SUSTAINABLE PRACTICES OF SOLID WASTE MANAGEMENT OF DHAKA NORTH CITY CORPORATION

K.Tabassum[1], F. Tabassum[2] and N. Majed*[3]

[1] *Student, Department of Civil Engineering, University of Asia Pacific, Bangladesh, e-mail: 19105015@uap-bd.edu*
[2] *Student, Department of Civil Engineering, University of Asia Pacific, Bangladesh, e-mail: 19105023@uap-bd.edu*
[3] *Professor, Department of Civil Engineering, University of Asia Pacific, Bangladesh, e-mail: nehreen-ce@uap-bd.edu, nehreen23@gmail.com*

***Corresponding Author**

ABSTRACT

The sustainable management of solid waste is an urgent global concern, particularly in rapidly urbanizing areas like Dhaka North City Corporation (DNCC). This investigation provides an overview of the sustainable practices employed in the solid waste management system of DNCC. Dhaka, the capital of Bangladesh, faces significant challenges related to waste management due to its dense population, limited resources, and inadequate infrastructure. The Dhaka North City Corporation plays a crucial role in addressing these challenges by implementing sustainable practices for solid waste management. This study attempted to highlight the key sustainable practices DNCC employs to manage solid waste effectively. The study assessed waste generation, management practices, and landfill impacts in DNCC, offering insights for zone-wise collection, evaluating leachate treatment, and subsequent impact on Turag River water quality. A questionnaire survey showed solid waste management perspectives in DNCC for households and workers, focusing on practices, waste traits, and health effects. Leachate samples from the Amin Bazar landfill were analyzed for contamination sources and pollution pathways. Zone-5 survey findings elucidated that DNCC collects 80% of waste using varied vehicles while 80% of household waste constitutes food, with plastic, paper, tin, glass, and fiber. Bin conditions were obtained as 40% good, 25% inadequate, 15% rotting, and 10% unsatisfactory, highlighting the need for enhanced maintenance and infrastructure for effective waste management. The comparative analysis of leachate treatment systems between Amin Bazar and Matuail landfill showed that the Amin Bazar system outperformed that of Matuail landfill, with discharged leachate containing COD, BOD_5, and TDS levels within DoE'2004 standards (85–142 mg/L, 12.52–17.1 mg/L, and 184.15–199.8 mg/L respectively). Notably, Amin Bazar treatment exhibited high removal rates for NH_4, NO_2-N, NO_3-N, BOD_5, COD, and TP (99.2%, 73.5%, 93.8%, 95.3%, 98.7%, and 93.2% respectively), effectively reducing contaminants. However, after treatment, the landfill's effluent disposal into Turag River adversely affected water quality, exceeding limits for Salinity (0.25–0.28 mg/L) and BOD_5 (19.96–18.28 mg/L) with low Dissolved Oxygen (DO) levels (2.29–2.37 mg/L), impacting aquatic lives and surrounding lands.

Keywords: *Solid waste management; leachate treatment; sustainable practice; Turag*

1. INTRODUCTION

Waste management has become a critical concern in Bangladesh, particularly in the sprawling metropolis of Dhaka. With a population exceeding 158 million and a density of 1,015 people per square kilometer, the country faces significant challenges in handling the escalating volume of solid waste generated by households and businesses (Rahman and Alam, 2020). The absence of robust policies, laws, strategies, management systems, and collaboration has resulted in the haphazard disposal of waste along roads and drains, posing severe health risks and deteriorating living conditions for millions (Rashid, 2019). In this context, a comprehensive investigation has been undertaken to shed light on the sustainable practices employed by Dhaka North City Corporation (DNCC) in managing solid waste. Kabir (2016) have looked into the Municipal Solid Waste Management System. The study explores waste generation and composition, collection and transportation, segregation, recycling, and disposal methods. The study shows that it is important to improve solid waste management practices to enhance the overall quality of life in Dhaka residential areas. This study aims to provide an overview of the current state of waste generation, characteristics, and management practices in the DNCC area and is driven to assess the prevailing situation of waste generation and management practices, offering valuable insights for informed decision-making on zone-wise waste collection and management strategies. The study extends its scrutiny to the leachate treatment system at the Engineered landfill in Amin Bazar beyond waste generation and management. By analyzing leachate's chemical and physical properties, the research contributes to a comprehensive understanding of the landfill's impact on the surrounding ecosystem (Parvin and Tareq, 2021). Simultaneously, it examines the water quality of the nearby Turag River, providing insights into the repercussions of waste disposal on aquatic ecosystems. To enhance the depth of inquiry, a questionnaire survey was conducted, capturing the perspectives of households and workers on waste management practices, waste characteristics, and associated health impacts. The findings from this survey, particularly in Zone 5, illuminate the methods employed by DNCC in collecting and managing solid waste, emphasizing the need for improved infrastructure and maintenance of public waste bins. The comparative analysis of leachate treatment systems at Amin Bazar and Matuail landfills forms a crucial component of the study, showcasing the efficiency of waste treatment processes. The results underscore the significance of effective leachate treatment in preserving the environment and minimizing pollution and the findings can help identify areas that require targeted interventions and strategies to improve waste management practices. Ultimately, the aim is to promote sustainable and effective waste management practices contributing to a cleaner and healthier environment in Zone 5 of the DNCC and provide a comprehensive assessment of landfill leachate pollution in Dhaka highlighting the levels of inorganic contamination and impact on surface water, groundwater and agriculture.

1.1 Objectives of the Study

• To evaluate the present state of waste generation, its characteristics, and its management practices in the DNCC area, which will also help in decision-making regarding zone-wise waste collection and management.
• To evaluate the leachate treatment system in the Amin Bazar Engineering landfill and the resulting water quality of the surrounding river.

2. METHODOLOGY

In this section, the Study delved into various aspects of our research such as the identification of research problems, the selection of appropriate approaches, methods for data collection, analysis techniques, and the justification for our methodological choices. This study was undertaken to view how solid waste is generated and transformed daily in DNCC. Also, depending on how leachate is treated and purified before discharging, it can harm surrounding landfills and streams. To achieve the research objectives, a combination of primary and secondary data has been collected through field visits, questionnaire surveys, published and unpublished sources, and laboratory analysis has been utilized to gather relevant information. Moreover, interviews were conducted with adult family

members as respondents and also incorporated participatory observation as a means to gather valuable insights. Samples have been collected from the Amin Bazar landfill treatment plant and its surrounding river. Then the collected sample was analysed in the laboratory to compare it with discharged leachate and surface water standards established by the Department of Environment in 2004 and The Environment Conversation Rules in 1997.

2.1 Flowchart of Strategy

The following diagram (Figure 1) shows the strategy of the study. An area was selected for this study. After that, a survey was conducted on households and workers in the DNCC area. Finally, samples were collected from the engineering landfill and its surrounding river, laboratory work was done after collecting samples.

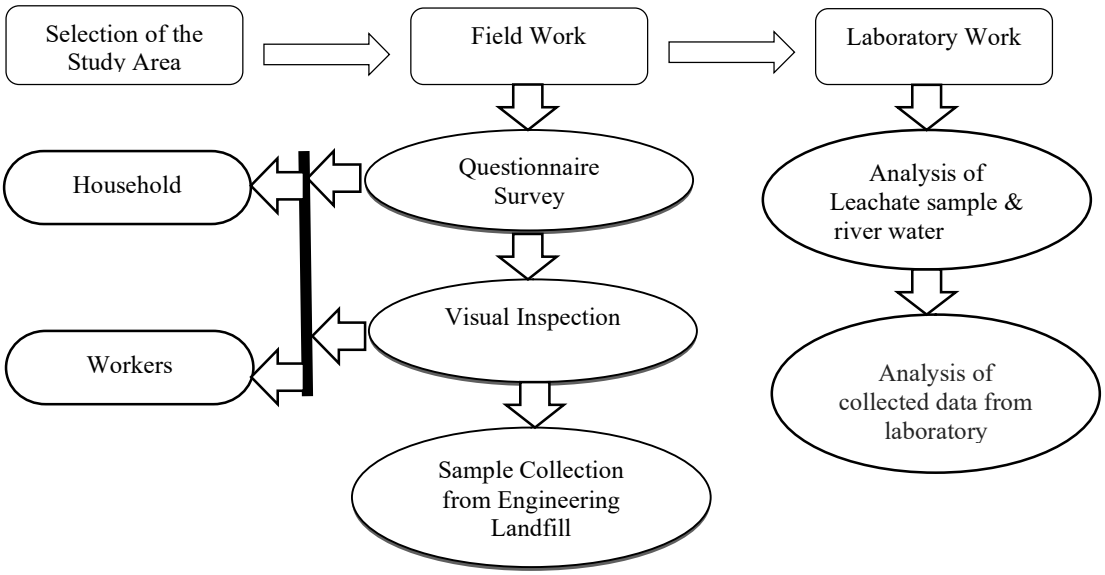

Figure 1: Flowchart of Study Strategy

2.2 Study Area

The Dhaka metropolitan area is the fourth most densely populated city in the world, with a population of 18.89 million. This study is conducted in the Dhaka North City Corporation (DNCC) area, with a total area of 18.802 sq. km (Parvin and Tareq, 2021). Wards 26, 27, 28, 29, 30, 31, 32, 33, and 34 are included in Zone 5, which is the focus of this study on waste generation, characteristics, and management practices. The geographical coordinates of Zone 5 lie between longitudes 90˚20' and 90˚28', and latitudes 23˚44' and 23˚54'. The reason for selecting this zone, it is one of the largest and busiest areas in Dhaka. Here, the maximum amount of waste is generated daily. Leachate samples were collected from the Amin Bazar Engineering landfill area, and surface water samples were collected from the Turag River, which is situated beside the Amin Bazar Engineering landfill. The area of the Amin Bazar landfill is 52 acres.

2.2.1 Field & Laboratory Work

This section includes a questionnaire survey, a visual inspection, samples collection from the Amin Bazar Engineering landfill, and analysis of the leachate and surface water samples (Parvin and Tareq, 2021; Urme et al., 2021).

Fieldwork for this study comprised a multifaceted approach, including a questionnaire survey, visual inspections, and sample collection from an engineering landfill. The questionnaire survey involved interviews in 32 households to assess waste management efficiency and environmental impacts, supplemented by site visits, key informant interviews, and secondary data collection from Zone 5. Interviews with local households covered a wide range of topics, from general information to waste collection systems and common diseases (Arena et al., 2021; Che et al., 2013). Local workers involved in waste collection and transfer were also interviewed to gather expert insights. Additionally, leachate and surface water samples were collected and analyzed for various parameters in a laboratory to assess water quality.

3. ANALYSIS & RESULT

3.1 Assessment of Solid Waste Management System

In Dhaka, like many other cities, regular collection schedules are functioning where waste management trucks or workers collect garbage from designated points or households. The DNCC is responsible for waste management in the northern part of Dhaka city (Zahur, 2007). The amount of waste generated is 300-350 tons/day, 9000-9300 ton/month & 10800-111600 ton/Year. DNCC has given the responsibility of collecting, transferring & final disposal of MSW to Cleantech Ltd. (a non-governmental company) (Ornob and Akter, 2020).

3.1.1 Knowledge of Solid Waste Management, Re-cycling, Disposal

Multiple questions were asked to household members about solid waste management, recycling, and Disposal. Questions were asked regarding their knowledge of solid waste management, recycling, disposal, sustainable practices of solid waste management, etc.

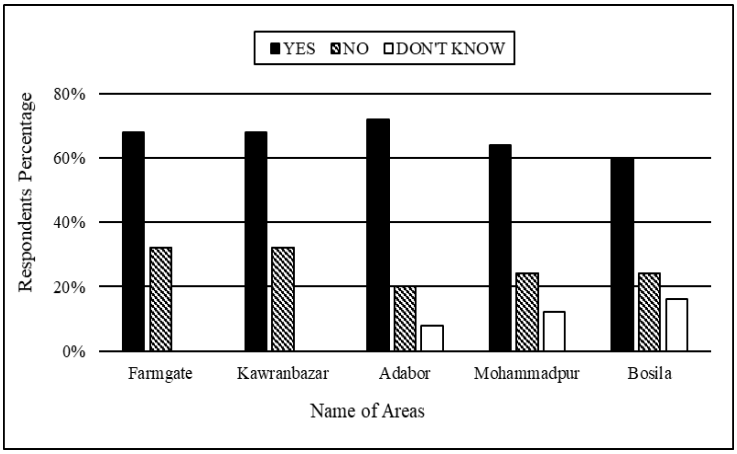

Figure 2: Questionnaire Survey on Solid Waste Management

Figure 2 shows the responses to queries on knowledge regarding solid waste management from Farmgate, Kawran Bazar, Adabor, Mohammadpur, and Bosila areas. From the graph, it can be seen that Adabor's people's knowledge of solid waste management is greater than that of other areas people. Adabor household people have 70% affirmative knowledge, which means they know more about solid waste management, recycling, disposal, and sustainable practices in the environment. On

the other side, it can be seen that Bosila household people have less knowledge and are less aware regarding waste management than in other areas, which is reflected in 60% affirmative knowledge according to the graph.

3.1.2 Types of Solid Waste Generated by Households

Multiple questions were asked to household members about which type of waste comes from their household the most. There were various types of options, which are food waste, plastic waste, paper, tin or can, glass, and fiber bags. The percentage of household waste as respondents' feedback is shown in Figure 3.

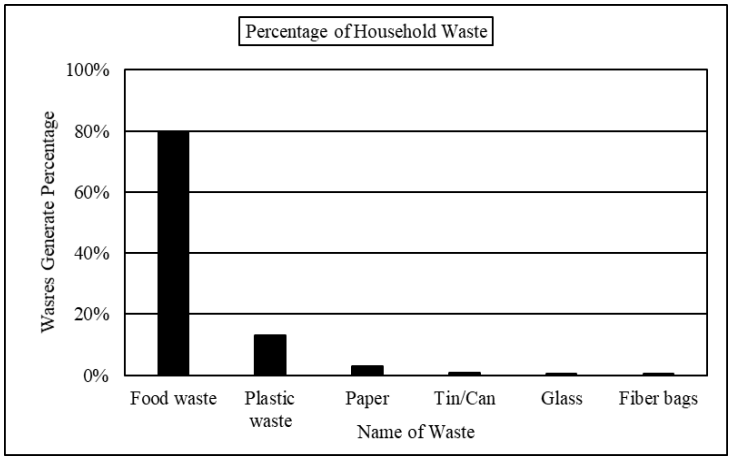

Figure 3: Percentage of Household Waste

Figure 3 shows that food waste is the most frequently generated waste from household waste, which is more than 80% based on the questions asked. Among the waste types, plastic comprises 13%, which comes out of household waste. Paper, tin or can, glass, and fiber bags are in very small amounts of household waste, which comprise 3%, 1%, 0.5%, and 0.5%, respectively. Here Food waste and plastic have serious environmental consequences. When food waste decomposes in landfills, it emits methane, a powerful greenhouse gas that contributes to climate change. Methane has a considerably larger potential for global warming than carbon dioxide. Also, Plastic waste is a major source of pollution, particularly in oceans and waterways. It causes harm to marine species by ingestion or entanglement.

3.1.3 Knowledge of Types of Containers

Respondent's opinion on which type of container they use to store household waste. A question was asked if they use an old bucket, wastebasket, plastic bags, cartons, tins, or cans to store household waste. Responses on the percentage of container usage are shown in Figure 4.

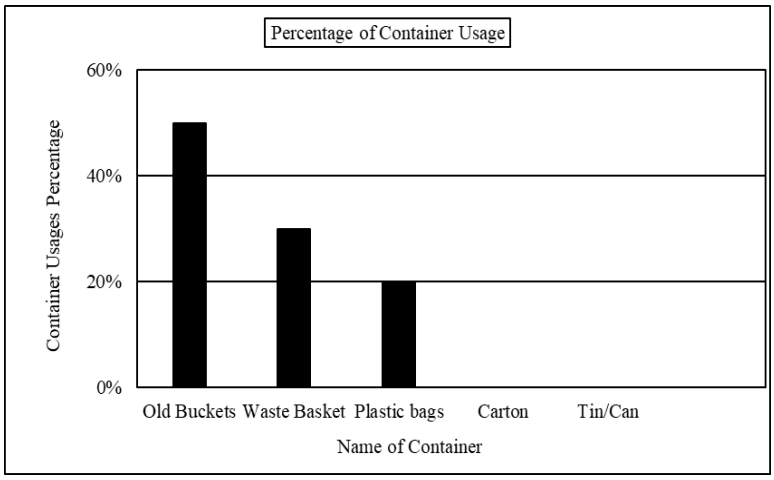

Figure 4: Percentage of Containers

From Figure 4, it can be seen that respondents use old buckets the most to collect waste in households, which is 50%. After that, they use a wastebasket to collect household waste, which is 30%. The percentage of plastic bags is 20%, according to the respondent's opinion. For household waste, they do not use cartons, tin, or cans at all, but after questioning people from the shops surrounding the area, it was learned that they use cartons, tin, or cans to use their shops' waste.

3.1.4 Knowledge of the State of Solid Waste Collection

The state of solid waste collection was based on inquiring for perceptions about how well waste is being collected from households every day. If workers come to collect the waste daily from their house, once a week, or twice a week, the state of solid waste collection is shown in Figure 5. It is evident that as much as more than 10% opined to either not having a satisfactory collection system or even not having a system at all while >40% opined to have a proper system with >25% mentioned to have a satisfactory collection system.

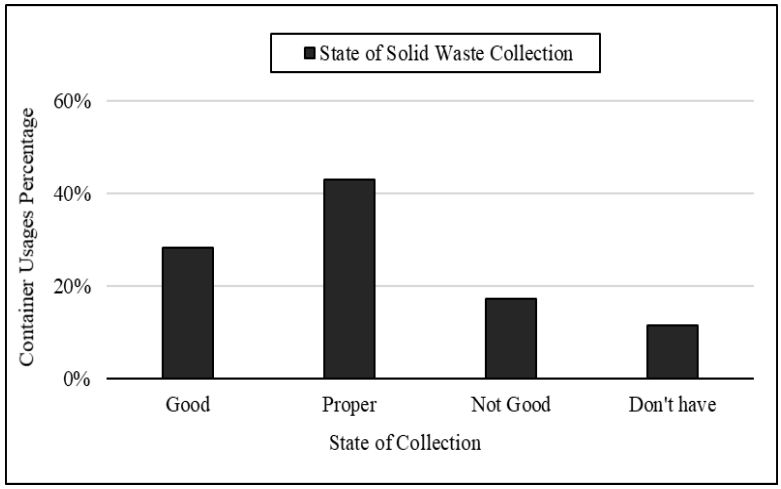

Figure 5: State of Solid Waste Collection

3.2 Assessment of Engineering Landfill

Assessing an engineering landfill typically involves evaluating various aspects related to its design, construction, operation, and monitoring. In Figure 6, the location of Amin Bazar Dumping Station is shown which has been prepared using ArcGIS.

Figure 6: Location of Amin Bazar Dumping Station Using ArcGIS

The Amin Bazar dumping site shown in Figure 6 near Dhaka has severely impacted the environment, contaminating air, water, and land. Although the Amin Bazar dump covers 52 acres, unchecked garbage disposal from the capital city has seriously harmed the two towns' air, water, and land. Trash disposal has led to pollution in nearby areas, with plastic debris and waste carried by rains, affecting local inhabitants. During dry seasons, leachate from the waste products further contaminates the soil, forcing farmers to abandon cultivable lands. The situation extends to neighbouring water bodies and streams, and the air is filled with the noxious odour of rotting waste.

3.3 Evaluation of Leachate and Surface Water Quality and Standardization

During the research, data was diligently collected on treated leachate at two different intervals. One of those collections took place during the monsoon season. Monsoon can bring about a shift in environmental conditions, which can subsequently affect the composition of leachate, such as the type of waste, its age, and the prevailing environmental conditions. During the monsoon season, there is typically an increase in rainfall, which can lead to higher moisture levels in the waste and an increased leachate generation rate. The analysis results of the treated leachate sample are shown in Table 1.

Table 1: Treated Leachate Sample Result

SL.	Parameters	Unit	Treated (Monsoon time)	Treated	ECR'97	DoE 2004
1	pH		8.2	8.99	6.5-8.5	6-9
2	DO	mg/L	7.39	7.65	6 or more	4.5-8
3	Eh	mV	41.35	124.5	-	-
4	Salinity	%	0.18	0.2	0	-
5	TDS	mg/L	184.15	199.8	1000	2100
6	NH_4		5.04	17.4	-	-
7	NO_2-N		2.53	0.369	Less than1	-

8	NO_3-N	8.3	6.7	10	-
9	COD	85	142	-	200(400)
10	BOD_5	12.54	17.1	6 or less	50
11	TP	0.5	10.8	6	-

ECR (1997) The Environment Conservation Rules. Government of the People's Republic of Bangladesh. Ministry of Environment and Forest

Leachate after being treated at the Amin Bazar dumping station gets discharged to the Turag River, which can be harmful for people surrounding that stream as they use water from the Turag River for agricultural works nearby. For this study, we collected the water samples shown in Table 2 from the Turag River to check to ensure that the water meets the necessary safety standards to protect public health.

Table 2: Turag River Water Sample Result

SL.	Parameters	Unit	Turag River near the dumping station	Turag River far dumping station	ECR* Standard 97
01	pH		7.1	7.03	6.5-8.5
02	DO	**mg/L**	**2.37**	**2.29**	6 or more
03	Eh	**mV**	30	27	-
04	Salinity	**%**	**0.28**	**0.25**	0
05	TDS	**mg/L**	278	253.5	1000
06	NH_4		11.77	8.96	-
07	NO_2-N		0.189	0.15	Less than 1
08	NO_3-N		4.5	4.2	10
09	COD		48	60	-
10	BOD_5		**15.96**	**18.24**	6 or less
11	TP		0.9	0.12	6

After testing the samples and comparing them, the results indicated that the effluent from the plant affects the aquatic life of the water body and can potentially damage the cultivable surrounding lands of the Turag River. It is important to ensure that the water contains the necessary safety standards to protect public health. The treatment process should effectively remove or reduce pollutant levels that are safe for human consumption. Water treatment, such as physical, chemical, and biological treatment techniques should be used to thoroughly treat the treated water. This could include advanced treatment techniques like activated carbon filtration or reverse osmosis as well as standard processes used like coagulation, flocculation, sedimentation, filtration, disinfection (such as chlorination or UV treatment), etc. These procedures are intended to get rid of or kill different types of contaminants and germs. But as Amin Bazar's leachate is already being treated like this before discharge, the water treatment plant should comply with local, national, or international water quality regulations and standards. Also, Regular monitoring and testing should be conducted to ensure that the treated water meets the required quality standards. This may involve regular sampling and

laboratory analysis to assess parameters such as pH, turbidity, residual disinfectant levels, microbial quality, and the presence of specific contaminants. It is crucial to inform the public about the source of their drinking water, the treatment processes involved, and the measures taken to ensure its safety. Transparent communication helps build trust and confidence among the affected communities.

3.4 Evaluation of Leachate Treatment Process in Amin Bazar Landfill

Leachate treatment is the process of treating and managing the liquid that forms when it passes through or comes into contact with waste materials, such as landfill sites, waste disposal facilities, or contaminated soil (Azim et al., 2011; Hossain et al., 2018). Leachate typically contains various pollutants and contaminants, including organic matter, heavy metals, ammonia, and other toxic substances. Results of the quality parameters of both raw and treated leachate from the Amin Bazar Landfill treatment system are shown in Table 3. Proper treatment is essential to prevent environmental pollution and protect human health.

Table 3: Sample Results of Raw, Aeration, Treated Leachate

SL.	Parameters	Unit	Raw Leachate	Aeration Leachate	Treated Leachate	DoE* Standard 2004
1	pH		8.3	6.75	8.2	6-9
2	DO	mg/L	.11	2.35	7.93	4.5-8
3	Eh	mV	406.05	47.7	41.35	-
4	Salinity	%	14.63	2.83	.18	-
5	TDS	mg/L	1168	278	184.15	2100
6	NH_4		642.08	67.29	5.04	-
7	NO_2-N		2.53	126.68	.67	-
8	NO_3-N		133	1496.5	8.3	-
9	COD		1790	330	85	200(400)
10	BOD_5		980.4	188.1	12.54	50
11	TP		7.3	23.5	.5	-

***Bangladesh's standard for discharging treated leached into inland surface water (DoE 2004)**

Table 3 presents the analysis data on leachate samples, including raw leachate, aeration, and treated leachate. Raw leachate's pH was 8.3, while aeration reduced it to 6.75 before the treatment process raised it to 8.2, falling slightly to 7.1-7.03 after discharge. Dissolved oxygen (DO) levels significantly improved during treatment, rising from 0.11 mg/L in raw leachate to 7.39 mg/L, but decreased slightly to 2.29 mg/L after discharge due to various factors like organic matter and temperature.

3.5 DNCC (Amin Bazar Landfill) and DSCC (Matuail Landfill) Comparison

Amin Bazar Landfill and Matuail Landfill in Dhaka, Bangladesh, are both major waste disposal sites but differ in environmental impact. Sample characterization and comparison of results indicate that the treatment performance at Amin Bazar landfill is more efficient and discharges less harmful leachate to the environment than that of Matuail Landfill as shown in Figure 7.

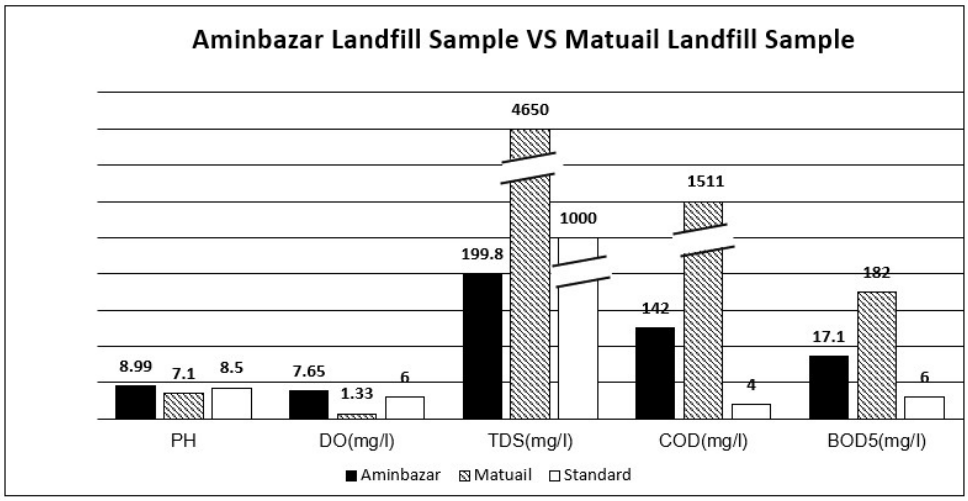

Figure 7: Comparison Between DNCC and DSCC Engineering Landfill Performance

Here, pH and COD both result in the standard range of DoE 2004. For the Amin Bazar landfill, treated leachate was in the range of DoE 2004 for DO, TDS, and BOD_5, which shows the treatment system in Amin Bazar is doing well compared to the Matuail landfill because, from the Matuail landfill result, DO was below 4.5-8 at an alarming rate. TDS is more than 2100 mg/l, and BOD_5 is more than 50 mg/l, according to the standard level. Though Amin Bazar landfill is doing well, it still needs to do better for a better environment because the effectiveness of leachate treatment can vary depending on various factors, such as the treatment methods employed, infrastructure, resources allocated, and regulatory compliance. It is essential to consider the specific treatment processes and technologies utilized at each landfill to assess their effectiveness accurately. Also, an effective leachate treatment system should aim to remove or reduce contaminants to levels that meet environmental standards before discharging or reusing the treated leachate (Alam, 2016; Kabir, 2015).

4. CONCLUSIONS

The study conducted a comprehensive analysis of waste management and leachate treatment systems in Dhaka North City Corporation (DNCC) also looking into the resulting impact on the surrounding environment, providing valuable insights for informed decision-making in the field of solid waste management. The research employed two key methodologies: a questionnaire survey and an examination of leachate treatment systems, offering a holistic perspective on waste management in the region.

The survey revealed several significant findings. It highlighted that in Zone 5, DNCC was collecting 80% of solid waste using operational vehicles, with different types of vehicles involved in waste collection. Various types of waste come out from households which can be categorized as biodegradable or non-biodegradable. Biodegradable waste includes food waste, fiber bags, and paper and non-biodegradable includes plastic, cans, and glass. Moreover, it was observed that food waste constituted the majority of household waste, exceeding 80%. Household containers were primarily old buckets. The condition of public waste bins was assessed, with 40% found to be in good condition, while 10% were in bad condition. Additionally, the study identified varying levels of knowledge about solid waste management among different areas, with Adabor residents exhibiting the highest level of awareness. The study also evaluated the effectiveness of the leachate treatment system, which demonstrated remarkable results. All parameters in the treated leachate were within the standard range of DoE'2004, indicating the successful removal of pollutants. The Amin Bazar landfill treatment plant achieved high removal rates for various contaminants, including ammonia, nitrite, nitrate, BOD5, COD, and TP. These results showcase the plant's contribution to environmental protection and waste management by significantly reducing harmful contaminants.

The examination of Turag River surface water revealed a concerning lack of dissolved oxygen (DO) and exceeded limits for salinity and BOD_5, damaging aquatic life and surrounding lands. Comparatively, the discharged leachate from Amin Bazar landfill demonstrated compliance with environmental standards, while Matuail landfill leachate exceeded the limits, emphasizing Amin Bazar's more efficient treatment processes. Nonetheless, the leachate treatment systems justified higher investments by effectively reducing the environmental impact of leachate discharge.

In conclusion, this study provided essential insights into waste management and leachate treatment systems in DNCC. The survey method enhanced our understanding of waste management practices and contamination sources, while the leachate treatment system demonstrated its efficiency in reducing pollutant levels. By integrating these approaches, policymakers can make informed decisions to improve waste management practices, protect the environment, and safeguard public health in the region.

REFERENCES

Alam, S. M. (2016). Strategic Institutional Capacity in Solid Waste Management: The Cases of Dhaka North and South City Corporations in Bangladesh.

Arena, M., Azzone, G., Grecchi, M., & Piantoni, G. (2021). How can the waste management sector contribute to overcoming barriers to the circular economy? *Sustainable Development*, *29*(6), 1062-1071.

Azim, M. D., Rahman, M. M., Khan, R. H., & Kamal, A. T. M. M. (2011). Characteristics of leachate generated at landfill sites and probable risks of surface and groundwater pollution in the surrounding areas: a case study of Matuail landfill site, Dhaka. *Journal of Bangladesh Academy of Sciences*, *35*(2), 153-160.

Chen, X., Geng, Y., & Fujita, T. (2010). An overview of municipal solid waste management in China. *Waste Management*, *30*(4), 716-724.

Hoornweg, D., & Bhada-Tata, P. (2012). What a waste: a global review of solid waste management.

Hossain, M. F., Jahan, E., Parveen, Z., Ahmed, S. M., & Uddin, M. J. (2018). Solid waste disposal and its impact on the surrounding environment of Matuail landfill site, Dhaka, Bangladesh.

Islam, F. S. (2016). Solid waste management system in Dhaka City of Bangladesh. *Journal of Modern Science and Technology*, *4*(1), 192-209.

Kabir, M. R. (2015). Municipal solid waste management system: a study on Dhaka north and South City corporations. *Bangladesh Inst. Plan*, *2075*, 9363.

Ornob, A., & Aktar, B. (2020). Solid Waste Management: A Study to Analyze the Current Waste Management Practices, Issues in Uttara, Dhaka City North. In *4th International Conference on Bangladesh Environment (ICBEN-4), Barishal, Bangladesh*.

Parvin, F., & Tareq, S. M. (2021). Impact of landfill leachate contamination on surface and groundwater of Bangladesh: a systematic review and possible public health risks assessment. Applied water science, 11(6), 100.

Rahman, M. S., & Alam, J. (2020). Solid waste management and incineration practice: a study of Bangladesh. International Journal of Nonferrous Metallurgy, 9(01), 1.

Rashid, M. H. O. Sustainable Municipal Solid Waste Management in Dhaka City: Challenges and Issues. *Journal of Bangladesh Institute of Planners ISSN*, 2075, 9363.

Urme, S. A., Radia, M. A., Alam, R., Chowdhury, M. U., Hasan, S., Ahmed, S., ... & Quayyum, Z. (2021). Dhaka landfill waste practices: addressing urban pollution and health hazards. *Buildings & cities*, *2*(1), 700.

Zahur, M. (2007). Solid waste management of Dhaka city: public-private community partnership.