A STUDY ON PLASTIC WASTE RECYCLING PROCESS IN KHULNA CITY

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ABSTRACT

Municipal Solid Waste Management (MSWM) has emerged as one of the greatest challenges facing environmental protection in least developed Asian countries like Bangladesh. This study is covered the plastic waste recycling in Khulna city, Bangladesh. In Khulna city, the generation of MSW was found approximately 0.38 kg per capita per day. The MSW of Khulna city mainly consisted of food and vegetable (78.9%), paper & paper products (9.5%), polythene and plastic (3.1%), textile & wood (1.14%), rubber & leathers (0.5%), metal & tins (1.1%), glass and ceramics (0.5%), brick, concrete & stone (0.1%) and dust, ash and mud (3.7%), others (1.46%). Recycling has become one of the primary strategies for sustainable management MSW in the most of the countries of the world. Plastic has become an essential part of our daily life because of its durability, light weight properties and also for its low price. In this study a traditional recycling pattern of plastic in Khulna city has been investigated. Through a number of field interviews to the waste collectors, primary dealers and secondary dealers, a complete hierarchy from waste collectors to the final sellers of recycled product has been identified and the profit at each level determined. In Khulna city the plastic wastes are mainly found in the form of plastic bottle, jars, buckets and plastic bags. In Khulna city there are four industries for recycling of plastic waste material. The study reveals that about 3400kg/day plastic waste are collected and 3100kg/day are processed and recycled in Khulna city.

Keywords:*Municipal solid waste, Plastic waste, Plastic waste recycling, Influence factors*

1. INTRODUCTION

Solid waste comprises all the wastes arising from human and animal activities that are normally solid which are discarded as useless or unwanted. The term solid waste means all-inclusive, encompassing the heterogeneous mass of throwaways from the urban community as well as the more homogeneous accumulation of agricultural, industrial and mineral wastes(Tchobanoglous, Theisen,&Vigil, 1993). Solid waste can be classified into different types according to sources such as Municipal Solid Waste (MSW), Industrial Waste, Agricultural Waste, Municipal Sludge and Other Wastes. (Peay, Rowe, & Tchobanoglous, 1985)

Municipal Solid Waste refers to the materials discarded in the urban areas for which municipalities are usually held responsible for collection, transport and final disposal (Islam, Alamgir, Howlader, Kraft E,&Headrich, 2009b). Municipal Solid Wastes are the heterogeneous composition of wastes, organic and inorganic, rapidly and slowly biodegradable, fresh and putrescible, hazardous and non-hazardous, generated in various sources in urban areas due to human activities (Alamgir M. , Ahsan, McDonald, Upreti,&Islam, 2005). In present days developing countries like ours are facing serious problems due to poor waste management system of MSW. This are happening due to the rapid industrialization and urbanization. Although the municipal and industrial waste produced in developed countries are enormous in compared to that of developing countries but they can handled it through well waste management system. Solid waste management may be defined as the discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal in a manner that is in accord with the best principles of public health, economics, engineering, aesthetics and other

environmental consideration and which is also responsive to public attitude (Bozkurt,Moreno,&Neretnieks, 1999).

Now a day's plastic is the most useable material in the world wide. Without it we cannot think about a single day. As we are using it in our everyday life enormous amount of waste of them are producing every day. Plastics are used in our daily life in a number of applications, such as greenhouses, coating and wiring, to packaging, films, covers, bags, containers etc. Plastic is one of the most popular building materials of modern human culture, but its widespread use brought us many problems and caused environmental dangers of unprecedented scale. For this reason the waste need to be managed in proper way one of the best means is recycling.

Khulna is one of the most beautiful city corporation in Bangladesh. Khulna is situated at the south-western part of Bangladesh near the world largest mangrove forest, Sundarbans also situated on the bank of river Rupsha andBhairab shown in Figure 1. The area of Khulna district is 4394 km^2 and the Khulna city area is 20.6 km^2 with population of 1.6 million. Most of the people in Khulna live on agriculture and fishing. But it does not have enough resources, man power or adequate system in place to treat its wastes which is generating every day. It is also one of the very cleanest city corporation in Bangladesh but the waste management process is not adequate. The amount of waste in Khulna has been increasing in recent years, due to the rapid population growth and improvement of the living standards of the residents. Therefore, the necessary of a reliable recycling system became a top priority for Khulna city. The waste are not collected properly in Khulna city. If these wastes can collected by proper grading and separately then the recycling process may be easier than present recycling management process although the process of recycling plastic is not as simple as recycling paper, glass and metals, because the greater number of steps involved for extracting dyes, fillers and other additives.

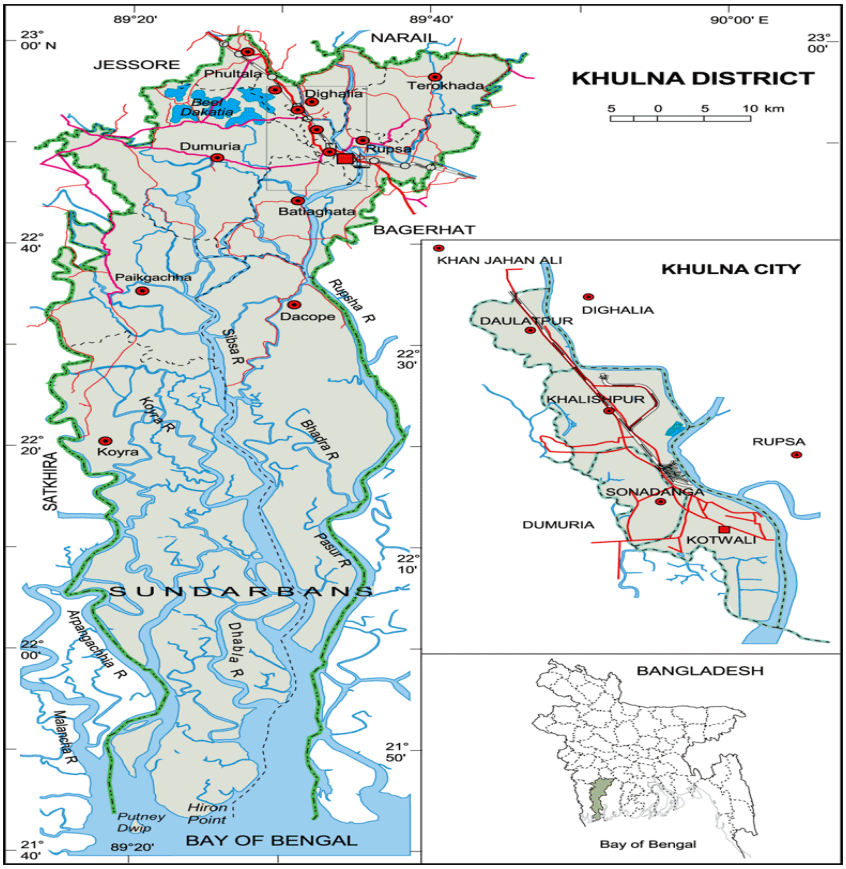

Figure 1: Map of Khulna District

Table 1 presented the components of MSW in Khulna city and characteristics of SW are presented in Figure 2(Ahmed, Hossain,&Islam, 2017).

Table 1: Composition of MSW in Khulna city.

Waste components	**(% by weight)**
Food and vegetable wastes	78.9
Paper and paper products	9.5
Polythene and Plastics	3.1
Textile and wood	1.14
Rubber and Leathers	0.5
Metals and tins	1.1
Glass and ceramics	0.5
Brick, Concrete and Stones	0.1
Dust, Ash, Mud	3.7
Others	1.46
Moisture content	65
Organic Content	52
pH	7.79
Volatile Solids	58
Ash Residue	46
Bulk Density	1000-1066 kg/m^3

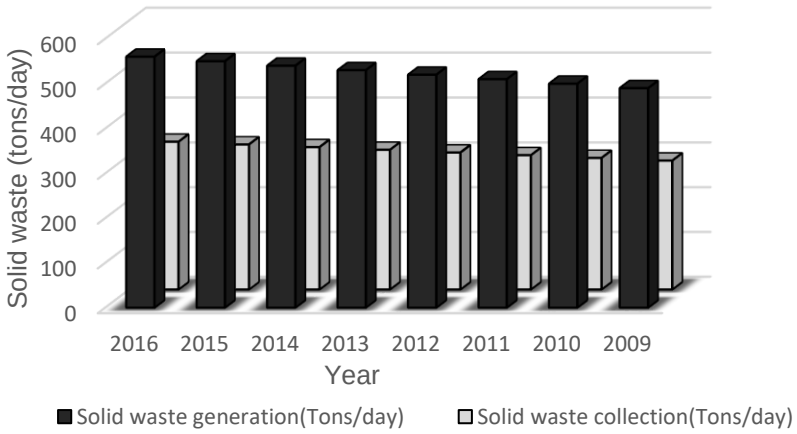

Figure 2: Characteristics of solid waste in Khulna city

2. METHODOLOGY

In present days the population of Khulna city has been increasing day by day. With the increase of population peoples everyday life leading pattern is also changed. For this reason the people used more materials than previous and the result is excess generation of solid waste is making serious problem for the Solid Waste Management System (SWMS). According to the recent report of Khulna City Corporation's Conservancy Department the current actual collected waste per day is 35% only whereas WG rate is 0.40 Kg per capita per day. In the other hand, the rapid population growth rate and urbanization cause the

significant fluctuations of waste generation in this city which consequently results many problems for SWMS.

2.1 Waste Collection

To know about the existing waste collection, storage and recycling pattern in Khulna city, a detailed questionnaire survey and field observation are carried out among the Waste collector (Feriwala/Tokai), Primary dealer (Vangari shop), Secondary dealer and Industry owner. The person who buys the Recyclable Solid Waste (RSW) from household and sells them to the primary dealer as well as secondary dealer is generally known waste collector. The person who buys RSW only from the feriwala and sells them to the secondary dealer and recycling industry is known primary dealer and the secondary dealer buys RSW from both feriwala and primary dealer and sells only to the recycling industry. Generally secondary dealer shops are relatively large compared with the primary dealers. The recycling industries generally collect their recyclable paper, plastic and glass as raw materials from theprimary dealers as well as the secondary dealers. The number of feriwala, primary dealers, secondary dealers & recycling industries in different places of Khulna city are given in Table 2. Two photographs of a feriwala and a primary dealer shop are shown in Figure 3 and Figure 4 respectively.

Table 2: The number of Feriwala, Primary dealers, Secondary dealers & Recycling industries in different places of Khulna city.

Places	Freiwala (No's)	Primary dealer (No's)	Secondary dealer (No's)	Industriesa (No's)
Fulbarigate	05	02	00	00
Daulatpur	07	06	02	01
Khalishpur	9	04	04	01
Sheikhpara	11	03	03	00
Sonadanga	10	05	03	00
Lobonchora	16	8	05	02
Total	57	28	17	04

Figure 3: A Feriwala in Khulna city

Figure 4: A Primary dealer shop in Khulna city

3. RESULTS AND DISCUSSION

The main purpose of this study was to find out the total amount of recyclable plastic wastes produced and the actual amount of recyclable plastic wastes that are recycled daily in Khulna city. The process of recycling plastic which follows in Khulna city recycling industries was also observed. The buying and selling price of the recyclable plastic waste and the plastic after recycle were also a part of this study. The profit of each stages were also find out in this study.

After collecting the recyclable plastic waste by recycling industries send them to the worker for sorting.Sorting of recyclable plastics are done by manual methods in Khulna city. They are generally done by eye inspection. Generally, clear PET (Polyethylene terephthalate) and HDPE (High-density polyethylene) bottles are positively identified and separated out of the stream. They are generally sorted as hard, soft and rubber and shoe. Sorting is also done according to their colour. The financial efficiencies of recycling process mainly depend on this step. More perfection of this process will increase the workability of recycling process as well as the financial profit. When sorting is done send them for cutting. This is the process in which the sorted plastics are reduced to a desired size by a cutting machine. This machine is provided with a motor and a cutter inside. It also has a half conical shape basket from which it is supplied with plastics. After the cutting process have been done the small pieces of plastic are then put into a machine named washing machine. The washing process is also done by hand. Then the cutting plastic are placed to the open place for drying. Drying process is generally done manually. Small pieces of plastics that has been washed by washing machine is dried under sun for natural drying. But in the rainy season they are dried by electric fan. Afterthat molding is done. This is the last step of recycling. In this process the plastics are put into a molding bag and molded manually to get a desired shape. Figure 5 represents the flow diagram of recycling of plastic in Khulna city. The typical photographs of sorting, cutting machine, washing, drying and molding of plastic recycling process are shown in Figure 6, Figure 7, Figure 8, Figure 9 and Figure 10 respectively.

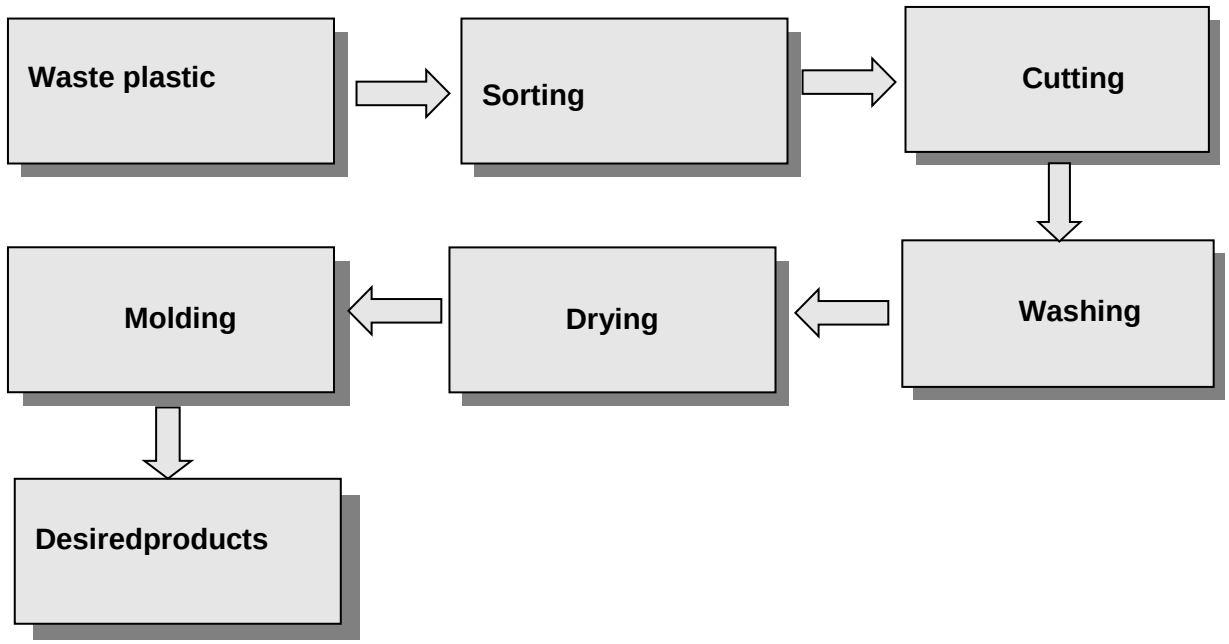

Figure 5:Flow diagram of recycling of plastic in Khulna city.

Figure 6: Sorting

Figure 7: Cutting machine

Fig

Figure 9: Drying

Figure 10: Molding

Total quantity of recyclable plastic wastes in different shops and Tokai are presented in a tabular form. The table shows the quantity of different type recyclable plastic waste collection per day, their buying and selling price. The source and the destination of solid waste are also shown in the table. The working hours of the workers per day and their daily income are also given below the table. Table 3 represents the daily collection of recyclable plastic waste from house to house by a Feriwala. Table 4, Table 5 and Table 6 are also represent the daily collection, buying and selling price, source and destination of recyclable plastic waste of primary dealer shop, secondary dealer shop and recycling industry respectively.

Table 3: Quantity, price, source and destination of collected plastic waste according to Feriwala.

Types of Recyclable Plastic waste	**Amount of collection (Kg/day)**	**Price (Tk./day)**		**Source and Destination of Plastic Waste**
		Buying	**Selling**	
Soft	15-20	15	20	Collected : From houses Destination: primary and secondary dealers
Hard	15-22	25	28	
Rubber/ Shoe	20-23	5	7	

Total amount of collected plastic waste by a Feriwala is 60 kg/day in which 55 kg is recyclable. Total number of feriwala is 57. So Total amount of recyclable plastic waste collected by all Feriwala = 57 x 55 = 3135 kg = 3.1 ton/day.

Table 4: Quantity, price, source and destination of collected plastic waste according to Primary dealer shop.

Types of Recyclable Plastic waste	**Amount collection (Kg/day)**	**Price (Tk./day)**		**Source and Destination of Plastic waste**
		Buying	**Selling**	
Soft	25-35	20	26	Collected: from feriwala Destination: Higher industry
Hard	30-35	30	35	
Rubber/ Shoe	35-40	7	10	

Daily working hours for the workers in a primary dealer shop is 8am to 6pm and the monthly income of every worker is 2000-2200 taka. Total amount of collected plastic waste by a Primary dealer is 115 kg/day in which 95 kg is recyclable. Total number of primary dealer shop is 28. So the total amount of recyclable plastic waste collected by all primary dealer shop = 28 x 95 = 2660 kg/day = 2.7 ton/day.

Table 5: Quantity, price, source and destination of collected plastic waste according to Secondary dealer shop.

Types of Recyclable Plastic waste	Amount collection (Kg/day)	Price (Tk./day)		Source and Destination of Plastic waste
		Buying	Selling	
Soft	60-75	25	33-34	Collected: from feriwala and primary dealer Destination: Higher industry
Hard	55-70	35	45	
Rubber/ Shoe	25-40	8-9	13-14	

Daily working hours for the workers in a secondary dealer shop is 8am to 6pm and the monthly income of every worker is 2200-2500 taka. Total amount of collected plastic waste by a Secondary dealer is 170 kg/day in which 155 kg is recyclable. Total number of secondary dealer shop is 17. So the total amount of recyclable plastic waste collected by all secondary dealer shop = 17 x 155 = 2635 kg/day = 2.6 ton/day.

Table 6: Quantity, price, source and destination of collected plastic waste according to Recycling Industry.

Types of Recyclable Plastic waste	Amount collection (Kg/day)	Price (Tk./day)		Source and Destination of Plastic waste
		Buying	Selling	
Soft	300-380	32	55	Collected: from feriwala and primary dealer Destination: Higher industry
Hard	250-230	40	60-65	
Rubber/ Shoe	220-260	12-13	20-25	

Daily working hours for the workers in a recycling industry is 8am to 10pm and the monthly income of every worker is 3000-3500 taka. Total amount of collected plastic waste by a Recycling industry is 790 kg/day in which 770 kg is recyclable. Total number of recycling industry in Khulna city is 4. So the total amount of recyclable plastic waste collected by all recycling industries = 4 x 770 = 3080 kg/day = 3.1 ton/day. The approxiate net profit per day for a feriwala, primary dealer secondary dealer and recycling industry are given in Table 7. Figure 11 represents the mass balance diagram of recycling of plastic waste in Khulna city.

Table 7: Approximate net profit per day for a Feriwala, Primary dealer shop, Secondary dealer shop and Recycling industry.

Plastic waste collector	Average profit (Tk/Kg)	Amount of waste sell (Kg/day)	Net profit (Tk/day)
Feriwala	3	55	165
Primary dealer	5	95	575
Secondary dealer	7	155	1085
Recycling industry	15	770	11550

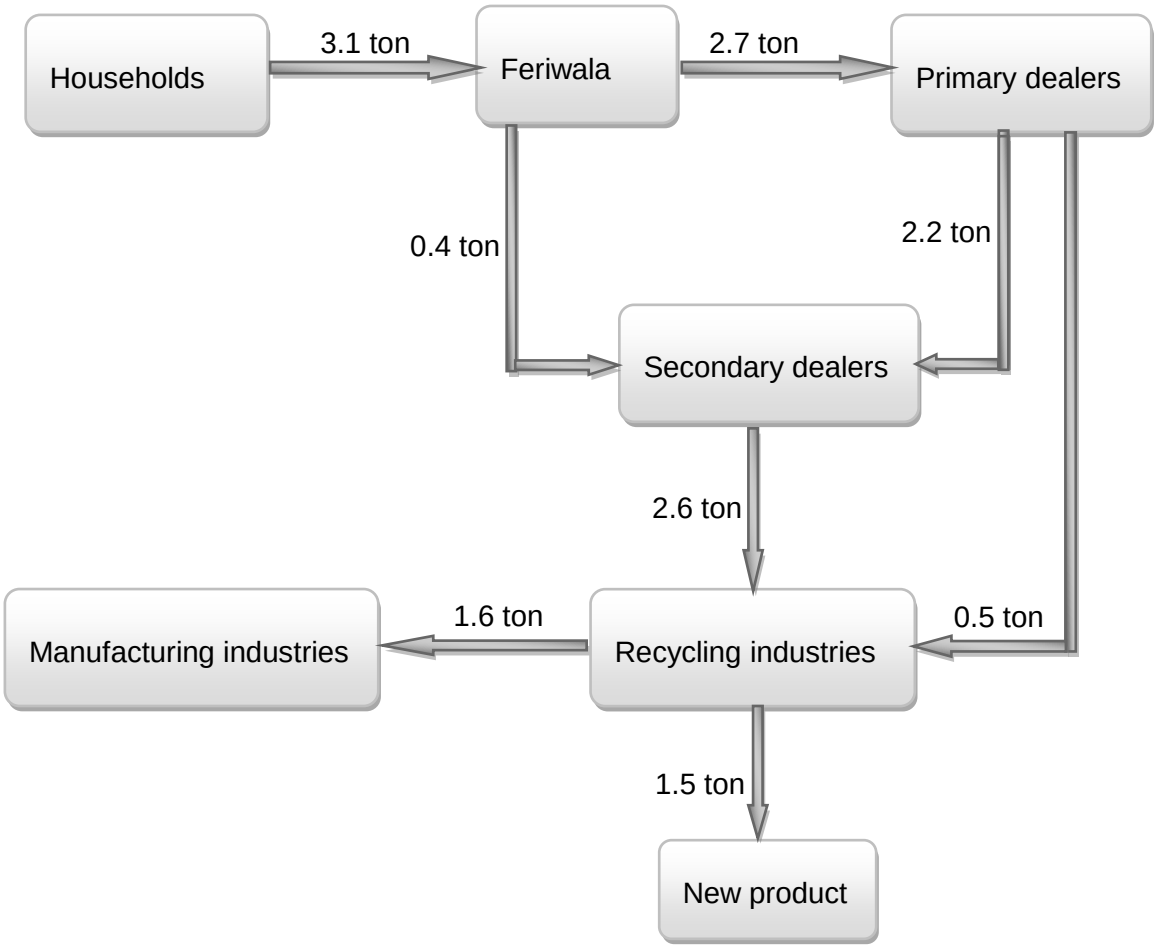

Figure 11: Mass balance of plastic waste recycling in Khulna city.

3.1 Influence Factors

The study reveals that there have some factors of solid waste management system in Khulna city which is influenced the whole system. These factors are necessary to effectively improve waste management, growth and performance, as well as to reduce the environmental degradation of the household waste. The study affirms that understaffing, lack of household education, poor supervision, lack of technological and human resources, lack of government policy and government finances are among reasons leading to poor solid waste management in Khulna Municipality. The study also found thatwaste characterization, waste collection and segregation, local recycled-material market, technology used in recycling are factors influencing solid waste recycling. The manpower in waste disposal, facilities available at the council, attitude of community towards waste disposal, funding for waste disposal programs and technology used in solid waste disposal are factors influencing solid waste disposal.

4. CONCLUSIONS

In this study the process of plastic waste recycling in Khulna city was properly observed.Based on results, it can be observed that the total amount of collected plastic waste was 3400kg/day where 3100kg/day of plastic waste was recycled. The net profit of feriwala, primary dealer, secondary dealer and recycling industry are 165tk/feriwala/day, 575tk/primary dealer shop/day, 1085tk/secondary dealer shop/day and 11550tk/recycling

industry/day respectively. Finally, the mass balance of recycling plastic waste was estimated as well as the influence factors of plastic waste recycling were also identified.

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