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STATUS OF HOUSEHOLD SOLID WASTE AND PEOPLE'S PERCEPTION ON ITS MANAGEMENT AT SITAKUNDA UPAZILA, CHITTAGONG

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Abstract

Urban household solid waste (HSW) is well-known, but has little knowledge about the rural areas and sub-cities. The quest of the study was to investigate current HSW management system and people's attitude towards it's at Sitakunda Upazila. The study was conducted through a semi-structured questionnaire survey by interviewing 150 households from 3 different socioeconomic groups. The results showed that on an average each household generated 1.26 kg/day wastes which stands at 0.24 kg/person/day in the study area. However, HSW generation is positively correlated with family size (r_{xy}=0.991, $p<0.05$), average age of family members (r_{xy}=0.455, $p<0.01$), and monthly earnings (r_{xy}=0.999, $p<0.01$) of the households. Amidst the various categories of wastes, vegetable and food wastes (VFWs) were identified as the highest value 68.4%. In contrast, 24.6% of the generated wastes were recyclable and 75.4% non-recyclable; 82.1% organic and 17.9% inorganic. A large percentage of sampled households opined that present HSW management involves merely partial collection that is also irregular in urban areas but absent in rural areas. Unfair HSW collection was noticed by 58.7% and partial source segregation is also rare 14%. Besides, 42.7% people were found to dispose their daily generated wastes by open dumping and 25.3% nearby lagoon. A large number of people were dissatisfied 68% and only 6.7% were satisfied with the existing HSW management system. In addition, most of the people encountered bad odor problems by 28.7% and wastes spread on roadside by 38%. Significant quantity of recyclable wastes was noticed to collect from households by hawkers/scraps in the study area and very few household were found to use VFWs with cow-dung to generate biogas.

Key words: Dumping, HSW, Management, Sitakunda, Recyclable, and VFW.

Introduction

Solid waste is considered to be one of the most serious environmental burdens and multidimensional challenge faced by urban authorities, especially in developing countries like Bangladesh (Bartone, 1990; Sujauddin et al., 2008; BMDF, 2012). It consists of discarded portion of the households, dead animals, trade, commercial, agricultural and industrial waste and others (Cunningham and Saiogo, 1990). Huge production and disposal of solid waste causes the degradation of environment, particularly in developing countries (Asraf, 1994; BMDF, 2012). But it is not problem for developed countries because of having sufficient fund, technology and skilled manpower. Developing countries per capita waste generation rate is less due to lower purchasing capacity but aggregated volume is high (Cairncross and Feachem, 1993). Unfair and partial solid waste management (SWM) accelerates environmental pollution and put public health at risks (Alam et al., 2002). In addition, uncontrolled population growth enhances daily generated wastes volume and thus creates environmental snags and economic loss (Salequzzaman et al., 2001).

In Bangladesh, solid waste generation rate is augmenting day-to-day proportional with expansion of urban areas but the overall management and disposal system is not yet enough appropriate for safe environment and human health. Typically, one to two-thirds of the daily generated waste is not collected in most of the developing countries (WRI, 1996; Riyad et al., 2014). Consequently, such uncollected waste often get mixed with human and animal excreta and indiscriminately dumped into the streets and drainage flow which contributes in flash-floods along with acting as breeding house of insects and rodent vectors (USEPA, 1995). Herein, SWM encompasses all aspects concerned with generation, on-site handling and storage, collection, transportation, reuse, recycling, and final disposal; therefore, it is considered as multi-disciplinary approach based on engineering principles (Samsudin and Don, 2013). Due to the dearth of financial resources, institutional weakness, and improper choice of technology SWM services is still far from satisfactory level in Bangladesh. To date, many investigations have already been accomplished for SWM to resolve problems but rare in wastes treatment, pollution control, and resources recovery (Alamgir and Ahsan, 2007; Enayetullah et al., 2005; Rahman, 2000; Bhide, 1990; Hoq and Lechner, 1994).

Though developed countries, currently, practice many advanced technologies for solid waste treatment but Bangladesh lags behind (Zhao et al., 2012; Matsuto and Ham, 1990). Anyway, composting and anaerobic digestion are being practiced in several places such as in Cities (Dhaka, Chittagong and Khulna) and rural areas respectively. Besides, compost and biogas are environment friendly product as well reduce disposal cost (Zurbrugg et al., 2005; Hasan et al., 2012; Alam et al., 2015). Recently, Bangladesh government has introduced 3Rs policy in 2010 with-a-view-to resource recovery from wastes; and in limited number of families (big cities) – household solid waste (HSW) segregation materials were supplied to facilitate the noble initiative (DoE, 2010; Chowdhury et al., 2014). Implementation of 3Rs policy for wastes management includes socioeconomic and climate change adaptive policy (Chowdhury et al., 2014) where city dwellers show positive attitude towards 3Rs policy (Ivy et al., 2013). Now, informal sector for recyclable waste collection and recycling is getting popularity in Bangladesh day-to-day. Dhaka city only saves BDT10 million/year through informal recycling, so it has become a lucrative business now (Matte et al., 2013; Alam et al., 2015; BMDF, 2012).

Best of our knowledge, a little work has been performed on residential HSW in Bangladesh (Sujauddin et al., 2008; Salam et al., 2012; Muttalib et al., 2015). Lately, a study in Chittagong university campus shows that the overall HSW management is unhygienic and risks for public health and environment (Rahman et al., 2013). On the other hand, very little work is done on rural HSW generation, characteristics, management and disposal. Another study in Lohagara Upazila of Chittagong found that actually there is no waste collection system and almost all the daily generated waste is disposed in open places (Islam et al., 2015) and very few families disposed by adopting anaerobic digestion for biogas. Unfortunately, HSW, which is daily generated in huge volume and closely linked with environmental pollution and act as a source of resources and energy, has not really been quested to explore their quantity, characterization and recycling opportunity in Bangladesh hereto. Hence, the absence of any known study about the volume of waste quantity and characteristics in the rural areas has made policy makers ignorant and has coupled the problems. Therefore, the study is an attempt to explore the quantity and physical composition of HSW and people's perception towards its management system at Sitakunda Upazila.

Methodology

Description of the study area

Sitakunda is an upazila under Chittagong District; it was renamed as Sitakunda Upazila in 1983. It occupies an area of 483.97 square kilometres including 61.61 square kilometres of forest (Rahaman, 2010). It is located between 22°22' and 22°42' north latitudes and between 91°34' and 91°48' east longitudes. It is bounded by Mirsharai and Fatikchhari Upazilas on the north, Pahartali thana on the south, Fatikchhari, Hathazari upazilas and Panchlaish thana on the east, Sandwip upazila and Sandwip channel on the west. According to the population census of 2001, it had a population of 335,178 distributed to 55,837 units of households and density is 693/km^2 (BBS, 2001). At Chandranath temple or Sitakunda peak is the highest peak (1,155 ft) in Chittagong. It includes one urban settlement, the Sitakunda Town, and 10 unions. It is the home of the country's first eco-park, as well as alternative energy projects, specifically wind energy and geothermal power.

It is one of the oldest sites of human habitation in Bangladesh. Its economic development is mainly driven by the Dhaka-Chittagong Highway and the railway. It is predominantly an agricultural area and also has the largest ship breaking industry (SBI) in the world. SBI has been accused of neglecting workers' rights, especially concerned work safety practices and child labour. It has also been accused of harming the environment, particularly by causing soil contamination and water pollution (Sarraf, 2010; BOBLME, 2011). The attraction of Sitakunda as a tourist destination is elevated by the hill ranges, the eco-park, lake and Buddhist temple (Rahaman, 2010).

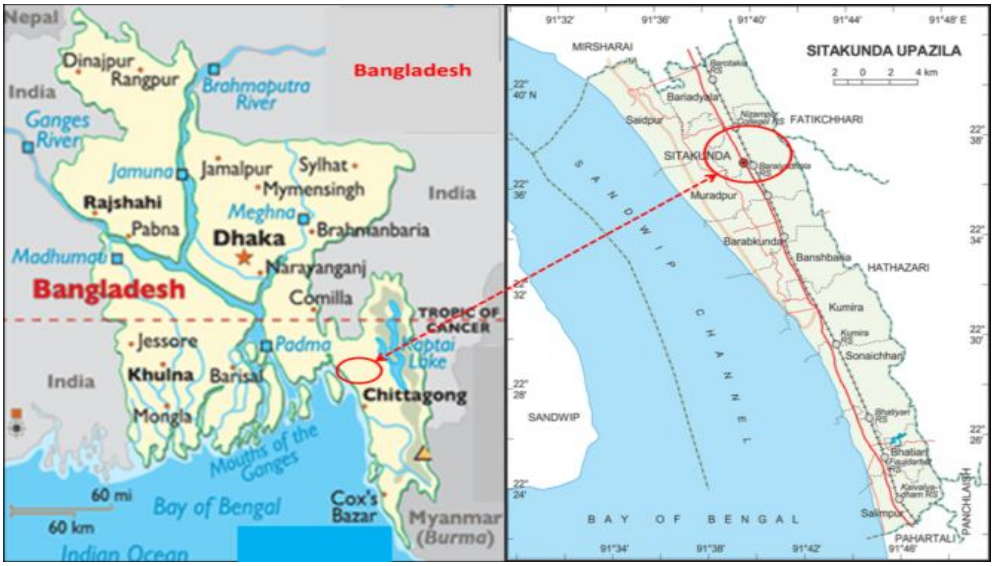

Figure 1: Sketch of survey area marked by red colored circles (http://map.janlewala.com).

Selection of the study area

The study area was selected at Sitakunda Upazila which consists of 9 wards and 22 mahallas including 10 unions. Among the 10 unions, two villages namely – Gulia Khali and Purbo Vater Khali and Uttar Sitakunda (Pourashabha) as urban area were selected as study areas wherein 150 households were randomly selected. To date, many researches have already been accomplished for this topic in different cities or municipalities. But such study in rural areas, basically Jele Para (fishermen community) and sub cities not yet has done.

Gulia Khali (Jele Para) – is about 3 kilometers far away from the Pourashabha. It is comparatively densely populated village where most of the people are fishermen and the education rate is very low. Purbo Vater Khali – is also near to the town of Sitakunda but slightly far compared to Gulia Khali. Similarly, most of the people are fishermen including a large number of people working in SBI. Uttar Sitakunda (Pourashabha) – is situated in the proper area of Sitakunda town. It is the dumping site of the study area where minor quantity of HSW is segregated. Different category of the people live here and most of them are educated. But there is no appropriate SWM system at all; even rural people have no knowledge about waste segregation, collection and management.

Reconnaissance survey and questionnaire survey

Initially, a reconnaissance survey was conducted to observe the present HSW management and disposal system in the study area and to identify the various problems created due to the absence of appropriate solid waste collection and disposal system. Based on the gathered knowledge, the whole study area was classified into three different socioeconomic groups on the basis of the household's monthly income: (a) Lower socioeconomic group (LSEG) – monthly income <BDT 15,000, (b) Middle socioeconomic group (MSEG) – monthly income BDT 15,000-30,000, and (c) Upper socioeconomic group (USEG) – monthly income >BDT 30,000.

Based on preliminary survey, a semi-structured questionnaire was designed emphasising people's concepts about solid wastes, their level of awareness, nature and severity of the problem; they face due to the absence of systematic solid waste collection, management and disposal system. Besides, what were their suggestions for developing a sustainable SWM system for Sitakunda Upazila was included. Finally, questionnaire was surveyed among randomly selected 150 households (hh) – (50 urban and 100 rural) from study area. In addition, the questionnaires included a number of attitudinal questions aimed at assessing household's awareness and attitudes towards the rural and urban SWM system.

Weighing and physical categorization

During the survey, 5 similar size polythene bags were supplied to each household to collect their generated wastes of 3 different days for weighing. Collected wastes from each polythene bags were weighed and recorded. Then the wastes within each bag were separated and segregated items were weighed individually and then recorded. The same task was done for each of the three days for each of the 150 households. In contrast, collected and weighed HSW were identified and categorized based on their physical composition. Herein, on an average collected solid wastes were categorized into 9 groups based on their physical characteristics such as – (a) Vegetable and food wastes (VFWs), (b) Paper, book and printed materials (PBPM), (c) Packaging materials (PM), (d) Plastic, rubber and polythene (PRP), (e) Textile, rags and jutes (TRJ), (f) Glass and ceramic (GC), (g) Can, jar, tin and metal (CJTM), (h) Wood and leaves (WL), and (i) Miscellaneous (dirt, stone).

Data analysis

Finally, all the collected primary data were compiled in MS Excel sheet and then made re-arrangement. Later, the data was analysed by using MS excel sheet (version: 2010) and required graphs were also created by using MS excel sheet.

Results and Discussion

Waste generation based on family size and age

Quantity of daily HSW generation depends on the number of family members along with average age of the family members. The results showed (table 1) that the average family size (mean) is 5.5 persons/hh. Here, the highest percentage 40% of member was found in the family consists of 7-8 members and the lowest percentage 10% of member was observed in the family having 1-2 members. In contrast, the percentage of family member possessing 3-4 is about 20% that is 2 times lower than the family consists of 7-8 members. The average waste generation rate (WGR) by the family size 7-8 is 1.89 kg/day, the family size 5-6 is 1.52

kg/day, the family size 3-4 is 1.24 kg/day, and the family size 1-2 is 0.69 kg/day. The HSW generation is positively correlated with family size and significantly varied (r_{xy} = 0.991, $p<0.05$). Muttalib et al. (2015) found that per household WGR was 0.65 kg/day by 1-2 members, 0.95 kg/day by 3-4 members, 1.17 kg/day by 5-6 members, and 1.29 kg/day by 7-8 members of the studied families. It is stark clear that the larger size of the family, the lager quantity of the waste generation; hence, household WGR varies with-regard-to family size.

On the other hand, (table 1) shows that the average family members age (mean) is 40.32 years. The percentage of average family age which ranges 20-30 years is about 20%, 31-40 years is around 36.66%, 41-50 years is approximately 17%, and 51-60 years is almost 26.66%. Besides, it is seen that different age groups of people generated wastes in various amount (table 1). The WGR for the age group 20-30 years is 0.76 kg/hh/day (lowest) while for the age group 51-60 years is 1.85 kg/hh/day (highest). Similarly, the WGR is positively correlated with average age of the family members and differed significantly (r_{xy} = 0.455, $p<0.01$). Thereby, it is very clear that if average age of the family members is higher; then WGR is higher due to high purchasing and consumption capacity. On the contrary, Muttalib et al. (2015) found that per household WGR decreasing trend with the increase of average of family members such as 1.16 kg/day by 20-30 years, 1.24 kg/day by 31-40 years, 0.97 kg/day by 41-50 years, and 0.69 kg/day by 51-60 years subsequently in Chuadanga Municipal.

Table 1: WGR based on family size and age of the family members at Sitakunda Upazila.

Based on number of family members				**Based on average age of the family members**			
Family size	Number of family	Percent (%)	WGR (kg/hh/day)	Average age	Number of families	Percent (%)	WGR (kg/hh/day)
1-2	15	10	0.69	20-30	30	20	0.76
3-4	30	20	1.24	31-40	55	36.66	1.22
5-6	45	30	1.52	41-50	25	16.66	0.93
7-8	60	40	1.89	51-60	40	26.66	1.85
Total	150	100	avg. =1.26	Total	150	100	avg. = 1.17
Mean = 5.5 (persons/hh), standard deviation = 1.927 (persons/hh).				Mean = 40.32 (years), standard deviation = 11.399 (years).			

Waste generation based on socioeconomic status

From (table 2), it is seen that the HSW generation rate per household per day increased from LSEG to USEG in a traditional stratification. The highest HSW generation was seen 1.53 kg/hh/day in USEG and the lowest 0.81 kg/hh/day in LSEG respectively; while in MSEG is 1.15 kg/hh/day. Anyhow, the average HSW generation rate is 1.16 kg/hh/day. The HSW generation rate per family is positively correlated with economic condition of family and varied significantly ((r_{xy} = 0.999, $p<0.01$). Therefore, it is stark clear that the HSW generation rate varies with the family income too, not only based on family size and age of the family members. In a sub-city, per household HSW generation rate was found – 1.21 kg/day, 1.05 kg/day, and 0.77 kg/day by USEG, MSEG, and LSEG subsequently (Muttalib et al., 2015) while Salam et al. (2012) found 3.35 kg/day by USEG, 1.07 kg/day by MSEG, and o.37 kg/day by LSEG in Chittagong City. Another report at Lohagara Upazila identified the maximum number of family generated HSW between 0 (zero) and 1 kg/day by USEG (20.8%), MSEG (15%) and LSEG (11%) and the rests within 1-3kg/day (Islam et al., 2015).

Similarly, (table 2) represents that the HSW generation rate in kg/person/day increased gradually from LSEG to USEG. The HSW generation rate by different socioeconomic groups was calculated as 0.27 kg/person/day by USEG, and 0.25 kg/person/day by MSEG, and 0.22 kg/person/day by LSEG, respectively. The WGR per person is positively correlated with socioeconomic status and significantly differed ($r_{xy} = 0.984$, $p<0.01$). Therefore, it is very clear that HSW generation rate varies with the total income of the family members both per capita and per household. It is estimated that the per capita WGR in six major cities of Bangladesh viz. Dhaka, Chittagong, Rajshahi, Khulna, Sylhet and Barisal was 0.56 kg, 0.48 kg, 0.3 kg, 0.27 kg, 0.3 kg and 0.25 kg per day, respectively (Enayetullah et al., 2005). According to another report, the HSW generation rate of Bangladesh was 0.15 kg/person/day (World Bank, 1999). BMDF (2012) calculated that WGR is 0.34 kg/capita/day in Chittagong City Corporation, 0.25 kg/capita/day in Rajshahi City Corporation, 0.24 kg/capita/day in Rangpur Municipality and 0.22 kg/capita/day in Patuakhali Municipality subsequently. Muttalib et al. (2015) found that per person HSW generation 0.26 kg/day, 0.21 kg/day, 0.19 kg/day, respectively by USEG, MSEG and LSEG in Chuadanga Municipal, Khulna while Salam et al. (2012) found 0.56 kg/day, 0.24 kg/day and 0.06 kg/day respectively in Chittagong City.

Table 2: Household WGR based on socioeconomic status at Sitakunda Upazila.

Socioeconomic group	Number of persons studied	WGR	
		Kg/hh/day	(kg/person/day)
LSEG	37	0.81	0.22
MSEG	49	1.15	0.25
USEG	64	1.53	0.27
Total	150	avg. = 1.16	avg. = 0.24

Physical composition of HSW

Identification and categorization of physical composition of HSW is very important for appropriate and smoothly collection, handling, management, treatment, and resource recovery. It is seen (figure 2) that LSEG generates 64% VFWs which is the highest amount compared to other types of wastes. On the contrary, the second, third and fourth highest quantity of wastes is wood/leaves 7%, packaging materials 6%, textile/rags/jute is 5%, and can/jar/tin/metals 5%. In addition, glass/ceramic, miscellaneous, and paper/book/printed materials individually 3% including plastic/rubber/polythene is 4% in the study area.

Muttalib et al. (2015) found that LSEG discharged 72% VFWs, 5.2% glass/ceramic, 4.7% can/jar/tin and 4% dirt/stone respectively. The rest types was identified as 3.5% packaging materials, 3.3% wood/leaves, 3% plastics/rubber/polythene, 2.8% textile/jutes/rags, and 2.5% paper/book/printed material subsequently.

Similarly, (figure 2) indicates that the highest amount of wastes 69.8% was generated by MSEG is VFWs that is higher than that of the amount of VFWs generated by LSEG. Then the second and third highest quantity is glass/ceramic 6.3% and can/jar/tin/metals 5.5%. Further, the rest types of WGR is plastic/rubber/polythene 4.3%, paper/book/printed materials 3.7%, packaging materials 2.9%, textiles/rags/jute 1.9%, wood/leaves 1.4%, and miscellaneous 4.2% respectively. The quantity of individual physical composition of HSW in MSEG is much higher than that of LSEG due to variation in purchasing and consumption capacity of foods and products. Salam et al. (2015) measured vegetables 74%, paper 5%; packaging and glass 4% individually; can, plastic, and textile 3% separately; and rocks and woods 2% individually in residential wastes of MSEG of Chittagong City.

Here, (figure 2) shows that USEG generates the highest amount of VFWs 71.5%, which is higher than that of LSEG and MSEG. But the next highest quantity of waste is glass/ceramic about 5.9% and the other categories are can/jar/tin/metals 5.7%, plastic/rubber/polythene 3.6%, packaging materials 2.8%, wood/leaves 2%, textile/rags/jute 1.4%, and miscellaneous 3.5%. However, these types of wastes mainly vary from their socioeconomic group perspective which is very important to know such variation of physical composition in different socioeconomic groups to ensure appropriate and smoothly collection of daily generated HSW. Sujauddin et al. (2008) measured vegetables 47%, paper 3%, packaging 14%, glass 5%, can 15%, plastics 2%, textile 0 (zero)%, rocks 10%, and woods 4% in USEG of Chittagong City.

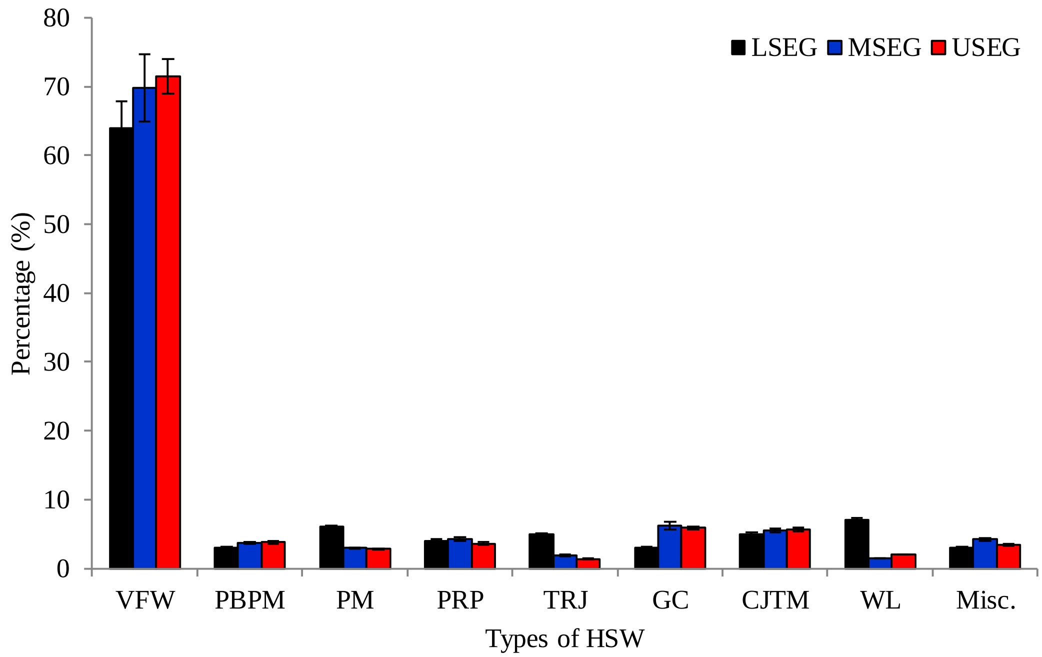

Figure 2: Physical composition of daily generated HSW in different socioeconomic groups.

From (figure 3), it is seen that on an average the highest amount of wastes generated by household is VFWs 68.4% compared to the other types of wastes. Herein, the second and third highest quantity is can/jar/tin/metals 5.4% and glass/ceramic 5.1% respectively that was obtained from the three socioeconomic groups in the study areas. In addition, the average percentage of other types of HSW is wood/leaves 3.5%, paper/book/printed materials 3.5%, packaging materials 3.9%, plastic/rubber/polythene 4%, textile/rags/jute 2.7% and miscellaneous 3.6% subsequently. Sujauddin et al. (2008) conducted a study on residential HSW in Chittagong City and identified physical composition of wastes vegetables 62%, rocks 6%, glass 5%, plastics 2%, and textiles 1%; while packaging and can individually 9%; and paper and woods separately 3%. Later, Salam et al. (2012) found vegetable 72%, packaging 6%, paper 5%, and can 4% respectively, while plastics, glass and textile individually contributed 3%. Similarly, rocks and woods contributed separately 2% in Chittagong City. Similarly, Rahman et al. (2013) accomplished a survey based study in University of Chittagong campus and identified vegetables/food wastes 67.7%, paper/book/printed materials 8.4%, packaging materials 6.5%, plastic/rubber/polythene 6.1%, textile/rags/jutes 2.1%, glass/ceramics 1.3%, can/jar/tin/metals 3.2%, wood/leaves 1.8%, and miscellaneous 2.9%. Lately, Muttalib et al. (2015) calculated VFWs 75%, glass/ceramics 4.07%, can/jar/tin/metals 3.8%, plastic/rubber/polythene 3.43%, textile/rags/jutes 2.1%, and wood/leaves 1.93%; while paper/books/printed materials, packaging materials 3%, and miscellaneous individually 3% in HSW of Chuadanga Municipal.

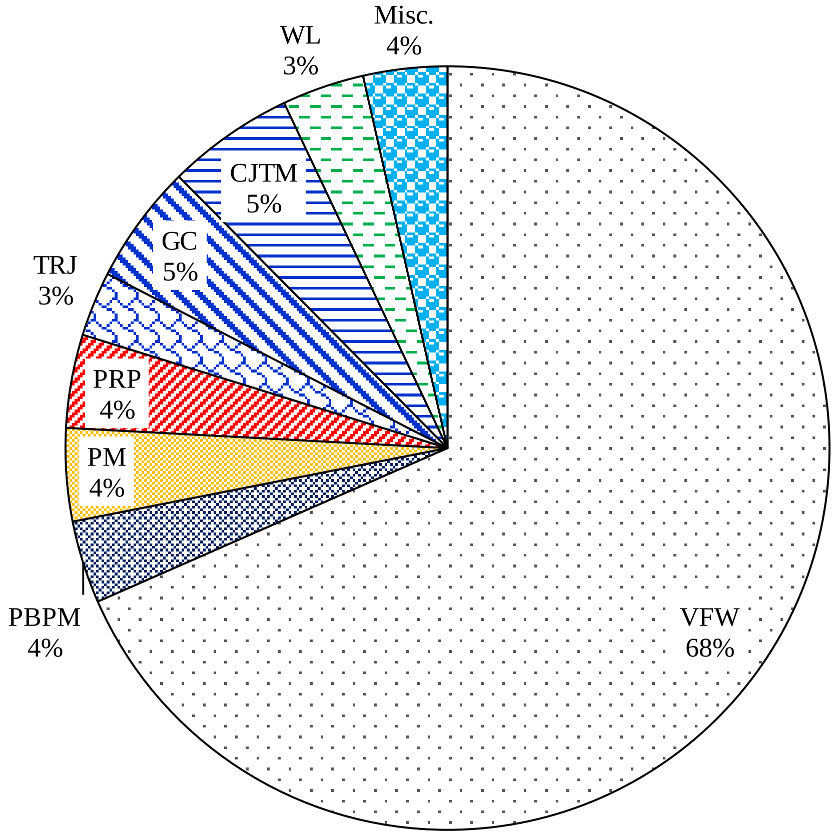

Figure 3: Average physical composition of HSW in studied areas.

Quantitative analysis of HSW

From (figure 4), it is seen that 75.4% of the generated wastes is non-recyclable which is approximately 3 times higher than recyclable waste 24.6%. Such larger volume of non-recyclable wastes demands appropriate collection and disposal. On the contrary, a significant amount of recyclable wastes need to be recycled for resource recovery and sustainable environment. Amidst 24.6% recyclable waste, the highest amount is identified – can/jar/tin metals and the lowest quantity – textile/rags/jute giving 21.9% and 11.2% respectively. The rest types are 14.3% by paper/book/printed materials, 16% by packaging materials, 16.1% by plastic/rubber/polythene, and 20.57% by glass/ceramic subsequently. Herein, can/jar/tin/metals and textile/rag/jute were the highest and the lowest orderly. Some previous studies accomplished different places of Bangladesh found that recyclable wastes is lower than non-recyclable but significant quantity viz. 28% (Sujauddin et al., 2008; Rahman et al., 2013), 21% (Salam et al., 2012), and 20.7% (Muttalib et al,. 2015) recyclable wastes was calculated in HSW. Recently, many informal sectors are working on recycling HSW throughout the country, especially in urban areas (Matter et al., 2013) and to facilitate such initiative source segregation of wastes is very important.

On the other hand, among 75.4% non-recyclable wastes, the highest value 90.7% was calculated as VFWs. Besides, wood/leaves and miscellaneous were found 4.6% and 4.7% respectively (figure 4). Similarly, larger segment of non-recyclable HSW was measured 72% by Sujauddin et al. (2008) and Rahman et al. (2013), 79% by Salam et al. (2012), and 79.93% by Muttalib et al. (2015) Chittagong and Khulna respectively. Apparently, non-recyclable wastes have no economic value, informal sectors are not interested to collect and recycle such types of wastes. Hence, such wastes are accelerating environmental burdens but among them, biodegradable wastes can be used for recovery of energy (biogas) (Hossain et al., 2014; Halder et al., 2014) and compost (fertilizer) (Hasan et al., 2012; Moqsud et al., 2011).

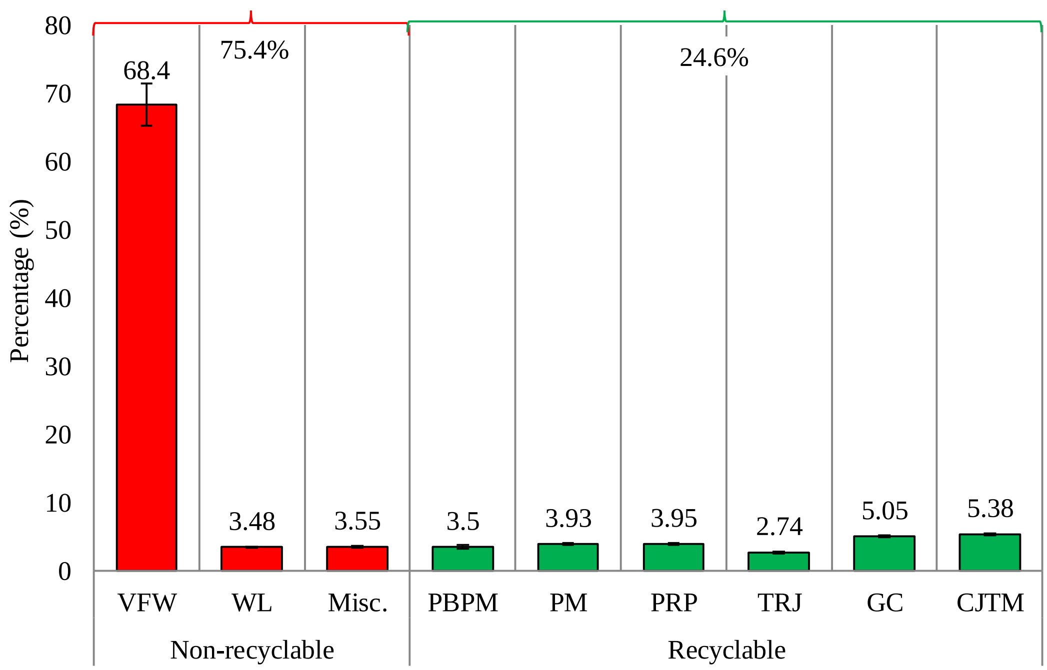

Figure 4: Percentage of average recyclable and non-recyclable wastes of HSW.

Similarly, (figure 5) showed that on an average 82.1% of HSW was organic (decomposable) which is almost 4 times higher than that of inorganic wastes (non-decomposable) 17.9%. Organic wastes can be converted into organic manure which is viable to environment. So, it is needed to convert organic wastes into organic manure (compost or fertilizer) for better environment and organic foods production. Among 82.1% organic wastes, VFWs contributed 83.4% and the rest wastes are 4.3% by paper/book/printed materials, 4.8% by packaging materials, 3.3% by textile/rag/jute and 4.2% by wood/leaves respectively. Herein, textile/rag/jute was found in the lowest quantity. According to literature review, Sujauddin et al. (2008) 66%, Salam et al. (2012) 77%, Rahman et al. (2013) 77.9%, and Muttalib et al. (2015) 86.5% calculated biodegradable or organic wastes in HSWs. Large volume of such wastes demand new landfills which is difficult to find in urban areas (Rafizul et al., 2012;

Ashraf et al., 2015). Therefore, such organic wastes can be utilized to produce biogas (Sufian and Bala, 2006; Moqsud et al., 2014) and compost or fertilizers (Zurbrugg et al., 2005; Hasan et al., 2012).

On the contrary, the inorganic wastes (non-biodegradable) can't be converted into compost or manure, so it is need to be recycled and treated. Therefore, it is necessary to recycle the inorganic wastes to recover valuable resources and to ensure friendly environment. In 17.93% non-decomposable wastes, can/jar/tin/metals contributed 30% (the highest amount), plastic/rubber/polythene 22%, glass/ceramic 28.2%, and miscellaneous 19.8% subsequently where miscellaneous waste is the lowest percentage. Sujauddin et al. (2008) measured 34% non-decomposable wastes in residential HSW. Similarly, Salam et al. (2012) 23%, Rahman et al. (2013) 22.1%, and Muttalib et al. (2015) 13.5% identified non-decomposable wastes in HSW. Currently, non-decomposable wastes viz. paper, plastics, metals and glass are comprehensively being recycled in almost all major cities of Bangladesh due to high market demand (Bari et al., 2012; Matter et al., 2013; Alam et al., 2015).

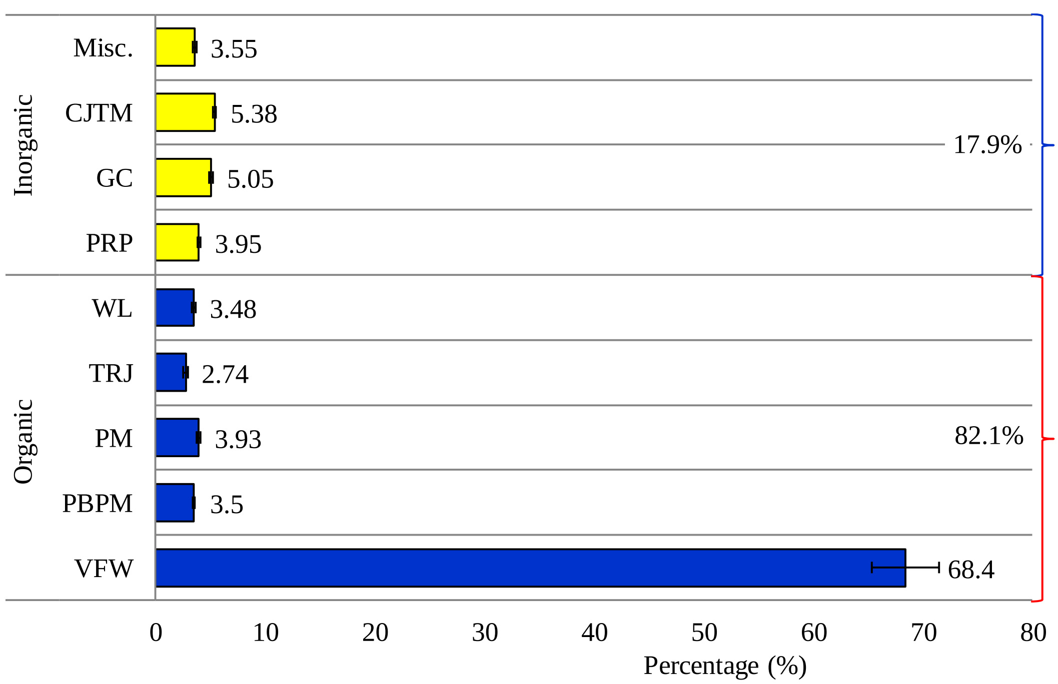

Figure 5: Percentage of average organic and inorganic wastes of HSW.

People's attitudes towards HSW management system

It was found (table 3) that on-site collection of HSW is very low 19.3% and unfair or partial collection was 58.7% in the study area. Source segregation of HSW is very significant for swiftly handling and disposal of wastes, but segregation was noticed 8% and poor separation was seen 14%. BMDF (2012) found that wastes collection efficiency was 42% in Chittagong City Corporation, 72% in Rajshahi City Corporation, 32% in Rangpur Municipal, and 60% in

Patuakhali Municipality respectively. In case of HSW disposal, most of the people dump their daily generated wastes towards open places (fallow lands and roadsides) that is about 42.7% which is the highest in percentage. Herein, around 8.7% of people dump their wastes into open dustbins and almost 14.7% of people throw their wastes nearby the canal. Further, about 25.3% people throw their daily generated wastes to the adjacent lagoon that was affected the aquatic life of fish and hamper the environment. It is stark clear that the tendency of throwing wastes towards the nearby places and lagoon is higher than that of any other disposal system. Waste is disposed by wastes collector and in covered dustbin is negligible than that of disposing towards surrounding the open places and water bodies, that is the result of unfair management system of Pourashabha as well as Jele Para (Rural area). In addition, 8.7% people were found to collect and sell recyclable wastes (plastics, metals, paper) to scrap shops or hawkers. Muttalib et al. (2015) found that daily generated solid wastes disposed by open dumping 33.3%, throwing besides pond 6.7%, covered dustbins 26.6%, and to waste collector and throwing in drain individually 16.7% in Chuadanga Municipal while Sujauddin et al. (2008) found 10.7% open places, 80% to waste collector, 6.7% throwing into drains, 1.3% own yards, and 1.3% covered dustbin in Chittagong City. At Lohagara Upazila, it was seen that most of the people disposed their daily generated wastes either in open places or own compound (Islam et al. 2015). It is transparent clear that most of the daily generated HSW is disposed unfair way which is responsible to climate change induced impacts and create public health hazards too (Ivy et al., 2013; Chowdhury et al., 2014).

Field survey had been accomplished to identify the people's perception regarding to existing HSW management actively, where they are accepting it as good or not. Four different criteria i.e. good, poor, satisfied, and dissatisfied were selected to differentiate perception level of respondents within the study area. According to (table 3), it was found that 68% of people were dissatisfied while 6.7% of the people were satisfied with the present HSW management services provided by municipal. In contrast, 12.7% of the people opined that the overall HSW management was poor where another 12.7% people commented that the existing system was good. On the other hand, Muttalib et al. (2015) found that people's satisfaction level about existing HSW management was 5% good, 15% poor, 25% satisfied, and 55% unsatisfied in Chuadanga Municipal. Similarly, present SWM system was found inappropriate and harmful for environment and public health in Narayanganj and Comilla Cities (Ahmed and Huq-Hussain, 2011; Majumder and Karim, 2012). Hence, it can be said that the present condition of HSW management system in the study area is not good system rather it should be improved immediately for ensuring sound environment. Therefore, the appropriate environmental management initiatives should be taken by concerned authority at Sitakunda Pourashabha as well as Gulia Khali and Purbo Vater Khali (Jele Para). It is important for sustainable environment and keeping both urban and rural environment in sound.

From the (table 3), it is clearly seen that 28.7% of the people face bad odor problem from scattered HSW in the study. On the other hand, the highest trouble faced by people is the presence of waste beside road which is 38%. In addition, the problem associated with disease vector that is around 13.3% and almost 20% of people faced the trouble due to blockage of drain flow. According to field observation and data analysis, it is clear that most of the people in the study area suffer from bad odor problems as well the presence of disease vector that is threated to their sound health and environment. Further, people face the problem of blockage of drain and waste beside the road due to lack of dustbin supply in the study area. Sujauddin et al. (2008) found that due to existing SWM system 41.3% bad odor,35.3% open dumping/roadsides, 12% drainage block, and 6.7% individually by irregular collection and not problem faced in Chittagong City while Muttalib et al. (2015) found bad odor 467%, roadside dumping 10%, drainage block 16.7%, and disease vector 26.7% in Chuadanga Municipal. However, the overall HSW management system in Pourashabha (urban) area and Jele Para is quite in unsatisfactory level. So, to ensure sound health and environment for the people of urban area and rural areas, the authority should immediately improve the present waste collection and management system.

Table 3: Frequency distribution in relation to HSW management and people's perception.

Current HSW management system					
Options	Variables	Number of family		Percentage (%)	Cumulative percentage
		Urban (50)	Rural (100)		
Handling system	On-site collection	12	17	19.33	19.33
	Unfair collection	25	63	58.67	78
	Segregation	5	7	8	86
	Partial segregation	8	13	14	100
Disposal system	Open dumping	17	47	42.67	42.67
	Throw into canal	7	15	14.67	57.34
	Throw beside lagoon	8	30	25.33	82.67
	Open dustbin	13	0	8.67	91.34
	Recycling	5	8	8.67	100.01
People's perception on HSW management					
Satisfaction level	Good	12	7	12.67	12.67
	Poor	6	13	12.67	25.34
	Satisfied	5	5	6.67	32.01
	Dissatisfied	27	75	68	100.01
Problems related to HSW disposal					
Exposed problems	Bad odor	10	33	28.67	28.67
	Waste beside road	20	37	38	66.67
	Blockage of drain	12	18	20	86.67
	Disease vector	8	12	13.33	100

Conclusion

Currently, public health and environmental risks are increasing due to unfair or partial HSW management not only in major cities but also in sub-cities and rural areas. The waste generation rate is being increased in the residential areas of both in urban and rural areas. So, the general communities, which are the most important stakeholders in waste management activities, can take an active part in source segregation of HSW. Still, there is no planned and formal recycling system in the rural areas, even in urban areas rather partially informal recycling is done by scavengers and hawkers. Currently, a few NGOs have started recycling and reuse of paper, bottles, containers, metals, glass, cloths, shoes, polythene bags etc. for their own economic benefits. Anyway, HSWs are mainly dumped in open areas through crude dumping without any pre-treatment or sanitary landfilling. Such inadequate and uncontrolled management of HSWs cause serious health hazard and environmental degradation, i.e., soil, air and water pollution as well public nuisance at Sitakunda Upazila. In addition, lack of awareness amidst the mass people and the failure of upazila administration to take the proper initiative, has augmented the overall SWM problem significantly. Hence, to avoid further environmental pollution, reduce public health risks and utilize the opportunities of resources recovery from wastes; local government and policy makers should pay attention in HSW management of sub-cities and rural areas.

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