Sustainable household waste management improvement in Dhaka city, Bangladesh

Rafia Afroz

Department of Economics,
Faculty of Economics and Management Science,
International Islamic University Malaysia,
50278, Kuala Lumpur, Malaysia
E-mail: Rafia_afroz@yahoo.com

Abstract: The objective of this study is to conduct an economic study to identify the factors which affect households' solid waste generation, households' willingness to pay to improve the solid waste management and households' recycling behaviour in Dhaka City. The results showed that the waste generation of the households in Dhaka City was significantly affected by household size, income and concern about the environment. The results showed that the aggregate value of WTP of the respondents in Dhaka City was 7.6 million Taka (USD 0.1 million). Another logistic regression model was used to identify the factors which affect households' recycling behaviour. The results showed that environmental consciousness, the availability of storage space, and age (25 to 35), are significant positive predictors of recycling behaviour. Another variable INCOME 2 (TK3,000 to TK15,000) is also positively correlated with recycling.

Keywords: solid waste generation; willingness to pay; recycling behaviour; logistic regression model; Chi-square test; Bangladesh.

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Biographical notes: Rafia Afroz has completed her PhD in Environmental Economics from University Putra Malaysia (UPM) in 2004. Currently, she is an Assistant Professor in Department of Economics, Faculty of Economics and Management Science, International Islamic University Malaysia. She has published more than 30 journal papers, conference papers and book chapters in international journals, proceedings and edited books.

1 Introduction

Urbanisation in Dhaka city is taking place rapidly (at an annual rate of 4%), and the living values are civilising steadily (Yusuf and Rahman, 2007). One of the depressing impacts of this is that more municipal solid waste (MSW) is being generated which is causing rigorous environmental degradation. With the passage of years, MSW in Dhaka city has been predicted to increase from 3,200 tons/day in 2004 to 3,909 tons/day in 2010 and to 4,634 tons/day in 2015 (JICA, 2005). The annual rate of increase of solid waste

has been estimated at an average 1.2%, which is less than either the urbanisation rate of about 4% or the GDP growth of Bangladesh of about 6% (Tariq and Mostafizur, 2007).

Three primary sources of waste are classified as MSW. These are residential, institutional and commercial waste, and municipal services wastes (street sweeping). However, significant amounts of recyclable materials are being recycled by the informal sector and supplied to appropriate processing factories as raw materials. Composting is the most desirable recycling process because of high moisture content and organic materials in waste, but it is still practised on a very small scale in developing countries (Yousuf, 2005).

Table 1 shows the amount of waste produced by individual income groups based on their economic conditions and life style. The average waste generation rate from domestic sources is found to be 0.34 kg/person/day (JICA, 2005), which varies widely from the UNCRD (1998) assumption of 0.47 kg/person/day for Dhaka. According to JICA (2005), the total solid waste amount from domestic sources is estimated at 1,950 tons/day, generated by the population of 5.728 million with an average generation rate of 0.34 kg/person/day. The total solid waste amount from business sources is estimated at 1,050 tons/day and the street waste is estimated at 200 tons/day.

Table 1 Waste generation rate in Dhaka city

Sources	*Income level*	*Rate*		
		Dry	*Wet*	*Average*
Domestic waste (kg/person/day)				
High income group	>= 20,000	0.588	0.438	0.513
Middle income group	20,000 >, >= 10,000	0.371	0.428	0.400
Middle-low income group	10,000 >, >= 5,000	0.279	0.346	0.313
Low income group	5,000 >, >= 3,000	0.326	0.345	0.336
Lowest income group	3,000 >	0.314	0.205	0.260
Weighted average (kg/place/day)				0.340
Business waste (kg/place/day)	-			
Restaurants	-	24.0	23.6	23.8
Shops	-	0.9	0.8	0.9
Hotels	-	11.0	19.6	15.3
Offices	-	2.4	5.6	4.0
Markets (kg/m^2/day)	-	0.91	1.31	1.11
Street waste (kg/km)	-	344.5	384.5	364.5

Source: JICA (2005)

The general situation of poverty and illiteracy of the masses makes Bangladesh very vulnerable to environmental damage and the general populace of Bangladesh is busy trying to meet their basic material needs therefore, have little scope to be concerned about environmental amenities (Salequzzaman and Stocker, 2001). The Summary Report (BBS, 1999) shows that 46.7% of the urban population (14.5 million) lives in absolute poverty and in Dhaka, some 40% to 45% of the people live in slums and slum like areas (Zuberi, 1998). Number of homeless individuals who make road their home or those who use boxes as their shelter they call home, in which some people considered these ‘boxes’ as

waste. Alternatively, households with low income have too little to recycle, and households with middle income might have no space at home to keep recycle materials and they see little incentives to manage waste. In addition, there is no structured recycling mechanism being implemented to households at this moment in Dhaka.

Many people do not know the location of the nearest recycling centre. Location of recycling centre is poor or too far away and so it easier to throw the recyclables into the street than to bring them to a recycling centre (Sujauddin et al., 2008). Finding adequate waste disposal sites for the future is also very difficult at this moment with the increased in population and horizontal expansion of the city. Overall the city corporations have failed to manage the solid waste of this increasing population, mainly because of lack of financial support and willingness to pay and low recycling participation of the households for overall sustainable solid waste management policies. So, there is a dire need to increase the public awareness of the waste minimisation problem and to estimate the factors which are responsible for increasing waste generation, households' willingness to pay and recycling behaviour. If the influential factors of increasing waste generation, households' willingness to pay and recycling behaviour can be identified, it will be helpful for the environmental and waste management planners in their decision making for sustainable waste management in Dhaka.

Research on waste recycling in the developing world places less emphasis on understanding the indirect motives of one's behaviour (i.e., recycling research focus in developed countries), but more heavily on the practical, direct factors influencing the institutions and elements associated with waste management. The studies conducted in developing country like Malaysia, China, Mexico have found that recycling activities are further influenced by the availability of storage space in the home, the presence of recycling agents and the proximity of collection centre to households. They have also observed that competencies were the best predictors of actual behaviour, whereas beliefs were more indicative of perceptions of behaviour or desired behaviour. In the case of recycling, one was more likely to recycle waste when fully understanding the proper way and the reasons to do it as opposed to one simply desiring to recycle (SERI, 2008; Corral-Verdugo, 1997; Harvie and Jaque, 2003).

A considerable amount of research work on solid waste management has already been conducted in Bangladesh (Salequzzaman et al., 1998, 2001; Salequzzaman, 2000; Ahmed and Rahman, 2000; Alam et al., 2002; Hasan and Chowdhury, 2005; Enayetullah et al., 2000; Rahman et al., 1999; Sinha, 2006). However, no study to investigate the effect of the socioeconomic level of householders on solid waste generation, willingness to pay and recycling behaviour yet been undertaken. In Bangladesh, household waste constitutes 65% of the total solid waste. Sustainability of household waste management depends on the factors which affect the generation of household waste, households' willingness to pay for improved solid waste management and households' recycling behaviour. The objectives of the study were, therefore, to contribute to a better understanding of household waste management behaviour by examining waste management practices and behaviours of the residents of Dhaka city, Bangladesh. More specifically, it analyses the factors that promote household's waste generation, their willingness to improve the solid waste management in Dhaka city and recycling behaviour. The results of the study will provide inputs into the formulation of local waste minimisation plans and programmes, particularly on waste segregation and recycling activities of the residents of Dhaka city, Bangladesh which will bring the sustainable waste management in Dhaka.

2 Methodology

2.1 Household selection

Dhaka city comprises of 10 zones and within these zones there are 90 wards (subdivision) (BBS, 2001). Each ward consists of one or more *mohallas* (blocks), each of which contains one or few streets and a varying number of households. In total, there are 659 *mohallas* and the number of households in Dhaka city is 643,016 (BBS, 1999). This project utilises stratification process and random sampling on the number of households. First, from each zone, we selected one ward with the highest level of waste generation. Then, two *mohallas* from each *ward* were chosen. This resulted in a total of 20 *mohallas* from the 10 *wards*. Next, from these 20 *mohallas*, 413 households were randomly chosen in proportion to each zone's population. In most cases the joint-family system still exists therefore, 'household' was chosen as the unit of analysis. Within each house, interviewed respondents were above 17 years old.

2.2 Research instrument

In developing countries like Bangladesh, telephone or mail surveys are impractical and not common. Many people do not have telephones (more than 80% in Dhaka city) as telephones normally belong to the population's richer class (BBS, 1999). Moreover, mailing addresses' list or street directory is non-existent and the mailing system is not reliable. Bangladesh's literacy rate is 47.9% (CIA, *The World Factbook*), many people are not able to read information printed on the mailed survey. The direct face-to-face interview is the most commonly used approach and was employed in this study.

The questions in the interview were grouped into two sections: A and B. Section A asked the respondents about their knowledge and concern towards the environment, knowledge and attitude towards waste management, who collect and dispose the solid waste, whether DCC collects and clean the dustbin and drain of their area and whether they are satisfied with the waste collection services provided by DCC. A respondent's concern for the environment was evaluated based on responses to a set of five questions in the questionnaire. The respondent was only classified as being environmentally conscious if, in response to these questions, he/she satisfied all the following criteria: perceived a clean environment as a personal responsibility, not the responsibility of other parties; participated in any clean environment campaign or project; disposed of waste responsibly during outings when no waste bins were available; was involved in some environmental protection activity; and rated him/herself as being environmentally conscious. In this section, the respondents were also asked whether they would be agreeing to separate the household waste if facilities were provided. This section also asked about their solid waste generation per day. Section C queried the respondents about their socio-economic information.

Furthermore, the contingent valuation method has been used to estimate the willingness to pay of the households for improving the waste management system in Dhaka city. For this reason, the current waste management system was presented to the respondents in Section B. After describing the current situation, they were asked if the government implemented a new waste management system, how much service charge they were willing to pay. The question was as follows:

> Obviously the implementation of this program incurs cost, which would be directly or indirectly paid by us. The government will finance this program through an increase in waste collection service charge that will increase your family expenditures. When you consider your household's income and expenditure, are you willing to pay this cost so that the government may achieve this program? Remember that this will give you less money for, for example, food, clothing, shoes, travel car use and savings.

A double-bounded dichotomous choice question was used in this study for estimating the wiliness to pay of the respondents to improve the waste collection system is Dhaka city. In this format, respondents were confronted with only one single bid and therefore a further subdivision of samples is necessary. A vector of four prices was chosen for the implementation of the dichotomous choice format. Each individual randomly received one of these prices. The amounts for the first bid vectors were 10, 15, 25 and 35 Taka (Bangladesh currency, 1.00 US$ approximately 70.12 Taka). If the respondents gave a positive answer, they were asked if they would be willing to pay a higher amount chosen from among bids of 15, 25, 35 and 50 Taka. If the answer to the first question was negative, then the second bid vector was 5, 10, 15 and 25 taka. Before the final data gathering, two pre-tests were conducted in April 2006. The first pre-test involved ten participants, to test on their understanding and clarity of the questions. One week later, 50 individuals were interviewed based on the modified questions from the first pre-test. In August 2006, the final data gathering was conducted in Dhaka city.

3 Results and discussion

3.1 Waste generation in the households

The respondents were asked on who normally collect and place solid waste generated in the households. Servants/maids are in charge of waste discharge among 64% and 23% was wife or mother, 10% child and 3% husband or father. Attitudes towards waste disposal (as a menial task) or the social status of such a job imply that even within a household, this task is likely to be done by the weaker members, for instance, children or dependent women such as a widow, daughter-in-law or house maid. The respondents were asked on how many container of waste each household produced in 3 to 4 days. Most respondents (55.2%) produced 3 to 4 waste containers. A typical waste container contained about 1 kg of waste. Waste generation in the study area averaged 38kg/month for each household. As the household average number is 4, the waste generation averaged is 0.3 kg/day per capita, which is similar to the findings of DCC (2005). DCC was supposed to clean drains and dustbin regularly Ministry of Law Justice and Parliamentary Affairs (1983). Only 25% of the respondents said that drains were cleaned daily. For most of them stated that drains are irregularly cleaned in fixed frequency mode or never been cleaned. People claim that they have to pay some money to the DCC sweeper for some time to clean the drains in the locality. In most cases, they appoint labour to clean the drains. We have discussed with the DCC about this complains. However, most of the ward commissioners did not agree with the findings. Those who had agreed, complained about lack of manpower and authority over DCC staff. For the dustbins, the situation is little bit better compared to the drains. More than half of the respondents agreed that dustbins are cleaned daily. Only 15% of the respondents claim that dustbins are not

cleaned at all by DCC. These respondents live a little away from the main roads of the ward. The respondents were also asked about their satisfaction on the waste collection services provided by the DCC. Majority (75%) of the respondents stated their dissatisfaction on the waste collection services provided by the DCC. About the separation of household waste, 27% of the respondents stated their willingness to separate the waste. It could be concluded from this result that Dhaka residents have a positive WTP for the new solid waste management programme with waste minimisation option. This is a welcome development in the process towards a sustainable solid waste management programme.

3.2 Knowledge about solid waste management

The respondents were asked about their knowledge of solid waste management. A majority of the respondents (61.94%) stated that they have knowledge about solid waste minimisation. The results of this study also show that the majority obtained their sources of knowledge from newspaper (50.2%), television (20.9%) and radio (4%). In this case, newspaper and television have been most influential in promoting environmental issues.

4 Estimation model of waste generation of the households

Chi-square test for two unrelated samples is used to evaluate the existence of relationship between two variables (Green and Salkind, 2008) or whether the difference between the observed and expected frequencies is bigger than the expected by chance (Wheater and Cook, 2000). This technique is used to identify which factors significantly affect the solid waste generation. The Chi-square can be calculated as;

$$X^2 = \frac{(O-E)^2}{E} \tag{1}$$

where O is the observed (measured) value and E the expected (calculated) value. In this study, Chi-square test has been used to evaluate the relationship between household waste generation and some socio-economic variables such as income, family member, environmental consciousness, extra land, and willingness to separate the waste.

A two-way contingency table analysis was conducted to evaluate whether waste generation is significantly affected by income, family member, willingness to separate the waste and environmental consciousness. The results shown in Table 2 stated that that income, family member and environmental consciousness have a highly significant relationship with household waste generation. This result seems reasonable since increased in income is expected to increase the demand for commodity products and consequently increases the household waste generation. It is expected that large family are generating more waste than the smaller family. So, it is reasonable to conclude that family member has a significant relationship with household waste generation. As expected, the attitudinal variable for concern about environment is statistically significant, which supports the hypothesis that the respondents who are more concerned about the environment in Dhaka city would have generated less waste and willing to have improved solid waste management programme. It has been also found that extra land and

willingness to separate wastes were not significantly related with the household waste generation.

Table 2 Factors affecting the waste generation of the households

Willing to separate	*Waste generation (kg/month/household)*		
	> 50	*50–80*	*> 80*
Yes	50	30	28
No	14	100	180
γ^2	1.22		
Environmental consciousness			
Yes	100	150	115
No	10	37	10
γ^2	15.34**		
Income group			
Lower income group (≤ TK3,000)	90	5	5
Middle income group (TK3,000 to TK15,000)	150	40	10
Higher Income group (≥ TK15,000)	40	32	50
γ^2		8.44*	
Family member			
5	50	15	5
5–10	10	90	150
> 10	5	15	80
γ^2	11.84**		
Extra land			
Yes	23	45	10
No	79	113	132
γ^2	*2.33*		

Notes: *$p < 0.10$; **$p < 0.05$

5 Estimation model of willingness to pay of the households for improving solid waste generation

The double-bounded model is built from the answers to two dichotomous choice elicitation questions. In this method, the individual is presented with a first bid (BID_1) and asked whether she or he would pay this price for the mew waste management programme when thinking about her or his maximum subjective value. If the answer is yes, then a second higher bid (BID_U) is presented. If the answer is no, then a lower second bid (BID_L) is presented. The respondent then chooses between two alternatives: an improved state with three potential costs (BID_1, BID_U and BID_L) that derive a utility U^1, and the status quo U^0 yielding no improvement in environmental conditions and no increase in cost. Four possible outcomes arise with different probabilities of:

1 both answers are 'yes'

2 a 'yes' followed by a 'no'

3 a 'no' followed by a 'yes'

4 both answers are 'no'.

Assuming each random term is Type 1 extreme value distributed, following Hanemann (1991), the following response probabilities are obtained for our model:

$$P(Yes-Yes)=P_n(YY)=1-\frac{1}{1+e^{\left(\alpha+\beta BID_U+\sum\gamma Z_n\right)}}$$

$$P(Yes-No)=P_n(YN)=\frac{1}{1+e^{\left(\alpha+\beta BID_U+\sum\gamma Z_n\right)}}-\frac{1}{1+e^{\left(\alpha+BID_1+\sum\gamma Z_n\right)}}$$

$$P(No-Yes)+P_n(NY)=\frac{1}{1+e^{\left(\alpha+\beta BID_1+\sum\gamma Z_n\right)}}-\frac{1}{1+e^{\left(\alpha+\beta BID_L+\sum\gamma Z_n\right)}}$$

$$P(No-No)=P_n(NN)=\frac{1}{1+e^{\left(\alpha+\beta BID_L+\sum\gamma Z_n\right)}} \quad (2)$$

where BID_1 is the initial bid; BID_U is the higher bid; BID_L is the lower bid; α, β and γ are parameters; Z is the socio-economic characteristics of the respondent n. For the dichotomous choice question, a double bounded logit model was used in this study. In this model, gender was entered as a dummy (MALE) that was assigned a value of 1 for males and 0 otherwise. Age was entered as two dummies, AGE1 and AGE2 representing the 16 to 24 and 25 to 35 age categories, respectively; the above 35 age group was the omitted category. Monthly income was measured by two dummies-INCOME1 representing the ≤ TK3,000 group and INCOME2 representing the TK3,000 to TK15,000 group; the > TK15,000 was the omitted category. Multicollinearity between income and education forced us to drop the latter from the estimated equation. Keeping income (rather than education) yielded better log likelihood ratio and McFadden R^2 statistics. Household size was entered in the model as the number of family members. Satisfaction on waste collection service provided by the waste collectors was a dummy (SATISFACTION) assigned a value of 1 if the individual was satisfied and 0 otherwise. All estimation analysis used in this study was undertaken by using the Econometric package LimdepNlogit 8.0 (Greene, 2002).

The estimation results from logistic regression model have been shown in Table 3. The mean WTP has been calculated from the estimated coefficients. Overall, the model depicts a satisfactory fit of 0.178 (McFadden R^2). The signs for all coefficients were consistent with our intuition. This study has found that AGE2, INCOME 2 and satisfaction variables were expectedly positive and highly significant. The negative coefficient on AGE2 variable, at level 1% level of significance, indicates that holding all other variables constant, older people are more willing to pay than younger and middle age people. This is unexpected and contradicts with the findings of other study (Caplan et al., 2002; Basili et al., 2006). The reason for this is in Bangladesh older people are more resistant to changing their ways of doing things around the house, and since waste

segregation and composting may be considered relatively new waste management practices, the households with older household heads are less likely to engage in waste segregation. So, their wiliness to pay is low.

Table 3 Factors affecting the willingness to pay of the households

Variables	*Estimation*	*Standard error*	*t-statistics*
Male	–0.126	0.297	–0.428
AGE1	0.12	0.45	0.04
AGE2	0.919	0.013	1.727*
HOUSE SIZE	0.071	0.095	0.747
INCOME1	0.064	0.083	0.771
INCOME2	0.623	0.203	3.06**
SATISFACTION	1.03	0.224	4.59**
BID	–0.1241	0.0111	–11.18**
LR statistics	21.23 (11 d.f.)		
McFadden R^2	0.172		

Notes: *$p < 0.10$; **$p < 0.05$

INCOME 2 (at 5%) has significant positive relationship with WTP. It is consistent since it can be seen from the literature, income and education has a positive effect on WTP (Jin et al., 2006; Danso et al., 2006; Basili et al., 2006; Caplan et al., 2002). Household member variable was unexpectedly not found to affect WTP levels significantly but it has a positive sign which is similar with the results of some previous studies (Othman, 2002; Jin et al., 2006). The positive coefficient of satisfaction is significant at 5% level of significance. This means that the respondents who are more satisfied on waste collection services are more willing to pay than the unsatisfied respondents. This is reasonable since the WTP of the respondents depends on their satisfaction on waste collection service provided by the waste collectors (Kassim and Ali, 2006). Considering the value of LR statistic with very small *p*-value (0.00001), it can be concluded that all the variables have a significant effect on the WTP of the Respondents.

Results from the logit equations in Table 5 are used to demonstrate the relationship between socio-economic variable, environmental attitudes and mean WTP. Mean WTP is calculated by assuming no negative values for waste management improvement in Dhaka city and using the formula suggested by Hanemann (1989):

$$E(WTP) = \left(\frac{1}{\beta_1}\right)^{*} \ln\left(1+\exp^{\beta_0}\right)$$

From the calculation, it has been found that the increase in service charge on average is 14.23 TK (USD0.16) per month. Presently, they are paying 10 TK. This means that they are willing to pay 24.13 TK per month as the waste collection service charge. Although this is very low compare to other studies (Morrison et al., 1998; Altaf and Deshazo, 1996) but it is reasonable compare to the current waste collection service charge which they are paying. The total number of households in DCC is 643,016. So, the aggregate value of WTP of the respondents in Dhaka city is (24.23 × 643,016) or 15.5 million Taka (USD 0.18 million).

6 Estimation model of households' recycling behaviour

The data collected via the survey were used to run a logit regression model of the form:

$$Log\left[P/(1-P)\right] = \beta_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots\ldots + \beta_k X_k + \varepsilon$$

$$Log\left[P/(1-P)\right] = \beta_1 + \beta_2 Gender + \beta_3 Age1 + \beta_4 Age2$$
$$+\beta_5 Income1 + \beta_6 Income2 + \beta_7 EnvConcern$$
$$+\beta_8 Distance + \beta_9 storagefacility$$

where P is the probability of the respondent being the recyclers; the Xs are explanatory variables hypothesised to influence the probability of recycling; βs are the coefficients of the explanatory variables; and ε represents the stochastic disturbance term. In the empirical exercise that follows, we only distinguish between who is recycler and who is non-recycler. Recycling is a relatively new idea in Bangladesh and respondents could not be expected to quantify the waste they recycled in a given time period. The dependent variable in the equation is dichotomous and measures whether the respondent recyclers (value = 1) or not (value = 0). In this study, $p / (1 - p)$ may be interpreted as the ratio of the probability that the respondent will recycle to the probability that he/she will not. Alternatively, it is the odds of the respondent participating in recycling. Gender was entered as a dummy (MALE) that was assigned a value of 1 for males and 0 otherwise. Age was entered as two dummies, AGE1 and AGE2 representing the 16 to 24 and 25 to 35 age categories, respectively; the above 35 age group was the omitted category. Monthly income was measured by two dummies-INCOME1 representing the ≤ TK3,000 group and INCOME2 representing the TK3,000 to TK15,000 group; the > TK15,000 was the omitted category. Multicollinearity between income and education forced us to drop the latter from the estimated equation. Keeping income (rather than education) yielded better log likelihood ratio and McFadden R^2 statistics.

Concern for the environment was a dummy (ENVIRON CONS) assigned a value of 1 if the individual was concerned and 0 otherwise. In trying to assess the importance of situational variables, actual distance (DISTANCE) to the recycling centre, in kilometres, was used to capture the effect of distance. Having storage space was captured by a dummy (STORAGE) that took on a value of 1 if storage space was present and 0 otherwise.

Table 4 presents the estimated model of households' recycling behaviour. It is evident that environmental consciousness, the availability of storage space, and AGE2 (25 to 35), are significant positive predictors of recycling behaviour (at the 1% level). Another variable INCOME 2 (TK3,000 to TK15,000) is also positively correlated with recycling (at the 5% level).

Space availability is self reported and some of those disinclined to recycle could be seeking to justify their behaviour by invoking storage constraints. The respondents who recycling regularly they have enough storage facility in their house to store the recyclable materials. Studies since the 1980s have examined so-called situational factors (such as availability of storage space and the distance to recycling centres) and personal factors (including awareness of pro-environmental campaigns and attitudes towards environmental protections) in influencing the propensity to recycle. Some studies have found that those with storage space in their homes were more likely to recycle (Margai,

1997; Stern et al., 1995; Tonglet et al., 2004). The lack of storage space increases the perceived cost of recycling by raising the level of personal discomfort.

Table 4 Factors influencing the recycling behaviour of the households

Variables	*Estimation*	*Standard error*	*t-statistics*
Constant	–1.23	0.72	–1.70
MALE	–0.28	0.20	–1.41
AGE1	–0.03	0.14	–0.21
AGE2	0.54	0.21	2.57*
HOUSE SIZE	0.33	0.23	1.39
INCOME1	0.02	0.41	0.04
INCOME2	0.54	0.26	2.07*
ENVIRON CONS	0.52	0.13	4.56**
STORAGE	0.92	0.20	4.52**
DISTANCE	0.01	0.01	1.00
LR statistics	–121.24		
McFadden R^2	0.36		

Notes: *$p < 0.10$; **$p < 0.05$

The coefficient of AGE2 is positive and it indicates that respondents in the middle age group (25 to 35) are likely to have a higher propensity to recycle relative to the old group. Demographic variables like gender and age have not shown consistently significant correlation with recycling behaviour. Studies in Holland, Germany and Norway suggest that older respondents are more devoted to recycling (cited in Fenech, 2002; Martin et al., 2006). This concern was hypothesised to reflect the frugality of the older generation. Barr (2004), Guerin et al. (2001) and Jenkins et al. (2000) reported similar findings. Fenech (2002), on the other hand, suggests that older people recycle simply because they have more time on their hands; after all, recycling is a time-intensive activity (Martin et al., 2006; Bruvoll et al., 2002). However, other studies failed to find a similar link between age and recycling (see the survey by Schultz et al., 1995), while at least one study reportedly found age to be negatively related to environmental concern (cited in Guerin et al., 2001). So, the results do not show a consistent, positive relationship between the probability of recycling and age. The reason may be interpreted as follows; the youngest respondents have not yet internalised the need to recycle, while the oldest respondents belong to a generation that never saw the need to recycle. Recycling and concern for the environment is a relatively recent phenomenon; in time, it is likely that the positive correlation between the likelihood of recycling and age will become more apparent in Dhaka Bangladesh.

INCOME2 is positively related with recycling behaviour. This suggests that the schedule reflecting the cost of recycling of the rich lies below those earning middle level and lower incomes. This is possibly because the rich have maids or others in their service to do households recycling; if recycling were an additional chore to the existing duties of the paid staff, the cost of recycling to the rich would be minimal. A constrained utility maximising model by Saltzman et al. (1993) predict that rising income levels would increase the propensity to recycle only paper, not other household materials. Jenkins

et al. (2000) report empirical evidence consistent with that prediction. However, the review of recycling studies by Schultz et al. (1995) found high income to be a good predictor of participation in recycling in general.

Environmental consciousness is also a positive indicator of recycling behaviour. If people are more conscious about the environment, they will know about the benefit of recycling and are more willing to recycle.

7 Conclusions

This study is to analyse the factors that promote household's waste generation and Dhaka city' residents' willingness to pay for waste management improvement. Data was gathered through interviewing the residents and 402 responds were further examined. The results of the study showed that the waste generation of the households in Dhaka city was significantly affected by family member, income, concern about the environment. This study has also found that the willingness to pay of the households has been significantly affected by middle age, middle income, satisfaction and bid/price variables. Furthermore, the results of the study showed that environmental consciousness, the availability of storage space, and middle age are significant positive predictors of recycling behaviour (at the 1% level). Another variable middle income is also positively correlated with recycling (at the 5% level).

The level of urbanisation in Bangladesh is low, but the rate of growth of urban population is very high and due to large total population the absolute number of population is also large. As a capital city, the rate of urbanisation is also high in Dhaka City Corporation area. Dhaka has a large population with high density but less support for waste management. The existing facilities need to be increased and the method of waste management needs to be developed to ensure proper waste management. The legal and institutional framework for waste management are not going in line with the right path to resolve the problems of solid waste management due to various limitations, irregularities, mismanagement, lack of good governance, etc. If the factors influencing household waste generation identified by the analysis of the study be managed properly, the present scenario of improper solid waste management will be improved. Majority (75%) of the respondents stated their dissatisfaction on the waste collection services provided by the DCC. The municipal authority should take a lead in organising a concerted and coordinated effort with other governmental and non-governmental agencies in solving the problem of the city. The community people should also be mobilised in such efforts, because people's participation is very much fruitful in improving the environmental situation. Recycling of waste at a rudimentary level is an age old trend of Bangladesh and source of livelihood of many poor people. But no significant attempt has been taken so far to create awareness among residents regarding proper disposal of waste and recycling. It is worth mentioning here that several non-government organisations (NGOs) like waste concern, Prodipon are working relentlessly in this sector. It is necessary to create an institutional structure where community organisations, NGOs and government organisation (GOs) can work together. Especially NGOs can bridge the gap between the community and the GOs.

In addition to municipal tax, most of the residents are paying voluntarily or compelled to pay for the services to improve environment of their community. It includes disposal of waste, maintenance of drains, mosquito control, certification process service, etc. It is

evident from the study that residents are willing to pay on average an increase in service charge 14.23 TK (USD0.22) per month. So, the aggregate value of WTP of the respondents in Dhaka city is (24.23 × 643,016) or 15.5 million Taka (USD 0.18 million).

About the separation of household waste, 27% of the respondents stated their willingness to separate the waste. This indicates that Dhaka residents have a positive attitude towards solid waste management programme and this is a long-awaited development in the progress towards a sustainable solid waste management in Dhaka city.

The present solid waste management practice being followed is based on the end-of-pipe approach, i.e., collect-transport-dispose. This approach is neither sustainable nor cost-effective. The strategy for sustainable solid waste management in Dhaka city should be based on 4R's principle, i.e., reduce, reuse, recycle and recovery of the waste. The main objectives of this strategy should be

- Prioritising waste avoidance over recycling and recycling over the other forms of environmentally sound disposal methods.
- Reuse non-avoidable waste as far as possible.
- Maintain the content of hazardous substances in waste at the lowest possible level.
- Guarantee an environmentally sound waste collection, transportation, resource recovery and disposal system.
- Promotion of public-private-community partnerships in solid waste.
- Establishment of recycling programme could be an effective strategy in implementing sustainable waste management in Bangladesh. For this strategy to succeed, however, active partnership between the households and waste management service department is required. The households' willingness to pay for improving the solid waste management and determinants of waste generation and recycling behaviour of the households should therefore be taken into consideration as should the results of this study, which are important indicators of households' positive attitudes toward sustainable waste management in Dhaka.

References

Ahmed, M.F. and Rahman, M.M. (2000) 'Solid waste management: water supply & sanitation – rural and low income urban communities', ITN – Bangladesh, Center for Water Supply and Waste Management, BUET, Dhaka, Bangladesh with contribution from IRC, International Water and sanitation Center, Delft, The Netherlands.

Alam, A.K.M.M., Saha, S.K. and Rahman, M.M.S. (2002) 'Aspects of solid waste management – a case study at Nirala Residential Area, Khulna', in Ahmed, M.F., Tanveer, S.A. and Badruzzaman, A.B.M. (Eds.): *Bangladesh Environment*, pp.698–711, Bangladesh Poribesh Andolon (BAPA), Dhaka.

Altaf, A. and Deshazo, J.R. (1996) 'Demand for solid waste management: a case study of Gujrawala, Pakistan', *World Development*, Vol. 24, No. 1, pp.857–868.

Bangladesh Bureau of Statistics (BBS) (1999) Population Census 1991.

Bangladesh Bureau of Statistics (BBS) (2001) Population Census 2001.

Barr, S. (2004) 'Are we all environmentalists now? Rhetoric and reality in environmental action', *Geoforum*, Vol. 35, No. 2, pp.231–249.

Basili, M., Matteo, M.D. and Ferrini, S. (2006) 'Analyzing demand for environmental quality: a willingness to pay/accept study in the Province of Siena (Italy)', *Waste Management*, Vol. 26, No. 3, pp.209–219.

Bruvoll, A., Halvorsen, B. and Nyborg, K. (2002) 'Household's recycling efforts', *Resources, Conservation and Recycling*, Vol. 36, No. 4, pp.337–354.

Caplan, A.J., Grijalva, T.C. and Jakus, P.M. (2002) 'Waste not or want not? A contingent ranking analysis of curbside waste disposal options', *Ecological Economics*, Vol. 43, No. 13, pp.185–197.

Central Intelligence Agency (CIA) *The World Factbook*, available at https://www.cia.gov/library/publications/the-world-factbook/geos/BG.html (accessed on 8 July 2010).

Corral-Verdugo, V. (1997) 'Dual 'realities' of conservation behavior: self-reports vs. observations of e-use and recycling behavior', *Journal of Environmental Psychology*, Vol. 17, No. 2, pp.135–145.

Danso, G., Drechsel, P., Fialor, S. and Giordano, M. (2006) 'Estimating the demand for municipal waste compost via farmers' willingness to pay in Ghana', *Waste Management*, Vol. 26, No. 12, pp.1400–1409.

Dhaka City Corporation (DCC) (2005) 'Clean Dhaka master plan: the study on the solid waste management in Dhaka city', Final Report, Dhaka.

Enayetullah, I., Sinha, A.H.M.M. and Khan, S.S.A. (2000) 'Urban solid waste management scenario of bangladesh: problems and prospects', Waste Concern Technical Documentation, pp.3–18, Dhaka, Bangladesh.

Fenech, M. (2002) 'Understanding public participation in source separation of waste', MSc thesis, Institute for Industrial Environmental Economics, Lund, Sweden.

Green, S.B. and Salkind, N.J. (2008) *Using SPSS for Windows and Macintosh: Analyzing and Understanding Data*, Pearson Prentice Hall, USA.

Greene, W.H. (2002) *LIMDEP Econometric Modeling Guide Version 8.0*, Econometric Software Inc., New York.

Guerin, D., Crete, J. and Mercier, J. (2001) 'A multilevel analysis of the determinants of recycling behaviour in the European countries', *Social Science Research*, Vol. 30, No. 2, pp.195–218.

Hanemann, M.W. (1991) 'Willingness to pay and willingness to accept: how much can they differ?', *American Economic Review*, Vol. 81, pp.635–647.

Hanemann, W.M. (1989) 'Welfare evaluations in contingent valuation experiments with discrete response data. Reply', *American Journal of Agricultural Economics*, Vol. 71, No. 4, pp.1057–1061.

Harvie, M. and Jaque, P. (2003) 'Public awareness and the environment: 'how do we encourage environmentally responsible behavior?', *Water Supply*, Vol. 3, No. 3, pp.247–254.

Hasan, G.M.J. and Chowdhury, M.A.I. (2005) 'Municipal waste management and environmental hazards in Bangladesh', *Pakistan Journal of Biological Science*, Vol. 8, No. 6, pp.921–928.

Jenkins, R.R., Martinez, S.A., Palmer, K. and Podolsky, M.J. (2000) 'The determinants of household recycling: a material specific analysis of recycling program features and unit pricing', Discussion Paper 99-41-REV, Resources for the Future, Washington, DC.

JICA (2005) 'The study on solid waste management in Dhaka city', Clean Dhaka Master Plan, Final Report, Japan International Cooperation Agency, Pacific Consultants International, Yachiyo Engineering Co., Ltd.

Jin, J., Wang, Z. and Ran, S. (2006) 'Estimating the public preferences for solid waste management programs using choice experiments in Macao', *Waste Management and Research*, Vol. 24, No. 3, pp.301–309.

Kassim, S.M. and Ali, M. (2006) 'Solid waste collection by the private sector: households' perspective – findings from a study in Dar er Salaam City, Tanzania', *Habitat International*, Vol. 30, No. 4, pp.769–780.

Margai, F. (1997) 'Analyzing changes in waste reduction behavior in a low-income urban community following a public outreach program', *Environment and Behavior*, Vol. 29, No. 6, pp.769–792.

Martin, M., Williams, I. and Clark, M. (2006) 'Social, cultural and structural influences on household waste recycling: a case study', *Resources, Conservation and Recycling*, Vol. 48, No. 4, pp.357–395.

Morrison, M.D., Bennett, J.W. and Blamey, R.K. (1998) 'Valuing improved wetland quality using choice modelling', Choice Modelling Research Report No. 6, School of Economics and Management, University College, The University of New South Wales.

Othman, J. (2002) *Estimating Public Preferences for Waste Management in Malaysia*, Economic and Environmental Program for South Asia (EEPSEA).

Rahman, M.M., Hossain, M.D., Badruzzaman, A.B.M., Ali, M.A. and Rahman, M.M. (1999) *Characterization of Municipal Solid Waste and Preliminary Environment Impact Assessment of Collection and Disposal Wastes in Dhaka City*, Bureau of Research, Testing and Consultation (BRTC), BUET, Dhaka.

Salequzzaman, M. (2000) 'Perceptions of vehicle air pollution in Khulna, Bangladesh', in *Proceedings of the Habitus 2000 Conference*, Perth, Australia, pp.5–09.

Salequzzaman, M. and Stocker, L. (2001) 'The context and prospects for environmental education and environmental careers in Bangladesh', *International Journal of Sustainability in Higher Education*, Vol. 2, No. 2, pp.104–127.

Salequzzaman, M., Awal, M. and Alam, M. (2001) 'Willingness to pay: community based solid waste management and its sustainability in Bangladesh', in *Proceedings of the International Conference 'The Future is Here'*, RMIT, Melbourne, Australia, pp.15–19.

Salequzzaman, M., Murtaza, M.G. and Saroar, M. (1998) *Evaluation Study on Municipal Solid Waste Management Project in Khulna City*, PRODIPAN, Shaheb Bari Road, Khulna 9203, Bangladesh.

Saltzman, C., Duggal, V.G. and Willians, M.L. (1993) 'Income and the recycling effort: a maximization problem', *Energy Economics*, Vol. 15, No. 1, pp.33–38.

Schultz, P.W., Oskamp, S. and Mainieri, T. (1995) 'Who recycles and when: a review of personal and situational factors', *Journal of Environmental Psychology*, Vol. 15, pp.105–121.

SERI (2008) 'Cash from trash: recycling as an economic activity in Penang', *Penang Economic Monthly*, Vol. 10, No. 9, pp.1–9.

Sinha, A.H.M.M. (2006) 'Community based solid waste management through public-private community partnerships: experience of waste concern in Bangladesh', in *3R South Asia Expert Workshop*, Kathmandu, Nepal.

Stern, P.C., Dietz, T. and Guagnano, G.A. (1995) 'The new ecological paradigm in social psychological context', *Environment and Behavior*, Vol. 27, No. 6, pp.723–743.

Sujauddin, M., Huda, M.S.M.S. and Rafiqul, A.T.M. (2008) 'Household solid waste characteristics and management in Chittagong, Bangladesh', *Journal of Waste Management*, Vol. 28, No. 9, pp.1688–1695.

Tariq, B.U. and Mustafizur, R. (2007) 'Monitoring quantity and characteristics of municipal solid waste in Dhaka City, Bangladesh', *Journal of Environmental Monitoring and Assessment*, Vol. 35, Nos. 1–3, pp.3–11.

Tonglet, M., Phillips, P.S. and Read, A.D. (2004) 'Using the theory of planned behaviour to investigate the determinants of recycling behaviour: a case study from Brixworth, UK', *Resources, Conservation and Recycling*, Vol. 41, No. 3, pp.191–214.

UNCRD (1998) *Compendium of Facts and Figures on Solid Waste Management in Asian Metropolises*, United Nations Centre for Regional Development, Nagoya, Japan.

Wheater, C.P. and Cook, P.A. (2000) *Using Statistics to Understand the Environment*, Routledge, London.

Yousuf, T.B. (2005) 'Sustainability and replication of community-based composting-a case study of Bangladesh', PhD thesis, Loughborough University, Leicestershire, UK.

Yusuf, T.B. and Rahman, M. (2007) 'Monitoring quantity and characteristics of municipal solid waste in Dhaka City', *Environmental Monitoring and Assessment*, Vol. 153, Nos. 1–3, pp.3–11.

Zuberi, M.I. (1998) 'Environmental, socio-cultural and developmental linkages in a South Asian set-up', *International Journal of Social Economics*, Vol. 25, Nos. 6/7/8, pp.1112–1127.