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Households willingness to accept collection and recycling of waste cooking oil for biodiesel input in Petaling District, Selangor, Malaysia

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Abstract

The main reasons for the recent growing concern about waste cooking oil (WCO) are the resulting effects of its improper disposal on one hand and viability input in biodiesel production on the other. This study applied contingent valuation method (CVM) to estimate households' willingness to accept (WTA) collection and recycling of WCO in Petaling district, Selangor, Malaysia. The results revealed that the bid, income level, age level, higher educational level (university), Malay, Chinese, and female were the significant predictors of WTA. The mean WTA of the households was MYR 0.72 per kg of WCO and the annual running cost for the programme was MYR 9, 438, 829. These results will help the relevant authorities in their efforts to enhance WCO collection and recycling programme in Petaling District, Selangor.

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Keywords: Waste Cooking Oil; Contingent Valuation Method, Biodiesel; Recycling; Willingness to Accept;

1. Introduction

Waste cooking oil collection for recycling into biodiesel targets to curtail environmental, infrastructural and health effects associated with its improper disposal and reuse for food preparation. WCO recycling has been in practice for decades in developed countries and regions such as the EU, Japan, United States, and Taiwan [1]. In Malaysia, some recycling companies were contracted not long ago by some local authorities in order to collect WCO

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from various sources so as recycle into biodiesel. Waste cooking oil especially from the fry process is among the liquid residues generated daily in most households, restaurants, catering establishments, and industrial kitchens [3]. However, previous studies revealed the environmental and health effects associated with WCO makes some consumers to get rid of it through sinks, waste bins, drains, toilets, or directly to the immediate water bodies and soils. Kheang et al., [4], revealed that about 500,000 tons of WCO obtained annually in Malaysia alone are discharged to the environment without proper waste treatment. This practice at long run contributes to water pollution, soil pollution, marine ecosystem distraction, clog of drains, and consequently generates negative effects to the environment and results to an increase in water treatment cost [5]. There are quite a lot of end-uses for the WCO, which include production of soaps, energy by anaerobic digestion, thermal cracking, and recently the production of biodiesel. Recycling of WCO to biodiesel is simple, economical and sustainable way of abating its associated problems [6], and offers an advantage of not interfering with food resources. Therefore, this study was conducted to estimate the households' willingness to accept collection and recycling of WCO for biodiesel input in Petaling district. The valuation was intended to yield the value of willingness to accept (WTA) of the households for the protection of the environment through WCO collection and recycling into biodiesel.

2. Materials and methods

2.1. The Contingent Valuation of WCO Collection and Recycling among Households in Petaling, Selangor

This study applied contingent valuation method (CVM) on households in Petaling district, Selangor, Malaysia. Petaling is the most populated and urbanized district in Selangor State. The district experiences wonderful urbanization and has total households of 446, 862 [7]. The local authorities (Shah Alam City Council, Petaling Jaya City Council, and Subang Jaya Municipal Council) monitor the WCO collection and recycling programme in their respective areas. CVM is the most widely used environmental valuation method used for valuation of environmental good and services [8]. In fact, despites its limitation where most of the studies are based on hypothetical status quo rather than reality, CVM remains the most direct and straight forward method for evaluating public opinion on environmental goods and services, including the WTA to participate in new or maintain programs [9]. Willingness to pay (WTP) and Willingness to accept (WTA) are the two standard measures of economic value in CVM. WTP is the appropriate measure in the situation where a consumer wants to acquire a good while, WTA is the appropriate measure in a situation where a consumer is being asked to willingly give up a good or carry out certain task. The possession right of goods and services determines the correct measure to use between WTP and WTA [10].

2.2. Sampling Technique and Questionnaire Design:

The survey used face-to-face approach and randomly collected data from 360 households in Petaling district. Carson et al., [22] recommended face-to-face interview as the most reliable approach in CV studies. The interviewed respondents were the households' heads or their representatives. A total of 352 valid questionnaires were analyzed (8 were rejected due to inconsistencies) from three (3) local authorities from the district as, Subang Jaya Municipal Council (41.0%), Petaling Jaya City Council (36.0%) and Shah Alam City Council (23.0%). The questionnaire were structured to elicited households' socio-demographic information and the scenario of WCO collection and recycling programme in Petaling district followed by WTA questions was produced in both English and Malay versions. The scenario gives clear situation on how the programmes works and put more emphasis on problems associated with improper disposal of WCO and its reuse among consumers as well as the benefits of recycling WCO it into biodiesel. Next to the scenario, dichotomous choice questions were presented to the respondents with five bid amounts (MYR 0.60, 0.70, 0.80, 0.90, and 1.00). The bidding method was based on percentage value as adapted by Yacob et al., [23]. The softwares used for this study were Statistical Package for Social Sciences (SPSS) version 2.0 and NLOGIT Software version 4.0.

2.3. WTA Model

The WTA questions presented a dichotomous choice-questioning format in which the respondents were asked if they would or would not be willing to accept a given bid. Thus, the respondents have 'yes' or 'no' and the approach is commonly used to elicit respondents' WTP or WTA for changes in the environment in each case [9]. Thus, based on Adamawicz [15], the probability that a respondent would be willing to accept a given bid for collection and recycling of WCO for biodiesel input is assumed to follow a logistic variate:

$$WTA_i = H_i\beta_i + e_i \quad (2.1)$$

where, H_i is a vector of explanatory variables including demographic characteristics and corresponding bid values, and β_i is a vector of corresponding coefficients. An i.i.d error term e_i is included to account for unexplained variation in respondents' estimated WTA. For estimation purposes, a binary choice variable, At_i, is defined, which equals 1 if the respondent accepts t_i and else equals 0. Thus, $At_i = 1$ responses imply $WTA_i > t_i$ and $At_i = 0$ responses imply $WTA_i \leq t_i$. Meanwhile, $t_i = \{0.60, 0.70, 0.80, 0.90, 1.00\}$. Using equation (2.1), the probability that household *i* accept bid *ti* is:

$$\begin{aligned} P_i &= Pr[At_i = 1] \quad (2.2)\\ &= Pr[WTAi > ti]\\ &= Pr[H_i\beta_i > t_i]\\ &= Pr[e_i > t_i - H_i\beta] \end{aligned}$$

Thus, the mean WTA could be determined using:

$$WTA = (\beta_0/\beta_i) + (\beta_2/\beta_i)\, H_i + ((\beta_3/\beta_i)\, H_2 \quad (2.3)$$

3. Results

3.1. Socio-Demographic Background of the Respondents:

The surveyed households were distributed in all local authorities in Petaling district. Table 1 presents the socio-demographic information on the 352 respondents. The average age of the respondents was 39 years. It was shown that majority of the respondents are within the age range from 21-30 years (29.0%) while those who are few in the survey are within the age range of less than 20 years who are 4.3% respectively. This tells us that majority of respondents were within the active age with adequate capacity to respond objectively to the survey questions. Other respondents were within the age range from 31 – 40 (23.3%), then those from 41 – 50 years are 23.9%, and 19.6% are above 50 years of age. Of 352 participating respondents 66.5% are females while males are 33.5%. This show that the females respond more on surveys related to the domestic issues like WCO recycling than their males counterparts. It was also found that in terms of family size 22.7% of the respondents live in fours per households, another 22.7% live in fives, followed by 22.2% who live in more than five persons per households. The respondents who live in twos and threes per households are 13.9% and 18.5% respectively.

With regards to races, Malay respondents were found majority in the survey (58.5%), followed by Chinese 20.2%, then Indians households 15.9%, and only 5.4% were others (not Malay, Chinese or Indians). This result is attributed to the fact that Malays' population is higher than that of other races in Petaling district. Amongst the respondents 47.2% completed secondary school, 7.4% completed primary school, 17.6% completed polytechnic/college, and 27.8% completed university education. It can be seen from this result that the surveyed respondents have low level of education in general as majority (47.2%) completed only secondary school education. The respondents who work with private sector are 38.6%, 18.5% work with government, unemployed are 10.5%, self-employed are 15.9%, retired are 7.4%, and 9.1% are others. Of the total respondents based on this finding, it could be noted that majority work with private sector. The average monthly gross household income of the surveyed households was MYR3206. It was found also that 65.3% earn monthly income less than MYR 3000, 20.2% earn

from MYR 3001 – MYR 5000, 8.8% from MYR 5001 – MYR 7000, 3.1% have their monthly income from MYR 7001 – MYR 9000, and only 2.6% of the respondents' monthly gross household incomes are above MYR 9000. The mean of MYR 3206 for the surveyed households falls around the Malaysian average monthly gross household income which is MYR 3000. The surveyed households were in terrace houses as against condominium, apartment, and bungalow, terrace houses accommodate as more as numbers of persons per household. The result here revealed that more than half of the respondents (55.4%) reside in terrace houses, followed by those in apartments 28.7%, then 9.7% are in condominium, and only 6.3% live in bungalows.

Table 1 Socio-Demographic Background of the Respondents

Variables	Frequency (n=352)	Percent	Variable	Frequency (n=352)	Percent
			Education		
Age			Primary School	26	7.4
Mean	39		Secondary School	166	47.2
Less than 20	15	4.3			
21 – 30	102	29.0	College or Polytechnic	62	17.6
31 – 40	82	23.3	University	98	27.8
41 – 50	84	23.9	**Working Status**		
Above 50	69	19.6	Employment with Government	65	18.5
Gender			Employment with Private Sector	136	38.6
Male	118	33.5	Unemployed	37	10.5
Female	234	66.5	Self Employed	56	15.9
Number per household			Retired	26	7.4
Two	49	13.9	Others	32	9.1
Three	65	18.5	**Gross Monthly Household income**		
Four	80	22.7	Mean	MYR3206	
			Less than RM3000	230	65.3
Five	80	22.7	MYR3001 – RM5000	71	20.2
More than five	78	22.2	MYR5001 – RM7000	31	8.8
RACE			MYR7001 – RM9000	11	3.1
Malay	206	58.5	Above MYR9000	9	2.6
Chinese	71	20.2	**Accommodation Type**		
Indian	56	15.9	Apartment	101	28.7
Others	19	5.4	Condominium	34	9.7
			Terrace House	195	55.4
			Bungalow	22	6.3

3.2. Summaries of Households' WTA Responses:

From Table 2, the results revealed that only 83 (23.6%) of the respondents expressed their unwillingness to accept due to their various reasons such as; need higher prices and do not just want to participate. The survey questionnaire set which carries initial bid of MYR 0.60 has 11.4% of the respondents who are willing to accept, survey with initial bid amount of MYR 0.70 has 12.2%, survey with initial bid amount of MYR 0.80 has 15.1%, survey with initial bid amount of MYR 0.90 has 18.5%, and the highest bid amount of MYR 1.00 has 19.3% respectively. We noted that there is continues increase in the number of households WTA with the increase in the offered bid amounts in the surveys. Hence, respondents' WTA increases with the increase in the bid amounts. Simply put, the higher the bid amounts, the more respondents WTA and vice-versa. This coincides with the findings of Basili [25].

Table 2 Summaries of Households' WTA Responses

	YES		NO		TOTAL	
Price (MYR)	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
0.60	40	11.4%	27	7.7%	67	19.1%
0.70	43	12.2%	23	6.5%	66	18.7%

0.80	53	15.1%	15	4.3%	68	19.4%
0.90	65	18.5%	10	2.8%	75	21.3%
1.00	68	19.3%	8	2.3%	76	21.6%
TOTAL	**269**	**76.5%**	**83**	**23.6%**	**352**	**100**

3.3. Logit Regression Model Results

All the tested variables have shown significant predictability in the logit regression analysis. From Table 3 we note that the explanatory variables were significant at different percentage level with both positive and negative signs of coefficients. The different signs of coefficients from the regression results revealed the type of relationships exist between the dependent and each explanatory variable. The positive signs of coefficients signify the direct relationship between the dependent and explanatory variables. The negative signs of coefficient on the other hand, indicate the indirect relationship between the two. The offered bid amount, age, and income were all found with positive signs of coefficients and significant at 1% each. The constant was found with negative sign of coefficient and significant at 1% also. Variables 'university', 'Malay' and 'Chinese' were found with positive signs of coefficients and significant at 5% each, whereas only 'female' is significant at 10% respectively and with positive sign of coefficient also.

Table 3 Result of Logit Regression Model

Variable	**Coefficient**	**SE**	**Z**	**p-value**
Constant	-4.44920039	1.40064557	-5.675	0.0000*
Bid	3.67060575	1.21873799	3.012	0.0026*
Age	0.06766967	0.01539335	4.396	0.0000*
Income	0.00102236	0.00016354	6.251	0.0000*
Univ.	1.05199069	0.44102448	2.385	0.0171**
Malay	0.90012134	0.39598380	2.273	0.0230**
Chinese	1.30663022	0.51505408	2.537	0.0112**
Female	0.64862257	0.38493679	1.685	0.0920***
Statistics summary				
Number of observations	= 352			
McFadden's R^2	= 0.3774349			
Adjusted R^2	= 0.37743			
Log-likelihood (β)	= -119.6925			
Log-likelihood (0)	= -192.2570			
Percentage of Correctly Predicted	= 86.6%			
Mean WTA	= MYR 0.72			

Note: *Significant at 1%, **Significant at 5%, *** Significant at 10%

The negative sign of the constant in WTA analysis coincide with the previous findings of Adamawicz [24] and indicated that all things being equal without inclusion of the explanatory variables to specify the model, the households would not be willing to participate in the collection and recycling programme of WCO in Petaling district. The positive sign of the coefficient of the bid amount shows that the higher the bid offered, the more likelihood households will accept to collect and recycle WCO for biodiesel input. Also, the significant positive effect of income, university and age on WTA corresponds with the previous related findings by Golder and Misra [26]. For the female respondents who were found to have a positive relationship with WTA shows their more concern to the management of domestic waste like WCO compared to their male counterparts. The statistical summary of the model showed the overall goodness of the model fitness. The McFadden R^2 of 0.377 is considered as an excellent because it falls within the range between 0.2 and 0.4 [27, 28, 23]. Mean Value of WTA and Aggregate Value:

The mean WTA for the collection and recycling of WCO for biodiesel input was calculated from the regressed results in the logit model. The result shows that the average mean WTA is about MYR 0.72, which indicated that households are willing to accept MYR 0.72 per kg of WCO. The total number of households in Petaling is 466,862 and the average monthly quantity of WCO generated per household in the district was found as 2.34 kg. So by multiplying the total number of households in the district with the average monthly quantity of WCO generated we get the monthly aggregate of generated WCO as 1,092,457.1 kg in Petaling. The yearly aggregate cost for environmental protection through WCO collection and recycling is the monthly aggregate of generated WCO (1, 092, 457.1) multiplied by the mean willing to accept per kg of WCO (0.72), multiplied by the number of months in a year (12) or (1,092,457.1 x 0.72 x 12) = MYR 9,438,829. Thus, we term this economic value as the total environmental protection cost via WCO collection and recycling programme among households in Petaling district.

4. Conclusion

In conclusion, this study began with an attempt to find solutions to the main challenges facing the waste cooking oil collection and recycling programme among households in Petaling district. Through investigations, it was found that cash incentives that will encourage consumer participation and pricing policy that will regulate the price of a kg of WCO were necessary. The findings from this survey revealed that the mean WTA and the annual aggregate value of WTA of the households in Petaling district are MYR 0.72 and MYR 9, 438, 828. In other words, the annual total cost required for environmental protection via waste cooking oil collection and recycling programme among households in Petaling district is MYR 9,438,828.

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