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OVERALL ASSESSMENT OF INFORMAL SECTOR ENGAGED IN OPEN WASTE DISPOSAL SITE IN KHULNA

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ABSTRACT

The informal sector plays a vigorous role for the betterment of the environment by sorting out recyclable material and turning waste liabilities into assets. This study analyzes the informal sector involved in scavenging activity at Rajbandh, the only in-operation open waste dumping site in Khulna, Bangladesh. Data were collected through an extensive questionnaire survey among household waste collectors and medical waste collectors. The questionnaire survey was structured to collect information that included their waste collection types, monthly income and fluctuation in income, living standard, social acceptance of their activities, health allegations, and education level. A composition analysis of the incoming waste and recycled waste gives an indication of the types of waste that has market value and final waste residue disposed of at the dump site. The daily amount of collection of recyclable waste is 237.14 kg ± 26.43 kg including glass, PET bottle, coconut shell, soft plastic, aluminum can, paper, rubber, bone, medical waste, scrap metal, etc. Money flow and economic characteristics indicate scavenging activity as an employment opportunity for the poverty-stricken people in Khulna city. The demographic composition indicates that most of the waste collectors involved in scavenging at the Rajbandh open dump site are women. Child labor problem is not present and middle-aged people are mainly working here indicated from age. Most of the waste collectors are privileged with basic living standard parameters but they are not aware of education facilities. Due to their low level of education, they are not aware of the harmful effect of mixed waste and infectious medical waste. Sometimes they are indifferent to the use of suitable protective measures that expose them to dangerous occupational risks and hazards. Sanitary toilet facilities and hand washing facilities at the landfill can help waste collectors greatly to maintain personal hygiene. Enhancing safety awareness among waste collectors regarding the harmful effects of mixed waste, risk exposures at the waste disposal site and the importance of using protective measures helps to improve the working environment without any risk events.

INTRODUCTION

Solid Waste Management (SWM) is a global concern due to its associated harmful impact on the environment and human health, especially in developing countries. Due to rapid urbanization, population growth in the urban area, and consumption pattern change, sustainable management of municipal solid waste is a big issue (Marshall and Farahbakhsh, 2013). As the third largest metropolitan city in Bangladesh, Khulna City Corporation (KCC) authority is also facing challenges in regard to municipal solid waste management. The amount of municipal solid waste (MSW) generated by Khulna city dwellers is about 420 to 520 tons per day, of which 20 to 25 tons per day is being recycled by waste collector (Ahsan et al., 2012). The municipality authority disposes of the generated waste at an open dumpsite named Rajbandh open dump site which is located 10 kilometers west from the City Corporation headquarter. The only operational waste dump site, Rajbandh open dump site is over 25 acres in area with unplanned and uncontrolled MSW disposal that is a possible source of pollution in and around the site (Rafizul and Khair, 2018).

The "informal sector" at landfills is generally defined as a group of people who collect waste with the primary goal of providing employment and income to those involved but are not formally recognized. In an open dump site, waste collectors are involved in scavenging recyclable waste from the mixed waste that helps to reduce the total amount of waste as well as providing earning opportunities for the poor. Due to rapid urbanization and population growth, city dweller is in lack of basic needs, such as electricity, education, water supply, sewerage system, waste management and so on. Scavenging activity helps to meet some probable solutions to this problem by providing employment opportunities for the poor, reducing the amount of waste at dumpsites, and prolonging the lifespan of landfills (Igwe et al., 2018). Scavenging activity will continue to happen for a long time because of profitable business for poor people, the high unemployment problem, demand for recyclables (Aljaradin et al., 2015). However, working with mixed waste without protective measures may cause a serious health hazard. Exposure to smoke from fire and dust emissions from open dump sites may create respiratory disorders. Injured by sharp objects sometimes can be fatal to the waste collector if it contains harmful microbes like human immune deficiency virus (HIV), hepatitis, etc. Inadequate education and lack of safety awareness mainly exposed them to higher risks to health (Nyathi et al., 2018). Gwisai revealed in his study that landfill employees and waste collectors working for more than five years usually suffer from different occupational health problems and respiratory symptoms. Most of the time, the reason behind this low health condition is offensive odor, dust particles, lack of toilet facilities, and absence of soil cover materials (Gwisai et al., 2014). Hence, this study focuses on the risk exposure assessment of waste collector working at the Rajbandh open dump site.

Eerd mention that, risk exposure to the waste collector can be classified into seven parts including occupational accidents, physical risks, chemical risks, ergonomic risks, psychological risks, biological risks, and others. Injured by sharp objects, and hitting by waste leveling vehicles or trucks that convey waste from the municipality is an example of an occupational accident that was considered to assess risks for informal sector workers. During the dry season, landfill fire is a common phenomenon, especially in open dump sites like Rajbandh open dumpsite which exposes the waste collector to risks for burns. Landfill fire emits different types of toxic gases that also create chemical risks to the waste collectors (Eerd, 1997). Most of the waste collectors are exposed to intestinal protozoa, helminths, and diarrhea that creates biological risks to the waste collectors. Snakebite and insect bite is also other common risks of exposure to the waste collector (Afon, 2012).

Community acceptance helps to involve a large community in this profession and it is required when poverty rose. Contribution to resource recovery can increase significantly if can be socially acceptable to the community to which they belong. Poverty reduction, community development, and ensuring environmental and social safeguards can be the outcome of supporting scavenging activity. Supporting scavenging activities can increase work performance, help to increase income, and improve their living condition (Aljaradin et al., 2015).

It is mandatory to build up a waste management and disposal system that is environmentally, economically, and socially sustainable for the betterment of city dwellers and the informal sector is an integrated part of the whole management process. As a developing country, the proper infrastructure of landfill is not well developed in Bangladesh, especially in the Khulna region. In practice, most of them are in open dump conditions where access for the informal sector, like waste collectors, is easy without any proper guidelines to maintain their daily working activities. So, this study aims to assess the demographic characteristic, economic characteristics, and living standards of the informal sector involved at the waste disposal site. The daily amount and composition of recyclable collected by the waste collector are also investigated. Safety awareness has an intensive relationship with the frequency of hazardous events and these two factors are also investigated.

METHODOLOGY

Study Area (Rajbandh Open Dump Site)

The Khulna city is located in southwestern Bangladesh, regarded as the third-largest metropolitan city of Bangladesh. The city, situated beside Bay of Bengal, sits between 22°47’16” to 22°52’0” north latitude and

89°31'36" to 89°34'35" east longitude (Rafew and Rafizul, 2021). Currently, the area covered by Khulna City Corporation (KCC) is 45.65 km^2 and near about 1.5 million people are living here (Pangkaj, 2018). Rajbandh open dump site, only operative waste disposal site is located 22°47'51.7" to 22°47'42.8" north latitude and 89°30'02.6" to 89°30'02.5" east latitude covers an area about 80937 square meters as shown in the location map of Rajbandh, Khulna, Bangladesh. Municipal Solid Waste (MSW) generation rate of Khulna City is about 450 tons per day with an increase of 50 tons due demand variation and consumption variation with different season (Hasib and Rafizul, 2020). After waste collection, the municipal authority dumps the MSW to the open dump site at Rajbandh, Khulna. Only 250–270 tons of MSW are deposited into the open disposal point at Rajbandh, Khulna, out of the total amount. (Khan *et al*., 2015; Rafew and Rafizul, 2021). In Khulna, waste collectors frequently visit to collect recyclable waste from Rajbandh open dump site. Hence, Rajbandh open dumping site Khulna has been selected as study area.

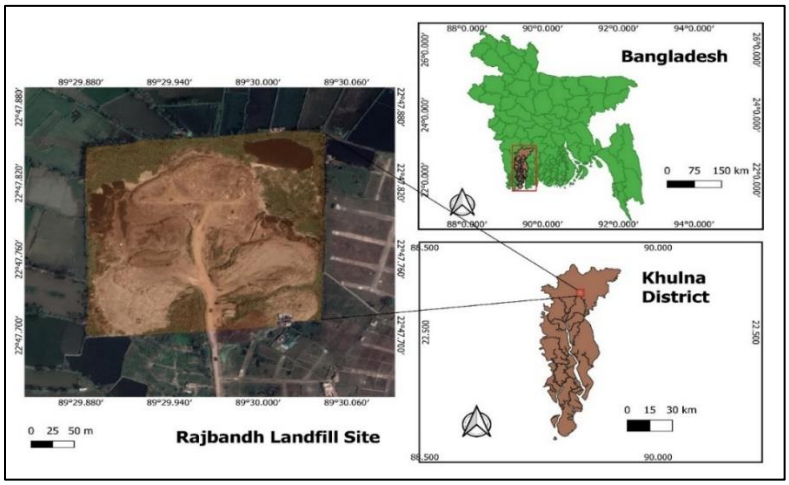

Figure 1. Location of Rajbandh open dump site

Data Collection and Analysis

Onsite questionnaire survey among waste collectors and key informants (landfill supervisors) was conducted to collect data. It was carried out in November 2022. During this time, twelve waste collectors were interviewed at Rajbandh open dump site and that's all the waste collectors available during this pe riod. The questionnaire-based survey was conducted on medical waste collector and municipal solid waste collector on their demographic composition, economic characteristic, risk exposure at the landfill and their perception towards landfill operation. A questionnaire survey form was prepared based on the information as shown in Table 1. Associated risks and hazards exposure with scavenging, including insect bite, snake bite, injuries from sharp object, burns, etc. is investigated during this survey based on previous findings by Afon (2012). At the place of sorting near the waste pile, the survey team took their interview as shown in Figure 2(a). To quantify the amount of recyclable waste, the survey team measure the waste sack from the stored sack pile as shown in Figure 2(b) that they have collected the previous day. Composition analysis of the sorted waste from waste sack was done to find out the type of recyclable waste is collected by waste collector. To find out the amount of recyclable in the final residue for landfilling, a composition analysis was also accomplished.

Table 1. Survey information to assess informal sector

Age	Amount of daily collected waste
Gender	Daily income
Residence (Residence/ Rent/ Slump)	Fluctuation of income
Education level	Living standard
Duration of waste collection	Community acceptance
Type of collected waste	Risk exposure
Duration in this profession	Safety awareness

Any fixed buyer	

Quantification of recycled waste and number of waste sack defines the material flow from dump site to the recycling shop and money flow from recycling shop owner to the waste collector.

(a) (b)

Figure 2. (a) Questionnaire survey for assessment of informal waste collector (Setu, 13 November 2022) (b) vehicle for transporting collected waste with full packed waste sack (Setu, 13 November 2022)

RESULT AND DISCUSSION

Waste collectors' Operations on Site

The number of waste collectors engaged in scavenging at the Rajbandh open dump site can be categorized into two types. Some waste collectors collect recyclable waste from hospital waste that is conveyed to the landfill by different NGOs. After the recycling process, they handover some infectious waste to the NGO workers and some selected waste was sold by the waste collectors to some fixed buyer at a recycling shop. Household waste is collected by another group after dumping waste from the carrying vehicle. Vehicles from KCC collect waste from secondary disposal points after gathering waste from households, markets, and other places to the dump site.

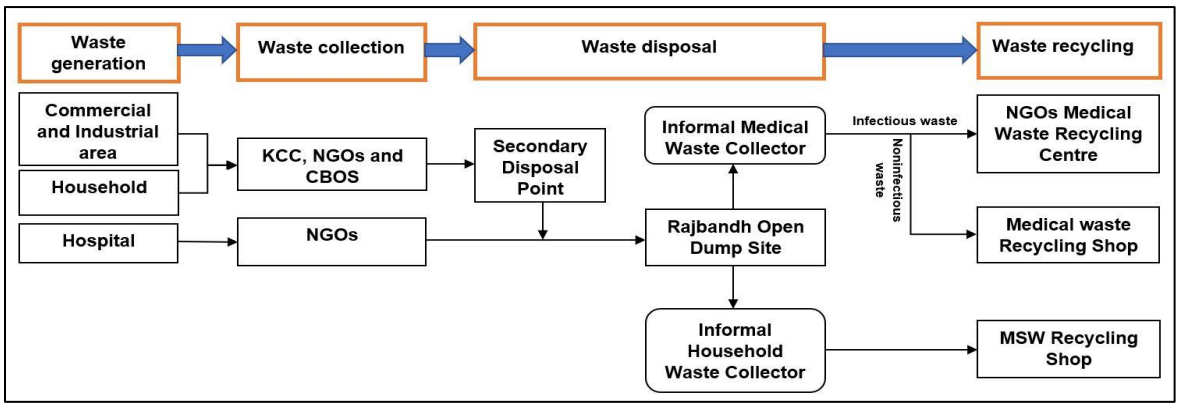

Figure 3. Waste flow diagram showing the role of informal waste collector at Rajbandh open dump site.

NGOs and CBOs workers along with KCC workers are mainly involved to collect waste from the whole municipality and some waste collectors involved in secondary disposal point to collect recyclable waste. After some sorting process by informal waste collector, municipality authority transports this mixed waste to the Rajbandh open dump site.

Composition analysis of municipal solid waste after sorting recyclables by waste collectors was done

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using the quarter method which is followed according to Neftali and Hugo (2012). The homogenized waste heap of 200 kg sample, collected from the waste left after sorting recyclable, was divided into four equal parts as shown in Figure 4. Then A and C waste heaps were chosen for further mixing. After ensuring a thorough and uniform mixing, this operation was repeated till at least 50 kg were obtained for sub-sample selection purposes.

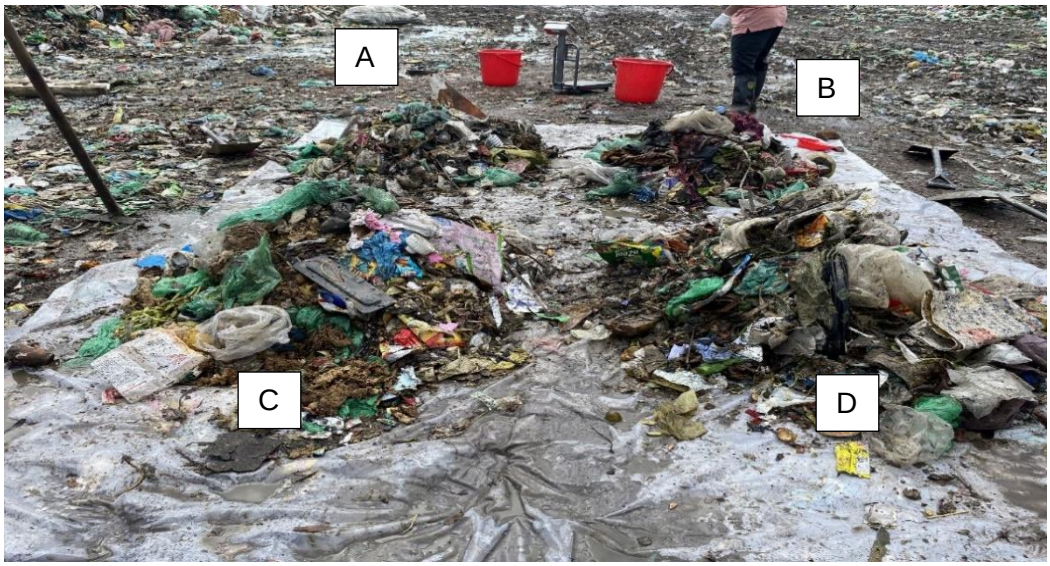

Figure 4. Quarter method followed for waste composition at landfill (Nahid, 22 September 2022).

In this study, the separated waste has been segregated according to the specified twelve categories. The categories contain recyclable portion such as metal, recyclable plastic, glass, electrical waste, rubber, medical waste and some non-recyclable portion such as clay pot, non-recyclable plastic, paper, cardboard, shoe waste, construction waste. Composition analysis of the mixed waste shows that mainly bio waste was present there and its amount was approximately 79.64(weight)% as shown in Figure 5. Among recyclable waste, 2.05(weight)% was glass, 0.59 (weight)% was paper, 0.40(weight)% was recyclable plastic, 0.57(weight)% was metal, 0.59(weight)% was electrical waste, 0.85(weight)% was rubber and 0.08(weight)% was medical waste. No PET fraction was observed there, but the composition analysis of recyclable shows a notable amount of PET bottles (Figure 5). The weight percentages also indicate that most of the recyclable portion was removed from the landfill waste.

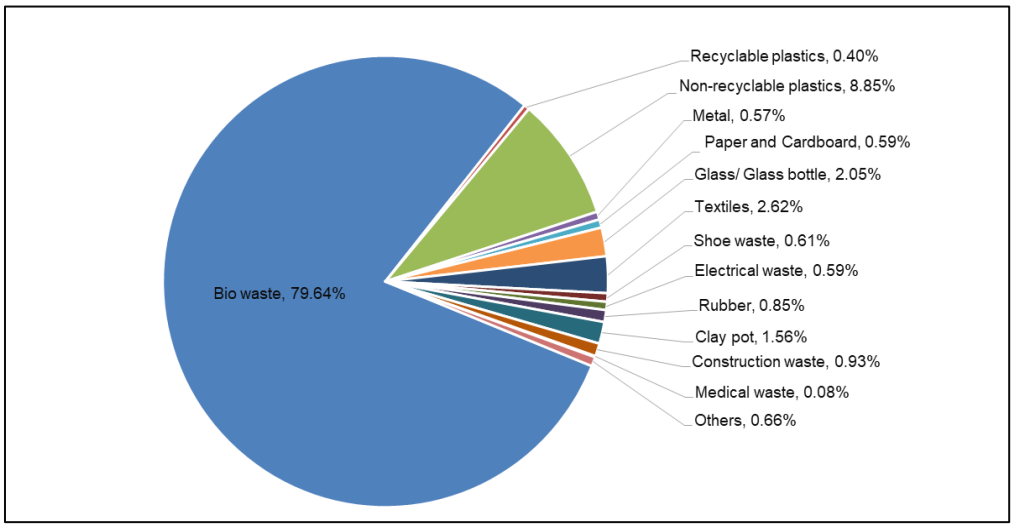

Figure 5. Waste composition (weight percentages of different fractions) at Rajbandh open dump site based on a 200 kg sample

Type of recyclable waste collected by waste collectors

Municipal waste collectors working at Rajbandh open dump site collect recyclable waste in a plastic sack and they sell it 100 taka per full packed sack. They started their collection more or less at 9.00 am and 60% of the waste collectors work between 5 hours to 8 hours. The composition analysis of the most common types of the collected waste indicated glass as the main fraction, with around 31.28%, pet bottles around 24.10%, soft plastic around 17.68% and aluminum around 3.31%. The material collected everyday ranges from coconut shell, paper, packaging plastic, bones, PVC, electrical waste, medical waste and some non-recyclable portion like soil and dust as shown in Figure 6. After collecting, they store those waste sacks in a pile and wait for collection by the waste recycling shop owner. Shop owners use their own vehicle to collect waste sacks after payment.

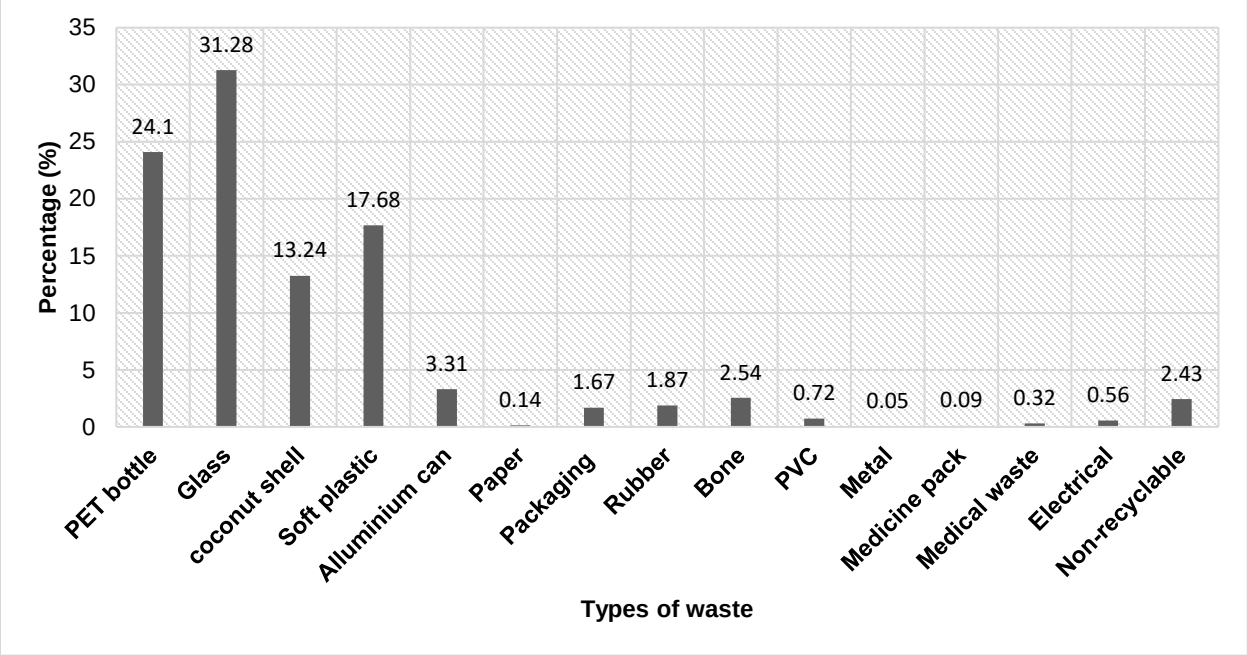

Figure 6. Type of recyclable waste (in weight percentage) collected by waste collector

(a)

(b)

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Figure 7. (a) Stock pile of waste after scavenging (Setu, 13 November 2022). (b) Transportation vehicle carrying scavenging material to the recycling shop (Setu, 13 November 2022).

The average daily amount collected of recyclable waste by the household waste collector is 237.14 kg ± 26.43 kg. Based on observations during the survey, sometimes waste collectors are involved in the on-site sorting process at dumpsite along with mixed collection using different sacks when specific type of recyclable waste occur in high quantities, such as PET bottles. After one week, when the recycling shop owner collects waste, they sell it separately to get higher prices. The weekly collection indicates on-site sorted collection is shown in Figure 8 including the amount of one-week waste collection. The maximum amount of waste collected during data collection was 245.67 kg.

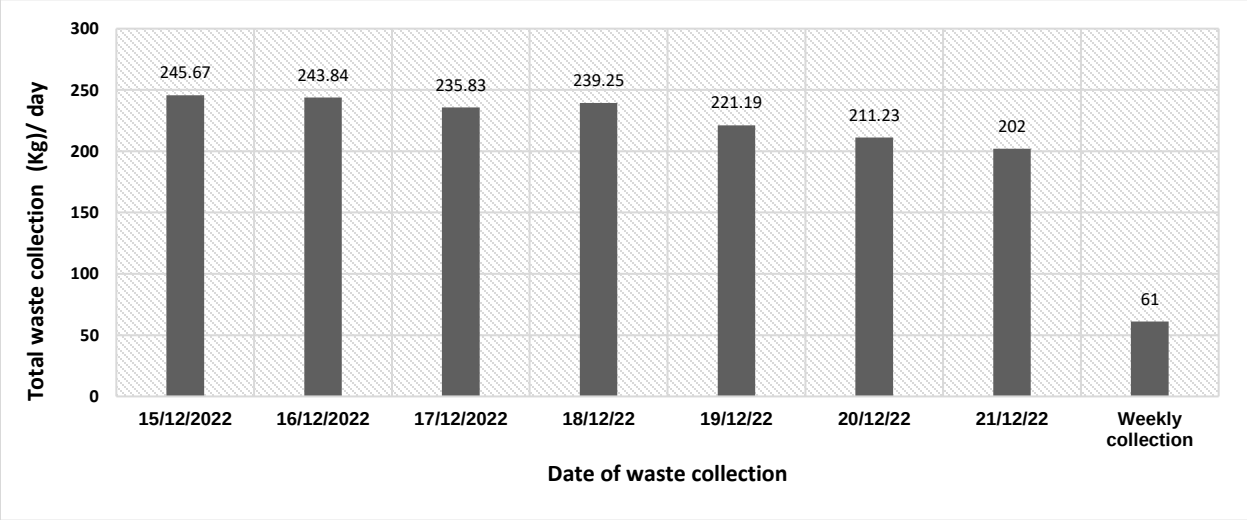

Figure 8. Amount of material flow from waste dumpsite to recycling shop per day

After payment, the recycling shop owner takes over the recyclables and uses their vehicle to carry the waste from the dumpsite to the recycling shop. People engaged in transporting waste from dumpsite to recycling shop stated that, most of the time, they do not collect recyclables every day because having a few days' worth of waste sacks reduces their transportation costs. Figure 9 shows the amount of money earned by the waste collector from the recycling shop owner. The daily income of a household waste collector is 334 takas ± 26 takas. During the questionnaire survey conducted as an integral part of the study, the house waste collector stated that their income is above 200 takas, which supports the money flow diagram.

Figure 9. Money flow from recycling shop owner to waste collectors

Waste collector's Socio-economic and Demographic Attributes

Table 2 provides information on the waste collectors' demographics. Among all the waste collectors working at the dump site, the number of female workers is predominant at about 58.33%. Female workers are working here because of their work flexibility, and working hour flexibility and they can add some extra income for their families. Most of the time they don't have enough education to get a better job opportunity. The interviewees are mainly aged between 25 years and 50 years about 66.66%. There were fewer old people and no child waste collectors (under the age of 18). The majority of waste collectors are married, and some of them work alongside their partners, demonstrating that they can support their families by continuing their current employment. In terms of educational quality, the majority of waste collectors are in lack of literacy and, in some cases, only have a primary education, which exposes them to a variety of challenges when working at an open dump site.

Table 2. The demographic composition of the waste collector at Rajbandh open dump site

	Number (Household waste collector)	Number (Medical waste collector)	Total Number	Percentage (%)
Gender				
Male	1	4	5	41.66
Female	5	2	7	58.33
Age				
Bellow 18 Years			-	
18-25 Year	-	-	-	-
25-50 Year	5	3	8	66.66
50-60 Year	1	2	3	25
Above 60 Years	-	1	1	8.33
Marital status				
Single	1	-	1	8.33
Married	4	6	10	83.33
Others	1	-	1	8.33
Education				
Illiterate	5	5	10	83.33
Literate (primary level)	1	1	2	16.66
Literate (secondary level)	-	-	-	-

In terms of economic characteristics, the daily income of an informal medical waste collector affiliated with NGOs and CBOs is between 400 and 500 takas higher than the income of a household waste collector, which is around 300 takas. Municipal solid waste collectors work 5-8 hours per day starting at 9-10 in the morning, whereas medical waste collectors work 3-5 hours per day starting at 7-8 in the morning.

The 2030 Agenda for Sustainable Development includes a key goal of eradicating extreme poverty for all people everywhere by 2030. According to the World Bank's updated global poverty line in September 2022, a daily income of less than $ 2.15 (225.94 taka) per person

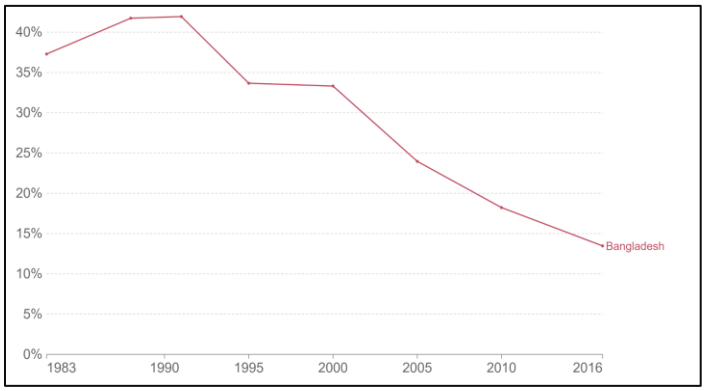

Figure 10. Share of population living in extreme poverty in Bangladesh, 1983 to 2016 (Ritchie et al., 2018).

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is considered extreme poverty. According to the World Bank's poverty and inequality platform, people in Bangladesh are still living in extreme poverty, with 13.47% living below the poverty line in 2016 as shown in Figure 10 (Ritchie et al., 2018). Table 3 indicates that 83.32% of the waste collectors earn more than 200 takas. The average daily income of household waste collectors, as indicated in the money flow diagram, is 334± 26 takas, which also indicates that scavenging helps them move out of extreme poverty.

Medical waste collectors sort recyclables from mixed hospital waste, processing them partly at the dump site and then transporting them to their homes for additional processing before selling them to the owner of the recycling business. In the case of additional processing, they sort recyclables by material type like soft plastic, metal and sell them at different prices. 58% of the waste collector said they are engaged for more than 6 years in scavenging which could be because they don't have any sufficient formal education to get better job opportunities or this profession is suitable to support their family. Most of the waste collectors live in rented houses because they do not have any own properties or they migrated here from another rural area.

Table 3. Economic characteristics of the informal waste collector at Rajbandh open dump site

Daily income	Number (Household waste collector)	Number (Medical waste collector)	Total Number	%
Bellow 200 tk	2	-	2	16.66
200 - 300 tk	4	1	5	41.66
300 - 400 tk	-	1	1	8.33
400 - 500 tk	-	4	4	33.33
Above 500 tk	-	-	-	-
Daily working hours				
3-5 hours	1	5	6	50
5-8 hours	5	1	6	50
Above 8 hours	-	-	-	-
Duration in this profession				
Bellow 1 year	-	1	1	8.33
1-5 years	1	3	4	33.33
6-10 years	1	2	3	25
Above 10 years	4	-	4	33.33
Residence				
Own	1	1	2	16.66
Slump	-	-	-	-
Rent	5	5	10	83.33

They do not have any fixed working hours, and this flexibility is the key factor for women choosing to work as waste collectors. Mainly female workers work here all day long for about 5- 8 hours and the field investigation shows that, sometimes their male family members are engaged in same profession which implies that female workers add some extra income to their families. Flexibility of working hours and workday, insufficient formal education, and insufficient funds are also the reason behind choosing this profession as listed in Table 4.

Table 4. Waste collectors' justification for selecting scavenging as their field of employment

Insufficient formal education for getting a better job	Incapable of conducting another job due to lower back pain
Flexibility of working hours	Family members are also engaged in scavenging
Flexibility regarding the workday	Insufficient funds to start a business
Serve as a source of additional income	Having no other source of income

The majority of waste collectors live in rented houses, which are equipped with water supply facilities,

sanitization facilities, a sewer system, and electricity. However, some rented homes lack sewerage system and water supply facilities as shown in Figure 11. Furthermore, they live near the city corporation and have access to formal education.

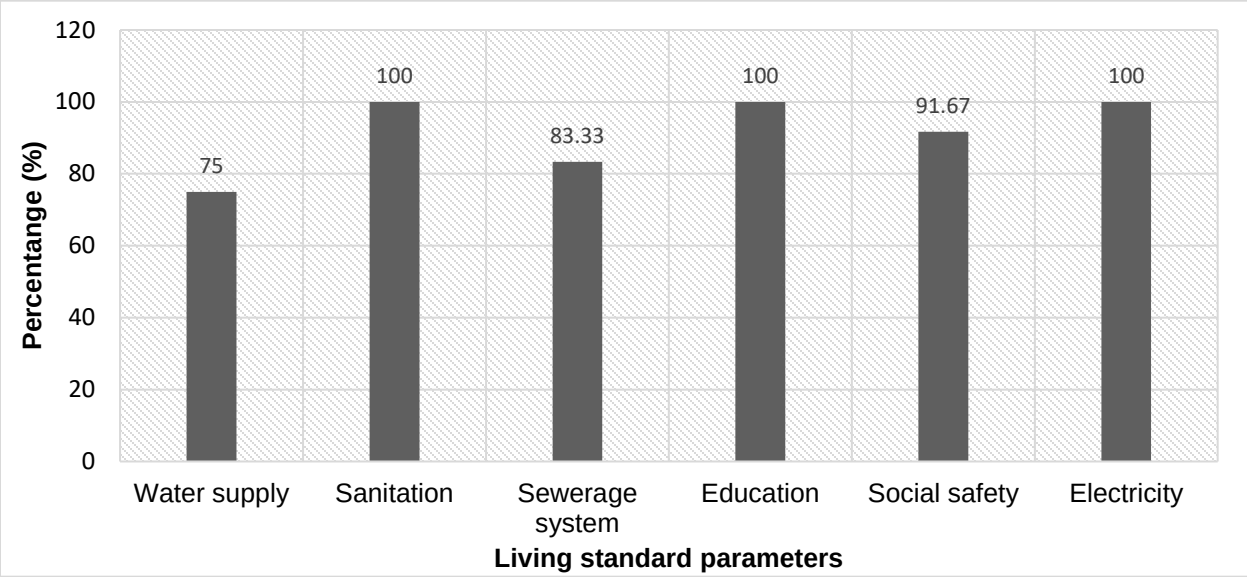

Figure 11. Living standard of the waste collector

Respondents mention that social acceptance of scavenging activity helps them to perform their work with dignity. This statement illustrates that, if social acceptance is higher, a large number of people will choose this profession, which will create employment opportunities. 41.67% waste collector answered 'Yes' on this question as shown in Figure 12. Most of the time they choose their rented house in such a community where they are accepted and their answer was positive. On the other hand, some waste collectors face negative behavior from their neighbors as a result of their profession.

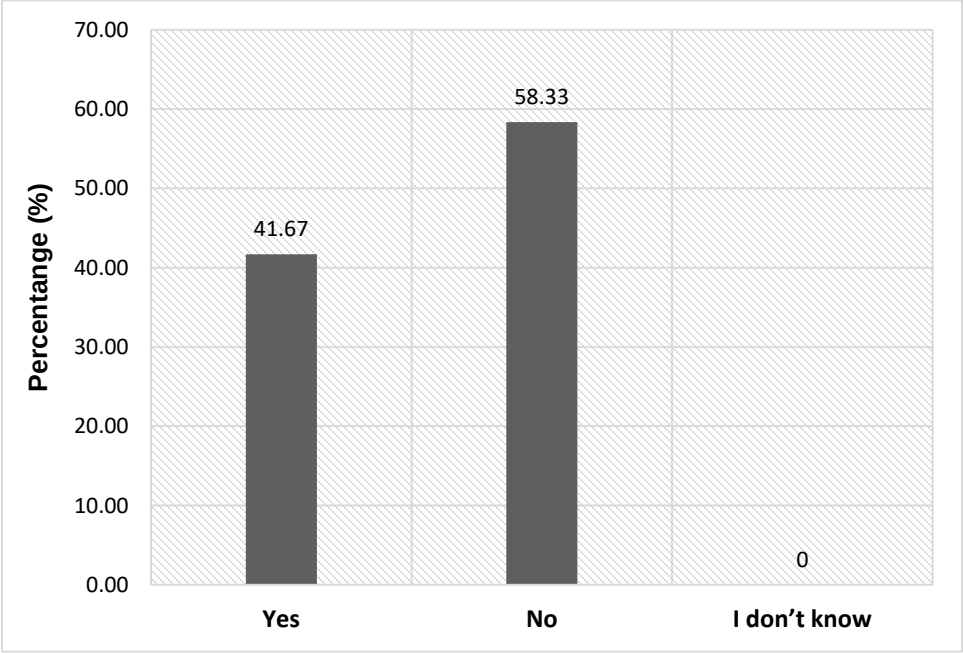

Figure 12. Community acceptance of waste collector's work

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Risks exposures in Scavenging Activity

Scavenging operation is associated with environmental and health hazards if waste collectors are not aware of this and do not use suitable protective measures. Waste collectors were interviewed along with field inspection to identify the different risks and health hazards that they had been exposed to during their scavenging operations as shown in Figure 13. The hazard experienced by waste collectors and possible risks that may create hazards at the open dump site are taken into account to present risk exposures. While 50% of the interviewed waste collectors reported exposure to insect bite, around 42% reported to have experienced burns from hot ashes and snakebites.

Dumping locations for trucks loaded with municipal solid waste choose the same dumping locations from the trucks carrying medical waste; resulting in various risk exposures. The most frequent risks for both medical waste collectors and municipal solid waste collectors are wounds from sharp objects and skin infections. Due to their manual sorting process at the waste pile, almost all waste collectors experience injuries from various sharp objects such as needles and syringes, surgical blades, broken bottles, and metals. Sometimes their safety boots are unable to provide protection. There is no evidence of any separated sorting area at the dump site to dispose medical waste. They scavenge medical waste at different location based on different season that may create serious health risk for both household waste collectors and medical waste collectors. If there is a separate area for sorting and dumping medical waste, the risks from infectious needles, syringes, and surgical blades might be reduced. Wounds from sharp objects on the landfill site in combination with exposure to medical waste increases the risk to contract a life-threatening diseases like hepatitis, AIDS, tetanus, and others.

Dust stirred up by the vehicle movement on the dumpsite road poses an extra risk of air pollution during the dry season. The dumpsite authority could spray water on the roadways every day to keep them clear of dust throughout the dry season as a feasible solution to this issue. Furthermore, the likelihood of landfill fires increases. as a result of the dryer and hotter temperatures during the dry season. Landfill supervisor reported that smoke from landfill fires causes shortness of breath during their daily operations. The above discussion indicates that waste collectors are exposed to environmental and health risks, at the Rajbandh open dump site of Khulna, Bangladesh.

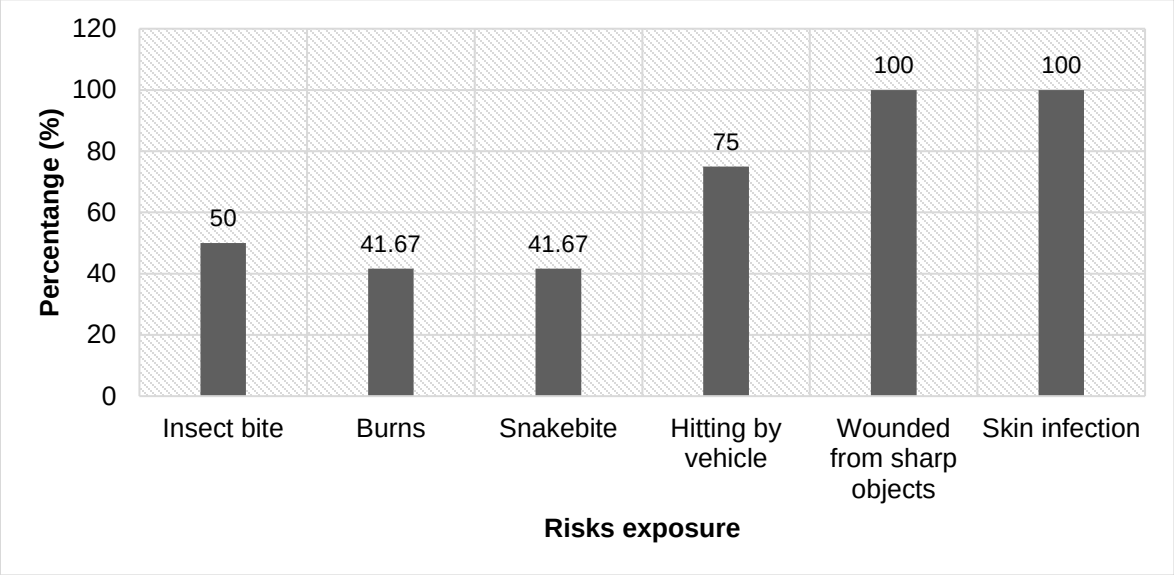

Figure 13: Risks exposures to the waste collector

Safety awareness can be a viable solution to decrease risk exposures. Most of the waste collectors working at the Rajbandh open dump site use protective boots and hoes during collection but they do not

use gloves and masks. This study finds that 66.67% of waste collectors are aware of the harmful effects of mixed waste and use some protective measures as shown in Figure 14. Additional education and training could help to increase the safety awareness and ultimately reduce the overall risk levels.

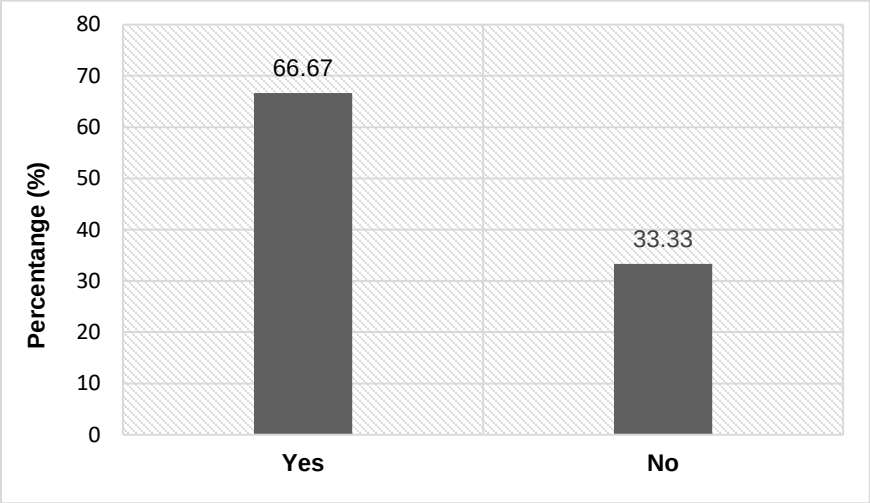

Figure 14: Safety awareness among waste collector

Suggestion for a Better Working Environment for the Waste collectors

1. On-site hand washing facilities should be provided to maintain personal hygiene after scavenging activity, which will prevent the transmission of pathogens.
2. Sanitary toilet facilities with proper maintenance should be provided at landfill sites to promote hygiene and safety, especially among female workers.
3. Health cards can be a probable solution; they can be provided because they are usually wounded by different types of sharp objects. By using this health card, they can be provided with easy access to the hospital and desired health facilities.
4. Proper operation management at the landfill with a trained landfill supervisor will help to reduce risk events occurred at landfill.
5. Safety equipment should be mandatory at any stage of the waste collector's working activities.
6. Medical waste collectors should have special protective measures, and a separate area should be selected for sorting and dumping of medical waste.
7. Awareness campaigns among waste collectors can be the best possible solution to aware of them about the harmful effect of mixed waste and the importance of using protective measures.

CONCLUSIONS

Waste management is a challenging task for any city administration. Although these processes require additional adjustments if informal workers are involved, the inclusion of the informal sector can be overall beneficial for recycling and recovery rates. Earning opportunities from scavenging is a driver to engage in this profession but unintentionally, they are working for a better environment. The result from this study shows that informal waste collectors play an important role at Rajbandh waste disposal point, especially in terms of waste minimization, reduction and material recovery. Despite the fact, that most of the time the municipality authority is not aware of their impact on waste management, and does not have any information or guidance regarding the informal sector activity within the whole waste management process. A demographic analysis of the waste collectors reveals that the number of waste collectors is not high and female waste collectors are predominant here. Community acceptance towards scavenging may create employment opportunities and helps to engage more people in this sector. Nevertheless, economic condition and money flow analyses give a clear indication that this is a sustainable earning opportunity for poverty-stricken people. The result from this survey and observation indicates that their living conditions

are relatively low but they are provided with assisted living facilities. Waste collectors are exposed to different types of risksdue to a lack of safety awareness. This study can be helpful to assess the informal sector including their whole working activities, occupational risk exposure, and social circumstances. Proper guidelines, safety awareness, and proper enforcement of laws can be a probable and effective way to improve overall working conditions. Assess to free medical facilities should be obligatory to the waste collectors by providing health cards aimed to reduce financial barriers and fast assess to access healthcare facilities.

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