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Household preferences for improved municipal solid waste management services in Penang and Terengganu

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Abstract. It is important to acknowledge the interdependent relationships between the economic and the environment system in achieving sustainable development. The environmental system provides typically four classes of services to the economic system: the natural capital for production, amenity services, basic life support services, and waste sink services. High investment in technology, programmes, projects, or any measures related to the recycling concept in the circular flow of production and consumption relationships should be given more concentration in the future waste management plan and policies. This is because the mass of waste generated from the production and consumption relationships is continually increasing as the population grows, leading to a more polluted environmental system. This study examined the households' perspectives on the potential improved municipal solid waste management system in their residential area. Two study sites were compared to their households' willingness-to-pay (WTP) for the waste management system. By using the Contingent Valuation Method (CVM) approach, the study concluded that the economic value of the improved municipal solid waste management services in the study sites ranged from MYR 15.42 to MYR 29.67 per month, which on aggregate, ranged from MYR 13.3 million to MYR 117.7 million per year. These economic values indirectly indicated the amount the population preferred to pay as the cost to reduce the impacts of improper management of municipal solid waste.

1. Introduction

For the past several decades, the amount of solid waste generated in Malaysia was recorded to increase drastically every year [1]. Hence, the management of solid waste becomes a very crucial issue to be considered whereby without proper measures, adverse effects on the environment and the human health from the increasing of waste generated and become worsened every year [2, 3]. With the current conventional management of solid waste management, the changing quality and composition of waste with more hazardous and toxic waste are adding into the waste stream. It is necessary to collect waste separately such as the practice of 3Rs waste bin facility for households and more specific treatment is needed or improved rather than only dumped the waste at the landfill area.

Many studies came with various estimated amount of waste or municipal solid waste generated by Malaysian. According to Budhiarta et al. [4], the average per capita generation of municipal waste in Malaysia is about 0.85 kg per person per day, depending on the economic and geographical status of an area. The estimated amount of waste was higher than the amount stated by Jusoh [5], which recorded 0.7 kg per day per person in 1987. As for the capital city of Malaysia, Kuala Lumpur, it is estimated that



the generation of waste was 1.5 kg per person per day [4]. However, Kathirvakle et al. [6] estimated that, on average, the amount of solid waste generated by Malaysian is higher than residents in Kuala Lumpur, which was at 1.7 kg per day per person.

Another study by Nadzri [7], stated that Malaysian generated more than 25,000 metric tonnes of domestic/solid waste per day. The amount increased to, between 30,000 to 33,000 metric tonnes in 2012 as recorded by Moh and Abd Manaf [8] and Carol Boon [9]. The study in 2012 showed that the overall waste composition in Malaysia is dominated by municipal solid waste (MSW) (64%), followed by industrial waste (25%), commercial waste (8%) and construction waste (3%). There are 20 different categories of MSW which are food waste, paper (mixed), cardboard, plastics (rigid, film and foam), textile, wood waste, metals (ferrous or non-ferrous), diapers, newsprint, high grade and fine paper, fruit waste, green waste, batteries, construction waste and glass, which sometimes categorized as organic and inorganic waste.

Generally, it is concluded that the MSW in Malaysia consists of 50% of food waste, which 70% to 80% was disposed at the landfill sites [7, 10]. Despite the cheapest cost and most common method to treat solid waste with high percentage of organic components, open dumping landfill creates severe impacts to the environment [11].

With the increasing rate of MSW generation, the current landfills are known to reach their capacity limits (i.e. over-loaded in capacity), unsanitary and always due to land scarcity problem in establishing new sites [10, 12]. In conclusion, households waste is the primary source of MSW in Malaysia [7]. The conventional management of municipal solid waste especially the waste collection in Malaysia covers almost all communities in urban areas, but only 66% of the populations in rural areas are covered [13]. Without the services like proper waste collection, it can be seen that wastes were dumped on the streets and drains in most rural areas. Serious environmental and social threats will occurs such as flood, breeding of insects and rodent vectors as well as the spread of diseases [14].

It is clear that dumping the MSW to landfills is not a sustainable way for our promising future. Hence, Malaysian Government, through the Eleventh Malaysia Plan (MP 11) (2016-2020), had revisited the Solid Waste and Public Cleansing Management Act 2007 (Act 672). Actions were taken to strengthen the institutional framework and reinforce coordination among relevant ministries and agencies. The MP 11 had targeted to achieve a 22% recycling rate among households in Malaysia by 2020. A better solid waste management system needs to be established as well as getting households to practice recycling concept in their residential area. However, it is a quite challenging task for Malaysian as it requires changes in mind-set and social behavioural from old-fashioned way of dumping waste to inculcate better consumption and waste disposal behaviour [15].

Given the said introduction on MSW, current conventional management system as well as its constraints, this study addresses two research questions; do households are willing to participate and contribute certain amount of money for a special improved municipal solid waste management services?; and what is the economic value of establishing the improved municipal solid waste management services at households residential area?. Therefore, this study attempts 1) to determine significant factors affecting household willingness to pay (WTP) to contribute for the improved municipal solid waste management services, and 2) to estimate the economic value of the improved municipal solid waste management services potentially provided by the local authority in the future

2. Methodology

2.1. Study area

There were two study sites selected in this preliminary study namely, Kuala Nerus District in Terengganu and Northeast District in Penang. The field surveys were conducted in 2014 (i.e. Northeast District, Penang) and 2017 (i.e. Kuala Nerus District, Terengganu). Due to time and budget constraints, Kuala Nerus sub-district (KNSD) and Jelutong sub-district (JSD) were chosen to represented Kuala Nerus District and Northeast District respectively.

2.2. Data collection design

2.2.1. Data collection. This primary data collection used field survey to gather information on socio-economics background of the respondents (randomly selected households), their responses in participating and contributing for improved municipal solid waste management service as well as their stated maximum economic value for the new prospect services. Impersonal mode or face-to-face interviews was selected as the communication mode for this study. A structured questionnaire form, as the research instrument, provides the respondents instructions, questions as well as space for them to complete their answers. The questionnaire contained both standardized open-ended questions and close quantitative questions to probe and obtain responses from respondents

2.2.2. Sampling. About 100 respondents each in both study sites (i.e. total of 200 respondents) which are the households of residents in randomly selected residential areas in KNSD (representing Kuala Nerus District of Terengganu) and JSD (representing North East District of Penang) were interviewed. Cluster sampling was used as the sampling design in this study. The questionnaire was administered in a single interview with every respondent for about 30 to 40 minutes.

2.2.3. Research instrument. Various methods of eliciting WTP have been employed previously, including open-ended questions, a payments card, dichotomous choice, iterative bidding games, and referendums [16]. This survey employed open-ended question by asking the respondents whether they are sincerely ready to participate and contribute to a special fund of improved solid waste management services (i.e. hypothetical market) at their residential area that will be provided by the local authority. The related question intended to elicit a point estimate of the respondent's WTP.

To gather the WTP amount of respondents to contribute for the special fund, s specific elicitation questions was asked;

‘‘Assume that the State Government of Terengganu/Penang decided to improve the system of solid waste management, and they are encouraging the population/households to contribute for a special solid waste management services fund’’

Are you willing to contribute?

Yes
 No

If you are willing to contribute, how much is your maximum willingness to pay for the special fund?

RM _____ per month?

Socioeconomic information was also collected (gender, age, marital status, educational status, monthly income of individual, occupation and so forth) as main variables to be analysed in determining factors affecting the maximum WTP for the improved solid waste management services.

2.3. Data analysis

Ordinary Least Squares (OLS) model was used for the estimation. The IBM Statistical Package for Social Science (SPSS) Statistics Version 20 application was used to estimate the OLS model. The model follows the following form;

$$WTP = \alpha + \beta Xs. \quad (1)$$

Where α and β is a vector of estimated parameters. WTP is maximum willingness to pay and Xs are vector of socio-economic and other potential variables.

3. Results and Discussions

3.1. Respondent's profile

Majority of respondents in KNSD aged ranged from 40 to 49 years old (30%). The mean age for the respondents was 42.5 years old. As for JSD, most of them aged between 20 and 29 years old (46%). Respondents in JSD aged 28.6 years old, on average. It can be concluded that most respondents in JSD are younger than those respondents in Kuala Nerus sub-district. Majority respondents in both study sites worked with private companies; 43% recorded in KNSD and 65% in JSD. However, there were also respondents that are already retired in KNSD (5%). More than 95% of respondents in both sites have attained at least primary school. Majority of them were college and university graduated; 57% in KNSD and 63% in JSD.

Respondents interviewed in KNSD were 100% Malay. In JSD, the percentage of Malay respondents was slightly exceeded Chinese respondents by only 3%, Indian comprised of 19% while other races was at 4%. In KNSD, although majority of the respondents worked at private companies and majority of them attained college or university, most of them gained a monthly income of less than MYR 1,000. The mean monthly income was at MYR 2,042. As for respondents in JSD, with the same situation, majority of them were paid between MYR 2,000 to MYR 2,999 per month (Table 1). The average monthly income of respondents in JSD was MYR 2,200 which was slightly higher than respondents in KNSD.

Table 1. Sociodemographic of respondents

Socio-demographic	Percentage (%)	
	Kuala Nerus sub-district (KNSD)	Jelutong sub-district (JSD)
Age		
20-29 years old	19	46
30-39 years old	24	37
40-49 years old	30	9
>50 years old	27	8
Ethnicity		
Malay	100	40
Chinese	0	37
Indian	0	19
Others	0	4
Employment status		
Retires	5	0
Private sector	43	65
Government Servant	31	17
Self employed	24	18
Monthly income		
<RM1000	33	2
RM1000 – RM1999	17	36
RM2000 – RM2999	19	45
>RM3000	31	17
Education level		
Non formal education	2	0
Primary school	10	0
Secondary school	31	37
Tertiary education	57	63

3.2. Respondent's willingness to participate for the improved municipal solid waste management services (IMSWMS)

During the interview session, the respondents were asked about their opinions on the current management system of solid waste by the local authority. They were agreed that the current management system of solid waste (i.e. household waste) are non-environmental friendly and didn't encourage them to practice recycling approach in minimizing the total household waste to the landfill. They also argued that 3Rs facility such as 3Rs Bin is crucially needed for them to segregate their household waste easier. The services (i.e. 3Rs Bin facility) had been long practiced by the local authority of states in developed countries as one of measures for achieving environmental sustainability. By creating a hypothetical situation which assumed that their residential area or district area will be provided with an improved solid waste management service, begins with the 3Rs Bin facility for each household premise, questions related to respondent's willingness to pay (WTP) were asked using the Contingent Valuation Method (CVM) approach. The CVM is a direct valuation method in which respondents are asked to express a WTP or willingness to accept in response to a hypothetical market situation [17]. Although CVM is subject to a number of limitations, the deficiencies can be reduced by providing sufficient accurate information about the resource being valued, is usually provided to the respondent prior to asking for the amount he or she is willing to pay for public goods [18].

3.2.1. Respondent's participate towards the IMSWMS fund. Before the respondents were asked about their maximum WTP value for the special fund, the potential respondents that willing to participate for the improved municipal solid waste management services had been identified. About 66% of the respondents in KNSD and 42% of the respondents in JSD stated that they are willing to participate to the donation fund if the improved services of municipal solid waste management services will be seriously conducted by the local authority (Figure 1).

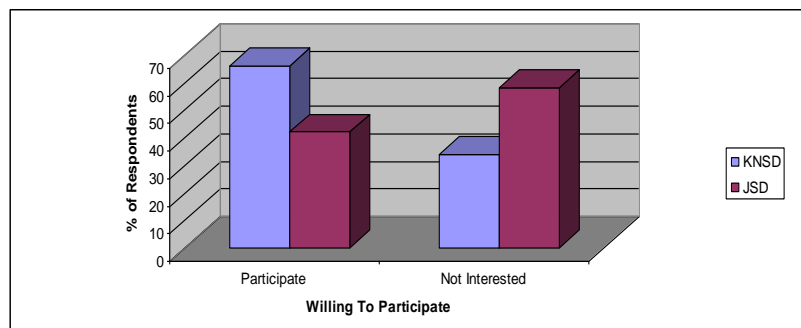


Figure 1. Status of willingness to participate for the IMSWMS fund

3.2.2. Respondents maximum WTP for the IMSWMS fund. Based on 66 potential respondents in KNSD that willing to participate in the special fund, majority of them (55%) stated their maximum WTP were lesser than MYR 11.00 per month. As for the 42 potential respondents in Jelutong sub-district, majority of them (33%) were more generous to contribute at less MYR 31.00 per month for the special fund (Figure 2). The average maximum WTP value was MYR 15.24 per month for KNSD which is slightly lower than in JSD which at MYR 29.50 per month.

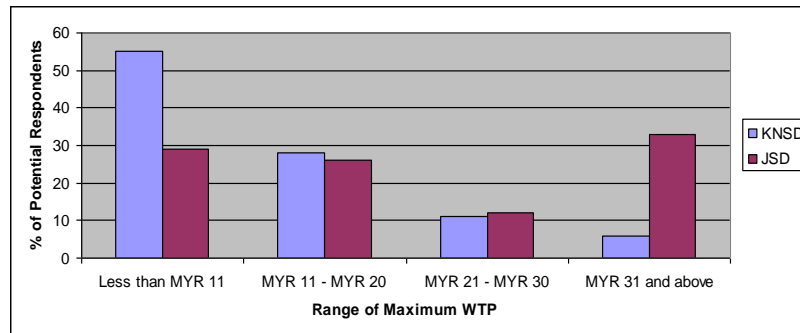


Figure 2. Range of Potential Respondents' Maximum WTP

3.2.3. Factors affecting respondents maximum WTP for the IMSWMS fund. To understand what factors can describe respondent's WTP; their bids were regressed against various explanatory variables such as socio-economic variables (income, age, educational level, gender and so forth) and other explanatory variables such as their level of knowledge on 3Rs Concept, involvement in any activities/programmes related to 3Rs, experiences in donation contribution, amount of last donation and other factors. The result of the regression estimation suggested that there exists a significant relationship between WTP bids with the explanatory variables as indicated by the regression diagnostic. The F statistic obtained is statistically significant at the 1% level of significance for both sites with the R² of 0.34 for KNSD and 0.45 for JSD. Statistically insignificant variables were excluded in the OLS model to help derive the best models. The results detail for both sites were as shown in Table 2 (KNSD) and Table 3 (JSD).

Table 2. Regression results for KNSD (N=66)

	Coefficient			
	B	Standard Error	T	Significant
Constant	-16.089	7.713	-2.086	0.041
INC	0.003	0.001	3.654	0.001
ARC	7.193	2.268	3.171	0.002
IRA	-12.270	4.268	-2.875	0.006

Based on 66% respondents that willing to participate in the special fund of improved municipal solid waste services, factors that found significant in affecting their maximum WTP were their monthly income (INC), awareness level of recycling concept (ARC) and frequency of involvement in recycling activities or programmes (IRA). The probability of WTP for all the explanatory variables was found statistically significant at the 1% level with the positive sign for INC and ARC.

Table 3. Regression results for JSD (N=42)

	Coefficient			
	B	Standard Error	T	Significant
Constant	17.619	9.304	1.894	0.068
GEN	-11.669	5.316	-2.195	0.036
AGE	0.542	0.283	1.917	0.064
RLD	0.106	0.043	2.456	0.020
IRA	-2.743	1.002	-2.737	0.010

As for the 42% respondents from Jelutong sub-district, the multiple regression indicated that four explanatory variables significantly affecting their maximum WTP towards the special fund. Those

variables were gender (GEN), age (AGE), the amount of respondents' last donation (RLD) and frequency of involvement in recycling activities or programmes (IRA). AGE and RLD had a positive sign which explained that as the age and amount of their last donation increased, it could increase the probability in contributing to the improved municipal solid waste services fund. All the explanatory variables were also found significant at 1% confidence level.

3.3. The estimated economic value of the IMSWMS

From Table 2 and Table 3, the multiple regression equation for both study sites can be generated as below;

Multiple regression equation for Kuala Nerus sub-district

$$\begin{aligned} \text{WTP} &= \beta_0 + \beta_1 \text{ WAGE} + \beta_2 \text{ KES} + \beta_3 \text{ PKS} \\ &= -16.089 + 0.003 \text{ WAGE} + 7.193 \text{ KES} - 12.270 \text{ PKS} \end{aligned}$$

Multiple regression equation for Jelutong sub-district

$$\begin{aligned} \text{WTP} &= \beta_0 + \beta_1 \text{ GEN} + \beta_2 \text{ AGE} + \beta_3 \text{ JDT} + \beta_4 \text{ PKS} \\ &= 17.62 - 11.67 \text{ GEN} + 0.54 \text{ AGE} + 0.106 \text{ JDT} - 2.74 \text{ PKS} \end{aligned}$$

To determine the mean maximum WTP for both study sites, the value was evaluated at the mean values of each significant explanatory variable. Therefore, on average, the economic value of the IMSWMS in KNSD was estimated at MYR 15.42 per month while the value increased to MYR 29.67 per month in JSD. According to Terengganu's Economic Planning Unit (EPU) in 2016, Kuala Nerus district was ranked fifth (out of eight district) in number of populations with 144,300 people in Terengganu. With the availability data of population by age group, the value of IMSWMS per month as well as per year for the Kuala Nerus District can be estimated by multiplying the average economic value of IMSWMS with the number of Kuala Nerus District's population. It is estimated that the economic value of IMSWMS was MYR 1.1 million per month or MYR 13.3 million per year for the Kuala Nerus District of Terengganu (Table 4).

Table 4. The estimated IMSWMS value per year in Kuala Nerus District, Terengganu

Age group	No. of population	Average economic value of IMSWMS per month (MYR)	The IMSWMS value per month (MYR)	The IMSWMS value per year (MYR)
20 - 24	15900	15.42	245178	2942136
25 - 29	14900	15.42	229758	2757096
30 - 34	9400	15.42	144948	1739376
35 - 39	6300	15.42	97146	1165752
40 - 44	5600	15.42	86352	1036224
45 - 49	6600	15.42	101772	1221264
50 - 54	6500	15.42	100230	1202760
55 - 59	6700	15.42	103314	1239768
Total	71,900	-	1,108,698	13,304,376

The data on Penang population in 2016 was also gathered from the state's Economic Planning Unit (EPU). With a population of 566,900, the Northeast District was the most populous district in Penang (32% of total population) compared to other four district. By using the same method of calculation as

the Kuala Nerus District, the IMSWMS value per year for Northeast District, Penang was estimated at MYR 9.8 million per month or MYR 117.7 million per year (Table 5).

Table 5. The estimated IMSWMS value per year in North East District, Penang

Age group	No. of population	Average economic value of IMSWMS per month (MYR)	The IMSWMS value per month (MYR)	The IMSWMS value per year (MYR)
20 - 24	54784	29.67	1625441	19505295
25 - 29	54048	29.67	1603604	19243250
30 - 34	50464	29.67	1497267	17967203
35 - 39	41088	29.67	1219081	14628972
40 - 44	37600	29.67	1115592	13387104
45 - 49	34592	29.67	1026345	12316136
50 - 54	30848	29.67	915260	10983122
55 - 59	27136	29.67	805125	9661501
Total	330,560	-	9,807,715	117,692,582

4. Conclusion

As discussed in many environmental, ecological, and green economics literatures, the environmental system is the foundation of development. This is because the environmental system provides many services to economic systems such as natural resources for economic production, life-support services, amenity resources, and area of waste sink. It is crucial for human being to manage their waste from the production and consumption activities in a very sustainable manner. As for the government, a new type of solid waste management system should be introduced to utilise the recycling concept fully. Investment in green technology is crucial for transforming waste into wealth. Some scholars have suggested including as many stakeholders as possible in the sustainable waste management practice. The integrated solid waste management should involve households in making decisions and providing them with more knowledge on the 3Rs concept and facilities in practising the concept (i.e. providing the 3Rs Bin system in every premise). Programmes and activities related to the 3Rs concept should be often held to increase household awareness and participation.

This study has shown that the majority of households (66%) in Kuala Nerus District of Terengganu are willing to contribute some amount of money to the establishment of the improved municipal solid waste management services (IMSWMS). Although the percentage of households that are willing to contribute to the same IMSWMS is lower than Kuala Nerus District in North-East District of Penang (only 42%), their maximum WTP for the IMSWMS per month was higher; an average of MYR 29.67 per month compared to MYR 15.42 per month. As on aggregate, the economic value of the services was estimated at MYR 13.3 million per year for Kuala Nerus District of Terengganu while MYR 117.7 million per year for the North-East District of Penang. Although the values are not paid by the households (i.e. hypothetical market), it portrays the net benefit of services that the local authority or government can generate (i.e. lower the cost of managing the solid waste) as well as the households in the future for the potential integrated solid waste management services. In addition, the suggested IMSWMS could generate a cleaner and greener environment for a sustainable living.

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