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The Role of Socio-Economic Factors on Household Waste Generation: A Study in a Waste Management Program in Dhaka City, Bangladesh

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Abstract: Information on waste generation, socio economic characteristics and willingness of the households towards waste separation of waste were obtained from interviews with 402 respondents in Dhaka city. Ordinary Least Square (OLS) regression was used to determine the dominant factors that might influence the waste generation of the households. The results showed that the waste generation of the households in Dhaka city was significantly affected by household size, income, concern about the environment and willingness to separate the waste. These factors are necessary to effectively improve waste management, growth and performance as well as to reduce the environmental degradation of the household waste.

Key words: Waste generation, ordinary least square method, socio-economic factors, recycling, wilingness, performance

INTRODUCTION

Urban solid waste management is considered to be one of the most serious environmental problems confronting urban areas in developing countries (Pfammatter and Schertenleib, 1996; Sinha and Enayetullah, 2000) and the city of Dhaka in Bangladesh is not an exception. Dhaka city with >10 million inhabitants is one of the fastest growing mega cities in the world. In the period of 1991-2004, it has an average annual growth rate of population >4%. The Dhaka metropolitan area also offered to as the Dhaka mega city, occupies an area of about 1353 km^2 (Enayetullah and Sinha, 1999). About 6 million residents live under the Dhaka City Corporation (DCC) in an area of 344 km^2 (Enayetullah and Sinha, 1999).

In the DCC area, solid waste generation is about 3200 ton day^{-1} of which 1400 ton day^{-1} is transported and collected, 435 ton day^{-1} is recycled, 1380 ton day^{-1} is illegally dumped and 1385 ton day^{-1} is finally disposed to the landfill (DCC, 2005). So, DCC is able to collect about 37% of total solid waste generated. Irrespective of the municipal authorities ability to collect it, both collected and uncollected waste creates problems for the city residents. Furthermore with increase in population and horizontal expansion of the city, it has become very difficult to find adequate waste disposal sites for the future. So, there is a dire need to increase the public awareness of the waste problem and to estimate the factors which are responsible for increasing waste generation. If the influential factors of increasing waste generation can be identified, it will be helpful for the environmental and waste management planners in their decision making for managing waste and environmental pollution. In early days economists discussed about the socio-economic factors influencing waste generation by the households. Kenneth (1976) discussed about the economic aspects of household's decisions to produce more or less refuse. He mainly analyzed the theoretical concept about household behavior on waste generation due to the changes in income, price of refuse service, frequency of service, site of refuse collection and packaging. He also discussed on resource implications of the local government policy which refrains from the pricing of public refuse service to households. Economists also compared the composition and quantity of waste in terms of income level, household size and age structure of the household. The household size, household income and population were important factors affecting the quantity and composition of solid waste. The study shows that grass, yard wastes and newspaper were positively correlated to the level of income (Richardson and Havlicek, 1978). Although, models are available to predict waste generation and recycling behaviour in developed countries, very little

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work has been done so far to develop models applicable in developing countries. Undoubtedly the data and the models generated in developed countries cannot be implemented in developing country situations without site specific data gathering and analysis.

This study aims to contribute to a better understanding of household waste management behavior by examining waste management practices and attitudes of the residents of Dhaka city, Bangladesh. More specifically, it analyzes the factors that promote household waste generation. The results of the study will provide inputs into the formulation of local waste management plans and programs, particularly on waste segregation and recycling activities of the residents of Dhaka city, Bangladesh.

MATERIALS AND METHODS

Empirical model of waste generation and socio-economic factors: To develop an effective waste management strategy for a given region, it is important to know the amount of waste generated and the composition of the waste stream. Various researchers have shown that the amount of waste generated by a country is proportional to its population and the mean living standards of the people (Kenneth, 1976; Grossmann *et al*., 1974; Medina, 1997) related waste generation rates to income levels of people. However, it has been shown that these are not only the governing factors. Among other socio-economic factors that have been said to influence solid waste generation are households size, cultural patterns, education and personal attitudes (Al-Momani, 1994; Grossmann *et al*., 1974). In recognition of the importance of a reliable tool to predict the solid waste characteristics, various researchers have attempted to construct models to predict these parameters. They found that relationships obtained between various parameters vary by country.

This has been attributed to variations in consumer behaviour and lifestyles. This section, mainly discusses the empirical analysis of the relationships of quantity and composition of household solid waste to selected social and economic variables. Normally waste is a function of consumption. The relationship between waste and consumption activities may be expressed as (Richardson and Havlicek, 1978):

$$W = \beta C$$

Where:

W = Vector of components of solid waste

β = Vector of technical waste transformation coefficients relating the types and quantities of solid waste to each consumption activity

C = Vector of consumption activities selected by the household and it is related to the classical utility maximization framework (Richardson and Havlicek, 1974)

Any particular waste may be generated by the consumption of more than one commodity. Here no attempt is made to identify the technical waste transformation coefficients associated with the individual products. It mainly tries to compare the relationship between household total waste generation and socio-economic variables affecting the quantity of waste. To determine the factors that affect waste generation of the households selected, this study followed a multiple regression model. The Ordinary Least Square (OLS) method was used to estimate the parameters in multiple regression models. The significant relationships between dependent and independent variables was examined by the value of the correlation coefficient (R) in two variable cases and for the multivariate case, t-values, R^2, adjusted R^2 and F-values were estimated. As such, the model assesses the relationship between various factors and the waste generation of the households. In this regression analysis, the total solid waste generation of the households per month is regressed due to its quantitative nature by several independent variables. The model is:

$$Y = \beta_0 + \beta_1 X_i + e$$

Where:

Y = Total waste generation per month

X_i = Independent variables

β_0 = Constant term

β_1 = Coefficient of independent variables

e = The error or disturbance term

The independent variables of this model are household size, education, income and extra land within the compound of the household which has been shown in Table 1.

Empirical design and data collection: All the respondents are 18 years old or above 18 years old. Before the final survey a pretest was conducted in April 2006. The pretest involved 10 participants and was conducted on their understanding of the question asked. After 1 week later, about 50 people have been interviewed in the second pretest which focused on the range of the bids used in the WTP questions. In August, 2006 the final survey was conducted in Dhaka city, Bangladesh.

Survey design and sampling method: In developing countries like Bangladesh, telephone or mail surveys appear to be impractical and are not common. Many

Table 1: Variables included in the regression model

Variables	Definition	Mean±SD
Family member	Number	4.4±1.40
Education	Dummy to represent university 1 and others 0	0.6±0.50
Income	Household monthly income (1000TKa/month)	11.7±7.00
Consciousness about environment	Dummy to represent conscious about environment 1 and not conscious about Environment 0	0.7±0.50
Agree to separate	Dummy to represent agree 1 and not agree 0	0.3±0.50
Extra land within the compound	In acre	0.1±0.02 0.1±0.02

people do not have telephones (<80% in Dhaka city) and normally, telephones belong to richer class of the population (BBS, 1999). On the other hand, there is no list of mailing addresses or street directory and the mailing system is not reliable. Many people are illiterate and do not have the ability to read mailed survey information. The direct face to face interview is the most commonly used approach and was employed in this study. The questionnaire has three sections. The first section asked the respondents about their knowledge and concern on environment, knowledge and attitude on waste management and recycling activity.

Knowledge here refers to respondent's awareness on recycling issues, information on what are recyclable and non-recyclable wastes who can collect wastes and where solid waste can be disposed (as advertised by Bangladesh Government in the mass media). 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.

The second section asked the respondents about their recycling activity and waste disposal practices. The third section asked the respondents about their socio-economic information.

Target population: The target population of the survey is residents of Dhaka city residing in a house be it an independent house, an apartment, a flat or a shanty. Institutional households such as hostels, hospitals, clinics, nursing homes, jails, barracks or orphan ages and floating people were excluded from the target population as they do not form a household for tax purposes. A residence-cum office/business was considered to be a household. It was decided to confine the survey within Dhaka city because of the time and resource constraints and on the basis of the understanding that these residents are the immediate beneficiaries of door to door waste collection systems which has been introduced by DCC.

Unit of analysis: Another consideration which needed to be addressed was whether the data on household waste management behaviour should be collected for households (Carson *et al*., 1992; McConell, 1995) or on an individual basis (Kealy *et al*., 1990; Imber *et al*., 1993). Given the household as unit of analysis, the reference income used is the household rather than the individual respondent's income.

The reason for choosing household as the unit of analysis is linked with the cultural practice in Bangladesh. In most cases joint-family structure still exists and incomes are joined together for the purpose of any expenditure decision.

All these justify the choice of households as a unit of analysis. The Bangladesh Bureau of Statistics (BBS's) definition of household namely a dwelling place where person or persons related or unrelated are living together and taking food from the same kitchen (BBS, 1999) was adopted for this study.

Household selection: The study area (i.e., geographic boundary) of this study is restricted to Dhaka city, the capital of Bangladesh. Dhaka city, as defines by DCC is comprised of 14 thanas and each thana is turn contains about 4-17 wards. In total, there are 90 wards as per the 2001 statistics (BBS, 2001). Each mohalla contains one or few streets and a varying number of households.

Altogether, there are 659 mohallas and the total number of households in Dhaka city is 643,016 (BBS, 1999). In selecting a sample from this target population of the survey, the important consideration was how to identify or select the respondents among the population (i.e., from >643 thousand households).

One of the options would have been to use the voters list. However, during the period of sample frame design and survey, a new voters list was being prepared to be used in 2007 general election and it was considered as a confidential document at that stage.

Furthermore, although in many studies the voters list has been used a sampling frame, it was not considered a reliable sample frame because the unit of analysis in this

study is the household (the voters list contains only the individual population). From 90 wards, 8 wards have been selected randomly which comprised of 16 mohallas and 413 households. After censoring for missing information and inconsistent answer, 402 (97%) were valid for further examination.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents: Table 2 shows the socio-economic characteristics of the respondents. The study has found that 64.4% of the respondents are male and 35.6% of the respondents are female. The average age was just under 39 with the lowest being 32 and the highest 65 years old. The household size is on average 4. The highest percentage of the respondents have university degree (57.0%) followed by 24.1% with diploma and certificates, 6.5% have reached Higher Secondary Certificate (HSC) levels, 3.5% have reached Secondary School Certificate (SSC) levels, 5.5% have reached primary level and 3.5% have no formal education.

The proportion of respondents with a university degree was quite high for a developing country like Bangladesh. The reason may be the study area was chosen on the basis of highest waste generation area. There is a positive relation between income and waste generation (Bandara *et al*., 2007) So, it can be assumed that most of the respondents were highly educated with high income. Most of the respondents (54.6%) were service holder (paid employment). The corresponding 21.2% were business man, 17.1% were house wives and 7.1% were retired persons. On average the monthly household income of the respondents was 176.1 US Dollar (I US Dollar = 70.1 BD Taka).

Table 2: Descriptive statistics of socio-economic characteristics of the respondent

Item	No. of respondents	Percentage
Sex		
Male	270	67.1
Female	132	32.9
Education		
No formal education	13	3.3
Primary education	19	4.8
Secondary School Certificate (S.S.C)	23	5.7
Higher School Certificate (H.S.C)	47	11.8
Diploma	54	13.4
University	246	61.0
Employment		
Service holder	216	53.7
Business man	90	22.4
House wife	78	19.5
Retired	18	4.4
Item	**No. of respondents**	**Average**
Household monthly income	Taka (USD)	12000 (172)
Age in years	402	39
Family members (number of persons)	402	4
Extra land with the compound	402	0.5 acre

Waste generation in the households: The respondents were asked normally who is collecting and placing of solid waste generated in the households. It has been found that 64% of the respondents stated that the waste has been collected and placed by the maid (Fig. 1). 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 or a daughter in law or house maid.

The respondents were asked how many container of waste each household produced on average per 3-4 days. Most respondents (56.4%) produced 3-4 waste containers (Fig. 2). A typical waste container contained around 1 kg of waste. Waste generation in the study area averaged 38 kg month^{-1} for each household. As the number of persons per household averaged 4, per capita waste generation thus averaged around 0.3 kg day^{-1} which is similar to the findings of DCC (2005).

Knowledge about recycling: The respondents were asked about the knowledge about recycling. Majority of the respondents (61.94%) stated that they have knowledge about recycling of solid wastes.

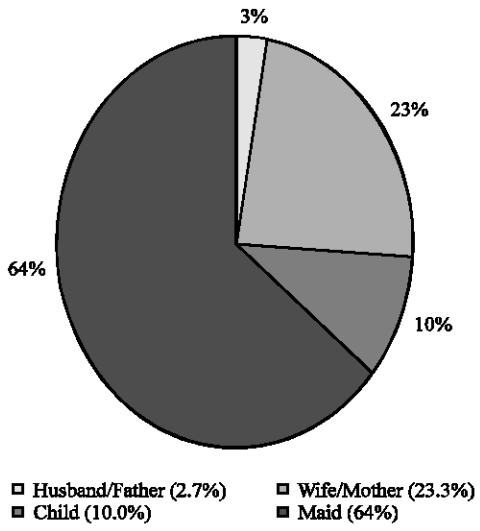

Fig. 1: Normally who does the collecting and placing of wastes for disposal (n = 402)

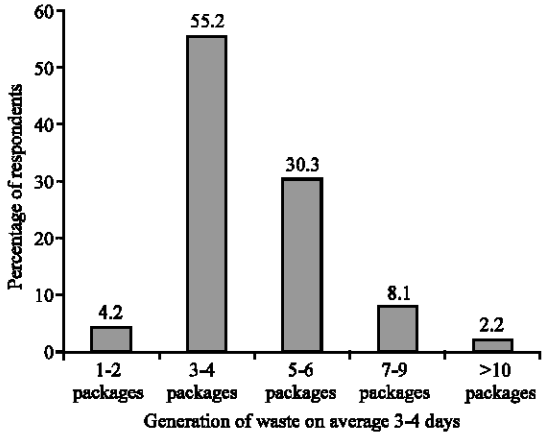

Fig. 2: Packages of wastes on average 3-4 days (n = 402)

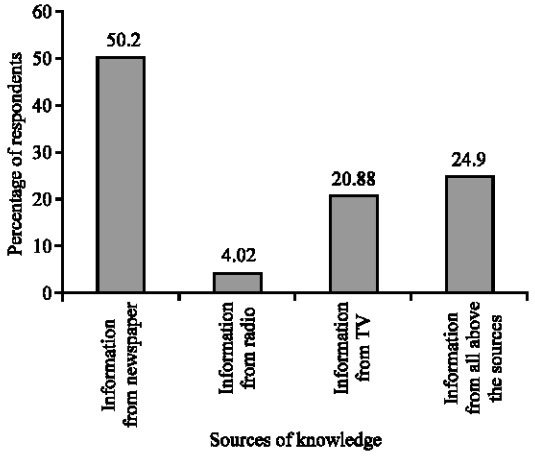

Fig. 3: Sources of knowledge about recycling (n = 402)

Then they were asked about their source of knowledge about recycling. With regard to the source of knowledge, the majority (50.2 and 20.8%) obtained their knowledge about recycling from newspaper and television (Fig. 3). So, newspaper and television have been most influential in promoting environmental issues.

Waste recycling practices: The respondents were asked whether they were doing recycling regularly, never or seldom. For recycling practice, only about (25.6% for regularly recycled (Table 3). On why respondents have never or seldom recycled their wastes, the reasons given were: no recycling facilities (3.09%), lack of time (38.49%), no economic incentives (3.9%), no space at home (37.2%), do not know (5.4%) and recycling is expensive (12.0%) (Table 4).

The reasons given by those who practiced waste recycling were good for the environment (68.0%) allows for waste composting (10.7%) and earn extra income (21.4%) (Table 5). The households were also presented the new policy of the government where they will be asked to separate the waste and will be given different container to keep their household waste. The study has found that 30.1% of the households are willing to separate their waste if the facilities will be provided to them.

Estimation results of waste generation and socio-economic model: The estimation result of waste generation and socio-economic model has been shown in Table 6. This study has found that income and household size were expectedly positive and highly significant. The positive coefficient on income variable at 5% level of significance indicates that holding all other variables constant, higher income people are generating more waste than the lower income people. The positive relationship between these two variables is generally supported by the previous literature (Jenkins *et al*., 2003; Jekins, 1993; Hong *et al*., 1993). The positive coefficient on households size, at 5% level of significance indicates that holding all other variables constant, large family are generating more waste than the small family. The coefficient of education

Table 3: Practice of recycling

Answer	No. of respondents	Percentage
Never practiced recycling	226	56.2
Seldom did	73	18.2
Regularly practiced it	103	25.6
Total	402	100.0

Table 4: Reasons of never or seldom practice of recycling

Reasons	No. of respondents	Percentage
There was no facility for recycling	9	3.1
Lack of time	115	38.5
No economic incentive	12	3.9
No space at home	111	37.2
Do not know	16	5.4
Expensive to recycle	36	12.0
Total	226	100.0

Table 5: Reasons for regular practice of recycling

Reasons	No. of respondents	Percentage
Good for evironment	70	68.0
Allows for composting	11	10.7
Earn for extra Income	22	21.4
Total	103	100.0

Table 6: Factors affecting the solid waste generation

Variables	Estimation	SE	t-statistics
Household size	0.221	0.0082	27.01***
Education	0.263	0.1413	1.23
Income	0.832	0.2659	3.15*
Concern about the environment	1.90	0.78	4.32***
Willingness to separate	0.56	0.12	2.33***
Extra land within the compound	0.08	1.58	0.05

*Significant at p = 0.05; ***Significant at p = 0.01

variable is positive but it is not significant. However, a number of other studies have also found that the effect is positive but statistically not significant (Hong and Adams, 1999; Fullerton and Kinnaman, 1996). As might be expected, the coefficient for the attitudinal variable for concern about Environment is positive and statistically significant at 1% level of significance 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 program. The positive sign for concern about Environment is supported by the results of the study conducted. The positive coefficient for willingness to separate wastes was also significant at 1% level of significance. This means that the respondents who agree to separate the waste at their house are willing recycling more and generating less waste. Extra land area has positive but insignificant effect. In the study area, there are very few households with extra land area; the result will not be useful in the analysis.

The goodness of fit for the model has been tested in this study with some diagnostic tests which fulfill the following criteria of good results. First, the adjusted R^2 value (which is a measure of goodness of fit of the estimated regression model) of 0.51 depicts a good fitting of the model which defines that 51% of the variation in change of the waste generation of the households could be explained by the independent variables in the model. In this model, the observed R value of 0.73, R^2-value of 0.55, and the F-test shows that the estimated regression is quite meaningful in the sense that the dependent variable is related to each of the specified explanatory variables. The linear relation of the model is highly significant (the p-value for the F-test is <0.0001). Second, the signs for the estimated coefficients are consistent with the theoretical or prior expectations.

Third, most of the estimated coefficients are statistically significant at the 0.01 and 0.05 level which is significantly different from zero. To identify the occurrence of multicollinearity, the correlation matrix of the explanatory variables was studied. The results of this multiple regression model showed the best in the sense of involving no multicollinearity that is ensuring No. 2 independent variables have a correlation in excess of 0.70. This means that the independent variables are not too highly related to each other. Moreover, the study employed the technique of collinearity diagnostics to eliminate the problem of multicollinearity. The eigenvalues of the explanatory variables were also studied by factoring the scaled, uncentered cross products matrix of the explanatory variables. Eigenvalue provides an indication of how many distinct dimensions are among the explanatory variables. In this model, several eigenvalues of the explanatory variables are not close to 0, thus the variables are expressed to not be intercorrelated and the matrix is showed to be efficiently conditioned.

CONCLUSION

This study has found that majority of the respondents stated that they have knowledge about recycling of solid wastes. With regard to the source of knowledge, the majority obtained their knowledge about recycling from newspaper and television. Regarding recycling although it is conducted mostly by informal sector, the government in Bangladesh is trying to promote the households through television and newspaper to separate their households waste and to recycle the recyclable materials. So, newspaper and television have been most influential in promoting environmental issues. The response for radio was low considering it is a developing city. But the reason is due to the sampling problem because we choose the sample from high income area and they eventually don't use radio. This study has also found that 25.6% of the respondents are doing recycling regularly. It must be pointed out that most people in Dhaka were not and still are not served by any convenient recycling network. But in this case, 25.6% of the respondents did at least sometimes separate household waste for recycling.

This was quite encouraging. This study employed regression model to determine the dominant factors that might influence the waste generation of the households. It is evident from the findings of the study is that income has a positive significant effect on waste generation of the households. This result seems reasonable since increase in income is expected to increase the demand for convenience factors and services embodied in commodities. Another variable is also expectedly positively related with household waste generation. A larger household size is expected to generate higher quantity of waste since more households are included in the unit thus, the sign is also expected to be positive. As might be expected, the coefficient for the attitudinal variable for concern about Environment is positive and statistically significant. Environmentally concerned food buyers were hypothesized to be less likely to buy foods with a high level of processing and packaging, This preference would lead to a negative relationship between favorable environmental attitude and the amount of food packaging. Furthermore, environmental awareness may lead to recycling or conservation which would reduce the solid waste. The positive coefficient for willingness to

separate wastes was also significant. This result indicates that Dhaka residents have a positive willingness to pay for the new solid waste management program which includes a waste minimization and recycling option. This is a welcome development in the progress towards a sustainable solid waste management program.

Policy implication: A number of the findings in this study, if confirmed by subsequent testing might be useful in developing public policies concerning household waste. It is evident that environmental consciousness is significant positive predictors of waste management. So, in this study it is suggested that concerted efforts to raise environmental consciousness through education and more publicity regarding waste reducing and recycling could affect the households waste generation.

In recent years reducing and recycling of households waste has become increasingly imperative because waste generation has been increasing with increase in population and economic development and resources has been becoming scarce making recycling not only sensible practice but essential. Although, there is wide spread public support for reducing and recycling of households waste this is not reflected in participation levels in Bangladesh. For example this study has found that only 30.1% of the households are willing to separate their household waste if the facilities will be provided. The study has also found that only 25.6% of the households are doing recycling regularly. So, the reasons for this disparity need to be investigated.

It is suggested in this study that we should investigate what motivates people to reduce and recycle their waste and what discourages them from participating. It is essential now because the government is also attempting to reduce waste and increase recycling rates which will improve the quality of waste management system. A study by Tam and Tam (2008) showed that reward schemes and incentive systems contribute to the employee awareness and motivation regarding waste reduction, reducing waste up to 23%.

As such, policies should be formulated to focus on raising awareness, promoting knowledge and motivating households with regard to environment and waste management practices. Thus, these policy implications should be helpful to environmental and waste management planners as well as to policy makers as they manage household waste in order to reduce environmental pollution and hopefully improve performance within the household. For the waste management program to be successful, the attitudes of the residents of Dhaka towards waste reducing and recycling should be taken into consideration as should the results of this study which are important indicators of positive attitudes of the residents towards waste reducing and recycling.

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