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## Assessment of Solid Waste Management Practices in Rural Bangladesh: A Case Study of Citizen Participation

A.K.M. Tajkir-Uz-Zaman<sup>1,2,\*</sup>

<sup>1</sup>Ph.D. Candidate, Department of Advanced Management, IBA, Kwansei Gakuin University, Japan 662-8501; <sup>2</sup>Deputy Secretary, Ministry of Public Administration, Bangladesh.

\*Corresponding author: A.K.M. Tajkir-Uz-Zaman; E-mail: tajkirbd@yahoo.com

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### ABSTRACT

Bangladesh's rural solid waste management (SWM) systems are still developing, and effective citizen participation is crucial for SWM success. This study highlights knowledge gaps, as the existing policies focus predominantly on urban areas. In this study, citizen participation, existing practices, and the community engagement of SWM were examined in the rural areas of Bangladesh. Primary data collected from 67 Bangladeshi respondents through questionnaires using a qualitative and quantitative mixed-methods study. The data were analyzed using descriptive statistics. This study found that Bangladeshi rural citizens participate in SWM "personally." Results showed that 41.9% of respondents often dump waste in pits or lowlands near their homes, and a general practice was to discard waste by digging a hole (54.8%) or burying it (41.9%). Household backyards (41.9%) and shallow terrain (48.4%) were used as dumping stations. Different indigenous systems and practices were observed in the rural areas due to the lack of formal SWM. Respondents mentioned that the informal sector recycles plastic, paper, glassware, etc., and a few citizens generate compost from organic waste. Citizens reported that they needed SWM training from rural local governments. Moreover, SWM efforts in rural Bangladesh did not involve citizen groups or associations. In conclusion, local governments can coordinate SWM policy by including citizens for a sustainable environment, and policymakers will have a scope to improve rural SWM in Bangladesh. Furthermore, this paper provides practical implications for researchers and policymakers on SWM in developing countries.

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## Introduction

As per the World Bank's data, almost half of the global population, or precisely 46%, lives in rural regions (Urban Development, The World Counts). In general, waste management services in rural regions of high-income countries exhibit comprehensive coverage, whereas in upper-middle-income countries, where the provision of such services to the rural population is only partial, and in low-income countries, where these services are either inadequate or absent (Mihai and Taherzadeh, 2017). A significant disparity in garbage collection coverage exists between urban and rural areas in developing and transitioning nations. According to Mihai (2017), it has been estimated that around 1.9 billion individuals residing in rural areas need access to waste collection services. Furthermore, the report reveals that the coverage rate for rural populations in 105 nations falls below 50%. Rural solid waste (RSW) typically receives lower priority in most developing nations (Zárate et al., 2008).

The aforementioned worldwide scenario is also applicable to the context of Bangladesh (BD). The rural areas of Bangladesh are inhabited by around 130 million individuals [According to the World Bank, in 2022, 60% of the total population live in rural areas (The World Bank open data). The degradation of the natural environment is a significant consequence of inadequate waste management practices resulting from the activities of a population of over 130 million individuals (MoLGRD, 2022). Rural Hatbazar and surrounding areas significantly contribute to environmental pollution (Saif, 2023). The pollution of rivers and canals in urban areas has also resulted in the contamination of water bodies in rural regions. Pollution levels in water bodies close to densely inhabited settlements are experiencing an upward trend (MoLGRD, 2022). Various studies have demonstrated that policymakers and researchers prioritize waste management in urban settings, particularly within municipal jurisdictions, above their rural counterparts. Within the given background, this study has examined the topic of rural waste management, which has received comparatively limited attention in Bangladesh and other regions globally.

Numerous studies have indicated that citizen participation is crucial to achieving success in SWM (Xiao et al. 2017; BIGD, 2015; Singhirunnusorn et al., 2012; Lin et al., 2010; Gaul and Ziefle, 2009; Joseph, 2006; Hari, 2023). The participation of households in the management of solid waste can be manifested through activities such as waste segregation and recycling. The effectiveness of waste management (WM) initiatives, including those about waste separation and recycling, depends upon the public's support, including that of local citizens, as they are both the recipients and the focus of waste management services (Garnett and Cooper, 2014; Tai et al., 2011). In this circumstance, Individual involvement is important to engage in SWM from its inception; however, this expectation may not be realized under various factors, such as a lack of responsibilities, insufficient awareness, an expectation of receiving incentives (Babazadeh et al., 2018), lack of knowledge and information (Rousta et al., 2017), attitude towards recycling (Jesson, 2009), attitude towards waste separation (Zhang et al., 2015), sorting skill (Passafaro et al., 2016), and individual's knowledge of recycling methods (Vicente and Reis, 2008). The exploration of existing practices related to SWM in rural areas by citizens remains unexplored in Bangladesh. Current research on Bangladesh suggests a notable research opportunity in examining the SWM practices adopted by rural inhabitants in Bangladesh (Matin and Mridha, 2010). This study highlights knowledge gaps, as the policy focuses predominantly on urban areas. This research aims to examine specific issues within the field of SWM in Bangladesh: citizen participation in SWM in the rural areas of BD, SWM practices in the rural areas of BD, and citizen groups' presence in BD's waste management practice.

## Literature review

Academic researchers express apprehension regarding exploring diverse topics closely related to this study, such as SWM in rural areas, citizen participation, and community engagement, variables influencing SWM, and the existence of the informal sector, among others, on a global scale. Prior research contributes to the comprehension of the broader worldwide practices of SWM. Nevertheless, these resources are valuable in comprehensively understanding and explaining the Bangladeshi environment's details.

### **Challenges of rural waste management**

Mihai and Taherzadeh (2017) discussed the problems of waste management in rural areas at the global level. Their observation shared that waste management services tend to disregard sparsely rural areas that are geographically distant from large urban centers. Waste companies tend to refrain from operating in these regions, while local authorities allocate limited financial resources to provide adequate public services. Furthermore, various geographical features such as mountains, hills, high plateaus, karst zones, and wetlands must be improved to implement appropriate waste management infrastructure effectively.

### Citizen participation

The active involvement of citizens in environmental betterment is a significant issue, widely recognized as Principle 10 in the Rio Declaration of 1992. This principle articulates the following:

“Environmental issues are best handled with the participation of all concerned citizens, on a relevant level. On a national basis, each individual should have appropriate access to information concerning the environment held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States should facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, should be provided” (Rio Declaration on Environment and Development, 1992; UNEP).

The significance of community engagement in waste management is acknowledged as a contributing factor to its effectiveness (Alam, 2016). However, the attainment of community engagement still needs to be improved despite its significance in addressing the issue of waste management. Researchers have proposed various success elements that promote community participation in SWM. Shukor et al. (2011) argued in their research that many debates and opinions exist regarding identifying optimal criteria that guarantee effective community engagement in SWM (Shukor et al., 2011). Mongkolnchaiarunya (2005) discussed community involvement and various factors affecting waste management activities, commonly known as the “Garbage for Eggs” program in southern Thailand. The optimal strategy for addressing the solid waste sector involves implementing an integrated and sustainable management approach that prioritizes society's and the environment's well-being while fostering active societal engagement. Implementing the Integrated Solid Waste Management (ISSWM) system, pioneered by the Palestinian Authority, holds significant potential for numerous developing and least-developed nations (Khatib, 2011).

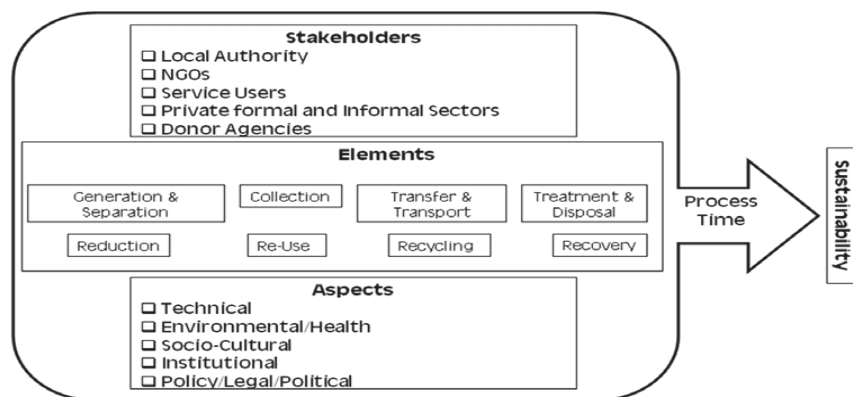


Figure 1. The integrated solid waste management diagram was cited by Khatib, 2011

According to Bandara (2008), the current state of the municipal solid waste problem in Sri Lanka has escalated to a critical level, mainly attributed to inadequate levels of public involvement. Several studies have recognized the significance of citizens' engagement in effectively executing SWM. Various researchers (Shukor et al., 2011; Mongkolnchaiarunya, 2005; Gustavson, 2008; Kuniyal, 2008; Rathi, 2006) acknowledged citizens' participation as a critical aspect in ensuring the successful implementation of SWM. The proper and timely collection of garbage necessitates a minimal level of community participation in the act of placing waste on the street. At the individual level, residents bear the responsibility of acting as users. This activity entails engaging in practices such as appropriately containing garbage within a designated receptacle, segregating recyclable or organic materials from non-recyclable waste, disposing of waste in the correct location and within the designated collection period, and maintaining cleanliness near one's residence. According to Visvanathan (2006), community participation emerges as a viable approach when municipalities have challenges in effectively managing garbage. According to Sukhor et al. (2011), integrating community needs and ideas through active involvement and participation in the project's design can enhance the effectiveness of its implementation (Mongkolnchaiarunya, 2005).

Rathi (2006) found strong evidence of community engagement for successfully implementing SWM in India. This research reveals that the expenditure per metric ton of waste management is Rs. 1518 (US\$35) when community engagement is involved, Rs. 1797 (US\$41) in the case of public-private partnership (PPP), and Rs. 1908 (US\$44) when MCGM solely handles the waste management. Therefore, the community's involvement in waste management proves to be the most economically efficient choice, making a compelling argument for the thorough inclusion of community engagement in waste management practices. An extensive number of case studies conducted in developing countries have demonstrated the crucial part played by community participation in waste management, contributing to the overall success of the services delivered. Community participation encompasses a comprehensive range of activities, including information dissemination, awareness building, outreach efforts, solicitation of input, engagement, and collaborative endeavors (Bernardo, 2008; Sujauddin et al., 2008; Ogu, 2000; Anand, 1999; Poerbo, 1991). According to Visvanathan (2006), government efforts to address proper SWM legally through laws and regulations should have the active support of the local community and public and private organizations.

Citizen participation also has a significant impact on SWM in the rural areas. Xiao et al. (2017) find that citizen awareness emerged as the primary influential element, with social motivation closely behind. Still, institutional factors exhibited a relatively minor beneficial impact on citizens' willingness to engage in waste management activities. Individuals who possess a higher level of knowledge and are exposed to a community or family context that promotes environmentally conscious behaviors are more inclined to engage in sustainable waste management practices. Public acceptance is the positive reception, active approval, and adoption of recently introduced technical equipment and systems (Gaul and Ziefle, 2009). The public acceptance of waste management can be assessed by evaluating the public participation rate. Public participation is widely recognized as a means to achieve sustainable waste management (WM), and it can foster better communication and understanding between government entities and individuals in environmental conflict management (Lin et al., 2010; Joseph, 2006). Singhirunnusorn et al. (2012) argue that public involvement in SWM should focus on the concepts of "waste as a resource" and "waste as an income generator" inside individual households. The structure and functions of public involvement are determined by the performance patterns and attitudes of the community, which are influenced by the local cultural and social backdrop argued by (Christen, 1996).

Meanwhile, the current task for waste management in Indonesia is to augment public participation. The current level of research in Indonesia regarding public desire to participate in WM and the factors that influence it remains limited. These factors encompass demographic variables such as age, gender, household typology, knowledge, and recycling time (Vicente and Reis, 1996; Cox et al., 2010; Gellynck, 2011). Additionally, educational level, occupation, and income level play a role (Kinnaman and Fullerton, 2000; Barr et al., 2005; Saphores et al., 2006; De Feo and De Gisi, 2010; Bringhenti and Risso Gunther, 2011).

### ***Education/training in SWM***

Ezeah and Roberts (2012) described the importance of public education in SWM improvement. The results indicate that there is a requirement for a continuous public education initiative focused on waste prevention and reuse as a potential solution to waste issues in Nigeria. Hari explained the Japanese lessons with many examples to illustrate clearly - that waste management is not a responsibility of just the local governments but requires concerted action from local businesses and straightforward action from residents and citizens' groups to produce unique localized and customized solutions - whether local rules and regulations, education and awareness, or technology solutions (Hari, 2023). Wasantha (2003) argues that education and awareness are crucial elements in ensuring the successful implementation of the national strategy for SWM. Public awareness and attitudes can influence the overall SWM system (Zurbrugg, 2015). The implementation of awareness programs and educational initiatives aimed at informing individuals about the challenges and importance associated with the disposal of Municipal Solid Waste (MSW) can be effectively carried out by Non-Governmental Organisations (NGOs) (Pattnaik and Reddy, 2010). According to Mangundu et al. (2013), it is recommended to implement an educational campaign initiative that includes road shows, distribution of information and communication materials, as well as radio and television broadcasts. The purpose of this campaign would be to distribute knowledge about solid-waste management effectively.

### ***Rural waste dumping***

Mihai and Taherzadeh (2017) concisely overview the current challenges rural areas face concerning municipal and agricultural waste management. Although dumps are widely recognized as the most detrimental outcome of contemporary waste management strategies regarding their impact on the environment and sustainability, they persist worldwide,

particularly in peri-urban and rural areas. In contrast, there exists a disparity in the inclination and involvement of individuals in maintaining cleanliness within rural areas as opposed to urban settings, where personal accountability in waste disposal tends to be minimal. In urban locales, the responsibility for waste management typically falls upon entities such as municipalities or private enterprises. Factors of open dumping are discussed by Taherzadeh and Rajendran (2015); according to their research, the presence of open dumps in contemporary times can be attributed to a range of factors, including inadequate governmental policies and financial resources, challenges in navigating political issues and implementing long-term waste management plans, societal resistance to change, such as the separation of waste at its source, limited access to regular waste collection services, insufficient waste management infrastructure, substandard quality of waste management services, limited funding, inadequate environmental awareness, and a relatively small market for recycled materials.

### ***Composting of organic waste***

Sheheli (2014) argued that citizens in the different areas of the Mymensingh district of Bangladesh needed more systematic planning in all spheres of making, processing, and utilization of organic waste. At various times, citizens were getting disposed of their solid waste. Because of this, there has been significant air and water contamination due to inefficient waste processing and preservation. Mihai and Ingrao (2016) and Matin and Mridha (2010) noted in their research that the implementation of conventional household waste recovery methods, such as home composting and animal feed use, has effectively diverted a portion of the biowaste fraction away from landfill disposal and instead directed it towards these alternative applications. Implementing practical home composting practices within rural communities presents a financially viable and ecologically sustainable approach, provided it is executed with care to minimize bio-waste wastage.

### ***Informal Sector***

Chi et al. (2011) describe the informal sector as not registered and characterized as illegal; non-regulated acts and unclear defined rules (Hold, 2012); labor-intensive, largely unregulated, and unregistered, low-technology manufacturing waste collection services (World Bank). In a study, Schneider et al. (2017) examined the national contexts of Austria, the Czech Republic, Germany, Jordan, Mexico, Nepal, South Africa, and Vietnam. In low- and middle-income nations, informal waste management systems typically coexist with formal waste management systems; this is true in both urban and rural areas. Waste recyclers are interested in recyclable resources. Rodic et al. (2010) reported that the informal sector collected 18% of the total waste in Dhaka- the capital city of Bangladesh. The informal sector exists mainly in urban areas and rarely in rural areas (Schneider et al., 2017) but is available in Bangladesh's rural (Matin and Mridha, 2010) and urban (Sinha and Amin, 2005) areas. Researchers mentioned that this sector needed to follow the mainstream government setup, like not paying taxes, not having a trade license, etc. (Haan et al., 1998). However, gradually, it was incorporated as an official system in many developing countries (Rodic et al., 2010; GTZ, 2010).

The studies mentioned above show the significance of rural waste management with the prior participation of the citizens. Various studies have been conducted in different rural and urban areas worldwide. Research on waste management in Bangladesh's rural areas is important to ensure environmental sustainability, especially in light of the country's extensive rural population and ongoing environmental contamination. This study tries to identify the problems and find out the scope to improve SWM practices, which can be used for future examination of rural waste management in other developing nations.

## **Methodology**

The data collection methodology follows mixed methods, which involves collecting empirical evidence through in-depth field interviews and administering questionnaires (Yin et al., 2006; Miles and Huberman, 1994). The primary data for this research study was acquired from Bangladesh throughout October and November 2022. Among the 67 respondents; 31 were citizens, 36 were service providers for SWM activities, and all were Bangladeshi citizens.

Data were collected from local government officials, elected representatives, and related specialists. Moreover, individuals and organizations within the citizenry who have received services are also interviewed. In this context, information was collected from the Union Parishad Chairman and Secretary, Upazila Parishad chairman, Upazila Executive Officer (UNO), senior local government officials, Mayors of Municipalities, and citizens of different unions. Data were gathered from seven Upazilas in Bangladesh, including Chunarughat in the Habiganj district, Dhobaura in the

Mymensingh district; Nachol, Bholahat, and Gomastapur in the Chapainawabganj district and Sadarupazila of Sariatpur district. Data were collected at the union level from the localities of Baghber, South Maizpara, Goatla, and Ghosgaon. Data has been gathered from the municipalities of Shariatpur, Dhobaura, Nachol, Rahanpur, and Chapainawabganj. The data about the residents of different unions within PirganjUpazila of Rangpur District and PuthiaUpazila of Rajshahi District has been gathered for citizen information collection (BIGD, 2015). The data were collected using a random sampling approach.

Data was collected through the prescribed questionnaires. Data-collection questionnaires differ slightly due to variations in context, while the subject is constant (Schneider et al., 2017). Questionnaires include both qualitative and quantitative questions (Yin, 1994; Miles and Huberman, 1994). Some questions were open-ended, while others were closed-ended (BIGD, 2015). Analyses and answers to relevant questions are used in this research.

The questionnaire was constructed following multiple research studies (Valera, 2020; Biswas et al., 2020). Although the original questionnaire was prepared in English, its translation was later used in Bengali for surveys and interviews in Bangladesh (Qun and Carey, 2023). Many respondents answered in English, while most answered in their native language (Bengali). Later, they were converted into English and used in this research.

The respondent's answers were segregated and expressed as statements (Carley, 1990; Weber, 1990). Different statements are designed to be positive and coded with numerical numbers (Miles and Huberman, 1994; Marshall and Rossman, 1989; Webb, et al., 1965). Data were analyzed using descriptive statistics (frequency and percentage), while cross-tabulation and nonparametric t-tests were used in the inferential part (Rabeiy et al., 2022).

Interviews were conducted based on the consent of the respondents (Eisner, 1991; Wax, 1982; Deyhle et al., 1992). Their opinions were freely reflected in the answers to the questions. The research was carried out with a commitment to upholding ethical principles that prioritize respect for diverse cultures, communities, individuals, and the autonomy of knowledge (Sieber, 1992; House, 1990). This study ensures the preservation of the participants' dignity, rights, safety, and well-being while appropriately documenting their statements (McQuillan and Muncey, 1990; McCall and Simmons, 1969). Before participating in the study, all respondents provided informed consent for inclusion (Erickson, 1986).

## Results

### *Demographic information of the respondents*

The study surveyed a total of 67 people. Among them, 31 respondents were citizens, and the remaining 36 respondents were service providers. From the citizen part, all respondents were male; incidentally, no female participants were found. The respondents' positions were categorized into six categories based on their professions. They are business person (23%), teacher (16%), farmer (15%), service worker (29%), and driver (10%). Most respondents (64.5%) were aged 41-54 years.

Among the 36 respondents of service providers, (86.1%) were male, and the remaining (13.9%) were female. Moreover, based on representatives, (72.2%) were elected representatives of different local governments, and the remaining (27.3%) were government officials. Based on age group, Most of the respondents (44.4%) belonged to the age group 54 to 64, and the next group (38.9 %) was related to the age group 43 to 53. From the education level, most respondents (33.3%) graduated.

### *SWM in the rural areas of Bangladesh at the citizen's level*

This study wants to know whether the citizens of rural Bangladesh are involved in SWM activities or not. How are they involved with these activities, and which practices do they follow for SWM? The answers were divided into two groups after analyzing to find the appropriate trend in the rural areas of Bangladesh.

### **Citizen's Participation in SWM**

The opinions of the citizens were divided into three different segments. Each segment is considered a participation statement (PS), as shown in Table 1. The participation statements are coded with numerical values from 1 to 3. Where 3 represents waste collected and disposed of as personal responsibility, 2 indicates waste collected personally and disposed of with neighbors, and finally, 1 means waste collected personally and disposed of in a designated space.

**Table 1.** Citizen's participation in SWM in rural Bangladesh (Created by the author; Source: Fieldwork primary data)

Key	Participation Statement (PS)	n	Percentage	Assessment
PS1	Waste is collected and disposed of as a personal responsibility	22	71	Dominant
PS2	Waste is collected personally and disposed of with neighbors	6	19.3	Close to rare
PS3	Waste is collected personally and disposed of in a designated space	3	9.7	Rare

The most common way of SWM is that waste is collected and disposed of as personal responsibility (PS1), with 71% of the total respondents at the citizen level in the rural areas of Bangladesh. PS2 indicates that a few participate (19.3%) with their neighbors. On the other hand, a sporadic case is that waste is collected personally and disposed of in a designated space only (9.7%). The dominant character of PS1 indicates that citizens in rural areas of Bangladesh participate in SWM activities personally.

The citizens' opinions were consistent with those of different service providers in the rural local governments. One of the senior supervisory-level government officials who are in charge of looking at eight district's activities mentioned that: "According to the Union Parishad and Upazila Parishad regulations, waste management is not an obligation. Any Union or Upazila is not required to comply in that case. It appears that rural areas lack a waste management system. Because of this, a citizen's participation in rural areas is voluntary, ad hoc, self-directed, and unique to each place. In conclusion, waste management in rural areas is one kind of personal management" (EBD1). Representatives of the central government at the Upazila level and the CEO of Upazila Parishad (UPZ) think the same: "Citizens dispose of their waste in their own way. The whole activities are done by themselves. In that case, they do not follow specific rules and scientific processes" (UNO1). Chairman of the Union Parishad (UP) supported this issue. He said, "Citizens of my union are very much concerned about waste management. They manage and dispose of waste by themselves in their responsibilities" (UPC1).

### Waste disposal practice by the citizen

Waste disposal practices in the rural area of Bangladesh are divided into five activities (AS) and coded with numerical values: AS1 = 5, AS2 = 4, AS3 = 3, AS4 = 2, and AS5 = 1, as presented in Table 2. Among the respondents, 41.9% described that citizens practiced their household waste dumped in pits or lowlands near houses. Upazila Executive Officer (UNO) explained the SWM activities in his Upazila, which is a supportive statement of the findings mentioned above. "There are no such general approaches in this Upazila. Individuals generally manage household-level waste. Citizens dumped their waste in open spaces, riversides, and backyards of houses" (UNO1). Though this practice status (AS4) is more dominant than others, a significant number of respondents, 38.7% of households, mentioned that waste is collected personally and buried at a safe distance by the citizens is a commanding practice (AS1) in the rural areas of Bangladesh. In a sporadic case, only 3.2% of household waste is cleaned daily by the house owner (AS3). Very few citizens, 6.5% of households, shared that waste is preserved at household levels through dustbins and disposed of by municipality trucks because they live within the municipality area. During the interview, the mayor of a municipality also mentioned this finding and described his municipality's activities regarding SWM.

"There is no such project implemented regarding waste management within this municipality. However, as I mentioned, small-scale activities are happening in this municipality's two selective WARDS. This activity is now ongoing in two WARDS out of nine WARDS. Households of these two WARDS accumulate their waste in front of their house. Designated waste collection vans (man-operate and non-mechanical) are collected waste in front of their house" (M1). Household waste is disposed of in a designated place and used as green manure after three months by 9.7% of citizens. This practice is a valid statement (AS2) that indicates the further uses of waste in the rural areas of Bangladesh.

**Table 2.** Waste disposal practice by the citizens in the rural areas of Bangladesh (Created by the author; Source: Fieldwork primary data)

Key	Activities (AS)	n	Percentage	Decision
AS1	Household waste is collected personally and buried at a safe distance.	12	38.7	Commanding
AS2	Household waste is disposed of in a designated place and used as green manure after three months.	3	9.7	Reuse
AS3	Household waste is cleaned daily by the house owner.	1	3.2	Rare
AS4	Household waste is dumped in pits or lowlands near the house.	13	41.9	Dominant
AS5	Waste is preserved at household levels through dustbins and disposed of by municipality trucks.	2	6.5	Municipality area

The descriptive statistics of citizen participation status are presented in Table 3; the mean value is 2.61, close to 3, which indicates that the waste is collected and disposed of personally. The standard deviation is 0.667, meaning less diversity in the participants' opinions, which is more consistent among the respondents' opinions. The t-statistic value is 3.91 and statistically significant, indicating the statistical significance of the mean value.

**Table 3.** Descriptive statistics of citizen participation status (Created by the author; Source: Primary data analysis)

Key	Statement	Mean	St. Dev.	t-statistic	Decision
PS	Participation's Statement	2.61	0.667	3.91	PS1
AS	Activities	3.32	1.514	2.19	AS4

For the activities, the mean value is 3.32, greater than 3, indicating that household waste is dumped in pits or lowlands near the house. The standard deviation is 1.514, which means diversity in the participants' opinions, which is a diverse activity among respondents' opinions. The t-statistic value is 2.19 and statistically significant.

### ***SWM practices in the rural areas of Bangladesh***

This chapter aims to explain the overall existing SWM practices in the rural areas of Bangladesh. As mentioned, three sub-chapters describe three different aspects of existing SWM practices.

#### ***Trends of SWM in the rural areas of Bangladesh***

This sub-chapter describes the existing SWM practices in the rural areas of Bangladesh. Through in-depth interviews, citizens, government officials, and local government representatives illustrate the practice trends. The overall situation is summarised in Table 4.

The respondents' opinions are segregated into four major areas: management practice, dumping process, dumping place, and reuse/utilization. Table 4 represents the citizens' opinions about the major and sub-areas. The citizens described two types of management practices during their interview. Most respondents (83.9%) said house owners disposed of their waste alone. Dumping places are shared with neighbors, and 16.1% of respondents support dumping in these places.



**Table 4.** Trends of SWM in the rural areas of Bangladesh (Created by the author; Source: Fieldwork primary data)

Major Area	Citizens participation	No.	Percentage	Decision	
Management practice	1. House owners disposed of their waste by themselves in their own way.	26	83.9	Dominant	
	2. In some cases, neighbors or a group of citizens used the same place for waste dumping.	5	16.1	Rare	
Dumping process	3. Waste is	(a) buried in the soil	13	41.9	Commanding
		(b) makes a hole and dumped there	17	54.8	Dominant
		(c) sometimes, waste is burned	1	3.3	Rare
Dumping place	4. Naturally, citizens disposed of waste	(a) in their backyard	13	41.9	Commanding
		(b) in low/shallow land	15	48.4	Dominant
		(c) in open space, or pond/ river.	3	9.7	Rare
Reuse / Utilization	5. (a) Some citizens make compost with their waste.	3	9.7	Organic household waste	
	(b) Presence of the informal sector for waste recycling	22	71	Others household waste	

UP chairmen of Dhobaura Upazila of Mymensing district expressed his opinion: *"It is exclusively managed personally. Most farmers dump their waste in their backyards and other open spaces. In that case, daily household wastages were dumped together"* (UPC5).

Other respondents gave a similar opinion: *"The people manage their waste by their management in this Upazila"* (UNO2). *"In this union, waste management is managed according to the individual's responsibility"* (UPS3).

These are three ways of dumping. They are (a) buried in the soil, (b) made in a hole and dumped there, and (c) sometimes waste is burned. Most respondents (54.8%) made a hole and dumped waste there. On the other hand, 41.9% of respondents buried their waste in the soil. Around 3.3% of respondents mentioned that waste is burned sometimes. In Table 4, respondents expressed their opinions and mentioned three types of dumping places: (a) in their backyard, (b) low/shallow land, and (c) open space or pond/ river. Though these are categorically separated from each other, commonly, all are open spaces and not designated for waste dumping places by any authority. UP Chairman of a union mentioned that: *"People in my union bury their waste in their place. It is left around the house's edge, in surrounding lowlands, fallow land, rivers, and canals"* (UPC6).

Most respondents (48.4%) mentioned using low/ shallow land as dumping places. That is the dominant response, according to their opinion. Moreover, the commanding response is that waste is dumped in their backyard, 41.9% of the total response. Occasionally, waste was dumped in open spaces or ponds/rivers. A few of the respondents expressed that they dumped in an open pond. During the interview, one respondent explained that: *"Most of the citizens of this union are involved in agricultural activities. They are not concerned about SWM. The educational status could be higher. So, there are no specific activities done by the citizens. They accumulated all the perishable household items together, buried them on the ground, and dumped them in open spaces"* (UPC8).

A few respondents, 9.7 percent, mentioned that some made compost from the waste. An Upazila Chairman discussed the compost issue: *"In this Upazila rural area, people leave waste around their houses. Moreover, the same procedure is followed in the case of the village market. Most of it is agricultural waste, and the waste is dumped in abandoned sinkholes next to houses. Some of them are involved in making compost"* (UPZC3).

A significant number of the respondents, around 71% of the total respondents, mentioned the presence of an informal sector for waste recycling in the rural areas of Bangladesh. Respondents also discussed the existence of the informal sector: *"The citizens sell some products like plastic, bottles, and scrap metal. There are about 15-20 mobile buyers in the upazila. I have learned that they collect them from the household level and then send them to Dholaikhal in Dhaka for sale"* (UPZC3).

### Scope of training facilities from the local government level in SWM

Table 5 summarizes the answer to the question asked by the service providers about the availability of training facilities for the citizens in the rural areas of Bangladesh. According to their answer, the statements were designed to be positive and coded with numerical values; there are no training programs available for the citizens in SWM = 3, training programs are available = 2, and I do not know = 1.

Most of the respondents (88.9%) confidently ensure that training facilities for the citizens are unavailable in rural areas. However, 8.3% of respondents said that training programs are available. In that case, they explained that the training is provided by different government departments like- agriculture, public health, etc. Very few, 2.8% of the respondents, have no idea about training facilities. Various respondents talked about the training scope regarding SWM and mentioned that: "No activities have been undertaken to train citizens on waste management. However, training will be arranged in the future" (UPC10). "Upazila Parishad has not given any such training regarding SWM" (UNO5). In Table 5, the mean value is 2.86, close to 3, indicating the unavailability of training facilities. The standard deviation is 0.424, meaning less diversity in the participants' opinions, which is more consistent among the respondents' opinions. The t-statistic value is 6.74 and statistically significant.

**Table 5.** Availability of training facilities (Created by the author; Source: Analysis of primary data)

Statement	Mean	St. Dev.	t-statistic	Decision
Availability of training for the citizens regarding SWM activities	2.86	0.424	6.74	No facilities

### Present status of the rural environment

The citizens face environmental hazards due to poor SWM in the rural areas of Bangladesh. The comments of the citizens mentioned in Table 6 indicate the severity of environmental pollution in the rural areas of Bangladesh due to poor waste management.

**Table 6.** Waste management-related problems faced by the citizens of the rural areas of Bangladesh (Created by the author; Source: Fieldwork primary data)

<i>People leave garbage everywhere around the road. As a result, pedestrians have to cross the road with bad smells (C1).</i>
<i>During the monsoons, waste gets mixed in rivers, streams, ponds, and reservoirs. As a result, residents are affected by various waterborne diseases (C7).</i>
<i>During the monsoons, waste gets mixed in rivers, streams, ponds, and reservoirs. As a result, children are affected by various waterborne diseases (C9).</i>
<i>Citizens do not throw garbage in designated areas, resulting in stench (C10).</i>
<i>Citizens do not throw garbage in designated areas, and the environment becomes polluted (C15).</i>
<i>Pedestrians face various problems due to the stench of garbage everywhere (C16).</i>
<i>Various diseases are constantly increasing due to garbage being scattered in different places and increasing mosquito attacks (C21).</i>
<i>Mosquitoes and fly infestation is increasing due to waste disposal everywhere. As a result, many people are suffering from various diseases (C27).</i>
<i>Every citizen should bury the garbage safely in a hole in the ground instead of leaving it anywhere (C31).</i>

### Presence of the Citizen's groups/ associations and NGOs in SWM

This study focused on investigating the presence of citizen groups/ associations and NGOs in SWM activities in the rural areas of Bangladesh. However, the same question was asked of the citizens and service providers. The reason is to cross-check the answer and validate it as well. In addition, the respected answers accumulated, and the statements were designed to be positive and coded with numerical values; no citizen's groups/ associations and NGOs are available = 3, citizen's groups/ associations and NGOs are available= 2, and I do not know = 1.

In the case of citizens' statements (CS), 87.2 percent of the respondents ensure the absence of citizens' groups/ associations and NGOs in the rural areas of Bangladesh, as presented in Table 7. On the other hand, the service provider's statement (SPS) 75% of the total respondents supported this statement. Consequently, 3.2% of the CS and 19.4% of the SPS expressed the availability of the citizen's groups/ associations and NGOs. In this case, they mentioned some names of the NGOs like- DASCO, BD Clean, etc., as they work on SWM in different rural areas. Despite that, they supported the statement of the absence of citizen groups/ associations and NGOs. Very few describe that they do not know: 6.6% for the CS and 5.6% for the SPS.

**Table 7.** Statements regarding citizen's groups/associations and NGOs (Created by the author; Source: Fieldwork primary data)

Statements	Key	n	Percentage
There are no citizen's groups/ NGOs/ are available	CS	27	87.2
	SPS	27	75
Citizen's groups/ NGOs are available	CS	1	3.2
	SPS	7	19.4
I do not know	CS	3	6.6
	SPS	2	5.6

In Table 8, the mean value of the CS is 2.77, close to 3, which indicates the absence of citizen groups/ associations and NGOs. The standard deviation is 0.619, which means less diversity in the respondents' opinions, which is more consistent among the respondents' opinions. The t-statistic value is 4.49 and statistically significant.

**Table 8.** Level of citizen's groups/ associations and NGOs (Created by the author; Source: Analysis of primary data)

Key	Statement	Mean	St. Dev.	t-statistic	Decision
CS	Citizens Statement	2.77	0.619	4.49	Absence
SPS	Service providers Statement	2.69	0.576	4.67	Absence

Compellingly, SPS also represented similar findings. In the same table, the mean value of the SPS is 2.69, close to 3, indicating the absence of citizen groups/ associations and NGOs. The standard deviation is 0.576, meaning less diversity in the respondents' opinions, which is more consistent among the respondents' opinions. The t-statistic value is 4.67 and statistically significant.

In this case, the coefficient of correlation value is 0.44. The coefficient of correlation indicates a highly positive relationship between the opinions of the CS and SPS. That is, both CS and SPS have the same opinions.

## Discussion

The findings of this study indicate that citizens residing in rural parts of Bangladesh engage in SWM activities based on their own preferences (personal management), as mentioned by the respondents. BIGD (2015); Sujauddin et al. (2008); Biswas et al. (2020); Salequzzaman et al. (1998); Salequzzaman (2000); Ahmed and Rahman (2000); Salequzzaman et al. (2001); Alam et al. (2002); Hasan and Chowdhury (2005) find partial citizens participation especially household waste dumping in the designated area in the urban areas of Bangladesh in their research. According to the study conducted by Babazadeh et al. (2018), there needs to be more citizen participation in source separation initiatives inside Iranian households. Significant researchers mentioned that citizen participation is a major factor in proper SWM activities (Xiao et al., 2017; Singhirunnusorn et al., 2012; Lin et al., 2010; Gaul and Ziefle, 2009; Joseph, 2006).

Mihai and Taherzadeh (2017) discuss management practices, dumping process, dumping place, and reuse/utilization of resources for understanding the SWM activities in different countries. According to the findings, that is a clear direction that, in the rural areas of Bangladesh, citizens personally handle SWM. Respondents mentioned that source separation

generally does not occur by the citizens during dumping due to the traditional waste management system (Ashikuzzaman and Howlader, 2020). They follow their technique for dumping. According to the citizens' opinions, there needs to be more institutional operations like local government activities and other private organizations in SWM in the rural areas of Bangladesh. Agovino et al. (2018) argue that the optimization of waste management in developed countries is achieved by the combined adoption of acceptable behaviors by residents and local governments.

According to the field interview, citizens follow three different dumping processes during dumping. However, no complex and fixed rules require citizens to choose any single process for the dumping time. Sometimes, they do it combined as per their need. Citizens explained during the interview that they do it casually without any significant reason. In general, it can be said to be a standard practice followed by year after year.

Citizens expressed that waste is burned in the agricultural field, and this process is going down more than in previous times. Chandrappa and Das (2012) also mentioned comparable findings: the disposal of agricultural wastes, such as straws, stalks, husks, wood, and sawdust, commonly involves burning them in open fields, exposing them to fire threats. Open burning activities are every day when disposing of household waste, including biowaste, plastics, textiles, and other materials. The field interviews and observation must say that citizens are not maintaining any specific dumping places due to the lack of such designated places in the rural areas of Bangladesh. Though these are categorically separated from each other, commonly, all are open spaces and not designated for waste dumping places by any authority.

Most respondents mentioned using low/ shallow land as dumping places. That is the dominant response, according to the respondent's opinion. Moreover, the commanding response is that waste is dumped in their backyard. Occasionally, waste was dumped in open spaces or ponds/rivers. A few of the respondents expressed that they dumped in an open pond. In their study, Ashikuzzaman and Howlader (2020) findings revealed that many improper waste management practices, like indiscriminate open dumping and burning, disposal of trash into water bodies, landfilling, and direct disposal into agricultural land, are prevalent in rural areas of Bangladesh. Relevant research mentioned that the existing dumping processes and places are not environmentally friendly and cause pollution (Mihai and Taherzadeh, 2017). Taherzadeh and Rajendran (2014) described different factors for poor waste dumping. The garbage dumps, alongside the ocean, open dump, and river dumping methods, have been a longstanding and widely adopted waste disposal method practiced by human settlements worldwide (Mihai and Taherzadeh, 2017).

The overall situation of waste recycling in rural areas needs to improve. A few respondents mentioned that some made compost from the waste. In those cases, respondents were involved with agricultural activities. Compost is made of household perishable products. El-Haggar (2007) found similar findings in other rural areas and described that this process is environment-friendly. According to his observation, rural areas without access to formal waste collection services must be encouraged to conduct home composting or vermicomposting to acquire high-quality natural fertilizers (El-Haggar, 2007). Organic farming aims to keep soil healthy, create high yields, conserve energy, maintain biodiversity, and reduce external costs (El-Haggar, 2007). Mihai and Ingraio (2018) also mentioned similar things in their research.

During the interview, respondents talked about private businessmen collecting reusable waste products like plastic products, paper/books/magazines, iron/metal products, glass bottles, etc., from the household level. They offered different products in exchange for waste or provided money. In most cases, the individual collectors sold their waste to the big seller. They collect and store such products and send them to the upper market, sometimes directly to Dhaka, Bangladesh's capital, for further recycling. Service providers mentioned that this is a private business without direct relation to local government authorities. Various researchers found similar things (Schneider et al., 2017) and defined it as an "informal sector" (Chi et al., 2011). The recycling and reuse activities in the urban areas of Bangladesh are predominantly carried out by informal sectors (DoE, Waste Concern, and ITN-BUET, 2004; BIDG, 2015). This study finds the presence of an informal sector for waste recycling in the rural area of Bangladesh.

In Bangladesh, formal education for SWM needs to be improved. Some relevant studies found no course or class about SWM at the primary level except class Three. Class Seven at the secondary level and the science group at the higher secondary level have one course, of which one or two chapters have some relevancy regarding SWM (BCAS, 2001; Majumder, 2011; Chakraborty and Rahman). The curriculum primarily focuses on pollution, prevention, conservation, and, to a lesser extent, waste management. However, this conceptualization needs to meet the expected level of comprehension regarding the SWM matter (Majumder, 2011). It is widely acknowledged that prevailing economic development patterns are no longer deemed sustainable, prompting a growing recognition of the pivotal role played by public awareness, education, and training in facilitating society's transition toward sustainability (McKeown, 2002). Subsequently, the training scope of the citizens becomes significant.

Most respondents confidently ensure that training facilities for the citizens are unavailable in rural areas. As they explained, Local government authorities cannot provide such training. Deficit budgets and inadequate government instructions are other factors for the unavailability of training. However, very few respondents said that training programs are available. In that case, they explained that the training is provided by different government departments like – agriculture, public health, etc.

The citizens' responses indicate environmental hazards and suffer from severe air and water pollution due to poor SWM in the rural areas of Bangladesh. Some have bitter experiences regarding open waste dumping, like a terrible odor and mosquito infections, as causes of choosing this process, and sometimes waterborne disease outbreaks. Epstein (2015) discussed the global scenario and mentioned that rural households might lack access to fundamental utilities such as improved drinking water sources, sanitation facilities, and waste management services in extreme circumstances. Additionally, nearby water bodies may become contaminated due to the improper disposal of waste and the practice of open defecation. Human waste disposal is a significant challenge in developing countries, particularly in rural regions of Africa, India, and China, in addition to household and agricultural waste management. Visvanathan (2006) also discussed the similar potential environmental emissions due to improper dumping. Extreme foul odor creates problems for the citizens.

Various researchers found that citizen participation, especially community engagement, is important for successfully implementing SWM (Alam, 2016; Hari, 2023). Most respondents ensure the absence of citizen groups/ associations and NGO activities in SWM in the rural areas of Bangladesh. The service providers provided the same statement. In this case, they mentioned some names of the NGOs like- DASCO, BD Clean, etc., as they work on SWM in different rural areas. Despite that, they supported the statement of the absence of citizen groups/ associations and NGOs.

## Conclusions

This research aims to examine specific issues within SWM in rural Bangladesh and obtain some exciting field findings. Citizens in the rural areas of Bangladesh participate in SWM activities "personally." That means by their choice, without following any legal bindings and scientific process. Most citizens dump waste in pits or lowlands near houses as a common practice. Other practices are also available, like burying waste at a safe distance. In addition, a general practice trend was discovered. Citizens dispose of their waste by themselves in their own way and dump waste by making a hole or burying it in the soil. Low/shallow land and the backyards of households are used as dumping places. In the case of organic waste, some citizens make compost, and the private sector, known as the informal sector, is involved in recycling different products like plastic, paper, glasses, etc.

Citizens mentioned that no rural local government authority provides training facilities for SWM activities. The overall environment is not up to the mark, and people suffer from environmental pollution. During the SWM activities in the rural areas of Bangladesh, any activities of citizen groups or associations were not found. This study aims to encompass a representative geographical locality during the data-collection process, considering the constraints imposed by limited time and resources. However, it is still possible to gather data from further rural areas. Potential avenues for future research could be explored in these particular domains. This study focused on an unconventional area for waste management issues. However, in Bangladesh's context, rural areas represent the maximum land area and deal with a significant number of the total population. That could be an example for the other rural areas of developing countries. This research finding sheds light on removing the darkness of SWM activities in rural areas of Bangladesh. Policymakers and researchers will obtain some insights for the future improvement of rural areas' SWM and the achievement of environmental sustainability.

**Notes:** Explanation of the use code: The coding methodology employed in this study facilitated the identification of distinct individuals belonging to the same occupational group. This was achieved by assigning a unique identifier to each subject, consisting of a word followed by a corresponding numerical value. This code aims to ensure the interviewee's anonymity, like- CBD1, UNO1, and so on. The detailed about coding; CBD: Citizens of Bangladesh; UNO: UpazilaNirbahi (executive) Officer; UPZC: Chairman of UpazilaParishad (council); UPC: Chairman of Union Parishad (council); UPS: Secretary of Union Parishad (council); M: Mayor of the Municipality; and EBD: Expert of Bangladesh (Senior officers; Local government).

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## Conflicts of Interest

The authors declare no conflict of interest.

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