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THE PRACTICE AND CHALLENGES OF SOLID WASTE MANAGEMENT: A CASE STUDY ON KHULNA RAILWAY SLUM

Upama Shahani[1], Nur-E-Jannat-Pollen[2]

[1]Imperial College of Engineering-Rajshahi University affiliated, Khulna-9000, Bangladesh
[2]Khulna University of Engineering and Technology, Khulna-9203, Bangladesh

ABSTRACT

Solid waste has to be appropriately handled since it results from daily human activity. The Khulna Railway Slum served as the survey site. The research goal is to analyze the potential, difficulties and SWM strategies in slum areas. The survey was conducted into 35 slum houses. SPSS Version 27.0 used for analysis in February-July 2023. The increases rate of generation 13% where collection 8% recycling 2% into 6 years. 45% and 7% slum dwellers respectively used poly bag and container as disposal bin. According to the study, poor SWM due to its location, proximity to the rail line, inadequate storing path, openly burning garbage. Inadequate funding, equipment, inefficient people, lack of promotion for waste recycling, reuse of energy are identified as financial and social issues. The study concluded by making some suggestions like practicing door to door waste collection system, segregation, landfill, Biogas plant to power generation, organic waste as Bio-fertilizer for enhancing the strategy.
Key words: *solid waste management, organic-inorganic, sustainability, landfilling, slum dwellers*

INTRODUCTION

Solid waste includes materials discarded from industrial and household activities, such as byproducts from chemical plants, power plants, and animal or human activity. Solid Waste Management (SWM) refers to the systematic processes of collection, separation, storage, transport, treatment, and disposal of this waste (Halim, 2021).Trash generates increasing day by day with population growth. Bangladesh is a developing country in Asia continent. But waste management has gone out of control nowadays and highly cost. Khulna is the most popular city in Bangladesh and suffers this issues. The study and analytical research need to take challenge and the practice of solid waste management (SWM) in Khulna Railway slum area because it's affected by poor route planning, improper collection bin system, environment polluted by waste odor and insects mostly flies found everywhere in slum dwellers household area. By highlighting the value of responsible SWM, the thesis hopes to raise awareness of the possible advantages that may be attained through smart waste management techniques, thereby assisting in the development of a cleaner, healthier, and more sustainable future for metropolitan populations. The research goals is to identify the types of solid waste & to investigate the waste disposal practice and challenges on urban dwellers (SW) in Khulna Railway slum (21no ward) specifically 4no & 5no ghat slum zone of Khulna city corporation (KCC).After finishing the data analysis method it refers 2 type framework- bio gas plant & bio fertilizer, also recommends the proper practice & challenges of (SWM).

METHODOLOGY

Selection of site

Khulna is located 4km far from zero point of KCC. In Khulna City Corporation (KCC) area consists of total 31 wards. The densely populated area near the Bhairav River banks and the opposition of upper Jashore road and in vertically direction of Khalishpur and BIWTA ghat is known as Railway Slum. In 473 homes and among the 1980 inhabitants of Khulna city stay in slum. The specific working zone is 21 no ward, fig 1(a) of Khulna City Corporation (KCC). The fig 1(b) rffer specific operational zones within the Khulna Railway slum, notably Montu colony and Greenland bosti. These areas, situated in

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close proximity to the 4no and 5no ghat along the banks of the Bhairav river, represent the core fieldwork locations for this research.

(a) Study area of Khulna 21no ward (b) Specific zone of Khulna Railway slum

Figure 1 Selected area

Case study on Khulna railway slum

The study investigates waste generation, disposal challenges, and SWM practices in Khulna Railway Slum, highlighting the complex factors influencing waste management behaviors. It examines waste collection systems, cultural practices, and disposal services, revealing the role of NGOs and CBOs in addressing challenges and promoting sustainability. While acknowledging its localized scope, the study emphasizes the need for broader research. Despite its limitations, it offers valuable insights for informed decision-making, policy development, and strategies to improve waste management in informal urban settlements.

Sample size determination

There are 4556 people living in Khulna's Railway slum as a whole. The sample size (n) is calculated by this formula: $n = [z^2 * p * (1 - p) / e^2] / [1 + (z^2 * p * (1 - p) / (e^2 * N))]$. Where, z = 1.645 for a confidence level (α) = 90%, p = proportion (expressed as a decimal), N = population size, margin of error e =10%, z = 1.645, p = 0.85, N = 4556, e = 0.1, n =34.243 n ≈ 35. The sample size (with finite population correction) is equal to 35. Due to time and resource limitations, a sample of 35 households were chosen for the questionnaire survey.

Reconnaissance survey

Reconnaissance survey was mainly data gathering procedure which refers to the collection of primary data by questionnaire field survey. Data was gathered through direct observations in the particular ward- 21 no ward of the slum of Montu colony & Greenland bosti.

Table 1 Types of data collected from Khulna Railway slum

Types of data	
Types of waste generation.	Waste disposal time interval.
Types of waste collection bin / container.	Suffering of the people of Khulna railway slums.
Income level and occupation.	Impact of environmental pollution on slum dwellers.
Gender.	Slum dwellers' views on the waste disposal cost.
Age group.	Acceptance of slum dwellers towards landfilling.
Literacy rate of Khulna railway slum's people. Durability of slum dwellers in Railway slum.	Slum dwellers' views on past and present condition of Khulna Railway slum.
Waste disposal area of Khulna Railway slum.	Impact of environmental pollution on health and livelihood of slum dwellers.

Primary survey

In this research 35 questionnaires were made to collect initial data and total 35 households were participated of the Khulna Railway slum. The design of questionnaire, first part is participant's own bio-data second part is stakeholder's opinion about solid waste management system in their slum. Here attached some pictures of survey, data collection.

Figure 2 Pictures of survey & data collection.

RESULTS AND DISCUSSION

For this research study, application of SPSS version 27.0 was utilized as a powerful tool for analyzing the primary data. These tests included the normality, reliability & validity test, all of which performed a significant role in validating the questionnaire model. Demographic profile was made by analyzing primary data.

Table 2 Demographic profile, from primary data

Demographic Profile		Frequency	Percent	Valid Percent
Age	1-15	7	20.0	20.0
	16-25	8	22.9	22.9
	26-45	10	28.6	28.6
	46-65	6	17.1	17.1
	>65	4	11.4	11.4
	Total	35	100.0	100.0
Gender	Male	22	62.9	62.9
	Female	13	37.1	37.1
	Total	35	100.0	100.0
Occupation	Businessman	5	14.3	14.3
	Worker	9	25.7	25.7
	Housewives	12	34.3	34.3
	Farmer	2	5.7	5.7
	Street Hackwer	7	20.0	20.0
	Total	35	100.0	100.0

Demographic Profile		Frequency	Percent	Valid Percent
Suffering of the people of Khulna railway slums	Too much	27	77.1	77.1
	Medium	6	17.1	17.1
	Little	2	5.7	5.7
	Total	35	100.0	100.0
Slum dwellers' views on past and present condition of Khulna Railway slum	Better	2	5.7	5.7
	Little better	7	20.0	20.0
	No improvement	26	74.3	74.3
	Total	35	100.0	100.0
Impact of environmental pollution on health and livelihood of slum dwellers	Very high effective	29	82.9	82.9
	High effective	3	8.6	8.6
	Few effective	3	8.6	8.6
	Total	35	100.0	100.0
Impact of environmental pollution on slum dwellers	Tolerable	4	11.4	11.4
	Not tolerable	31	88.6	88.6
	Total	35	100.0	100.0

Demographic Profile		Frequency	Percent	Valid Percent
Acceptance of slum dwellers towards landfilling	Yes	19	54.3	54.3
	No	2	5.7	5.7
	Maybe	14	40.0	40.0
	Total	35	100.0	100.0
Waste disposal area of slum	Open space besides your home	8	22.9	22.9
	Beside road	6	17.1	17.1
	Pond/River side/Lake side	7	20.0	20.0
	Drain	11	31.4	31.4
	In a ground hole	3	8.6	8.6
	Total	35	100.0	100.0
Waste disposal time interval	One Time	20	57.1	57.1
	Two Time	11	31.4	31.4
	Three Time	4	11.4	11.4
	Total	35	100.0	100.0
Income level	0-5000	10	28.6	28.6
	5000-10000	15	42.9	42.9
	10000-15000	7	20.0	20.0
	15000-25000	3	8.6	8.6
	Total	35	100.0	100.0

Demographic Profile		Frequency	Percent	Valid Percent
Literacy rate	Never schooled	3	8.6	8.6
	Primary (0-5)	12	34.3	34.3
	High school (6-10)	8	22.9	22.9
	Vocational	7	20.0	20.0
	Under graduate	5	14.3	14.3
	Total	35	100.0	100.0
Durability of slum dwellers in Railway slum	=<1	3	8.6	8.6
	1-5	7	20.0	20.0
	10-15	12	34.3	34.3
	15-30	8	22.9	22.9
	=>30	5	14.3	14.3
	Total	35	100.0	100.0
Types of waste collection bin	Broken bucket	8	22.9	22.9
	Polythene bag	13	37.1	37.1
	Cardboard carton	7	20.0	20.0
	Tin/plastic container	5	14.3	14.3
	Others	2	5.7	5.7
	Total	35	100.0	100.0
Types of waste generation	Food waste	12	34.3	34.3
	Plastic bag/bottle	10	28.6	28.6
	Paper/cardboard	7	20.0	20.0
	Glass waste	6	17.1	17.1
	Total	35	100.0	100.0

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Normality, Reliability & Validity test

In table 3 this study, the main 3 dependent variables of interest were the type of waste generation, waste collection bins & acceptance of slum dwellers' towards landfilling. These 3 variables relies on z (-1.96 to 1.96) value (Hair *et al.,* 2010). The data is confirmed to be approximately normally distributed by examining the histogram curve in the figure 3.

This test, all of the variables of these 6 variables "Waste disposal area, disposal time interval, suffering of the people, impact of environmental pollution, impact on health, acceptance of slum dwellers of Khulna Railway slum", are considered reliable. The Cronbach's alpha (α) value ranging questionable (0.6 to 0.7) < acceptable (0.7 to 0.8) < good (0.8 to 0.9) < excellent (above 9) reliability was shown in table 4.

For a validation, applying a Principal component analysis (PCA) in extraction method with varimax rotation. In table 5 the result of KMO (Kaiser-Meyer-Olkin) & Bartlett's test was filled up criteria. KMO is .818(above .6 acceptable) & Bartlett's sphericity significance is (p<.0005) (Hair *et al.,* 2014).In table 6 the obtained 3 components/factors were accepted for valid

ation.In total of 35 variables, 18 variables were discarded from the analysis & divided into 3 main category or putting label name in accordance with the objectives of the study. In table 7, first 7 variables loadings factor "waste generation" and second 7 variables loading factor "afflicted by waste" and last 3 variables loading factor "SWM implementation through an analysis of the past and present situation".

Table 3: Normality test value of main variables, SPSS output

Variables Name	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Acceptance of slum dwellers towards landfilling	35	1	3	1.86	0.974	0.301	0.398	-1.955	0.778
Types of waste collection bin	35	1	4	2.23	1.003	0.438	0.398	-0.774	0.778
Types of waste generation	35	1	4	2.20	1.106	0.409	0.398	-1.157	0.778
Valid N (listwise)	35								

Table 4: Reliability test value of co-efficient alpha, SPSS output

Reliability Coefficients for Item	Cronbach's Alpha	Cronbach's Alpha Based on Standardized
6	0.719	0.729

No	Variables/Item Name	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1	Waste disposal area of Khulna Railway slum	8.7714	6.299	0.266	0.350	0.794
2	Waste disposal time interval of Railway slum dwellers	9.6571	5.938	0.612	0.606	0.625
3	Suffering of the people of Khulna railway slums	9.6286	6.829	0.639	0.783	0.637
4	Impact of environmental pollution on slum dwellers	10.4571	9.373	-0.054	0.088	0.763
5	Impact of environmental pollution on health	9.4857	6.375	0.770	0.631	0.599
6	Acceptance of slum dwellers towards landfilling	9.8571	6.420	0.628	0.819	0.629

Table 5: KMO & Bartlett's test value

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.818
Bartlett's Test of Sphericity	Approx. Chi-Square	890.959
	df	136
	Sig.	0.000

Table 6: Total variance explained % value, SPSS output.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.490	67.586	67.586	11.490	67.586	67.586	6.503	38.252	38.252
2	2.097	12.334	79.920	2.097	12.334	79.920	6.036	35.508	73.760
3	1.016	5.976	85.896	1.016	5.976	85.896	2.063	12.136	85.896
4	0.826	4.861	90.757						
5	0.501	2.949	93.706						

Extraction Method: Principal Component Analysis.

Table 7: Rotated Component Matrix[a], SPSS output

No	Variables Name	Component		
		1	2	3
1	Types of waste generation	0.912		
2	Types of waste collection bin	0.892		
3	Acceptance of slum dwellers towards landfilling	0.797		
4	Slum dwellers' views on the waste disposal cost	0.751		
5	Occupation	0.725		
6	Waste disposal area of slum	0.683		
7	Gender	0.647		
8	Impact of environmental pollution on health and livelihood of slum dwellers		0.961	
9	Suffering of the people of Khulna railway slums		0.933	
10	Income level		0.786	
11	Waste disposal time interval		0.756	
12	Age		0.709	
13	Literacy rate		0.696	
14	Longevity of slum		0.674	
15	Waste disposal cost			0.448
16	Slum dwellers' views on past and present condition of Khulna Railway slum			0.910
17	Impact of environmental pollution on slum dwellers			0.442

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]

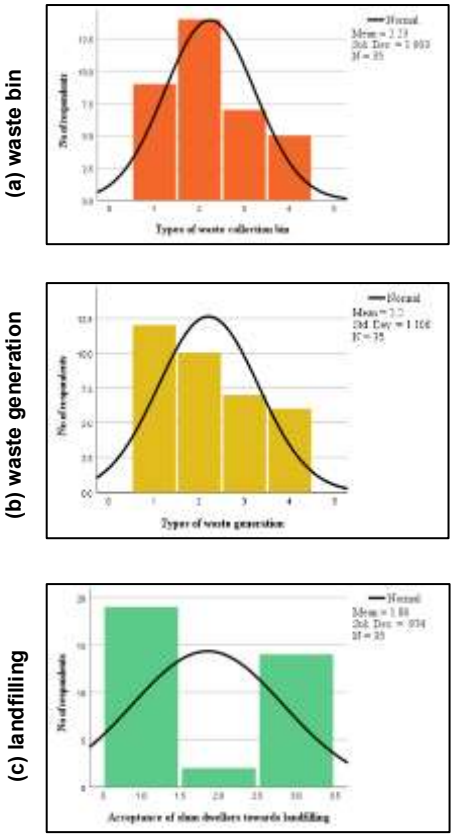
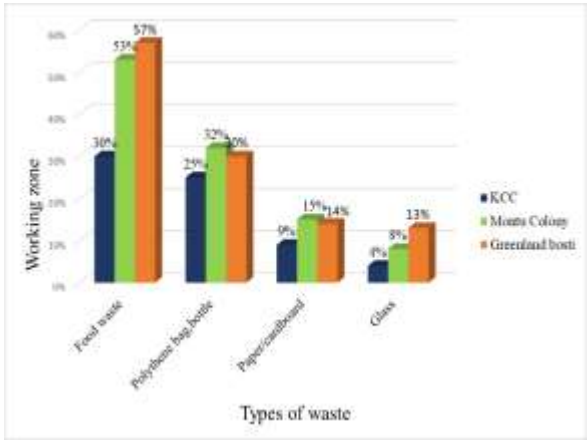


Fig 3: Histogram curve

Highest produces waste in different types, highly used waste disposal area & Comparing KCC with slum area for highly used bin & past and present practice of waste management

The fig 4 show the types of waste generation in slum area and identified waste. Becoming as city corporation area KCC produces less waste between Montu colony & Greenland bosti. Highest produces waste organic food waste. The fig 5 show the maximum slum dwellers uses polybag than KCC stakeholders because lacking of proper amount of disposal bin. The figure 6 find out the waste dispoal slum area. Most of slum dwellers throw away their waste into drain and roadside. The figure 7 illustrates the 6years waste management practices between KCC & slum. This data provides the weak and poor WM system in Khulna City Corporation vs slum area. So, Railway slum are lagging behind from the KCC due to lacking of KCC authority concern.



(a) Produces waste in different types

(b) Identified waste in slum area

Figure 4 Highest produces waste

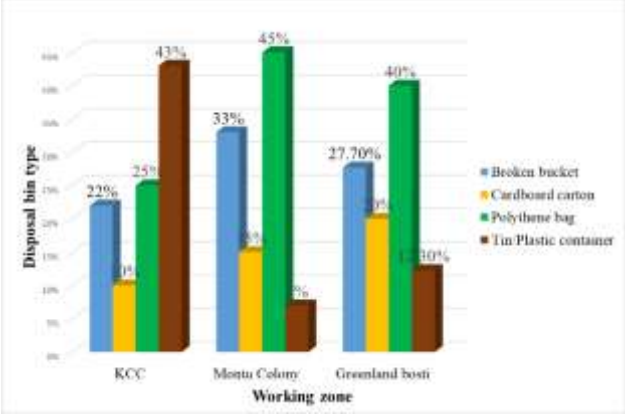


Figure 5 Highly used bin

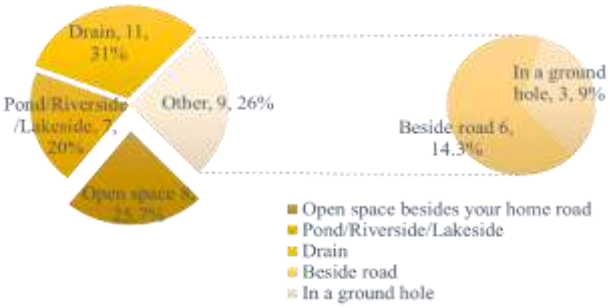
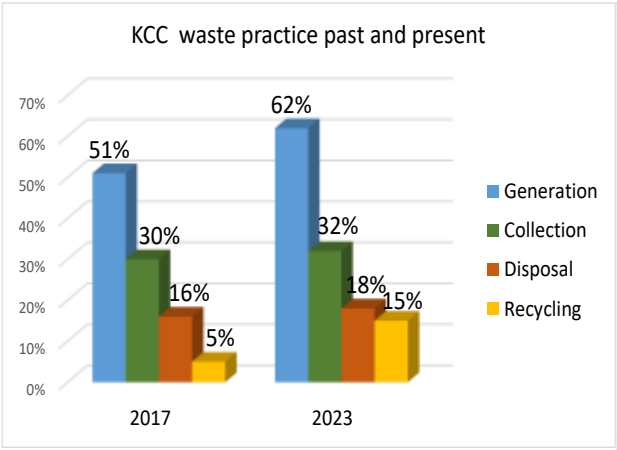
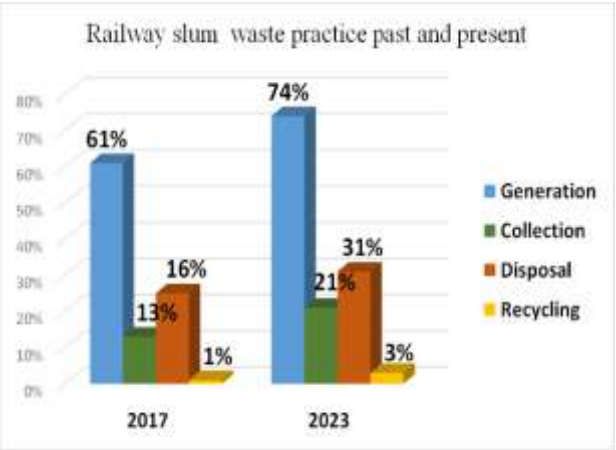


Figure 6 Highly used area



(a) KCC waste practice



(b) Khulna Railway slum waste practice

Figure 7 Past and present practice of waste management

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A framework for landfill gas to electric power generation by Bio gas plant and organic waste to Bio fertilizer or composting

Anaerobic digestion, widely used in countries like Australia and the US, is ideal for processing Khulna's 950 tons/day of high-moisture, low-energy waste. It uses sealed digesters to break down waste without oxygen, generating biogas for electricity. Although production costs are higher (Taka 8-9/unit vs. Taka 6.20) but it's lower cost than generator costing, it offers economical power during load-shedding, reduces waste, creates jobs opportunity & provides income for Khulna slum dwellers. The manufracturing process is shown by fig 8.
Composting is a sustainable way to manage organic waste in Khulna Railway slum. It converts kitchen scraps, vegetable remains, and dead leaves into nutrient-rich compost, reducing landfill waste and creating a cleaner, odor-free environment. This method promotes healthier living conditions and transforms waste into valuable soil conditioners. The framework is drawn by fig 9.

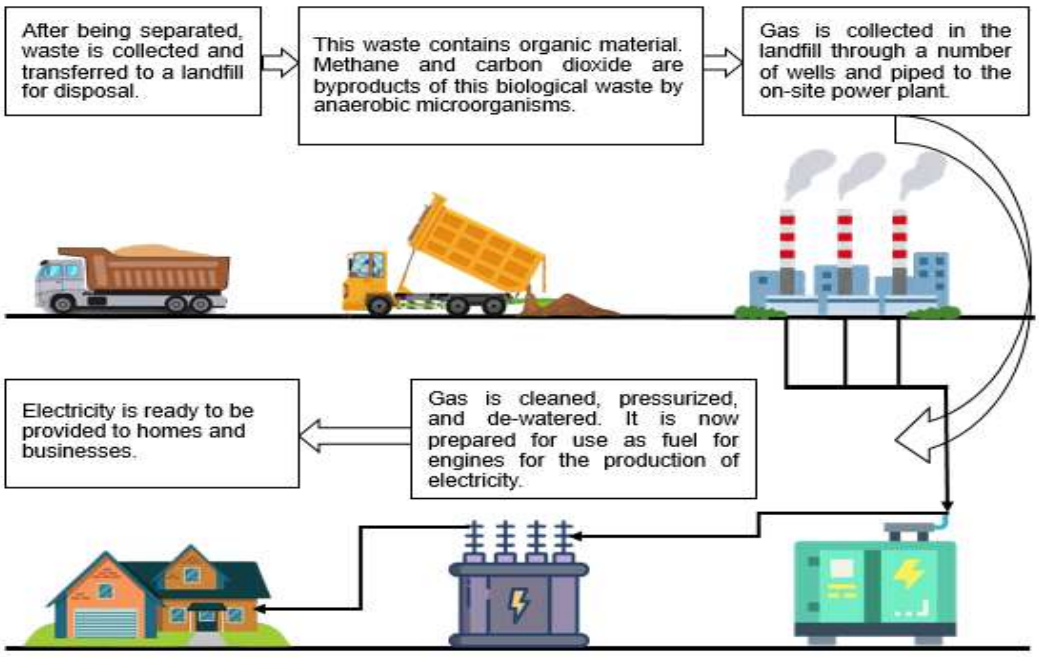

Figure 8 Bio gas plant

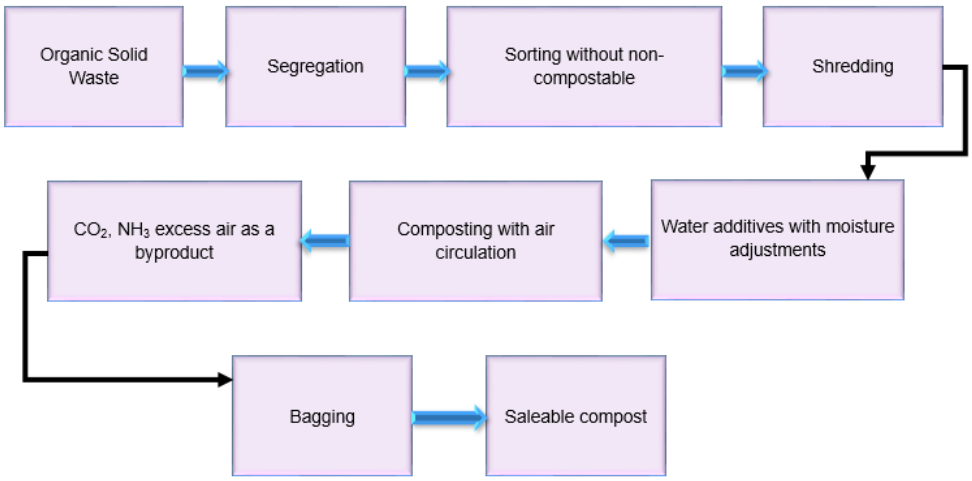

Figure 9 Bio fertilizer

The challenges of (SWM) in Khulna railway slum

Roads are narrow. Densely populated homes. Drains are about to get blocked. Drains overflowing with waste - plastic, polythene bag, packet, water bottle etc. Waste is left lying down and predators

dogs, birds, pigs, other animals, scatter the waste everywhere. Garbage is visible everywhere, scattered in small or large quantities. Frequently set on fire as a method of waste disposal. From open dumps, slow-burning fires emit dangerous smoke. Terrible smell comes from landfill site.

CONCLUSION & RECOMMENDATION

The study of SWM in Khulna Railway slum highlights key challenges, including cultural practices, inadequate municipal services, financial constraints, and limited disposal infrastructure. With a growing population, waste management poses a critical issue for Khulna City Corporation (KCC), requiring innovative solutions.

Anaerobic digestion offers a promising approach, converting biodegradable waste into bio-fertilizer, biogas, and electricity. This can address energy shortages, reduce environmental pollution, and save costs, benefiting not only the slum but the entire city. Collaborative efforts, targeted awareness campaigns, and advanced technologies are essential for creating sustainable waste management solutions and fostering a healthier living environment.

This research identified the types of solid waste (SW) generation from Khulna Railway slum of Khulna City Corporation (KCC) and majority of waste is organic waste.The study investigated the waste disposal practice and challenges on slum dwellers in Khulna Railway slum.

Timely door-to-door waste collection service**.** Availability of waste transportation service. Public awareness and motivation. NGO and CBO collaboration. Education and training practices. Offering incentive package for responsible worker.

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