

Solid waste collecting and recycling in Jashore city of Bangladesh

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Abstract: A sustainable and environmentally friendly for efficient recycling of solid waste is now a global concern. This study was done within August to October 2019 on Jashore municipality's traditional collecting and recycling pattern of solid waste. Jashore is an important city in Bangladesh due to Benapole land port with India. Everyday an estimated 70 tons of recycled solid wastes were handled in Jashore city area. There were 833 people found to be involved in recycling activities of the city. In Jashore municipality area there were 82 recycling shops for recycling the collected solid waste and most of them were located in the Dhaka road side, Rail station, Shankarpur, Bogchar etc. Major recycled materials from solid wastes were found to be iron, glass, plastic, and papers. The major fraction of these recycled solid wastes were sent to capital city Dhaka for further processing and manufacturing of different new product. In Jashore city only a small amount of solid wastes, specially plastics were processed in local recycle factories. Collecting and processing secondary materials, manufacturing recycled-content products, and then buying recycled products created a circle or loop that ensured the overall success of recycling and generated a host of financial, environmental, and social returns.

Keywords: Recyclable solid waste, Recycling, Waste collectors, Recycling dealers, Recycling factories

1. Introduction

Global solid waste discharge was 10.4 billion tons in 2010 that will be stood as 148 billion tons by 2025. The developing countries contribute about 56% of the world's total solid waste (JICA, 2015). Individual waste generation rate is high in developed countries while total WGR is high in developing countries (Ashraf, Islam, & Adnan, 2015). Developing countries are more sufferers from SW than developed countries. Solid waste is nothing but useful material at ill-suited place (Alamgir, McDonald, Roehl, & Ahsan, 2005). Appropriate handling and treatment of daily generated solid waste can be converted into resources and reduced environmental burdens. It can reduce pressure on natural resource demands and create new job markets (Suthar, Rayal, & Ahada, 2016).

Bangladesh is a developing Asian country which is comprised of more than 522 urban hubs. They generate together thousands of tons of solid waste daily from various sources (Yasin, Mumtaz, Hssain, & Rahman, 2013). However, the overall solid waste management, treatment and disposal systems are quite unsatisfactory level. It is aggravated due to lack of appropriate research and sufficient data about present municipal solid waste management system (Wilson, Rodic, Scheinberg, Velis, & Alabaster, 2012).

In the perspective of the importance of energy saving as well as conservation of resources, efficient recycling of solid wastes is now a global concern requiring extensive research and development works towards exploring newer applications and maximizing use of existing technologies for a sustainable and environmentally sound management (Demirbas, 2010).

A traditional solid waste recycling and reuse scheme has been established in different cities of Bangladesh under private initiatives whose sustainability was confirmed over the years without any official or formal funds (Bari et al., 2009).

The huge amount of daily generated solid waste is safely handled and disposed of in economically and technologically advanced countries. They have well-established waste treatment technologies such as composting, anaerobic degradation, incineration, pyrolysis, gasification and recycling. The remaining residues are disposed of in modern sanitary landfills (Chalcharoenwattana & Pharino, 2015). In addition, they are frequently attempting to develop new technologies to recycle and recover the entire locked valuable resources from solid waste (Suthar et al., 2016).

Solid waste produced by the medical hospitals in Jashore was surveyed. The amount of medical waste and the effect of these waste and remedial process were discussed in that survey (Rahman et al., 2013). The ultimate disposal of solid waste and investigate the effect of the disposed waste on surrounding soil and water was investigated at the Disposal Site, Jhumjhumpur in Jashore, Bangladesh (Martina et al., 2016). The objective of this study is revealing the traditional solid waste collecting and recycling pattern in Jashore city of Bangladesh. In this context, the major focus was encompassed with the participation of different levels of waste collectors and local factories.

2. Methodology

A system of broad principles or rules from which specific methods or procedures may be derived to interpret or solve different problems within the scope of particular discipline. Unlike an algorithm, a methodology is not a formula but a set of practices. The methods section describes actions to be taken to investigate a research problem and the rationale for the application of specific procedures or techniques used to identify, select, process, and analyze information applied to understanding the problem, allowing the reader to critically evaluate a study overall validity and reliability. Waste reuse scheme is managed by informal sector, specially the urban poor, as means of employment for developing countries. The decentralized system seems to work better in provisions of urban infrastructures, especially in situations where centralized system is not yet in place and in situations where the end users of these systems strive to function in dependent from higher level institutions and authorities.

2.1. Selection of study area

It lies between $89^{\circ}10'$ and $89^{\circ}16'$ East and latitude are $23^{\circ} 6'$ and $23^{\circ} 11'$ North. Its elevation is 8 meters above mean sea level and the area is nearly slope from north to south. Jashore is the oldest, biggest and important municipal area of south west Bangladesh. Jashore Pourashava has an area of 14.72km^2 and a population of 447914. A total of nine locations in 9 wards were surveyed and almost all the waste recycling shops (WRS) of Jashore city were situated in the selected area (Table 2).

2.2. Questionnaire survey

The survey is conducted in three different categories which include: primary waste collectors, wastes recycle shops, and wastes recycle factories. A structured questionnaire survey on the existing recycling process was conducted among those people who are related with the recycling process such as waste collectors, owner and workers of shops and recycling factories.

2.2.1. Primary waste collectors

Two types of primary waste collectors were involved in this process: waste pickers and house to house waste collectors locally named feriwala. Primary waste collectors were those people who collected recyclable waste materials from houses or dustbins and finally sold to various waste recycle shops. The waste pickers used to collect wastes from streets, municipal bins and other places.

2.2.2. Waste recycling shops

The shops were categorized according to the type of wastes they deal with, the size of shops, and the number of workers in each shop. The wastes recycle shops were found to be developed in cluster form. Based on this preliminary survey, some shops were selected for detailed survey. Most of the SFRM proprietors were not willing to provide the real data because they worried to increasing taxes. They used to maintain informal records. However, it was interesting to recover a number of sensible information from the traditional reuses pattern. The questionnaire survey in recycle shops documented information regarding the quantity of waste material they dealt with, type of wastes, number of workers, working hours, wages, collection process, etc. In this study, a total 32 shops were surveyed in details.

2.2.3. Waste recycling factories

A detailed questionnaire survey was conducted in these factories which included: factory activity raw material, number of workers, wages, amount of waste collected and products, etc.

2.3. Rate of waste generation

In 2013, the daily waste generation in Jashore was 39 tons per day and until 2021 an increase to 54 tons was expected and population was 201 796 (2011) (Martina and Rebecka, 2016). The current population of this city is 4,47,914 (2019) (Jashore pourashava) and the average solid waste generation rate is estimate 70tond^{-1} . The physical composition of solid wastes of Jashore, Rajshahi, Khulna and Dhaka city were represented in Table 2 where only food and vegetable wastes accounted for 51.89% of the total generated wastes (Hai and Ali, 2005; Yousuf and Rahman, 2007).

3. Collection of Solid Wastes

Different types of solid wastes are collected from various points of collection. The amount of collection per day is shown in table 1.

Table 1. Data collection table of solid waste

Name of waste	Amount(Kg)	Name of waste	Amount(Kg)
Food and vegetable waste	35120	Brick, Concrete and stone	570
Paper and paper product	7628	Green waste and straw	65
Polythene and plastic	9666	Medical waste	1398
Textile and woods	15	Glass and ceramics	150
Metal component	14315	Others	150
Total			69080 Kg

4. Results and Discussion

4.1. Primary waste collectors

The detail information on primary waste collector's and their activities have been documented in Table 3. Waste pickers and feriwala (buyer of recyclable wastes from house) normally work as the primary waste collectors. In Jashore city, the waste pickers were found collecting wastes from waste-bins or road sides. The detail information on primary waste collector's and their activities have been documented in Table 3. People of different ages were involved in picking wastes but most of them fall within 10–30 years old. There was a tendency among the poor people, who did not get job, to be involved in waste picking; because there was no financial investment in this work and the money they received by selling the waste was totally their income. Most of the primary waste collectors were found to be the inhabitants in a slum of 50 families and situated behind the Voirob residential area in Jashore. The waste pickers usually went out for work in the morning and returned back in the afternoon. During this period they used to collect an estimated $11-20 \text{ kgd}^{-1}$ of wastes from different parts of the city. Most of the waste pickers were found illiterate. In comparison to waste pickers, the number of feriwala was less, almost one third of total primary waste collectors; because in this case financial investment was needed. Moniruzzaman et al. (2011) found 658 number feriwala and 1349 number waste pickers involved in waste recycling in Khulna city with ratio of 1:2. Usually, feriwala used to collect an estimated $30-40 \text{ kg d}^{-1}$ of wastes and had better financial condition than waste pickers. Moreover, feriwala were of two categories: (i) walked door to door with container made of bamboo and a balance (ii) used rickshaw van to carry the waste materials. Finally, the waste pickers and feriwala sold the collected recyclable wastes to various recycle shops. A waste picker usually earns Tk 120-200 per day while a feriwala earns Tk 200-300 per day. The estimated amount of waste collected by waste picker and feriwala were found to be 17.5 kgd^{-1} and 34.63 kgd^{-1} , respectively (Table 4)

4.2. Waste recycling shops

A total of 82 waste recycling shops were identified in Jashore city area. Mainly four categories of wastes were recycled as

Table 2. Location of shops and characteristics of the place source: Jashore pouroushava web site

Ward number/location names	Characteristics of the ward	No. of house-holds in the ward	Population of the ward	No. of dealers
1.Barandi para/Nilganj	Residential and middle income people live in this area	3071	59187	4
2.Barandi para	Residential and paper waste shops	1872	31885	4
3.Ghop	Jell and sadar hospital	1327	36855	2
4.Khayertal & puritan kasba	Residential area and market	2883	44670	2
5.Arabpur & Kharki	Middle class and educated professional area	3985	91381	2
6.Chanchra	Residential area and middle income people area	1849	35451	2
7.Shankarpur	Recyclable waste	2641	61313	60

	market and residential area			
8.Bejpara	Mixed income households and market	1541	31115	1
9.Bogchar and murali	Agricultural land and high to middle income people	3287	56050	5

described in Tables 5–7. Major recycled materials were paper or bags, plastic, glass, and metals. A total 32 shops (39% of 82 shops) were surveyed in details. The number of workers in recycle shops were found to be varied according to the nature of job like only separation, only compaction or both. On the basis of the amount of waste handled, the shops were classified into four categories namely Large, Medium, small type A (STA) and small type B (STB) for further analysis. The large shops usually handled more than 2000 kg d^{-1} , the medium shops handled 1000–2000kg d^{-1} , the STA handled 500–1000kg d^{-1} and the STB handled less than 500 kg d^{-1} . There were three large recycle hops in the study area ,however, agreed to provide data (Table 5). This shop was located at Barandipara and Bogchar used to handle 4350kg,2000Kg and 12050Kg recyclable wastes. Generally, all large shops used to buy recycled wastes from medium and small shops. Only one medium shop was identified in the city area. This shop is located Barandipara use to handle 1020 Kg. A total of Three STA shops were identified and each had a capacity of handling 500–875kg d^{-1} recyclable wastes (Table 6). Two STA shops were located in Shankarpur area and One in Bogchar. Out of a total 62 STB shops in the city area, data from 25 shops were collected and documented as shown in Table 7. Most of those were found to dealing with mixed items and handled around 50–450kg d^{-1} of recycled wastes. Working time of the owner/ staffs were about 7–9h a day. Most of them did not provide information regarding their income or salary. The range of income or salary of the respondent owner or worker was Tk 1800–4500 per month.

4.3. Estimation of recycled waste

The average recycled wastes handled by the small type B shop is estimated from Table 7. Recycled wastes= 2823/25= 112.92 kg d^{-1} . Similarly, small type A shop 1620/3=540 kg d^{-1} (Table 6). Thus, the total recyclable wastes handled by 62 numbers small type B shops, 16 numbers small type A shops Large shop is 3 and only Medium shop. Large and Medium would be aggregated to 19.420 ton d^{-1} . The wastes from small and medium shops finally reached to large recycle shops. The Three large shops handled almost similar amount of wastes as estimated from the field survey. This value was very close to the amount handled by the small and medium shops. Therefore, the total estimated amount of recyclable wastes handled in Jashore was taken 23.863 ton d^{-1} .

4.4. Estimation of recyclable solid waste

Potential recyclable solid waste in Jashore city as calculated from Table 3, which include sthe recycle able composition such as paper and paper products, polythene and plastic, metal components, glass and ceramics. This data was important with regards to recycling. Therefore, the quantity of recyclable solid waste (JSW) was estimated from total waste generation 69.08 ton d^{-1} .

4.5. Estimation of readily recyclable solid waste

A term readily recyclable solid waste can be introduced to estimate the percentage of recycling as it was not possible for waste collectors to collect all of the JSW found in the waste bin, dustbin and disposal site. They can collect only those recyclable solid wastes, which were clean and have some selling value. In absence of proper separation at the source some slowly biodegradable components such as paper and bone tend to decompose and some other were spoiled with the mixed decomposable organic waste. Finally, they lost their selling value as well as opportunity

Table 2. Location of shops and characteristics of the places Source: Jashore city corporation web site. Ward number/location names Characteristics of the ward No. of house-holds in ward (area in acre)

The portion of recyclable solid waste, which were clean and had selling values, could be designated as readily recyclable solid wastes.

4.6. Plastic recycling factory

Most of the wastes collected by the large and medium shops were sent to Dhaka for the production of different new materials. Only a small amount of wastes were processed in local factories. Therefore, details information of these local factories were vital with regards to have a complete scenario on waste recycling in

Jashore city. Only five recycling plastic cutting factories were found in Jashore. These factories were located at shankarpur. The factories handled 2 ton d^{-1} and had workers from 2 to 20 persons. These were small type factories which dealt with plastics. These factories collected the plastic wastes from recycle shops and cut the sorted plastics into small pieces and sent to Dhaka for the manufacture of new products.

4.6.1 Processing of wastes in local factories

Four out of five local factories were associated with preliminary processing of waste materials which included: sorting, separation, cutting, washing, and drying the products.

Sorting: The plastic wastes were sorted according to their physical properties such as hardness, color, and thickness, because different types of processed wastes were sent to different production factories.

Separation: Separation included removal of unwanted objects such as dusts or other wastes particles.(Fig.4e)

Cutting: Cutting was done to reduce the size of the plastic waste materials in the range of 6 mm to 12 mm (Fig. 4b).

Washing: After cutting, the plastic wastes were washed with water using detergent.Fig:4(a)

Drying: The wet waste chips were then dried in the sun. Sometimes, the waste chips were mixed with colors and finally the dried plastic chips were packed and sent to Dhaka or local factory for the manufacture of new products.(Fig.4d)



Fig.4a Washing



Fig.4b Cutting



Fig.4cPacking after drying



Fig.4d Drying



Fig.4eSeparating

Fig. 4f. Road side food and vegetable

Table 3. Physical composition (%) of solid waste generated from Jashore, Rajshahi and Dhaka with typical values of Bangladesh.

City source composition	Jashore city waste (2019) %	Rajshahi city waste safe(2005) %	Dhaka city waste safe (2005) %	Dhaka city memon (2005) %	Typical values for Bangladesh Huda (2008) %
Food and vegetable waste	50.84	71.1	68.3	70.12	70.0
Paper and paper product	11.04	8.9	10.7	4.16	4.0
Polythene and plastic	13.99	4.0	4.3	4.17	5.0
Textile and woods	0.02	1.9	2.2	-	-
Metal component	20.73	1.1	2.0	0.13	0.13
Glass and ceramics	0.22	1.1	0.7	0.25	0.25
Rubber and leather	-	1.1	1.4	0.70	-
Brick, Concrete and stone	0.83	2.9	1.8	4.29	-
Green waste and straw	0.09	-	-	10.76	11
Dust, ashes	-	6.5	6.7	-	-
Medical waste	2.02	-	-	-	-
Others	0.22	1.4	1.9	5.42	9.62

Table 4
Amount of waste collected by primary waste collectors.

Type of waste collectors (age)	Male/female	Amount of waste collected ($kg\ d^{-1}$)				
		Glass	Paper	Plastic	Metal	Total
Waste picker (10)	Male	2	7-8	2-3	1-0.5	13.0
Waste picker(13)	Male	2	7-8	6	1-0.5	16.0
Waste picker(30)	Male	5	20	2	1	28.0
Waste picker(55)	Male	3	14-15	1.5	0.5	19.5
Waste picker(30)	Female	5	8	0.5	0.5	14.0
Waste picker(35)	Female	3	10	1	0.5	14.5
Average collection (kgd^{-1})		3.33	11.25	2.25	0.67	17.50
Selling price (Tk/kg)		3.0	6.0	25.0	25.0	
Income(Tk)		10.0	67.5	56.3	16.8	150.0
Feriwala(46)	Male	5-6	20-25	2-3	2.5	33.0
Feriwala(48)	Male	1	10	10	15	36.0
Feriwala(30)	Male	4-5	18-20	2-3	3	29
Feriwala(28)	Male	5-6	20-25	2-3	2.5	33.0
Average collection (kgd^{-1})		4	16.63	7.5	6.5	34.63
Profit(Tk/kg)		2.0	3.0	7.0	8.0	
Income(Tk)		8.0	50.0	52.5	52.0	162.0

Table 5. Amount collected by large and medium recycling waste shops.

Sl. No	Place	No. of worker	Paper bags	Plastic	Glass	Metal	Total ($kg\ d^{-1}$)	Working hours	Salary/income (Tk)
01.	Barandipara	8	4000	250	-	1000	4350	9	6000
02.	Barandipara	7	2000	-	-	-	2000	9	6000
03.	Nilganj	3	1000	-	-	20	1020	9	5500
04.	Bogchar	7	50	-	-	12000	12050	8	5000

Table 6. Collected data on small type Arecycling waste shops.

Sl. No	Place	No. of worker	Paper bags	Plastic	Glass	Metal	Total(Kgd^{-1})	Working hours	Salary/income (Tk)
01.	Shankarpur	5	-	500	-	30	530	8	5000
02.	Shankarpur	5	20	500	-	50	570	8	5000
03.	Bogchar	4	20	-	-	500	520	8	5000
Total		14					1620		

Pie chart of percentage of solid waste in Jashore city:

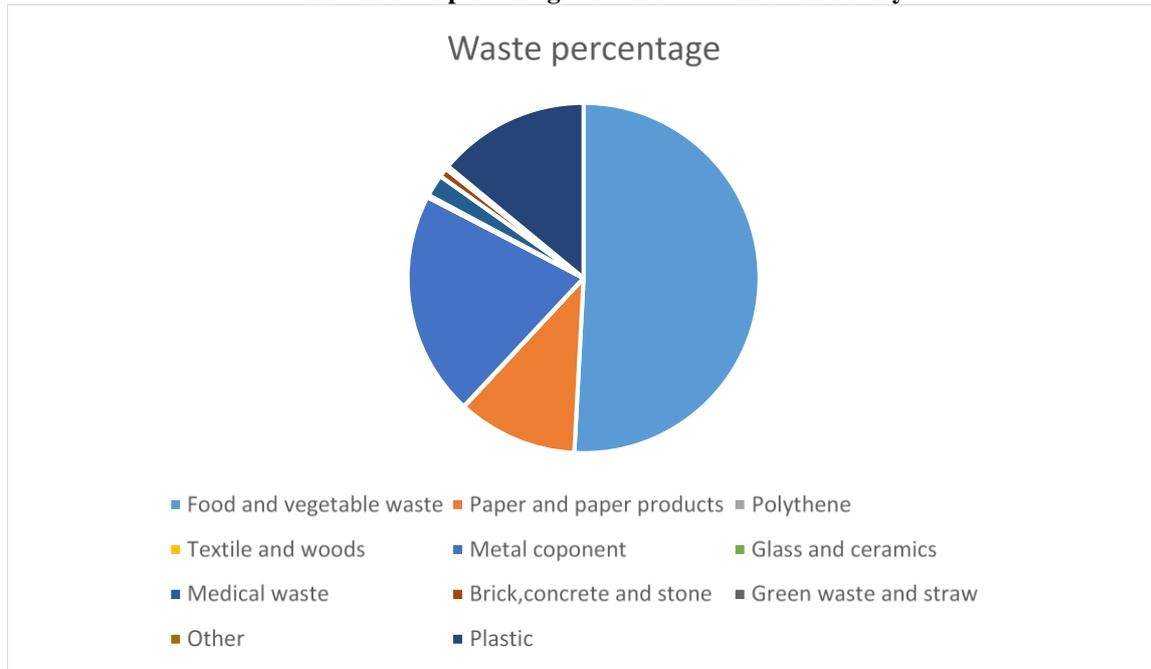


Fig.4g: pie chart of percentage of solid waste in Jashore city

Table 7
Collected data on small type B recycling waste shops

Sl. no.	Place	No. of worker	Paper bags	Plastic	Glass	Metal	Total (kg d^{-1})	Working hours	Salary/income(Tk)
01.	Barandipara	1	-	10	-	60	70	8	4000
02.	Barandipara	2	20	10	-	50	80	8	5000
03.	Barandipara	1	5	-	-	20	25	9	4000
04.	Barandipara	3	200	60	5	20	285	8	4000
05.	Barandipara	1	20	15	-	30	65	8	4000
06.	Gope	2	15	10	-	80	105	8	4000
07.	Gope	1	10	5	-	20	35	9	4000
08.	Khayertala	2	20	5	-	60	85	8	4000
09.	Khayertala	2	30	10	-	100	140	9	5000
10	Arabpur	2	50	10	-	60	85	8	4000
11	Kharki	1	20	5	-	80	105	9	5000
12	Chanchra	3	30	5	-	200	235	8	4000
13	Chanchra	1	20	10	-	30	60	8	4000
14	Shankarpur	1	5	10	-	10	25	9	5000
15	Shankarpur	2	20	30	-	5	55	8	4000
16	Shankarpur	3	-	200	-	5	205	8	4000
17	Shankarpur	1	3	15	-	15	18	7	4000
18	Shankarpur	1	-	-	-	20	20	5	4000
19	Shankarpur	2	5	100	-	30	145	8	5000
20	Shankarpur	2	-	100	-	40	140	8	4000
21	Shankarpur	2	5	100	-	5	110	8	4000
22	Bajpara	2	50	20	-	50	120	9	5000
23	Bogchar	1	-	-	-	200	200	8	4000
24	Bogchar	2	10	-	-	300	310	8	4500
25	Bogchar	1	-	-	-	100	100	8	4000
Total	42						2823		

4.7. Estimation of number of people involved in recycling process

The people involved in primary collection were waste pickers and feriwala. The number of feriwala was found one third of the total primary collectors. The capacity of waste collection by feriwala was found to be approximately double than a waste picker (Moniruzzaman et al., 2011). The average amount of waste collected by a waste picker was 17.5kgd^{-1} and a feriwala 34.63kgd^{-1} (Table 4). Thus, the total 23.863tond^{-1} of recycled wastes could be collected together by 300 number of feriwala and 200 number of waste pickers. Therefore, the total number of feriwala plus waste pickers is 500. The total number of people involved in recycling shops and factories were consisted of proprietors and appointed workers. Usually for small shops the owner worked alone. For the estimation of number of people involved in recycling activities, the average number of workers in each type shop was determined and then multiplied with total number of identified shops. The total number owner plus worker for all types of shops was estimated:

= Worker of (STA+STB+ Medium shop + Large shop)

= $(14 \times 16)/3 + (42 \times 62)/25 + (3 \times 1) + (22 \times 3)$ (Identified shop number is in italic font)

= 248 persons

Therefore, the total number of people involved in recycling in Jashore was estimated:

= Number of people involved in (primary collection+ shops + factories+ municipal collection)

= $(500 + 248 + 35 + 50)$ persons

= 833 persons.

Thus, a total 833 persons were working daily in Jashore city for waste recycling processes.

5. Significance

Solid waste management is not just a corporate social responsibility or a non-priority service anymore. Improper management of solid waste continues to impact public health of entire communities and cities, polluted local water, air and land resources; contribute to climate change and ocean plastic pollution. Inclusive waste management where informal waste recyclers are involved can provide an enormous economic opportunity to the marginalized urban poor. Additionally, a good solid waste management plan with cost recovery mechanisms can free tax payers money for other issues. Improper waste management is a public health and environmental crisis, economic loss, operational inefficiency and political and public awareness failure. Compared to solid waste management, we can consider that the world has achieved significant success in providing other basic necessities like food, drinking water, energy and economic opportunities. Managing solid wastes properly can help improve the above service further. Composting organic waste can help nurture crops and result in a better agricultural yield. Reducing land filling and building sanitary landfill will reduce ground and surface water pollution which can help provide cleaner drinking water. Therefore, it needs global attention to arrive at solutions which span across such a wide range of issues.

The recycling of solid waste was not included in the waste management policy of local authority, yet it had become a main source of income for several groups of the private sector. The waste collectors should be formally incorporated in waste management systems, both at local level systems, as well as in the larger urban framework. For this, training would be required on personal hygiene as most waste collectors were found to be unaware of the consequences of garbage sorting without adopting safety guide-lines. Moreover, attention should be paid to improve the living conditions of the waste collectors. A major portion of recyclable solid waste is transported to Dhaka and Khulna over a long distance. Thus, a huge amount of money was wasted for transportation in both directions: to export raw waste materials and to import recycled products for local consumption. Therefore, it is imperative to establish large recycling factories in Jashore city which would save a large amount of money and help in reducing unemployment.

6. Conclusions

From this study the major findings are outlined as below:

- Wastes are being collected from the 9 wards of Jashore city by feriwala, waste picker and the people assigned by the Jashore municipal and the population size is about 447914. The total amount of solid waste collected from Jashore city is about 69.08tond^{-1} . The collection rate is about 0.154 kg per day per capita.
- The number of recyclable shops is 82 and most of them situated at Shankarpur in Jashore. About 833 people were involved to execute the chain of collection and recycling process of the city.
- The total amount of recyclable waste handled in Jashore is 6.5tond^{-1} . The recycled portion accounted for 9.41% of the daily total generated wastes (69tond^{-1}), 18.25% of total recyclable wastes (35.609tond^{-1}).
- Six recycling factories are in Jashore where a small amount of waste, especially metals is being recycled. These factories produce different types of motor parts. Some recyclable solid wastes undergo

preliminary processing. The major portion of solid waste is sent to Khulna and Dhaka for further manufacture of different new products. All the food and vegetable waste is being sent to Jhumjhumpur disposal site in Jashore for ultimate disposal. Waste management system in Jashore is not improved. Wastes are being stored here and there, especially at intermediate storage points, odor spreading out and contaminating surrounding environment.

- Training program on personal hygiene should be arranged and also have to improve living conditions of waste collectors. These will ensure the long term sustainability of this traditional pattern of solid wastes collection and recycling process.

References

- [1]. Ashraf, M. A., Islam, M. R., & Adnan, S. G. (2015). GIS and multi criteria decision metho dbased approach of identifying appropriate landfill sites for the city of Chittagong. *International Journal of Environment*, 4(1), 1–15.
- [2]. Alamgir, M., McDonald, C., Roehl, K. E., & Ahsan, A. (2005). Integrated management and safe disposal of municipal solid waste in least developed Asian Countries. Final report of 'Waste Safe' a feasibility project under the Asia Pro Eco Programme of the EC Bangladesh: Department of Civil Engineering, Khulna University of Engineering and Technology.
- [3]. Bari, Q.H., Moniruzzaman, S.M., Uddin, M.A., 2009. Recycling of solid waste in Khulna city of Bangladesh. Scenario of solid waste management program of selected municipalities in Bangladesh. *In: Proceedings of the International Conference on Solid Waste Management*, Waste Safe, KUET, Khulna, Bangladesh, pp. 623–630.
- [4]. Chalcharoenwattana, A., & Pharino, C. (2015). Co-benefits of household waste recycling for local community's sustainable waste management in Thailand. *Sustainability*, 7,7417–7437.
- [5]. Demirbas, A., 2010. Waste management, waste resource facilities and waste conversion processes. *Energy Conversion and Management* 52, 1280–1287.
- [6]. Hai, F.I., Ali, M.F., 2005. A study on solid waste management system of Dhaka city corporation: effect of composting and landfill location. *UAP Journal of Civil and Environmental Engineering* 1 (1), 18–26.
- [7]. Huda, K.M.N., 2008. Municipal Solid Waste Management, Bangladesh Perspective. Academic press and Publishing Library, Dhaka, Bangladesh, p. 27.
- [8]. JICA (2015). JICA strategy paper on solid waste management. Global Environmental Department, Japan International Cooperation Agency.
- [9]. Martina, M.M., and Rebecka, O.(2016).An Inventory of the Waste Disposal Site Jhumjhumpur in Jessore, Bangladesh, via Soil and Water Sampling.KTH, School of Chemical Science and Engineering (CHE).
- [10]. Memon, M.A., 2002. Solid Waste Management in Dhaka, Bangladesh. <www.kitakyushu.iges.or.jp/docs/demo/dhaka_bangladesh/spdhaka.pdf>.
- [11]. Moniruzzaman, S.M., Bari, Q.H., Fukuhara, T., 2011. Recycling practices of solid waste in Khulna city, Bangladesh. *The Journal of Solid Waste Technology and Management*, USA 37 (1), 1–16.
- [12]. Rahman, M.S., Moumita, C., and Rikta, K.(2013). Medical Waste Management System: An Alarming Threat (A Case Studyon Jessore Municipality, Bangladesh). *J. Environ. Sci. & Natural Resources*, 6(2), 181-189.
- [13]. Safe, Waste, 2005. Integrated Management and Safe Disposal of Municipal Solid Waste in Least Developed Asian Countries – A Feasibility Study. Department of Civil Engineering, KUET, Khulna, Bangladesh.
- [14]. Suthar, S., Rayal, P., & Ahada, C. P. S. (2016). Role of different stakeholders in trading of reusable/recyclable urban solid waste materials: A case study. *Sustainable Cities and Society*, 22, 104–115.
- [15]. Wilson, D. C., Rodic, L., Scheinberg, A., Velis, C. A., & Alabaster, G. (2012). Comparative analysis of solid waste management in 20 cities. *Waste Management & Research*, 30(3),237–254.
- [16]. Yasin, N. H. M., Mumtaz, M., Hssain, M. A., & Rahman, N.-A. A. (2013). Food waste and food processing waste for biohydrogen production: A review. *Journal of Environmental Management*, 130, 375–385.
- [17]. Yousuf, T.B., Rahman, M., 2007. Monitoring quantity and characteristics of municipal solid waste in Dhaka city. *Environmental Monitoring and Assessment* 135, 3–11.