Comparative Study of Municipal Waste Management of Two Municipalities in Kushtia District: A Case Study

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Abstract

The efficient management of municipal waste is a critical challenge for developing nations, where rapid urbanization and population growth exacerbate the problem. This study provides a comprehensive analysis of municipal waste management practices in Bangladesh, focusing on a comparative study of two municipalities in the Kushtia District: Kushtia Municipality and Kumarkhali Municipality. The research aims to evaluate the effectiveness, sustainability, and environmental impact of current waste management systems in these municipalities. Data were collected through field surveys, interviews with municipal officials, and analysis of secondary sources. The study reveals significant disparities in waste management practices between the two municipalities, attributed to differences in resource allocation, community participation, and policy implementation. Kushtia Municipality, with better financial and infrastructural support, demonstrates more effective waste collection, segregation, and disposal practices compared to Kumarkhali Municipality, which struggles with inadequate resources and lack of public awareness. The findings highlight the need for a more integrated and inclusive approach to waste management, emphasizing community engagement, capacity building, and policy reforms. Recommendations include the adoption of advanced waste processing technologies, enhancement of waste segregation at the source, and the implementation of robust monitoring and evaluation frameworks. This study contributes to the growing body of knowledge on municipal waste management in developing countries and provides actionable insights for policymakers, practitioners, and researchers aiming to improve environmental sustainability and public health in urban areas of Bangladesh.

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1. Introduction

Municipal waste management is a critical concern in urban areas worldwide, particularly in developing countries where the current waste management infrastructures are challenged by accelerated urbanization and population growth (Chowdhury et al. 2014). The issue is particularly severe in Bangladesh as a result of inadequate waste management policies, inadequate resources, and inadequate public awareness. These challenges are exemplified by the Kushtia District, which includes Kumarkhali Municipality and Kushtia Municipality. The objective of this research is to conduct a thorough examination of municipal waste management in these two municipalities, identifying deficiencies and suggesting solutions to enhance efficiency, sustainability, and environmental impact. Urban areas contribute considerably to Bangladesh's daily solid waste generation, which amounts to approximately 25,000 tons (Elagroudy et al. 2016).). Substantial population growth has resulted in an increase in waste generation in Kushtia District, which is situated in the southeastern region of Bangladesh. Nevertheless, the district's waste management practices are still rudimentary, as it lacks the necessary infrastructure and resources to effectively manage the increasing waste (Hadidi et al. 2020). This situation leads to inefficient resource utilization, public health hazards, and environmental degradation.

The municipalities of Kumarkhali and Kushtia provide a distinctive opportunity to examine and contrast waste management practices within the same district. Kushtia Municipality is anticipated to have superior waste management practices in comparison to Kumarkhali Municipality, which is predominantly rural and less developed (Hafsa & Ahmed. 2021), due to its higher concentration of urbanization and economic development. Nevertheless, both municipalities encounter comparable obstacles, including inadequate funding, inadequate technical expertise, and inadequate public engagement in waste management initiatives. The necessity of an integrated approach to municipal waste management in Bangladesh has been underscored by existing research. For example, Haque (2021) underscore the significance of community-based waste management systems, while Hossain & Hossain (2008) advocate for policy reforms to improve waste segregation and recycling initiatives. Nevertheless, there is a dearth of comparative studies that assess the efficacy of refuse management practices in various municipalities within the same district. The necessity of the current research is emphasized by this lacuna in the literature.

The problem statement for this study is as follows: What are the primary factors that influence the efficacy and sustainability of waste management practices in Kushtia Municipality in comparison to those in Kumarkhali Municipality? In order to address this inquiry, it is necessary to investigate a number of sub-questions, including the

environmental impacts of waste management practices, community participation, policy implementation, and resource allocation in the two municipalities.

This research is significant because it offers valuable insights into the current status of municipal waste management in a developing country context. The study contributes to the overarching objective of attaining sustainable urban development and environmental preservation in Bangladesh by identifying areas for refinement and best practices.

2. Objective of the Study

The major goal of this research is to undertake an analysis of the current condition of solid waste management in municipalities, with secondary aims of identifying the challenges towns confront and the opportunities given by their situations. The specific objectives are as follows to evaluate current waste collection, segregation, and disposal practices, to assess community awareness and participation in waste management, to recommend sustainable strategies, including decentralized systems and innovative technologies.

3. Importance of the Study

Particularly in developing nations like Bangladesh, effective municipal waste management is essential to public health, environmental protection, and sustainable urban growth. This work closes a major gap in the literature by comparing the waste management strategies of two municipalities in the same area (Ahmed, S., & Rahman, M. 2020). Through an assessment of the efficiency, sustainability, and environmental effects of waste management systems in the municipalities of Kushtia and Kumarkhali, the study identifies the main elements affecting these practices.

To develop policies and plans that may enhance waste management in comparable urban and rural settings, one must understand these elements. The results of the research may direct legislators in better resource allocation, community engagement, and the implementation of stronger waste management laws (Islam. 2016). Furthermore, the study emphasizes the need of using cutting-edge waste processing technology and environmentally friendly methods, which are essential to lessen the negative effects of poor waste management on the environment and human health (Islam, S. 2021). This paper offers practical recommendations for enhancing municipal waste management in Bangladesh, so advancing the larger objective of achieving the United Nations Sustainable Development Goals (SDGs), especially SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production).

4. Literature Review and Theoretical Framework of the Study

Municipal waste management has been a major focus of study in developing nations because to the increasing issues provided by rapid urbanization and population increase. Existing literature gives a comprehensive review of waste management techniques in Bangladesh, illustrating both the triumphs and failures of various solutions

used in different locations. Kabir, F. (2020) emphasize the value of community-based waste management systems, arguing that incorporating local people in garbage segregation and collection may result in more sustainable results. Kader et al. (2006) conduct a thorough examination of solid waste management methods in Dhaka, emphasizing the need for regulatory changes and modern waste processing technology to efficiently address rising trash quantities. According to their findings, although considerable progress has been achieved, substantial gaps in resource allocation and public awareness still exist. Khatib, I. A. (2011) examines the problems and potential for solid waste management in the Kushtia District, highlighting important concerns such as limited finance, a lack of technical skills, and insufficient public engagement. They suggested that these issues impede the successful implementation of waste management solutions, posing environmental and public health hazards.

Despite these contributions, there is a notable dearth of comparison research assessing the efficacy of waste management techniques within the same area. This gap in the literature emphasizes the need of doing research that compares various municipalities' waste management systems to discover best practices and areas for development. This research intends to address that vacuum by conducting a thorough analysis of municipal waste management in Kushtia and Kumarkhali Municipalities, as well as providing policymakers and practitioners with practical insights.

Theoretical Framework of the Study: This study utilizes the Integrated Sustainable Waste Management (ISWM) framework, which encompasses technical, environmental, socio-economic, and institutional aspects of waste management (Wilson et al., 2015). The ISWM framework provides a holistic approach by integrating these dimensions to create sustainable and efficient waste management systems. The technical dimension focuses on the infrastructure and technology used in waste collection, segregation, and disposal. The environmental dimension assesses the impact of waste management practices on the natural environment. The socio-economic dimension examines the role of community participation and public awareness in waste management, while the institutional dimension evaluates the policies, regulations, and organizational structures governing waste management (Scheinberg et al., 2020). By applying the ISWM framework, this study aims to compare the waste management practices in Kushtia and Kumarkhali Municipalities, identifying best practices and areas for improvement to enhance sustainability and efficiency.

5. Methodology of the Study

This study employs a mixed-methods approach, combining quantitative and qualitative data to provide a comprehensive analysis of municipal waste management practices in Kushtia and Kumarkhali Municipalities. Quantitative data were collected through structured field surveys and waste audits, which measured waste generation rates, segregation efficiency, and disposal methods (Creswell & Creswell, 2018).

a. Selection of the Study Area: Two municipalities within Kushtia district were selected purposively for conducting this study. Number of population and

their socio-economic status were given important emphasis to select the study area. Researchers employed convenience sampling, a prominent non-probability sampling method. The sample size is 100, including service providers and users. From 100 demand side respondents (service receivers), 70 were male and female. The remaining 30 responders include Pourashavas executives, elected politicians, and NGOs.

Table 1: Composition of Respondents.

Name of the District	**Name of the Municipalities**	**Name of Respondents**	**Total Respondents**
Kushtia	Kushtia and Kumarkhali,	Mass people, Peoples representatives, Govt officials, NGOs staffs and Others	100
Total Respondents (One hundred)			**100**

b. Data collection Methods: In order to gather information on the intended respondents, a series of objective-based questionnaires has been designed. The data for this research was gathered using the following methods:

i. *Quantitative Data:* Structured field surveys and waste audits were conducted to measure waste generation rates, segregation efficiency, and disposal methods. Surveys involved 200 households and 50 businesses from each municipality to ensure representation (Creswell & Creswell, 2018).

ii. *Qualitative Data:* Semi-structured interviews were conducted with key stakeholders, including municipal officials, waste management workers, and community leaders. These interviews aimed to capture in-depth insights into the challenges and opportunities of current waste management practices (Sarker, M. N. 2019).

c. Sampling Technique

i. *Household and Business Surveys:* A stratified random sampling technique was used to select participants, ensuring that different socio-economic groups were adequately represented in both municipalities.

ii. *Stakeholder Interviews:* Purposive sampling was employed to identify key informants who have significant knowledge and experience in municipal waste management (Rahman et al. 2021).

d. Data Analysis

i. *Quantitative Data Analysis:* Descriptive statistics were used to analyze survey data, providing an overview of waste generation patterns, segregation rates, and disposal practices. Statistical tools such as SPSS were employed for this analysis (Khan, M. S. et al. 2021).

ii. *Qualitative Data Analysis:* Thematic analysis was conducted on interview transcripts to identify common themes and patterns related to waste management challenges and practices (Hossain, M. et al. 2022).

This comprehensive approach facilitated a comprehensive comparison of the environmental impact, sustainability, and efficacy of waste management systems in Kushtia and Kumarkhali Municipalities, resulting in actionable recommendations for improvement.

6. Scenario of Solid Waste Management in Bangladesh

In Bangladesh, the management of solid waste is a growing concern due to rapid urbanization, industrialization, and population growth. The country generates approximately 25,000 tons of solid waste daily, with urban areas like Dhaka contributing significantly to this volume (Majumder, S. C. 2012). However, the infrastructure and resources for effective waste management remain inadequate. Municipalities across Bangladesh, including those in the Kushtia District, face numerous challenges in managing solid waste. These include insufficient funding, lack of technical expertise, and limited public awareness and participation in waste segregation and recycling efforts (Mamun & Akther. 2018). In many areas, waste is often disposed of in open dumps, leading to severe environmental and health hazards. These unmanaged waste sites contribute to soil and water contamination, air pollution, and the proliferation of disease vectors (Masud, A. K. M. 2013). Despite these challenges, there are initiatives aimed at improving waste management practices. Some municipalities have started adopting community-based waste management systems and exploring advanced waste processing technologies (Mian, M. M et al., 2011). However, the implementation of these initiatives is often hindered by resource constraints and policy gaps.

The comparative study of Kushtia and Kumarkhali Municipalities aims to shed light on the effectiveness of different waste management practices within the same district. By identifying best practices and areas for improvement, this research seeks to contribute to the development of more sustainable and efficient waste management systems in Bangladesh.

7. Scenario of Solid Waste Management in Bangladesh

7.1 Demographic Characteristics of respondent

The demographic features of the responders include a range of age groups, educational backgrounds, and socioeconomic classes. These elements have a big impact on awareness levels and waste management techniques, according to Nasrin, S. T. (2014). In order to improve community involvement and efficacy in waste management projects. Peprah, K. et al. (2015) emphasize the need of focusing educational programs on various demographic groups.

The following table provides a distinct representation of the characteristics of the sampled homes. The table below indicates that 76% of household heads/respondents are male and 24% are female. This was due to the fact that women typically worked from home rather than outside. This research acknowledges and relies on the dominance of women, as they are more knowledgeable about managing the substantial refuse in their homes. In addition, the majority of the sample respondents, 80%, are adults aged 30 to 60. The table below illustrates that 16%, 24%, 13%, 10%, 25%, and 11% of individuals possess no formal education, have completed primary school, secondary school, upper secondary school, college, and graduate school. The majority of respondents (46%) have completed their secondary education or college. The educational backgrounds of the sample households facilitated the rapid generation of new concepts. This also enhances the precision of the data provided by these respondents.

Table 2: Socio-economic and demographic characteristics of respondents

Characteristics of respondents	**Description of characteristics**	**Frequency**	**Percent**
Sex	Male	76	76%
	Female	24	24%
	Total=	**100**	**100%**
Age	20-30	11	11%
	30-40	36	36%
	40-50	24	24%
	50-60	20	20%
	60+	9	9%
	Total=	**100**	**100%**
Status of Education	No formal education	16	16%
	Primary Education	24	24%
	Secondary Education	13	13%
	Higher Secondary Education	10	10%
	Graduation	25	25%
	Post-Graduation	11	11%
	Total=	**100**	**100%**
Family size	1-3 persons	41	41%
	4-6 persons	53	53%
	7-9 persons	4	4%
	10 persons and above	2	2%
	Total=	**100**	**100%**
	Trading	21	21%
	Private sector	37	37%
	Government sector	24	24%

Employment status	Daily labour	13	13%
	Other	5	5%
	Total=	**100**	**100%**
Marital status	Single	36	36%
	Married	59	59%
	Divorced	3	3%
	Widowed	4	2%
	Total=	**100**	**100%**
Average monthly income	Below 500	5	5%
	501-1500	30	30%
	1501-2500	17	17%
	2501-5000	18	18%
	5001 and above	27	27%
	No response	7	3%
	Total=	**100**	**100%**

Source: compiled from questionnaires survey, 2022.

In addition, 41% had 1–3 family members, 4% had 7–9, and 53% had 4–6. Only 2% of homes had more than ten people, the research revealed. Health, solid waste collection, and population crudeness are affected. The majority of study region respondents approached the national average. See table above for respondents' job conditions. 21% of 250 families are merchants, 37% are private sector workers (the majority), and 24% are government workers. Only 13% of responders work every day. The remaining 5% engage in various economic pursuits. Nearly 36% were single, 59% married, 3% divorced, and 2% widowed. Thus, marital status impacts solid waste composition and generation's economic and social worth. Money, another social and economic issue, increases solid waste and makes municipal solid rubbish control harder. Annual household income impacts municipal solid waste management. The table shows monthly family income. This data categorized residences into five. Most (30%) sample houses earn 501–1500 taka per month in the second group. Only 17% of category three families earn 1,500–2,500 taka monthly.

7.2 Waste production scenario of municipalities in daily basis

Municipal solid waste management is a major issue for any municipality. Along with trash from companies, industries, and other sources, solid waste comes from homes and street cleaning. The research locations' daily trash output rate is shown in Table 3:

Table 3: Scenario of Waste production of different municipalities/day.

Scenario of Waste production of different municipalities.	**Scenario of Municipalities**	
	Kushtia Sadar	**Kumarkhali**
1-5 kg	3%	5%
5-10 kg	10%	10%
10-20 kg	27%	26%
>20 kg	60%	59%
Total=	**100%**	**100%**

The above Table 3 showed the scenario of waste production. The average daily amount of waste created per person in Kushtia Sadar was reported to be above 20 kilograms, which accounted for 60% of the total waste generated. In Kumarkhali, the average daily waste per person was found to be over 20 kilograms, accounting for 59% of the total waste generated. According to the second highest response, Kushtia Sadar and Kumarkhali have waste generation rates of 27% and 26% respectively. They also said that the average quantity of rubbish produced per person per day is within the range of 10 to 20 kilograms. The remaining participants from Kushtia Sadar and Kumarkhali reported an average trash generation rate of 1-10 kg per person per day.

7.3 Place of Dumping Household Waste by the Participants

Participants primarily dispose of household waste in open dumps or unauthorized sites, reflecting inadequate formal waste collection services (Prajapati & Pamnani. 2017). This practice contributes to environmental pollution and health hazards, as highlighted by Nasrin, S. T. (2014). International studies emphasize the need for proper waste disposal infrastructure and public awareness campaigns (Saqib & Habib. 2018).

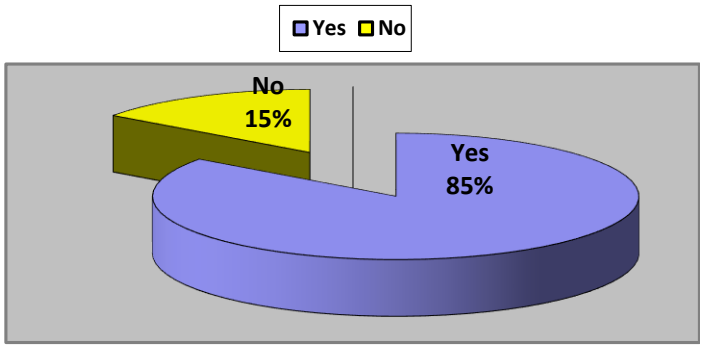

Figure 2: Dumping facilities of wastages.

The above Figure 2 shows that 15% of individuals express disagreement, although 85% of individuals have waste disposal locations in close proximity to their residences. The diagram below illustrates the area where municipal waste is disposed of. They provided clear explanations of the rationales and techniques used for their community's waste management.

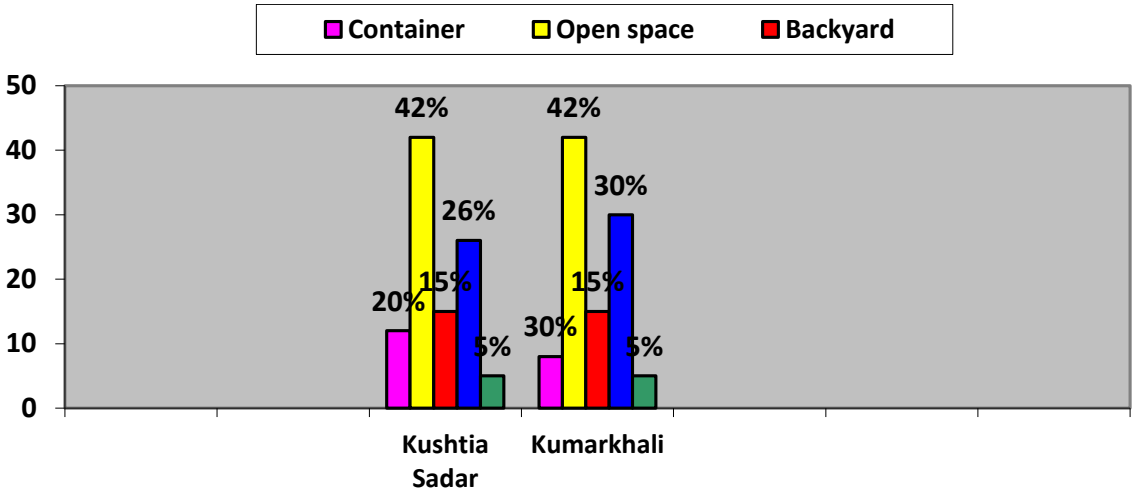

Figure 3: Place of Dumping Household Waste.

In our survey, most of the participants did not properly discard their garbage at the assigned locations. Open spaces next to dwellings or along roads and highways were used for rubbish disposal in 42% of the municipalities in Kushtia Sadar and Kumarkhali. In Kushtia Sadar, the second biggest group, with 26% of the population, reported putting their garbage by the road. In Kumarkhali, this group accounted for 30% of the population. The percentage of the situation was 24% in the Kushtia Sadar municipality and 30% in the Kumarkhali municipality. Only a few of participants reported using distinctive waste management strategies throughout the manufacturing process showed in Figure 3.

7.4 Opinions of Participants about Increasing of Solid Wastes in the Municipalities

Due to urbanization and population expansion, participants worried about solid waste rise. Shishir, A. R., & Islam, P. (2016) found that poor waste management infrastructure worsens the situation. Singh, P. (2021) advocates for sustainable waste management worldwide.

Table 4: Causes of Increasing Wastes in Municipalities.

How do you think the solid waste is increasing day by day?	**Scenario of Municipalities**	
	Kushtia Sadar	**Kumarkhali**
Increase of population	60%	58%
Change of food habit	12%	10%
Not taking care of it	27%	29%
Others	1%	3%
Total=	**100%**	**100%**

The reasons for the rise of municipal garbage are displayed in Table 4. While 58% of respondents in Kumarkhali blamed garbage increase, 60% of respondents in Kushtia Sadar municipality did the same. Furthermore, 12% of respondents in Kumarkhali and 10% in Kushtia Sadar claimed that a significant portion of the garbage in cities was caused by mass food consumption. Jobs and urbanization change people's eating habits. Waste management problems were attributed to authorities in the municipalities of Kumarkhali and Kushtia Sadar (27% and 29%, respectively) not knowing their duties.

7.5 Scenario of Wastes Collection

Waste collection in Kushtia Municipality is inconsistent and inefficient, with many areas lacking regular services. Informal collection practices are common, leading to unregulated disposal sites (Visvanathan, C., & Adhikari, R. 2007). Singh, P. (2021) emphasizes the importance of structured waste collection systems and community involvement to improve efficiency and sustainability.

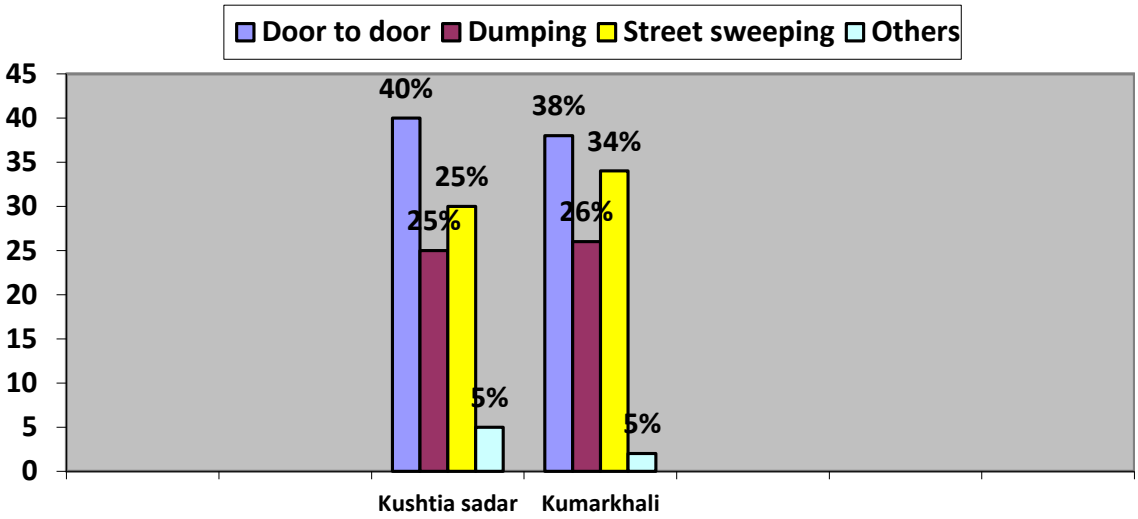

Figure 5: Types of Waste Collection System in the Society/Locality.

The above Figure 5 illustrates the wastage collecting mechanism used by the towns. According to Kushtia Sadar municipality, 38% of respondents from Kumarkhali municipality said that their garbage department collected rubbish daily via door-to-door service. As reported by respondents from Kumarkhali and Kushtia Sadar, 26% and 25% of the municipalities' respective concern departments collected rubbish from the dumping places. However, it is worth noting that 34% of the towns in Kumarkhali and 25% of the municipalities in Kushtia Sadar reported that their waste departments collected garbage from street sweeping. The remaining participants claimed that rubbish collection differed among municipalities. Our investigation could not uncover any ecologically sustainable way for collecting garbage from residences, corporations, or organizations in the different towns.

7.6 Nature of monitoring in waste management

Monitoring in waste management in Kushtia Municipality is often inadequate and sporadic, lacking systematic oversight and enforcement. This results in inefficient operations and regulatory non-compliance. Visvanathan, C., & Norbu, T. (2006) stresses the need for robust monitoring mechanisms, while international studies like Wilson et al. (2017) advocate for regular audits and community feedback systems to ensure accountability.

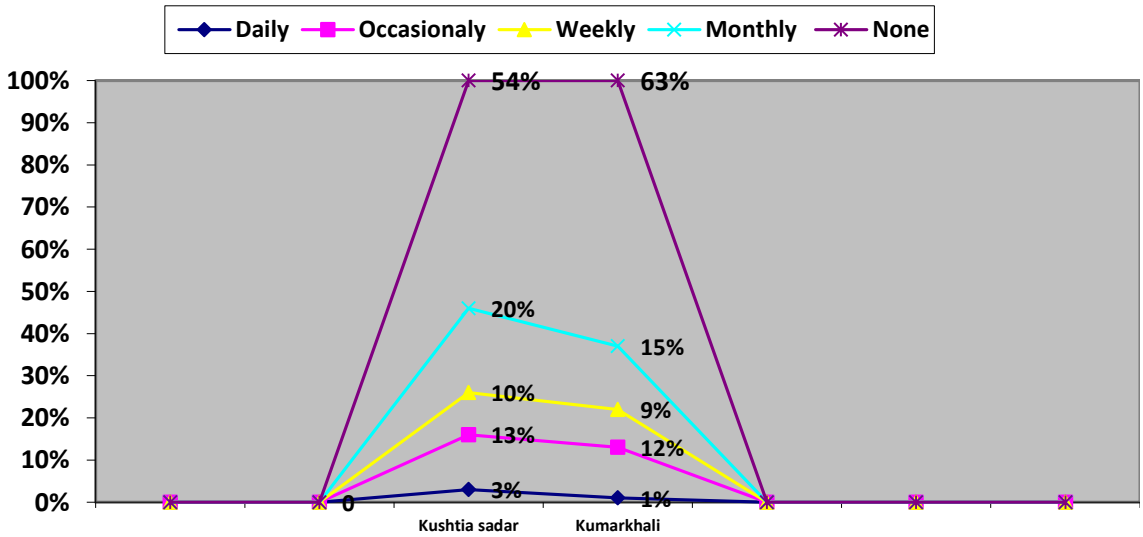

Figure 6: Nature of monitoring in waste management.

The municipal government does not supervise ward waste management, as indicated by 54% of respondents from Kushtia Sadar municipality and 63% of those from Kumarkhali municipality (Figure 6). According to 3% of respondents from Kushtia Sadar municipality and 1% of Kumarkhali municipality, the municipal body conducts routine monitoring of ward refuse management. In addition, 13% of Kushtia sadar and 12% of Kumarkhali municipalities reported that the municipal authorities occasionally visited their activities. Furthermore, we discovered that the municipal government is responsible for the administration of municipal ward refuse, as reported by 10% of respondents in Kushtia sadar and 9% in Kumarkhali municipalities. Alternatively, 20% of Kushtia Sadar municipality and 9% of Kumarkhali municipality reported that the municipal government regulates municipal ward refuse management on a monthly basis.

7.7 Major problems of waste management system

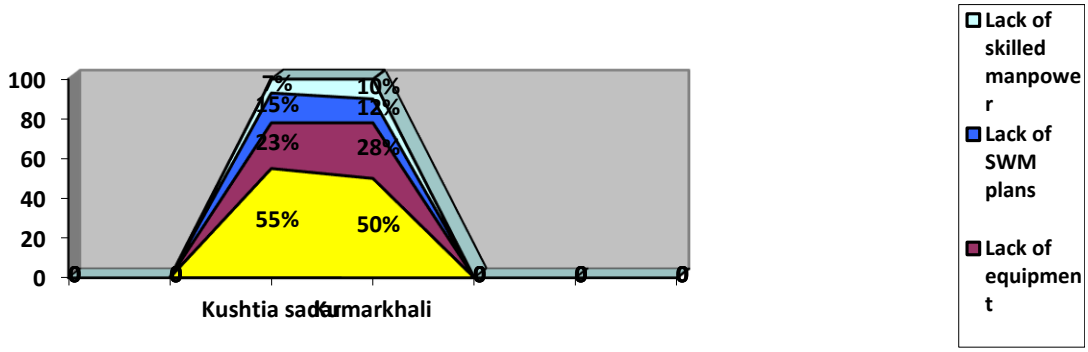

Figure 8: Major problems of municipal waste management system.

The Figure 8 above illustrates that 55% of participants from Kushtia Sadar municipality and 50% of participants from Kumarkhali municipality said that they were unable to provide the necessary services because of insufficient budget. Moreover, 23% of participants from Kushtia Sadar municipality and 28% from Kumarkhali municipality

said that insufficient equipment was a major obstacle to receiving the services they were promised. 15% of respondents from Kushtia Sadar municipality and 12% from Kumarkhali municipality highlighted a lack of garbage management policies as a key concern. However, 7% of participants from Kushtia Sadar Municipality and 10% from Kumarkhali Municipality said that a shortage of skilled staff hindered their capacity to provide planned services and obstructed waste management initiatives.

7.8 Suggestions regarding Reuse, Reduce and Recycle (3Rs) in Domestic Waste Management

The majority of responders mentioned initiatives were meant to cut back on waste, utilize existing materials, and recycle old ones.

Table 6: Respondents Suggestions regarding Reuse, Reduce and Recycle (3Rs).

Respondents' suggestions on 3Rs	**Municipality**	
	Kushtia Sadar	**Kumarkhali**
How to reduce waste generation (%)		
Only buy necessary goods	20%	15%
Buy endurable products	15%	10%
Use environmental friendly products	33%	35%
Bring reusable bags when shopping	32%	40%
Total=	**100%**	**100%**
How to reuse waste (%)		
Reuse used plastic bags	45%	35%
Donate used clothes, shoes or notebooks	15%	20%
Rese carton box to keep things	40%	45%
Total=	**100%**	**100%**
How to recycle waste (%)		
Selling recycle trash	25%	20%
Recycle is to recreate useful things from trash	20%	23%
Residents cannot do recycling by themselves	55%	57%
Total	**100%**	**100%**

The above Table 6 illustrates that purchasers of food and drink do not carry containers or reusable bags. Compact containers are less efficient yet provide more convenience. Based on our research, vendors see the act of providing consumers with

plastic bags as a positive gesture. Rubber bands, clothing, notebooks, shoes, and plastic bags are repurposed. The rates of reusing suburban areas are higher than the rates of reusing urban areas. Patients acquire the skill of reusing, resulting in cost savings. Reuse is limited by convenience and financial constraints within the household. Residents should engage in more reuse practices to reduce trash and save the environment. Similar to the principles of reducing and reusing, those with lower socioeconomic status tend to engage in recycling more often. Some individuals engage in recycling, selling, and using waste materials. Suburban trash recycling regions have a higher population density compared to cities. Household income and trash expenditures might restrict recycling. Because of its affordability, which may not cover waste disposal, individuals sell recyclable waste. Residential recycling is a more financially advantageous practice compared to green initiatives or waste reduction.

7.9 Authorities Perception on reasons behind increase of wastes

They were questioned about how the amount of rubbish in their municipality is growing in this portion of the questionnaire.

Table 10: Opinions of Increasing of Wastes in Municipalities.

Causes of increasing wastages	**Scenario of Municipalities**	
	Kushtia Sadar	**Kumarkhali**
Increase of population	40%	33%
Lack of logistic support	19%	22%
Lack of Budget	40%	41%
Others	1%	4%
Total=	**100%**	**100%**

The data presented in Table 10 indicates that 40% of respondents from Kushtia Sadar Municipality and 33% of respondents from Kumarkhali Municipality said that population development has posed challenges in waste management, hence hindering the provision of desired services. Further 19% of the population in Kushtia Sadar and 22% in Kumarkhali towns said that insufficient logistical assistance was a significant challenge in delivering services to the people. Additionally, 40% of participants from Kushtia Sadar Municipality and 41% of participants from Kumarkhali Municipality said that insufficient money was a challenge in providing desired services to the public. The remaining respondents said that waste occurs due to several factors, including lack of collaboration across government departments, inadequate waste regulations, and a lack of transparency and accountability among individuals.

7.10 Authorities suggestions about Reuse, Reduce and Recycle (3Rs) in Waste Management

Table 11 indicates that the majority of respondents indicated actions related to waste reduction, reuse, and recycling. Even if their comprehension is limited, it would contribute to the public's adoption of the 3Rs program. The availability of plastic bags and receptacles is the primary factor contributing to the increasing amount of waste being generated.

Table 11: Respondents' suggestions about Reuse, Reduce and Recycle (3Rs)

Respondents' suggestions on 3Rs	**Municipality**	
	Kushtia Sadar	**Kumarkhali**
How to reduce waste generation (%)		
Buy necessary & endurable goods	45%	40%
Use environmental friendly products	33%	35%
Bring reusable bags when shopping	22%	25%
Total=	**100%**	**100%**
How to reuse waste (%)		
Reuse used plastic bags	39%	40%
Donate used clothes, shoes or notebooks	25%	27%
Reuse carton box to keep things	36%	33%
Total=	**100%**	**100%**
How to recycle waste (%)		
Selling recycle trash	40%	30%
Produce useful things from wastages	60%	70%
Total	**100%**	**100%**

Customers don't bring containers or reusable bags to restaurants or shops. Smaller containers waste more yet are handier. Retailers that handed consumers plastic bags were friendlier. According to research, most respondents recycle plastic bags, bottles, rubber bands, clothes, notebooks, and shoes. More suburbanites than urbanites reuse such products. Reusing users go beyond thrifty. Family budget and convenience effect reuse. Communities must recycle and reuse more to reduce waste and enhance the environment. Like the other "Rs," poor people recycle more. Many replied by selling recycled things and manufacturing new ones from trash. Suburbs recycle more than cities. When recycling costs surpass discretionary funds, households recycle less. Recycling sales are slow since it's inexpensive and doesn't involve garbage disposal. Many communities recycle for profit rather than rubbish reduction or conservation.

8. Recommendations & Conclusion

8.1 Recommendations

The recommendations that are listed below can be helpful in closing the gaps that are present in the current system:

- ***a.*** *Implement Community-Based Waste Management Programs*: Engage local communities in waste management initiatives to enhance participation and efficiency. This approach has been shown to improve waste collection and recycling rates (Elagroudy et al. 2016).
- ***b.*** *Strengthen Regulatory Frameworks:* Update and enforce municipal waste management policies to ensure compliance and sustainability. Effective regulation can significantly reduce waste-related issues.
- ***c.*** *Adopt Advanced Waste Treatment Technologies:* Invest in modern technologies such as composting and anaerobic digestion to manage organic waste more efficiently and reduce landfill usage (Akter, S. 2021).
- ***d.*** *Enhance Public Awareness and Education:* Conduct awareness campaigns to educate citizens about the importance of proper waste disposal and recycling practices, which can lead to more sustainable waste management.
- ***e.*** *Improve Waste Collection Infrastructure:* Develop and maintain robust infrastructure for waste collection and transportation to ensure timely and effective waste management (Ahsan & Islam. 2009).
- ***f.*** *Encourage Private Sector Participation:* Foster partnerships with private companies to leverage their expertise and resources in waste management, enhancing overall system efficiency (Abedin & Karim. 2022).

8.2 Conclusion

The comprehensive analysis of municipal waste management in Kushtia District highlights substantial differences in waste management practices between the two municipalities. The findings indicate that municipalities with stronger community engagement, better infrastructure, and advanced waste treatment technologies are more successful in managing waste effectively. For instance, community-based waste management programs significantly enhance participation and efficiency, leading to improved waste collection and recycling rates. Additionally, robust waste collection infrastructure is crucial for timely and effective waste management. The study emphasizes the need for strengthening regulatory frameworks to ensure compliance and sustainability. Effective regulation has been shown to significantly reduce waste-related issues. Public awareness and education are also critical components, as they lead to more sustainable waste management practices by educating citizens on proper waste disposal and recycling. Moreover, adopting advanced waste treatment technologies such as composting and anaerobic digestion can reduce landfill usage and manage organic waste more efficiently. Encouraging private sector participation can further enhance the overall efficiency of waste management systems by leveraging their expertise and resources.

Overall, integrating these elements can lead to a more sustainable and effective waste management system in Bangladesh, addressing both current challenges and future prospects.

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