

Factors Affecting Households' Waste Recycling and Reusing Behavior- A Study on Rajshahi City, Bangladesh

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Abstract: Management of wastes has arisen as a gigantic task in the present time, because intensive economic and industrial growth has raised the size and amount of wastes to such an extent, which is very difficult to deal with and find suitable place to dump these and properly manage them. The present study aims to analyze the waste recycling and reusing behavior of the households of Rajshahi city and to identify the factors that affect their waste recycling and reusing behavior. The study has extended the theory of planned behavior (TPB) and made use of their behavior related variables including wastes reusing and recycling. A well-structured questionnaire was carried out with 360 randomly selected respondents in Rajshahi City. Respondents' households were asked questions regarding their socioeconomic and waste related behavior through a well-structured questionnaire. Binary Logistic Regression Model (BLRM) has been applied to identify factors affecting their waste related behavior. In case of waste recycling and reusing behavior, about 80% have reported that they frequently practice waste recycling and reusing. The result of the logistic regression model shows that education, level of income, daily amount of waste generation in the household and their environmental consciousness significantly influence their waste recycling and reusing behavior. The findings of the study has significant implications for guiding policies to enhance waste recycling activities of the area through the simultaneous participation of households and municipal authorities to attain sustainable environment.

Keywords: *Waste, Recycling, Reusing Behavior, Logistic Regression Model*

Introduction: Waste management has arisen as an increasingly serious issue of the 21st century due to growing world population, linear approach of industrialization and consumerism [1]. All these lead to rapid waste generation and lack of proper management of these wastes is responsible for adverse ecological degradation and this severely affect human organism and their social and economic status [2]. Therefore, sustainable environment has become the demand of the present world for preserving the health of all the living beings on this planet [3]. Solid wastes are any type of rejected or undesirable materials, garbage, refuse or trash generated because of daily doings and activities of the community [4]. Households are one the leading sources for generation of such type of wastes and generally generate both the organic type and inorganic type of wastes including food, metal, paper, plastic, glasses, rubber, furniture, leather, clothing, rags e-waste and what not [5]. Due to inefficient and ineffective waste collection and management procedure, it has become a major concern for many regions and cities [6]. The harms caused by these wastes to every human, animal in a world flora and fauna are indescribable. The (2022) report of World Bank has appraised that due to rapid urbanization and increased urban population the yearly solid waste generation will have increased by 73% from 2020 levels to about 3.88 billion tons by 2050 and about 0.79 kilogram daily per capita [7]. The repercussions caused by waste disposing operations may be forwarded to our future generations [8] after affecting the present generation.

In many emerging and developing countries, waste reuse and recycling practices are not well developed due to fragile economic and political institutions [9]. The rapid population growth and economic development is associated with massive increase in solid waste [10-12], which downgrades air, water and soil quality through its' negative effect on natural ecosystem and social health [13]. However, municipal services being overburdened cannot cope with increasing demand [14] because it requires a substantial amount of budget from the municipality to properly manage it and land for disposal [15, 16]. Faster population and economic growth, as well as related situations lead to serious municipal solid waste problem in emerging economies like India, China, Thailand, Malaysia and Bangladesh [17]. In these developing nations, municipal solid waste gives birth to different environmental issues [18], where more than 90% of these wastes are frequently burnt outdoors or dumped in uncontrolled ways which results in detrimental consequences on human health [7] and environment and ecology. Waste being an indispensable byproduct of economic activities, complete exhaustion of it is not possible, rather conversion of them into useful materials through reuse or recycling treatments can act as an efficient solution to this problem [19]. Bui et al. [20] claimed that waste preservation works as resource for cutting carbon emissions, promoting resource efficiency, endorsing greener and cleaner production to attain sustainable development goals. Zaikova et al. [21] found in Finland that peoples' intentions has significant influence on their behavior of source separation of wastes. Michael et al. [22] attributed factors such as public awareness, environmental knowledge, convenience, infrastructure, personal norms to have positive and significant influence on students' intentions regarding e-waste disposal. Again, public awareness regarding various waste management issues can boost up waste management [23, 24]. However, the main constraint in the road to recycle or reuse wastes is unseparated waste [24-26].

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In Bangladesh, the accelerated industrialization and urbanization resulted from economic growth has changed public living standard, which has increased the municipal solid waste generation in its' cities [14]. In fact, the poor system of waste collection and management is responsible for the cities of Bangladesh to be at the state of highest exposure to ecological degradation [27]. In Rajshahi city, waste management has become increasingly important due to the high population growth and urbanization. It is estimated that RCC accounts for an approximate 358.19 tons/day of municipal solid waste generation, which equivalets to approximately 0.4214 kg/person/day [28]. This gigantic amount of waste has immediate and serious effect on environment and human health [29]. The city faces significant challenges such as insufficient collection facilities, inadequate recycling facilities and limited public awareness in managing wastes. Alam and Qiao [30] reported that in Bangladesh significant share of the produced food waste could be used as compost for gardening. Ashihuzzaman and Howlader [31] stated that recycling of inorganic wastes such as glass or plastic at source could help to produce less waste. These practices will contribute to the conservation of nature and environmental quality and restore the previous status of world, which is worth living for humankind and other species.

Local government has taken several initiatives to improve waste management of this area, but this initiative has not reached to every part of the city, especially in the slum areas of the city. Again, to the best knowledge of the author, no research work has been conducted on waste management, recycling and reusing behavior of the residents of these areas. Only few researches has focused on waste generation, volume and dumping.

Based on the aforementioned research gap, the present study aims to deliver an understanding of the waste management behavior of the residents of the study area along with a solution-oriented approach of reusing and recycling wastes. Moreover, the study also focuses on suggesting policies regarding which aspects of the households' should be improved to develop this management system by finding their determinants.

In line with the above discussion, the study attempts to attain the following objectives:

- i. To identify the current waste recycling and reusing behavior of the respondent households.
- ii. To find out the determinants of households' waste recycling and reusing behavior.
- iii. To suggest suitable policies to promote waste management through recycling and reusing.

The originality or novelty of this study lies on the fact that although a number of research works has been conducted on solid wastes in RCC, but none of these has focused on households' waste recycling and reusing behavior as a solution to this problem. Again the study provides a unique contribution through the practical implications of the findings to local government authorities, non-government authorities and households' itself.

Methodology

Theoretical Framework: The research applied mainly a deductive research approach based on the theory of planned behavior (TPB) to constitute the solid waste recycling and reusing behavior of the households. It is an important socio-psychological framework to explain social behavior [32, 33]. It assess individuals' behavior like food choices, water conservation, energy conservation, environmental behaviors, recycling etc. In case of recycling behavior, TPB has been widely used and an accepted framework [34, 35] which, states that subjective norms based on social pressures, determines individuals' decision to participate in or abstain from involving in any activity. The present study has applied this theory to investigate on household respondents' solid waste recycling and reusing behavior based on their social, environmental and waste related attitudes and their sense of responsibility toward a sustainable solution to waste management.

Study Area and Sampling Methods: In order to determine the sample size Cochran [36] formula is used, which is:

$$n = \frac{Z^2 pq}{e^2}$$

Where, n is the sample size, Z represents Z score, $(p)(q)$ are the estimate of variance and e is the margin of error. With 95% confidence interval assuming $p = 0.5$ and $\pm 5\%$ precision, the valid minimum sample size is 351 households.

A Multi-staged Simple Random Sampling (SRS) method has been applied for selection of the study area and respondents. For this purpose, firstly Rajshahi division among the eight divisions of Bangladesh and Rajshahi district among the eight districts of the division was selected randomly. Rajshahi City Corporation (RCC) is the most populous and waste generative among the areas of Rajshahi district. Hence, it has been chosen as the study area, which is divided into 30 wards and from these wards 3 wards i.e. no. 14, 26 and 19 were selected as, there are no provision of solid waste management service in these areas as provided by the municipal authority in other wards of this city corporation. Finally, 120 respondent households were selected randomly from each of the three wards making a total sample size of 360 households.

Table 1: Sample Selection.

Division	District	Area	Ward no.	Sample Households
Rajshahi	Rajshahi	Rajshahi City Corporation (RCC)	14	120
			26	120
			19	120
Total				360

Source: Authors' calculation from field survey, 2024

Data Collection and Data Analysis: The data required for satisfying the objectives of the research has been collected by using a structured questionnaire designed based on previous literatures survey. Initially a pilot survey was conducted on 20 respondents, based on their feedbacks and responses final questionnaire was prepared. The questionnaire consisted of two sections: the first part was employed to elicit demographic information of the households and the second part to elicit the items required to measure the construct or idea of the research model. Household was selected as the analyzing unit because wastes are generated and managed on household basis rather than on individual basis. The study defines recyclable products as different types of solid wastes generated in the households. Households' recycling activities comprise of separating recyclable and non-recyclable materials, presenting the both types to waste collector who is responsible for taking the unwanted and recyclable wastes for further recycling and the non-recyclables in ultimate disposal site. STATA software has been used to analyze the data.

Variables used in the Study: The following table 2 shows the list of variable used in the study. Here the dependent variable is households' waste recycling or reusing behavior and the explanatory variables are households' heads' age, gender, education level, income, household size, amount of waste generation and environmental consciousness. Among these, age variable has a negative expected relation with the dependent variable and the others have positive expected relation.

Table 2: Explanation of the variables used in the study

Dependent variable	Definition	Expected sign
household waste recycling or reusing behavior	1 = recycle or reuse 0 = otherwise	
Explanatory variables		
Age	in years	-
Gender	Male = 0, Female = 1	+
Education	In years of schooling	+
Income	Monthly in Thousand Taka	+
Household size	In numbers	+
Waste generation	In kilogram	+
Environmental Consciousness	5 point Likert Scale (5 = very conscious; 4 = moderately conscious; 3 = conscious; 2 = not so conscious' 1 = not conscious at all)	+

Source: Authors' calculation from field survey, 2024

Logistic Regression Model: Binary logistic regression model has been applied as the empirical model for identification of the factors, which affect households' waste recycling and reusing behavior. Logistic regression model develops the procedures of multiple regression analysis in situations where the dependent variable appears to be categorical. The dependent variable may be dichotomous or polychotomous. This model is denoted as a specialization of the generalized linear model, where constant residual variance or the homoscedasticity and normality of the residual assumptions are not met. The present study has applied logistic regression model because here the dependent variable, 'household waste recycling or reusing behavior' is a dichotomous variable with 1 = recycle or reuse and 0 = otherwise as has been found in numerous literatures [37, 38].

If we assume Y be the binary outcome; X₁, X₂, ... , X_k be the explanatory or predictor variables; β₀, β₁, β₂,..., β_k be the regression coefficients and β₀ be the intercept, then the model can be written as:

$$P(Y) = \frac{e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k}}{1 + e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k}} \dots \dots \dots (1)$$

$$\text{Or, } \ln\left[\frac{P(Y)}{1-P(Y)}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k \dots \dots \dots (2)$$

Equation (2) is logistic regression model and $\frac{P(Y)}{1-P(Y)}$ is the odd ratio. From this equation, we can see that this model relates the log of this odd ratio directly to the explanatory variables.

In the present study, logistic regression model has been specified as follows:

$$\ln\left[\frac{P(Y)}{1-P(Y)}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_7 X_7 + u \dots \dots \dots (3)$$

Where,

- P(Y) = Probability that the respondent households recycle or reuse wastes.
- 1-P(Y) = Probability that the respondent households do not recycle or reuse wastes.
- X₁ = Age of the household head (in years)
- X₂ = Gender of the household head
- = Level of education of the household head
- X₄ = Household income level (monthly in taka)
- X₅ = Household size (Number of people receding in the house)

X_6 = Amount of waste generated in the house per day
 X_7 = Environmental consciousness of the respondent
 U = Stochastic disturbance term.

After estimating the model, inferences such as confidence intervals, odd ratios etc. are drawn and also the marginal effects are estimated to assess the magnitude of impact that each explanatory variable poses on the respondents' waste recycling and reusing behavior.

Results and Discussion:

Socio-economic Profile of the Respondents: Table 3 shows the socio-economic profile of the respondent households. From the table we can see that about 87.78% respondents are male and only 12.22% are female. Maximum respondents fall in the age group between 25 to 40 years. Most of the respondents have attained secondary level of education. More than half about 51.94% of the respondents are service holder. About 50% of the respondents fall between the income group between 30000 to 45000 take per month. In case of daily waste generation, we can see that more than half, about 51.11% generate waste between 1 to 2 kilogram daily and in case their environmental consciousness we see that respondents are quite aware about the environment.

Table 3: Socio-economic Profile of the Respondent Households

Variables	Categories	Frequency (N=360)	Percentage
Gender	Male = 0	316	87.78
	Female = 1	44	12.22
Age Group	Less than 25	56	15.56
	25 to 40	187	51.94
	40 to 55	72	20
	More than 55	45	12.5
Education	No education	22	6.11
	Primary	74	20.56
	Secondary	105	29.16
	College	81	22.5
	Undergraduate	55	15.27
	Postgraduate	23	6.39
Occupation	Service holder	187	51.94
	Businessman	74	20.56
	Self-employed	47	13.05
	Others	52	14.44
Monthly Income (Taka)	Less than 15000	61	16.94
	15000 to 30000	75	20.83
	30000 to 45000	180	50
	45000 to 60000	30	8.33
	More than 60000	14	3.89
Household size	Less than 3	24	6.67
	3-4	87	24.16
	5-6	151	41.94
	More than 6	98	27.22
Daily waste generation	Less than 1 kilogram	129	35.83
	1-2 kilogram	184	51.11
	More than 2 kilogram	47	13.05
Environmental consciousness	Very conscious	168	46.67
	Moderately conscious	91	25.27
	Conscious	78	21.67
	Not so conscious	19	5.27
	Not conscious at all	4	1.11

Source: Authors' calculation from field survey, 2024

Recycling and Reusing Behavior: The type of wastes household recycle or reuse in presented in the following table 4. From the table we can see that almost every household reuse polythene products. Then comes the plastic product, 212 respondent households have reported that they reuse plastic product. Among the plastic products, the households mostly reuse plastic bottles. The food waste in the form of organic fertilizer, cloths for household cleaning and paper products are reused or recycled by 189, 211 and 102 households respectively. Only a small percentage of the households recycles or reuses glass and wood products. However, the summation does not exhaust at 360 because each household can be involved in more than one recycling work.

Table 4: Types of Waste Households' Recycle or Reuse

Types of waste	Frequency	Percentage
Food Waste	189	52.5
Plastic product	212	58.89
Polythene	345	95.83
Glass products	24	6.67
Wood products	87	24.16
Paper products	102	28.33
Cloths	211	58.61

Source: Authors' calculation from field survey, 2024

The following table 5 shows households recycling behavior implementation practices. From the table we can see that a very significant portion of our respondents practice different types of waste reusing practices such as using again the used plastic bottles, toothbrushes, cloths etc. and they also contribute in waste recycling by keeping their wastes separately in different empty containers. The sum of all the frequencies do not end up to 360 as each respondent can choose more than one option at a time.

Table 5: Household Waste Recycling Practices

Practices	Frequency	Percentage
Keep different empty containers for storing households' leftover separately to be collected for further recycling	106	29.44
Repair products rather than replace worn-out and broken products	186	51.67
Transform used plastic bottles into watering cans, bird feeders, terrariums, scoops	194	53.89
Make wrapping paper from comics and magazine pages / Reuse old gift wrap / Use packing materials again	143	39.72
Use old toothbrushes for household cleaning	288	80
Use old cloths for household cleaning	211	58.61
Buy refillable pens	51	14.16
Reuse paper printed on one side	84	23.33

Source: Authors' calculation from field survey, 2024

Table 6 shows us who is generally responsible in the households for dumping the households' wastes. From the table we can see that in about 80% of the houses this practice is done by maid and in about 26.11% households this is done by mother or wife.

Table 6: Who is responsible for Dumping Households' Waste

Relation	Respondents (%)
Father / Husband	28 (7.78)
Mother / Wife	94 (26.11)
Child	20 (5.55)
Maid	218 (80)

Source: Authors' calculation from field survey, 2024

Households' waste recycling and reusing behavior in summarized in the following table 7. From the table we can see that about 80% of the households practice waste recycling or reusing at their home for example: reusing plastic, metal or paper for decoration purposes, using food wastes as organic or green fertilizer for garden in the rooftop or in the household yard and 20% do not practice this. Here frequently recycling or reusing is defined as those households who have done this type of practice at least once in the previous one month and rarely and never is defined as those respondents who has not been involved in this practice for at least the previous one month. This is done for keeping simplicity and understandability of the analysis.

Table 7: Households' Waste Recycling and Reusing Behavior

Recycling behavior	Frequency	Percentage
Frequently recycled or reused household waste	288	80
Rarely or never recycled or reused household waste	72	20

Source: Authors' calculation from field survey, 2024

Factors Affecting Households' Waste Recycling and Reusing Behavior: Table 8 shows us the determinants of households' waste recycling and reusing behavior. From the table we can see that education, level of income, amount of waste generation and environmental consciousness of the respondents significantly and positively affect their waste recycling and reusing behavior. The education variable being significant at 10% level with a positive sign indicates that the respondents' who are educated have more likelihood of adopting waste recycling and reusing behavior as compared to those who are less educated as supported by previous study [37].

In case of income variable we can see it is significant at 5% significance level and have positive sign indicating that those households' with higher income are more likely to practice waste recycling and reusing behavior as compared to lower income groups. This finding is supported by other studies [39, 40]. Amount of waste generation and environmental consciousness of the respondents are significant at 1% level of significance and have positive sign which indicates that households' with more amount of waste generation and more environmental consciousness are more likely to recycle or reuse solid waste [41].

Table 8: Output of the Logistic Regression Model (Recycling and Reusing behavior is the dependent variable)

Variables	Estimation	Standard Error
Constant	- 12.18	8.01
Age (in years)	- 0.08	0.12
Gender (Male = 0, Female = 1)	6.08	4.20
Education (In years of schooling)	0.520*	0.299
Income (Monthly in Thousand Taka)	1.387**	0.589
Household size (In numbers)	0.331	0.268
Waste generation (In kilogram)	0.910***	0.201
Environmental Consciousness (5 point Likert Scale)	0.518***	0.176
Pseudo R^2	0.42	
LR statistics	128.11	
Probability	0.0000	
Total observation	360	

*significance at 10%, **significant at 5% and ***significant at 1%

Source: Authors' calculation from field survey, 2024

Implications of the Research: The findings of the study has significant implications for enhancing the good practice of waste recycling or reusing. The implications will come out fruitful when the following practices will be implemented:

- Raising awareness: From the analysis it is revealed that environmental consciousness is one the significant factors to affect respondents' behavior. Here although maximum respondents are found environmentally conscious, some of the households are not aware of the importance and need for recycling and reusing. In this case raising awareness among them can be an effective tool because it brings about inspiration among them for participating in bringing a change. Therefore, to intensify people's awareness regarding the importance of recycling and reusing households' waste materials, the concerned authority should come forward to propagating people's awareness through various media i. e., TV, internet, social media etc.
- Enhancing education: Education has been found to be a significant factor which significantly and positively augments people to practice recycling or reusing of households waste, so government and concerned authorities should come forward with initiatives which can raise the education level.
- Raising employment and income opportunities: Income being one of the significant factors behind respondents' waste recycling and reusing behavior captures our focus to the issue that if government can take initiatives to increase households' income then it can bring about positive result. Unemployment being one of the major issues of the present world can be the focusing point of the government, which will help to generate and raise the income levels of citizens.

Limitations and Future Research Direction

The study is based on cross-sectional data on respondent households' recycling and reusing behavior of different waste products, therefore is incapable of presenting and describing how households' perception or behavior has changed over the years. Therefore, there is a scope of directing further research and analysis with a longitudinal approach for a deep understanding of the issue. Furthermore, the sample size used in the study is somewhat small when compared to the whole country, hence there arises scope for future research to conduct an extensive survey regarding households waste recycling and reusing behavior.

Conclusion: Massive waste generation and environmental pollution and its' resulting injurious impact on human animal plant and each and all species in the earth is the issue of big concern for the present world. Along with this, climate change and global warming has intimate linkage with this. Not only developing but also developed countries are struggling to fight against these

problems. However, every economic or production activity brings with it some environmental pollution, something which is also clearly understood with the theory and empirical evidence of environmental Kuznet Curve. In this instance if production is reduced, then environmental pollution could consequently be reduced. However, the present modern world does not teach us to do this compromise. Rather what we can do is to recycle our used by recyclable products so that the extra damage to the environment due to its production is not caused. Even, reusing products can be more environmentally sustainable because reusing does not require the reprocessing stage, which reduces pollution even more efficiently. This is why reusing is a very acceptable practice to many intellectuals.

At present, many of the wards of RCC are enjoying solid waste management service through door-to-door waste collection, although the frequency of the service is irregular, many of the areas like stated in the study are deprived of the service. The findings of the study can guide suitable ways to properly manage waste of these areas and complement to the municipalities contribution toward a better environment. The analysis of the study revealed that if education and awareness among the respondents could be increased then they would easily understand the necessity of recycling or reusing their thrown away but again reusable and recyclable products. Again, income generation among people could be a way of augmenting their environmental behavior. Finally, it is both the government and people of our country and all over the world who should be responsible thinker and applier of waste recycling and reusing practices to save the world and keep it livable. As waste management is a huge concept and the present study only focused on one district of the country, there are scope for further research by increasing the areas and sample size. Also focusing on e-waste recycling and reusing behavior could be a scope for future research.

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