week)	0.1963** (0.0889)
Frequency of collection (Everyday)	0.8522*** (0.0921)
Use of Specific Bin	0.0119 (0.0685)
Pick up time (Morning)	0.2169** (0.0928)
Pick up time (Evening)	0.0617 (0.0459)
Price	-0.0661*** (0.0027)
Frequency of collection (everyday)_Age2030	0.1838* (0.0963)
Pick up time (morning)_ Age2030	0.1723* (0.0972)
Frequency of collection (everyday)_Middle income	0.3821*** (0.1064)
Pick up time (morning)_Middle income	0.1915* (0.1079)
Log likelihood	-4777.04

Number of Observation = 21,600

Notes: Standard errors are in parentheses.

***Statistically significant at the 0.01 level

**Statistically significant at the 0.05 level

*Statistically significant at the 0.10 level

Table 7 below presents the marginal willingness to pay resulted from the interaction model. It was found that the marginal willingness to pay for waste management significantly varied by income and age of the respondents. For example, the results suggested that the households between 20–30 years old were willing to pay RM 15.67 more to have the food waste to be collected everyday relative to the household who were between 31 to 40 years old. This age group of respondents were willing to pay RM 5.89 more to have the food waste to be collected in the morning relative to the older respondents. The findings from this study suggested that young households were willing to pay more for the improvement in food waste management services relative to the older age group category. This finding is consistent with the previous studies in which they found that age has negatively influenced the willingness to pay for waste management (Mulat *et al.*, 2019; Padi *et al*., 2015). One possible reason could be because awareness of food waste and sustainability is becoming higher in younger generations than in older generations. The younger generation tends to be more concerned about environmental quality than the older generation. This is also aided by current means of technology like social media as tools to spread awareness and message.

In terms of income, the results showed that middle-income consumers were willing to pay RM 18.67 more if food waste is collected every day relative to the lower-income group household. The results also suggesting that the middle-income consumers were willing to pay RM 6.18 more if the food waste is collected in the morning relative to consumers who were in the lower-income group. These findings were supported by the previous studies in which the higher income households were willing to pay more for waste management relative to lower-income group households (Boyer, 2006; Hazra *et al*., 2013; Akil *et al*., 2015).

Table 7. Marginal willingness to pay for interaction model.

	Marginal Willingness to Pay (RM/month)
Frequency of collection (thrice)	2.95 (1.3508)[1]
Frequency of collection (everyday)	12.88 (1.4555)
Specific bin for food waste storage	0.17 (1.0366)
Pick up time (morning)	3.25 (1.4106)
Pick up time (evening)	0.89 (1.4106)

	Marginal Willingness to Pay (RM/month)
Frequency of collection (everyday)_Age2030	15.67 (0.4235)
Pick up time (morning)_ Age2030	5.89 (0.3586)
Frequency of collection (everyday)_Middle income	18.67 (0.3857)
Pick up time (morning)_Middle income	6.18 (0.3217)

Note: [1]Standard error in parentheses

5. Conclusion

The food waste management system in Malaysia is still under developed. The findings from this study suggest that the frequency and time of food waste collection are among the preferred attributes for food waste management system. The households preferred frequent collection of food waste. They are willing to pay about RM 14.87 more if the food waste is collected every day and they are willing to pay RM 3.56 more to have the food waste to be collected in the morning. The result also suggests that the willingness to pay for waste management significantly varied by income and age of the respondents. The findings from this study suggest that young households are willing to pay more for the improvement in food waste management services relative to the older age group category. Similarly, it is found that middle-income households are willing to pay more for waste management relative to the lower-income group household.

The government should consider to play a role in deciding and implementing food waste management system, pick up frequency and time to pick up the food waste . Since the marginal willingness to pay varied between age and income group, thus promoting the food waste management system can be focusing on these groups of households. The willingness to pay exhibited by most fellow respondents can be used to compare with the cost of implementing the food waste management system. Since the marginal willingness to pay for food waste management is not high, the alternative option might need to be considered. For example, instead of collecting the food waste from one household to another household, the government or municipal might provide a central drop-off or booth to collect food waste close to the area of residency. It would be a better way for household members to drop off their food waste at which time is convenient to them, meanwhile allowing the municipalities to collect them without time-constraint or high concern on no waste collections during public

holidays. Considering the households' preferences for food waste management is important to encourage participation by the households. The findings from this study could be used as the basis to provide some insight about the preferred attributes of the household and how much they are willing to pay if those attributes exist in the food waste management program.

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