Solid Waste Disposal and Management System in Netrokona Sadar Municipality Area of Netrokona District

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Abstract

Efficient solid waste management in urban areas like Netrokona Sadar municipality remains a pressing concern. A study conducted from December 17 to 20, 2023, surveyed 60 households to assess current methods, environmental and health impacts, and links with respondent characteristics, aiming to offer sustainable guidelines. Results reveal an average solid waste generation of 0.28 kg per person per day, with organic materials (53.83%) and plastic (26.95%) dominating. Demographically, the community is diverse, with young adults (43.3%), varying educational levels (from illiteracy to beyond secondary, 23.33%), and predominant occupations in rickshaw pulling (30%) and labor (26.67%). Correlation analysis indicates positive relationships between waste generation and household characteristics such as monthly income, family size, education level, and occupation. Notably, age showed no significant correlation. House-to-house collection systems are preferred (48.33%), yet challenges persist due to inadequate resources. The study highlights strong correlations between waste generation and education ($r = 0.2732$, $P < 0.05$), occupation ($r = 0.4788$, $P < 0.001$), income ($r = 0.6806$, $P < 0.01$), and family size ($r = 0.5764$, $P < 0.01$). Higher education, specific occupations, increased income, and larger families correlate with higher waste generation rates. This research illuminates the complex interplay between socio-economic factors and waste generation behaviors. It emphasizes the need for customized waste management strategies, including enhanced infrastructure, public awareness initiatives, and resource allocation, to effectively address urban waste disposal challenges.

Keywords: Environmental impacts, Solid waste management, Socio-economic factors, Waste disposal practices.

Introduction

Bangladesh's environment is shaped by various factors (Zohoori and Ghani, 2017), and poor waste management exacerbates environmental degradation (Ahmed, 2019). Urbanization and population growth increase waste generation, with daily urban solid waste reaching 25,000 tons (Bangladesh Waste Database, 2014), expected to rise to 47,000 tons by 2025. The complexity of waste sources includes municipal, industrial, medical, and agricultural waste, with household waste being predominant (Hasnine *et al.,* 2016). Inadequate waste management leads to pollution, health risks, and economic burdens (Ahmed, 2019). A multifaceted approach is needed, including waste reduction, segregation, improved collection, proper disposal, capacity building, and community involvement, for sustainable waste management (Hoornweg *et al.,* 2013). Socioeconomic factors influence waste generation, with higher-income areas and densely populated urban zones producing more waste (Trends in Solid Waste Management, n.d.). Current disposal methods, such as open dumping and landfills, are unsustainable and pose threats to ecosystems and public health.

Limited funding, awareness, and infrastructure hinder modernization of waste disposal methods in Bangladesh (Ahsan *et al.,* 2014). In Netrokona Sadar Municipality, poor waste management affects health and the environment, necessitating comprehensive assessment and sustainable management strategies. The study aims to assess waste generation rates, evaluate current management practices, identify impacts, and provide guidelines for sustainable waste management.

Materials and Methods

Study Area

Netrokona Sadar Municipality, situated in the Netrokona District of Bangladesh's Mymensingh Division, was established in 1887. Initially a subdivision within the Greater Mymensingh district, Netrokona became a separate district on February 1, 1984. Through ongoing development efforts and meeting increasing demands, the municipality attained 'A' category status on October 10, 1996.

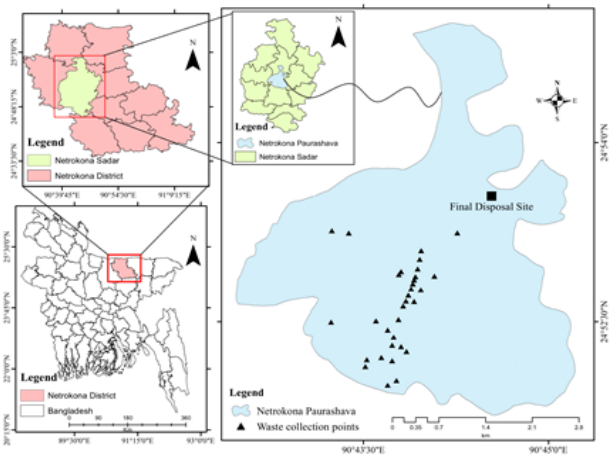

Fig. 1. Map of the Study Area

Netrokona Sadar Upazila spans 340.35 km² with a population of 421,933. The municipality itself covers 21.02 km², comprising 9 wards and 27 mouzas, housing 103,788 residents. The area experiences temperatures ranging from 13.33°C to 33.33°C annually and is bordered by the Magra and Dhalai rivers, with the Magra River being one of the five major rivers traversing the municipality.

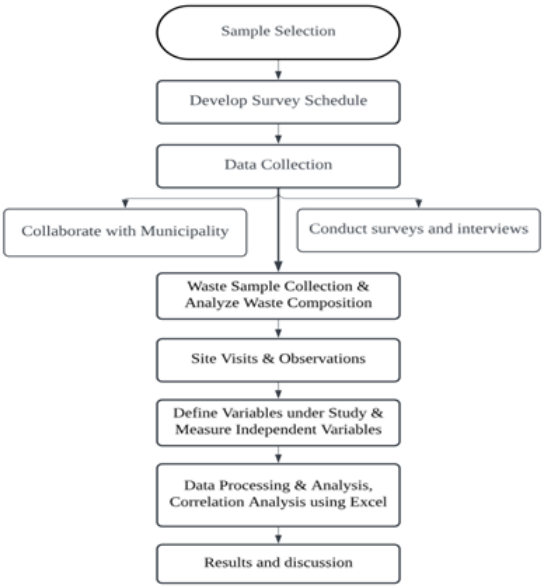

Fig. 2. Methodology of the Study.

Results and Discussion

Current Waste Generation Rates and Composition

Current waste generation rates

Municipal solid waste (MSW) in Bangladesh includes recyclables, hazardous substances, compostable organic material, and general solid waste, with organic materials predominating (Alamgir and Ahsan, 2007). MSW production is influenced by factors like dietary preferences, lifestyle, commercial engagement, and seasonal variations. In Netrokona Sadar Municipality, approximately 29 tons of solid waste are produced daily, with 86% collected by the municipal authority. The remaining 14% remains uncollected, with a per capita waste generation of 0.28 kg per person per day. Ensuring smart waste management system, municipal waste generation needs to be calculated (Shubho *et al.,* 2013). Ward-wise MSW generation for the municipality is detailed in **Table 1**, calculated by multiplying ward populations by the per capita waste generation rate. The determined outcome involved multiplying the population of each ward by the per capita municipal waste generation rate (0.28 kg/person/day), resulting in the calculation of the total solid waste generation for each ward.

Table 1. Ward wise municipality solid waste (MSW) generation.

Ward No.	Area (km²)	Population	Household No.	Total Waste Generation (kg)
1	2.75	14491	1916	4057.48
2	2	9975	1347	2793
3	2.25	10708	1076	2998.24
4	2	9481	1057	2654.68
5	2.75	10096	1192	2826.88
6	2	6871	1145	1923.88
7	2	12647	1977	3541.16
8	2	12153	2413	3402.84
9	3.25	17366	3585	4862.48

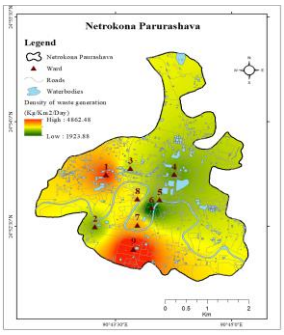

Fig. 3. Spatial distribution of waste generation in Netrokona municipality.

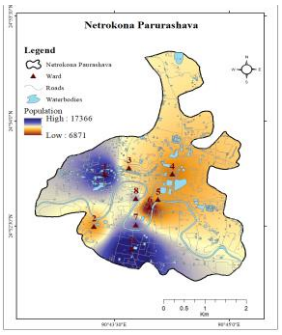

Fig. 4. Spatial distribution of population in Netrokona sadar municipality.

Ward 09 in the study area holds the distinction of being the largest in terms of area, and it also recorded the highest waste generation. The waste generation map indicates elevated waste density in Ward 09, as well as in Ward 01, Ward 3, and certain areas of Wards 08 and 07.

Waste Composition

Analyzing waste composition is crucial for improving waste management sustainability, as diversion methods from landfills hinge on waste composition. This analysis also identifies recycling opportunities, validates the need for recyclable waste collection, and informs charging mechanisms for mixed waste to incentivize recycling efforts.

Table 2. Solid waste composition in six significant zones of Netrokona sadar municipality area.

Composition	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Average
Organic	51%	68%	44%	47%	71%	42%	53.83%
Inert	4%	7%	5%	8%	3%	4%	5.17%
Plastic	26.2%	15.5%	38%	31%	18%	33%	26.95%
Paper	2.7%	1.5%	4.5%	8.5%	5%	13%	5.87%
Textile	4.5%	3.5%	2.5%	1.5%	1%	2%	2.5%
Metal	6%	4%	3%	2%	0.8%	2%	2.97%
Glass	2.3%	0.2%	2.2%	1.4%	0.5%	1%	1.27%
Wood	0.2%	0.3%	0.8%	0.6%	0.7%	3%	0.93%
Hazard	3.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.52%

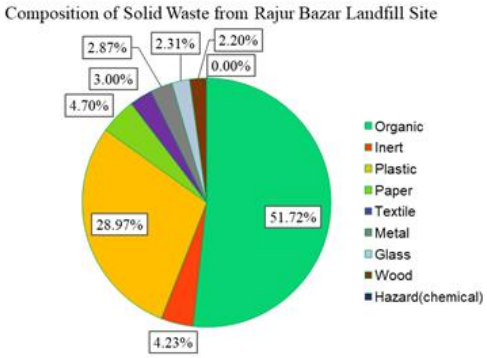

Fig. 5. Composition of solid waste from Rajur bazar landfill site (zone 7).

The waste composition analysis in **Table 2** revealed that the majority of generated waste comprised organic materials (53.83%), followed by plastic (26.95%), inert materials (5.17%), paper (5.87%), textile (2.5%), metal (2.97%), glass (1.27%), wood (0.93%), and hazardous materials (0.52%). And **Fig. 5** presents the composition analysis of the Rajur Bazar landfill zone (Zone 7), revealing that the predominant portion of generated waste consists of organic materials (51.72%), followed by plastic (28.97%), inert materials (4.23%), paper (4.7%), textile (3%), metal (2.87%), glass (2.31%), wood (2.2%), and no hazardous materials (0.0%).

Current Waste Management Practice

Collection and transport method

Netrokona Pourashava relies on conventional waste collection methods, yet its current system is inadequate and lacks environmental sustainability. Challenges include insufficient planning, infrastructure, resources, skilled labor, training, equipment, and a suitable disposal site. The Pourashava utilizes a fleet of vehicles, including 4 open trucks, 12 hand trolleys, 4 CNG-covered vans, 9 and vans, along with 163 cleaning staff, to collect, transport, and dispose of Municipal Solid Waste (MSW). Additionally, it maintains 182 fixed dustbins across different areas.

Fig. 6. Collection and transport method of Netrakona pourashava

Notably, not all bins are fully operational within Netrokona Pourashava. With an 86% waste collection rate, approximately 25 metric tons of waste are managed daily. New bins have been installed, promoting waste segregation: green for biodegradable and orange for non-biodegradable waste. Existing bins, marked red and blue, maintain their roles in waste disposal.

Open burning

During periods of excessive garbage accumulation, workers or locals sometimes resort to burning waste in open spaces due to a lack of proper disposal methods. This occurs in residential areas, near hospitals, clinics, and riversides. However, this practice is harmful to both the environment and public health. Burning waste releases harmful pollutants into the air, making breathing difficult and posing health risks.

Fig. 7. Open burning of solid waste inside Netrokona municipality

It's important to find better ways to deal with the garbage, like collecting it properly and not burning it in the open spaces.

Final dumping

Efficient waste disposal from various sources relies on effective management practices. The primary method of disposing waste in the Netrokona Municipality Area involves open dumping at the landfill site in Rajur Bazar, without any intermediate treatment. It is essential to transition from open dumping to a sanitary landfill system.

Fig. 8. Open dumping at the landfill site in Rajur bazar.

Rate of Satisfaction of the Existing Waste Management System

Household feedback shows overall satisfaction with the municipal waste management system, with 65% satisfied due to prompt waste collection. However, 35% are dissatisfied, citing issues like inadequate dustbins and unclean roads, leading to health and environmental concerns.

Table 3. Rate of satisfaction of the existing waste management system.

Category	Number of Respondents	Percent (%)
Satisfactory	39	65
Unsatisfactory	21	35
Total	60	100

Environmental and health impacts

Table 2 consistently shows that food and kitchen waste comprise over half of the total waste in all selected zones. Uncollected waste leads to odor emission and water pollution from organic decomposition, attracting pests. Plastic and paper materials, making up 26.95% and 5.87% respectively, pose ecological threats like drainage obstruction and soil contamination. Other components like textiles, metals, and glass also present dangers, with broken glass and sharp metal causing injuries, especially to scavengers and children. Waste workers face risks of contact dermatitis due to exposure to irritants, resulting in skin inflammation and itching.

Household Respondents' Selected Characteristics

This study investigated five key characteristics of the household respondents, including i) age, ii) level of education, iii) occupation, iv) monthly income, v) family size.

Age

Respondents aged 19 to 77 were divided into four groups: young adults (19-33 years), middle adults (34-48 years), late adults (49-63 years), and older adults (64-77 years). The highest proportions were 43.3% for young adults, 38.3% for middle adults, 16.67% for late adults, and 1.67% for older adults (**Table 4**).

Table 4. Distribution of respondents according to their age.

Category	Number of Respondents	Percentage	Mean	Standard Deviation	Observed Range
Young Adult (19-33)	26	43.3	37.49	11.8119	19-64
Middle Adult (34-48)	23	38.3			
Late Adult (49-63)	10	16.67			
Older Adult (64-77)	1	1.67			
Total	60	100.0			

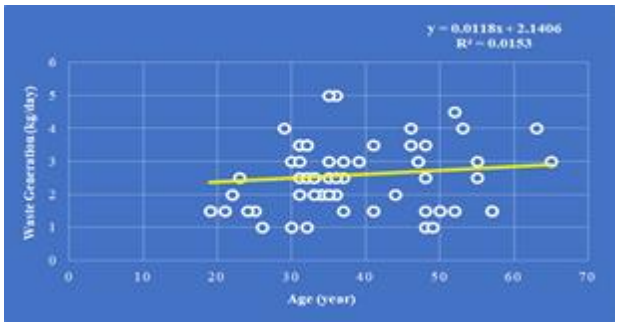

Fig. 9. The relationship between the age and per capita waste generation.

Pearson's coefficient revealed a weak correlation (r = 0.1238, P > 0.10) between waste generation and age. While older individuals may show a slight tendency to generate more waste, it's not a statistically significant relationship, as shown in **Fig. 9**.

Level of education

Respondents' educational levels ranged from 0 to 16, with a mean of 5.27 and a standard deviation of 5.38. They were categorized into four groups: illiterate (0), primary (1-5), secondary (6-10), and College/University (11-16). In the study, 36.67% of respondents were illiterate, 21.67% had primary education, 18.33% had secondary education, and 23.33% had above secondary education (**Table 5**).

Table 5. Distribution of respondents according to their level of education.

Category	Number of Respondents	Percentage	Mean	Standard Deviation	Observed Range
Illiterate (0)	22	36.67	5.27	5.38	0-16
Primary (1-5)	13	21.67			
Secondary (6-10)	11	18.33			
College/University (11-16)	14	23.33			
Total	60	100.0			

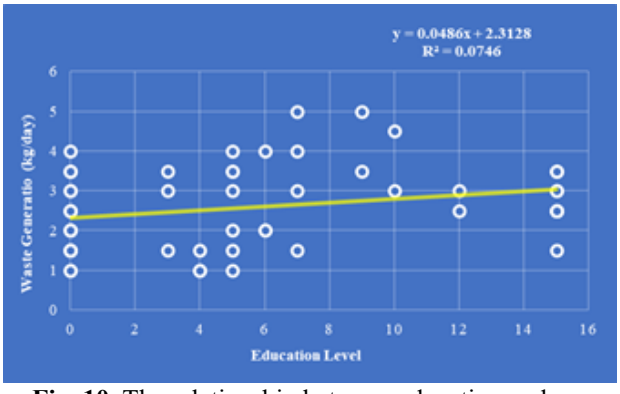

Fig. 10. The relationship between education and per capita waste generation.

Pearson's coefficient showed a moderate correlation (r = 0.2732, P < 0.05) between waste generation and education. This indicates that education level moderately explains variation in waste generation, with higher-educated individuals tending to produce more waste (**Fig. 10**), likely due to higher income and expenditure.

Occupation

Occupation, reflecting individuals' livelihood, spans roles like rickshaw puller, laborer, household activities, business, and service. Respondents were categorized on a scale of 1 to 5, with rickshaw pulling being predominant (30%), followed by service and housewives (13.33% each), laborers (26.67%), students (5%), and business professionals (8.33%) (**Table 6**).

Table 6. Distribution of respondents according to their occupation.

Category	Number of Respondents	Percentage	Mean	Standard Deviation	Observed Range
Rickshaw puller	18	30	2.8	1.79	1-5
Labour	16	26.67			
Housewife	9	13.33			
Student	3	5			
Business	5	8.33			
Service/Job	9	13.33			
Total	60	100.0			

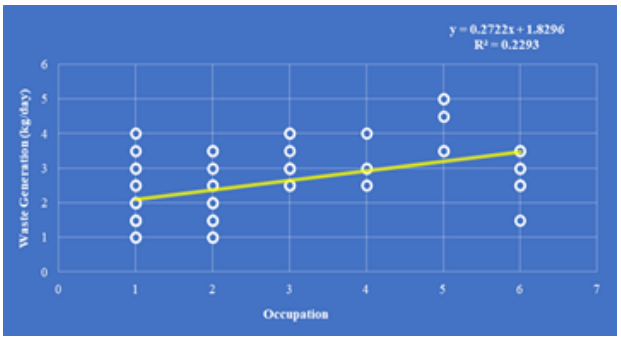

Fig. 11. The relationship between occupation and per capita waste generation

Pearson's coefficient revealed a moderate correlation (r = 0.4788, P < 0.001) between waste generation and occupation, suggesting occupation likely influences waste patterns (**Fig. 11**). Other factors such as income, household size, lifestyle choices, or industry practices may also contribute.

Monthly income

Respondents' incomes ranged from 7000 to 35000 Tk, with a mean of 17000.33 Tk and standard deviation of 7951.3030 Tk. They were categorized into low (7000-10000 Tk), middle (10001-20000 Tk), and high (20001-35000 Tk) income brackets. Sampling included 20 households from each income category, representing 33.33% of respondents from each (**Table 7**).

Table 7. Distribution of respondents according to their monthly income.

Category	Number of Respondents	Percentage	Mean	Standard deviation	Observed Range
Low income (7000-10000 Tk)	20	33.33	17000.33	7951.3030	7000-3500
Middle income (10001 -20000 Tk)	20	33.33			
High income (20001-35000 Tk)	20	33.33			
Total	60	100.0			

Fig. 12. The relationship between monthly income and per capita waste generation

Pearson's coefficient indicated a strong correlation (r = 0.6806, P < 0.01) between waste generation and income, with higher incomes correlating with higher waste generation (**Fig. 12**). This suggests a highly significant positive relationship between the two variables.

Family size

Respondents' family sizes ranged from 2 to 10, with a mean of 3.85 and a standard deviation of 1.363. They were categorized into small (2-4), medium (5-7), and large (8-10) families. The highest proportion (71.67%) had small families, 28.33% had medium families, and 0% had large families (**Table 8**). The average family size of 3.85 was lower than the national average of 4.26 (Bangladesh HIES: Average Household Size, 2024).

Table 8. Distribution of respondents according to their family size.

Category	Number of Respondents	Percentage	Mean	Standard deviation	Observed Ra
Small family (2-4)	43	71.67	3.85	1.363	2-10
Medium family (5-7)	17	28.33			
Large family (8-10)	0	0			
Total	60	100.0			

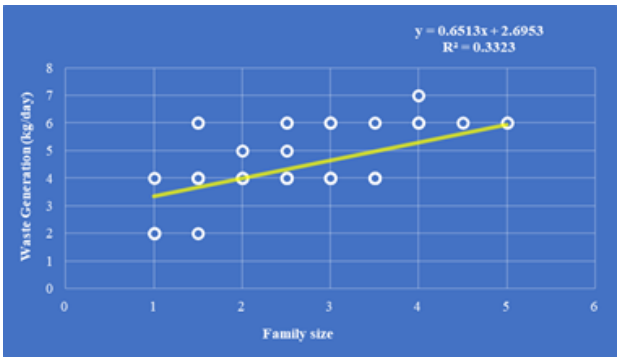

Fig. 13. The relationship between family size and per capita waste generation.

Pearson's coefficient showed a strong correlation ($r = 0.5764$, $P < 0.01$) between waste generation and family size, indicating that larger families tend to generate more waste on average (**Fig. 13**). This suggests a highly significant positive relationship between the two variables.

Conclusions

In conclusion, the study in Netrokona sadar municipality highlights key aspects of solid waste management, with an average daily waste generation of 0.28 kg per person, mainly comprised of organic materials. The demographic profile reflects diversity in education, occupation, and income levels. Positive correlations were observed between waste generation and household characteristics like income, family size, education, and occupation, while age showed no significant correlation. Challenges persist in waste disposal due to limited resources and manpower. Customized waste management strategies are recommended, including increasing dustbins, enhancing collection systems, conducting awareness campaigns, and enforcing regulations. Collaboration with stakeholders and allocating funds for infrastructure development are crucial for improved waste management and a healthier environment.

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