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ORIGINAL ARTICLE

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GENERATION AND CHARACTERISTICS OF HOUSEHOLD SOLID WASTE IN KHULNA CITY, BANGLADESH

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Abstract

For growing cities, solid waste management is a serious concern, focusing on household waste because it accounts for a significant portion of municipal solid waste. An accurate estimation of the quantity and characteristics of solid waste mixtures from diverse income levels is required for effective city-wide solid waste management planning. The purpose of this study is to assess the production and characteristics of domestic solid waste produced by different socio-economic groups in three wards (no. 17, 23 and 24) of Khulna city. Moreover, various factors that influence the pace of waste production have been critically investigated. The finding suggests that, household waste generation rate ranges from 0.421 to 5.81 kg/day, average of 1.917 kg/day and 0.476 kg/capita/day. The waste composition analysis depicts that kitchen garbage is the most prevalent component. The waste generation rate has a positive relationship with income level and household size. Nonetheless, the findings and proposed essential steps of this study would be beneficial in assisting policymakers in refining plans for controlling the municipal waste effectively.

Keywords: Solid waste, composition of waste, household size, socio-economic group, Khulna city.

Introduction

The overall system for managing municipal solid waste (MSW)is strongly influenced by the quantity of waste generated on a daily basis at home (Dangi et al., 2011a). During the previous several decades, the amount of MSW generated in cities of developing countries has grown many times. Most of the countries which are developing, have a substantial rate of MSW production (Jadoon et al., 2013).The expansion in waste generation has become one of the obvious consequences of overpopulation. Due to rural-urban migration, there has been a significant increase in population growth in metropolitan areas changing living conditions of city dwellers, growth in the urban economy, as well as social advancements in metropolitan areas, and concerned other factors are contributing to this massive increase in MSW amount in Asia and Africa's emerging cities (Suthar & Singh, 2015). Urban sprawl and slum growth result through migration, and these generate large amounts of uncontrolled solid waste in Bangladesh's main cities (Sujauddin et al., 2008a).

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The management of produced municipal solid waste is inadequate in most of the emerging countries, resulting in major challenges with garbage storage, collection, and final disposal (Al-Khatib et al., 2010; Batool & Ch, 2009; Gomez et al., 2008b). The problem of open garbage, dumping on unoccupied plots and roadways as well as inefficient waste storage systems is a big issue nowadays. Besides garbage bins of various sorts and sizes are put in diverse areas without regard for their appropriateness. Except for those that were wrongly put, few of them were discovered entirely filled. This is due to a lack of information regarding the amount and type of garbage created in certain areas. The placement of community storage bins was not thoroughly analyzed. It was also discovered that economic segmentation has a significant impact on MSW amount and content. These issueslead to inefficient collection routes and, as a result, unlawful open garbage disposal which is becoming a major obstacle for sustainable waste management system (Jadoon et al., 2013).

For developing and implementing a feasible management system of solid waste at any particular location, it is essential to measure waste generation rate and categorize their composition (Gomez et al., 2008a).In addition, to establish a garbage collection and treatment scheme for urban residential unit, household waste should be quantified and characterized. Because, it varies in both amount and content in different income levels(Khan et al., 2016).Household garbage is a complex substance that contains a variety of heterogeneous materials (Ogwueleka, 2013). However, a massive amount of heterogeneous uncontrolled solid waste that is creating health and environmental problems. For this consequence, management of municipal solid waste has emerged as a significant concern for Bangladesh's urban areas.In preventing the health and environmental hazards significantly connected with overall waste management process, such concerns must be considered while designing the core waste management operations (processing, segmentation, transporting, and treating) (Suthar & Singh, 2015).In Bangladesh, local administrations are responsible for solid waste management (SWM), which is carried out by the Chief Conservancy Officer (CCO) under the supervision of the city corporation's Mayor. Most important responsibility of these officials is to manage garbage appropriately to make the city more hygienic. However, many municipalities throughout most of the urban areas are overwhelmed and therefore unable to satisfy expanding expectations, due to a lack of staff and supplies, resulting in unsanitary and unpleasant living conditions (Hasan & Chowdhury, 2006).

Nevertheless, for developing and implementing a feasible solid waste management system for a particular location, it is essential to measure waste generation rate and categorize their composition (Gomez et al., 2008a). In addition, to establish a garbage collection and treatment scheme for urban residential unit, household waste should be quantified and characterized (Ogwueleka, 2013). A few studies have been conducted on the quantity and characteristics of urban household's solid waste for Khulna city and most of them are backdated, which is not useful for the present situation to develop any effective decision towards MSW management system targeting the Sustainable Development Goal (SDG).

Considering above facts, this study deals with the production and characterize the household solid waste among different income levels of households in three representative wards (ward no. 17, 23 and 24) of Khulna city. Furthermore, the study has explored factors, which are influencing the production rate of household waste as well as the characteristics of waste components. Besides, this study will be helpful in policy making considering the actual needs targeting appropriate solid waste management system and also reducing the dangers of solid waste to people's quality of life. The findings of this study, may be utilized and replicated across the entire city of Khulna to address the forthcoming difficulties of household waste management.

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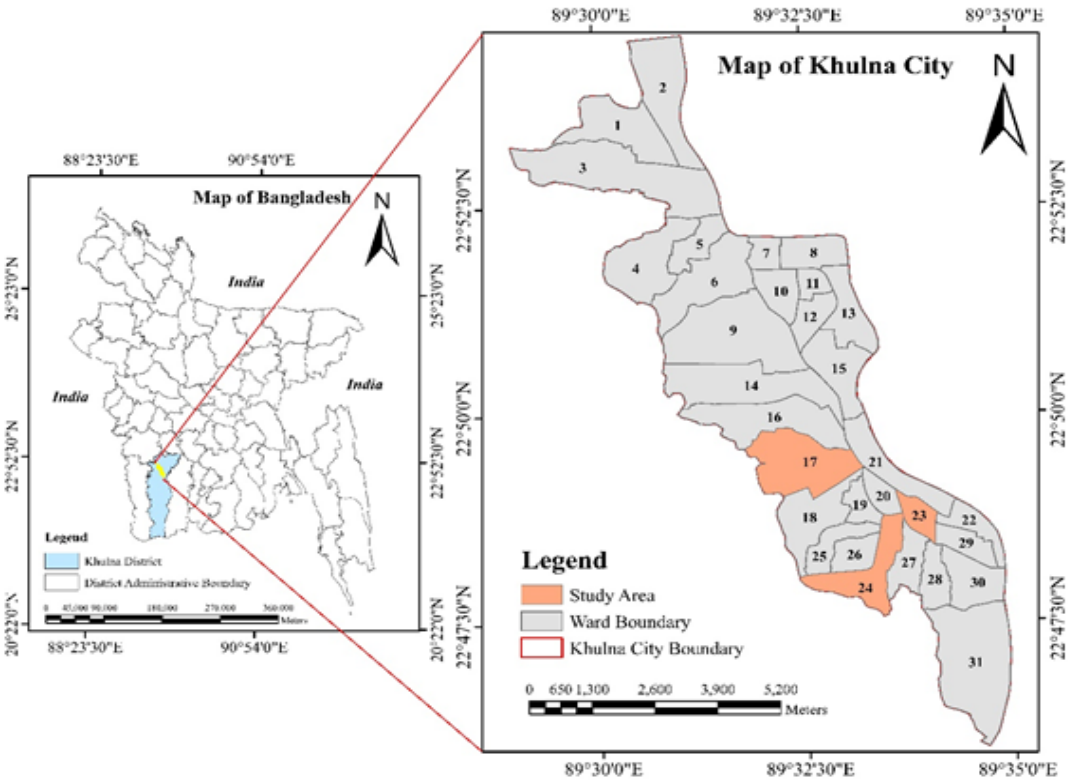

Figure 1. Map of study area.

Methods

Study area

The study has been performed in Khulna city under wards number 17, 23 and 24 which are representing the locality named Sonadanga, Dak Bangla and Nirala respectively. Khulna city is known as the third-largest city of Bangladesh, situated in the south-western part at 22°490"N and 89°33'0"E. The area of Khulna city is 45.65 sq. km and has about 1.30 million populations (BBS, 2015; Rahman & Kabir, 2019). The population density of Khulna city is steadily rising, resulting in rapid growth of solid waste production. MSW management is strongly correlated with increased amount of solid waste. Khulna city is becoming more contaminated day by day due to a lack of an effective solid waste management system. In recent years, rapid population growth and significant migration from rural to urban areas have considerable strain on the current solid waste management system of Khulna city. MSW production is predicted to be 520 Mg (megagram) per day, with a majority of food and vegetable wastes and the residential areas are the prime source of producing

MSW. About half of the garbage produced from the household level is properly disposed of at the dumping site. The majority of the rubbish is left uncollected and unregulated (Ahsan et al., 2015).

Sampling and measurements

The study has been conducted under wards number 17, 23 and 24.These wards have been selected purposively for the research. Because, out of 31 wards of Khulna City Corporation, people from different socio-economic

groups are found together in these three wards. Different socio-economic strata have been selected based on household income. And from every income group 48 samples have been taken which has helped to represent the study area's waste generation and composition scenario. In total, 144 sample households (48 from each ward)have been considered for this study (Table 1). The stratified random sampling technique has been used for selecting households(Manly, 2009). By following the sampling technique, 16 sample households have been taken from each income group.

Table 1. Categorization of income group and sample distribution

Ward No	Low Income Group (Less than 20,000 BDT/Month)	Middle Income Group (20,000 to 40,000 BDT/Month)	High Income Group More than 40,000 BDT/Month	Total
Ward No 17	16	16	16	48
Ward No 23	16	16	16	48
Ward No 24	16	16	16	48
Total	48	48	48	144

Source: Field Survey, 2021

Table 2. Demographic data of study population

Aspects	Categories	Ward no 17	Ward no 23	Ward no 24
Households	No of HH	7710	3226	9678
Gender	Male	16471	6982	19762
	Female	16692	6811	18127
Age Group	Aged 5-9 Years	3130	1101	3431
	Aged 10-14 Years	3543	1336	3693
	Aged 18 Years +	22090	9867	25977
Literacy Rate	7+ years	70.1	84.7	78.3

Source: Population and housing census, BBS 2011

A survey questionnaire has been distributed to 144 chosen representative families in order to gather demographic and financial information of the households. To examine the waste production rate and their characteristics at household level in Khulna city, collecting waste from selected households and waste segregation method has been followed. This is one of the most precise methods for calculating the rate and content of solid waste generation (Gu et al., 2015).Following this method, household's waste has been collected for consecutive seven days and weighted using an electronic weighing machine. The amount of garbage collected from each household and their categories are measured and recorded separately. Households were instructed to dump each and every single garbage to that provided bag for that particular day. For collecting the waste, trash bag labeled with income group and house numbers were supplied to each household for these seven days. The plastic bag, containing household wastes were collected, weighed and recorded for each residence. Then the dumped waste has been segregated according to the specified 6 categories by the waste cleaner with direct supervision. Each of the categories was weighted individually using electronic weighing machine. The collected wastes from each bag were spread out on clean plastic sheets and sorted by hand during segregation process (Harun & Rashid, 2019). Every day, the same process has been done for each of the 144 households in the month of June, 2021. The composition categories for this study are given bellow:

1.Kitchen waste
2. Paper & Garden waste
3. Plastic (film & dense) waste
4. Metal& Glass waste
5. Wood & Textile waste
6. Composite / Other waste

Results

Households' socio-economic characteristics

Table 3 shows the socio-economic characteristics of the selected households. Most of the selected families have household members in between 4 to 6, which is around 56.9%. Household members less than 4 in numbers have been counted as 35.4%.

Table 3. Socio-economic characteristics of households

Type	Value range	Frequency	Percentage
HH Members	Less than 4	51	35.4%
	Between 4 to 6	82	56.9%
	More than 6	11	7.6%
	Mean = 4.23	n = 144	100.0%
Education Level	Primary Level	28	19.44%
	Secondary Level	56	38.89%
	Higher Secondary Level	51	35.42%
	Higher Education	9	6.25%
		n = 144	100.0%
Environmental Concern	No Concern	43	29.86%
	Have Concern	88	61.11%
	No Response	13	9.03%
		n = 144	100.0%

Generation of household waste

Table 4 shows the average waste generation rate [kg/HH/day] of different socio-economic group among the three selected wards. It has been found that ward no.17 produces the highest amount of waste, 2.086 kg/HH/day. The middle-income group has the maximum waste generation rate among the three socio-economic categories, with an average of 2.143 kg/HH/day.

Table 4. Rate of average waste generation per household per day

Income Level	Average Generation Rate [kg/HH/day]			Average [kg/HH/day]
	Ward No.			
	17	23	24	
Low Income	1.465	1.536	1.415	1.472
Middle Income	2.303	2.102	2.023	2.143
High Income	2.489	1.94	1.986	2.138
Average [kg/HH/day]	2.086	1.859	1.808	1.918

Table 5 shows the per capita waste generation rate among the different income levels of three different wards. The maximum per capita waste generation rate has been found 0.63 kg/cap/day in ward No. 17 particularly for the high-income level household. And the minimum per capita waste generation rate has been found 0.29 kg/cap/day again for ward No. 17 particularly for the low-income level. Among the three different socio-economic groups, the highest per capita waste generation rate has also been found on an average 0.061 kg/cap/day for the high-income level households. Furthermore, within these three different wards, the highest per capita waste generation rate has been found on an average0.483 kg/cap/day for ward No. 17.

Table 5. Average per capita waste generation rate

Income Level	Generation Rate [kg/cap/day]			Average [kg/cap/day]
	Ward No.			
	17	23	24	
Low Income	0.29	0.33	0.35	0.32
Middle Income	0.53	0.48	0.48	0.50
High Income	0.63	0.53	0.52	0.56
Average [kg/cap/day]	0.483	0.447	0.450	0.460

Relationship between the quantity of household waste and socio-economic factors

The degree of relationship between different parameters (such as household income level, household size, per capita waste generation and households waste generation) have been determined using correlation analysis. From the Table 6, it is found that, there is a strong positive correlation between income level and average per capita waste generation per day (r_{xy} = 0.912, $p < 0.01$), which means, an individual who lives in a high-income group produces a greater amount of waste every day. Similarly, the income level has a strong positive correlation with the average waste generation per household (r_{xy} = 0.768, $p < 0.05$), that means the households with high income level generate larger quantity of solid waste per day. The correlation value between average per capita waste generation and average per household's waste generation shows very strong positive relationship (r_{xy} = 0.940, $p < 0.01$), which indicates that the per capita waste generation is larger for those households which produce larger quantity of solid waste per day. The household size also has a positive moderate correlation with daily average waste generation rate (r_{xy} = 0.650, $p < 0.01$), that means the more the household size the larger is the amount of daily waste generation (Table 7).

Table 6. Relationship between the waste quantity and Socio-economic factors

Variables		Income Level	Average [kg/cap/day]	Average [kg/HH/day]
Income Level	Pearson Correlation	1	0.912**	0.768*
	Sig. (2-tailed)		.001	0.016
	N	9	9	9
Average [kg/cap/day]	Pearson Correlation	.912**	1	.940**
	Sig. (2-tailed)	.001		.000
	N	9	9	9
Average [kg/HH/day]	Pearson Correlation	.768*	.940**	1
	Sig. (2-tailed)	.016	.000	
	N	9	9	9

*** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).*

Table 7. Relationship between the waste quantity and Demographic factors

Variables		HH Size	Average[kg/HH/day]
HH Size	Pearson Correlation	1	.650**
	Sig. (2-tailed)		.000
	N	144	144
Average [kg/HH/day]	Pearson Correlation	.650**	1
	Sig. (2-tailed)	.000	
	N	144	144

*** Correlation is significant at the 0.01 level (2-tailed).*

Table 8. Characteristics of household solid waste

Waste Categories	Average [kg/day] (n = 144)	Average [kg/HH/day]	Percentage
1.Kitchen waste	240.47	1.670	87.37%
2. Paper & Garden waste	12.06	0.084	4.39%
3. Plastic (film & dense) waste	9.05	0.063	3.28%
4. Metal and Glass waste	2.84	0.02	1.03%
5. Wood and Textile waste	4.47	0.031	1.63%
6. Composite / Other waste	6.33	0.043	2.30%

Characteristics of household solid waste

The characteristics of household solid waste generated from the selected 144 households shows that the kitchen waste (240.47 kg/day) has the largest share 87.37% among the other categories. Paper & garden waste, plastic (film & dense) waste, composite / other waste, wood & textile waste, metal & glass waste have the share of 4.39%, 3.28%, 2.30%, 1.63%, 1.03% respectively (Table 8).

Comparison between waste composition and households' income level

Figure 2 demonstrates the waste composition collected from the selected households. The result shows that, household income level is a determinant of characteristics of household waste. The findings show that the households with high income level generate larger amount of kitchen waste (90.37 kg), paper and garden waste (4.99 kg) and metal and glass waste (1.25 kg) per day. Whereas, the other compositions of wastes- plastic (film & dense) waste (3.32 kg), wood and textile waste (2.33 kg) and composite / other waste (2.67 kg) are more in amount per day for middle income household level. This occurs as a result of disparities in household consumption habits caused by socio-economic status. In other words, households with a high-income level and economic status generate a variety of kitchen waste because they consume a variety of foods and these different kinds of foods packaged in plastic, whereas households with a middle-income level are nearly identical to households with a high-income level. It also explains the observed increased use of plastic-film, plastic-dense for all of these socio-economic groups, and reduction of kitchen waste with the lower household's income.

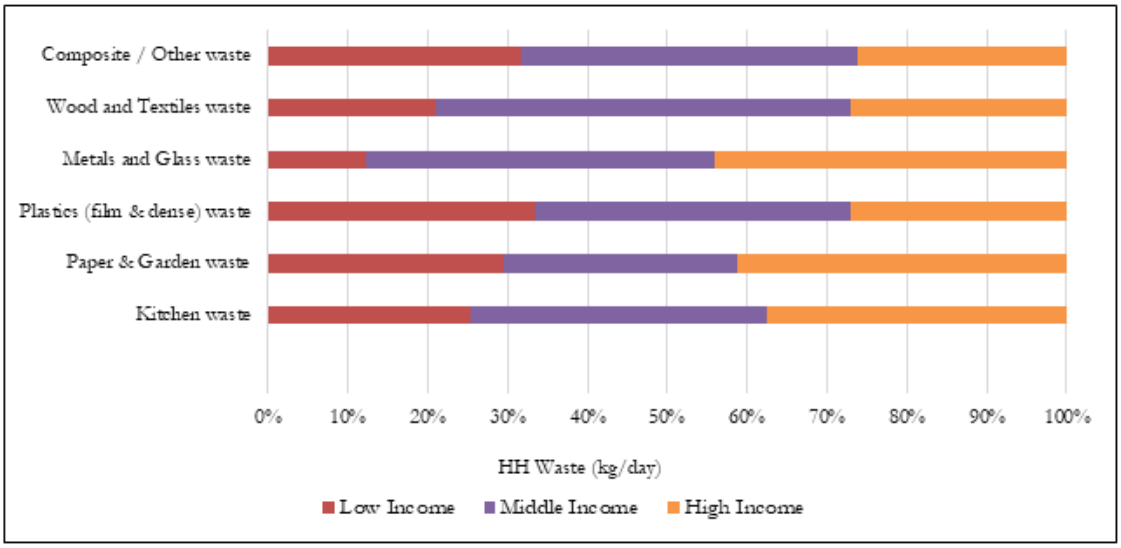

Figure 2. Comparison between waste composition and households' income level

Discussion

This study has tried to explore the generation of household waste among different socio-economic groups in three separate wards in Khulna city. We have calculated the waste generation rate and composition of domestic waste generation for each of the groups. According to the study, the average waste production rate per household is 1.918 kg per day and 0.460 kg per capita per day. The World Bank (1999) estimated a value of 0.15 per person per day, which differs from this result (Hoornweg & Bhada-Tata, 2012). Despite earlier work revealed that a higher income level generates more solid wastes(Khan et al., 2016). But in this study, the highest rate of waste generation has been identified in the middle-income group (2.143 kg/HH/day) (Table 4). The outcomes of this study matched up the findings of other studies, who also found that the middle socioeconomic class generated the most waste(Ojeda-Benítez et al., 2008; Saeed et al., 2009). Some of other investigations have been reported a strong correlation with waste generation rate and household size(Dangi et al., 2011b; Sujauddin et al., 2008b). So, as the size of the family rises, the amount of garbage produced per capita increases. The quantity of daily waste generated increases with household size (Table 7). Several researches (Masoud et al., 2011; Suthar & Singh, 2015)have documented comparable findings, such as the fact that kitchen waste has the largest shares of domestic wastes (87.37%). Paper and garden waste, plastic (film & dense) waste, composite / other waste, wood & textile waste, metal & glass waste account for 4.39%, 3.28%, 2.30%, 1.63%, and 1.03% of total waste, correspondingly (Table 8). The production of paper & garden waste, and plastic waste (bottles, cans, jars, tins, etc.) was relatively higher (7.28%) in the high-income group as well as minimal in the low-income group (Figure 2). All socioeconomic classes have extremely fewer waste for recycling (paper, plastics, metals, and glass).

Conclusion

The amount and composition of household solid waste of different socio-economic groups of Khulna city have been analyzed in this study (Table 4). Among the income groups, the average maximum waste generation rate is 2.143 kg/HH/day by middle income group. On the other hand, in terms of wards maximum waste generation rate is estimated higher in ward No. 17which is about 2.086 kg/HH/day. Again, the maximum per

capita waste generation rate is found as 0.56 kg/cap/day by the high-income level. And the minimum per capita waste generation rate is 0.32 kg/cap/day by the low-income level. A strong positive correlation between income level and average per capita waste generation per day (r_{xy} = 0.912, $p < 0.01$), which means a person who belongs to the high-income level household generate a larger quantity of solid waste per day. The income level has a strong positive correlation with the average waste generation per household (r_{xy} = 0.768, $p < 0.05$), that means the households with high income level generate larger quantity of solid waste per day. Household size also has a positive moderate relation with daily average waste generation rate (r_{xy} = 0.650, $p < 0.01$), that means the more the household size the larger is the amount of daily waste generation. It is observed that, the kitchen waste (240.47 kg/day) has the largest share 87.37% among the other categories. Paper & garden waste, plastic (film & dense) waste, composite / other waste, wood & textile waste, metal & glass waste have the share of 4.39%, 3.28%, 2.30%, 1.63%, 1.03% respectively.MSW management is strongly correlated with increased amount of solid waste. Lack of proper solid waste management system has been making Khulna city environmentally polluted day by day with an increasing amount of waste. The MSW management tiers such as generation, source storage, collection, on-site storage, transportation, and open dumping is assessed, and it is determined that the current MSW management situation in Khulna is insufficient and not satisfactory (Ahsan et al., 2015).The non-governmental organizations and community-based organizations should come forwards with the strategies suggested here. In order to meet the SDGs target 11.6 "Reduce the environmental impacts of cities" an effective municipal solid waste management system should be part of every city's development plan. So, having analyzed the existing waste generation and composition scenario of Khulna city, necessary measures should be taken for an effective municipal solid waste management system to meet the SDGs target. Such as-

Firstly, most of the cases it has been found that the dumping station is not placed in a proper location. As a result, for low-income group of people as well as environmentally not concerned people sometimes dump their waste in open place besides roads. So, with a proper spatial analysis, we need to place our dumping stations in a place where people of all income groups have an easy access.

Secondly, some of the surveyed dumping stations are beyond the capacity of the waste generated in that particular area. As a result, low-capacity dumping stations are unable to properly capture the waste generated daily. It causes spread out of waste around, spread to the streets and become harmful to the environment and health. So based on this analysis, we can move towards a sustainable waste management by expanding the capacity of dustbins in the area according to the rate of waste production of different income groups of households.

Thirdly, another major problem is that in each case, the dumping stations are open all the time. As a result, it spreads bad smell from there and has a detrimental effect on the environment and health. So, if all the dumping stations could be converted into covered dumping stations, it would be very helpful for the environment and health as well as for managing solid waste properly.

Fourthly, we need to think about this compostable organic waste. We need to set up a waste treatment plant in Khulna City so that we can make this waste into fertilizer.

Fifthly, determining the bin size at the household level can be an efficient strategy to decrease waste collection mismanagement. As a result, the higher income group will be more aware of excessive waste generation and will be penalized if a household generates excess waste under this system. This study finds that plastic (film & dense) waste, wood and textile waste and composite / other waste are some of the most commonly recycled waste materials in Khulna.

Sixthly, recycling & reuse at local level can be an effective way to solid waste management system. In this process, the households will separate waste materials and give it to intermediate seller, then the intermediated seller will give it to the apex traders and the apex traders will send it to the end of chain groups for recycling. Privatization through engaging the non-governmental organizations and community-based groups in the resource distribution, processing of biodegradable waste, and municipal solid waste management

systems, play a crucial role. As a result, they will be able to propose methods for overcoming current challenges as well as achieving the SDG.

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References

Ahsan, A., Alamgir, M., Imteaz, M., Shams, S., Rowshon, M. K., Aziz, M. G., & Idrus, S. (2015). Municipal solid waste generation, composition and management: Issues and challenges. A case study. *Environment Protection Engineering*, *41*(3), 43–59.

Al-Khatib, I. A., Monou, M., Abu Zahra, A. S. F., Shaheen, H. Q., & Kassinos, D. (2010). Solid waste characterization, quantification and management practices in developing countries. A case study: Nablus district – Palestine. *Journal of Environmental Management*, *91*(5), 1131–1138.

Batool, S. A., & Ch, M. N. (2009). Municipal solid waste management in Lahore City District, Pakistan. *Waste Management*, *29*(6), 1971–1981.

BBS. (2015). Bangladesh Bureau of Statistics - Government of the People's Republic of Bangladesh-Statistical-Yearbook. http://www.bbs.gov.bd/site/page/29855dc1-f2b4-4dc0-9073-f692361112da/Statistical-Yearbook

Dangi, M. B., Pretz, C. R., Urynowicz, M. A., Gerow, K. G., & Reddy, J. M. (2011a). Municipal solid waste generation in Kathmandu, Nepal. *Journal of Environmental Management*, *92*(1), 240–249.

Dangi, M. B., Pretz, C. R., Urynowicz, M. A., Gerow, K. G., & Reddy, J. M. (2011b). Municipal solid waste generation in Kathmandu, Nepal. *Journal of Environmental Management*, *92*(1), 240–249.

Gomez, G., Meneses, M., Ballinas, L., & Castells, F. (2008a). Characterization of urban solid waste in Chihuahua, Mexico. *Waste Management*, *28*, 2465–2471.

Gomez, G., Meneses, M., Ballinas, L., & Castells, F. (2008b). Characterization of urban solid waste in Chihuahua, Mexico. *Waste Management*, *28*(12), 2465–2471.

Gu, B., Wang, H., Chen, Z., Jiang, S., Zhu, W., Liu, M., Chen, Y., Wu, Y., He, S., Cheng, R., Yang, J., & Bi, J. (2015). Characterization, quantification and management of household solid waste: A case study in China. *Resources, Conservation and Recycling*, *98*, 67–75.

Harun, M., & Rashid, O. (2019). Sustainable Municipal Solid Waste Management in Dhaka City: Challenges and Issues Towards Sustainable Energy Transition in Response to Climate Change in Dhaka City: Challenges and Issues View project Md Harun Or Rashid Ministry of Environment, Forest & Climate Change Sustainable Municipal Solid Waste Management in Dhaka City: Challenges and Issues. *Journal of Bangladesh Institute of Planners*, *12*, 97–107.

Hasan, G. M. J., & Chowdhury, M. A. I. (2006). Municipal Waste Management and Environmental Hazards in Bangladesh. *Asian Journal of Water, Environment and Pollution*, *3*(1), 39–48.

Hoornweg, D., & Bhada-Tata, P. (2012). *What a Waste: A Global Review of Solid Waste Management*. https://openknowledge.worldbank.org/handle/10986/17388

Jadoon, A., Batool, S. A., & Chaudhry, M. N. (2013). Assessment of factors affecting household solid waste generation and its composition in Gulberg Town, Lahore, Pakistan. *Journal of Material Cycles and Waste Management 2013 16:1*, *16*(1), 73–81.

Khan, D., Kumar, A., & Samadder, S. R. (2016). Impact of socioeconomic status on municipal solid waste generation rate. *Waste Management*, *49*, 15–25.

Manly, B. (2009). Statistics for Enviromental science and management. Second Edition. *Environmental and Ecological Statistics*, 295.

Masoud, S., Ghasem, M. ·, Omrani, A., Karbassi, A., Farzaneh, ·, Raof, F., Monavari, S. M., Omrani, G. A., Raof, · F Fakheri, Karbassi, A., & Raof, F. F. (2011). The effects of socioeconomic parameters on household solid-waste generation and composition in developing countries (a case study: Ahvaz, Iran). *Environmental Monitoring and Assessment 2011 184:4*, *184*(4), 1841–1846.

Ogwueleka, T. C. (2013). Survey of household waste composition and quantities in Abuja, Nigeria. *Resources, Conservation and Recycling*, *77*, 52–60.

Ojeda-Benítez, S., Vega, C. A. de, & Marquez-Montenegro, M. Y. (2008). Household solid waste characterization by family socioeconomic profile as unit of analysis. *Resources, Conservation and Recycling*, *52*(7), 992–999.

Rahman, S. M. T., & Kabir, A. (2019). Factors influencing location choice and cluster pattern of manufacturing small and medium enterprises in cities: evidence from Khulna City of Bangladesh. *Journal of Global Entrepreneurship Research 2019 9:1*, *9*(1), 1–26.

Saeed, M. O., Hassan, M. N., & Mujeebu, M. A. (2009). Assessment of municipal solid waste generation and recyclable materials potential in Kuala Lumpur, Malaysia. *Waste Management (New York, N.Y.)*, *29*(7), 2209–2213.

Sujauddin, M., Huda, S. M. S., & Hoque, A. T. M. R. (2008a). Household solid waste characteristics and management in Chittagong, Bangladesh. *Waste Management*, *28*(9), 1688–1695.

Sujauddin, M., Huda, S. M. S., & Hoque, A. T. M. R. (2008b). Household solid waste characteristics and management in Chittagong, Bangladesh. *Waste Management*, *28*(9), 1688–1695.

Suthar, S., & Singh, P. (2015). Household solid waste generation and composition in different family size and socio-economic groups: A case study. *Sustainable Cities and Society*, *14*(1), 56–63.