Scientific Research Publishing

World Journal of Engineering and Technology, 2024, 12, 1-23
https://www.scirp.org/journal/wjet
ISSN Online: 2331-4249
ISSN Print: 2331-4222

Assessment of Municipal Solid Waste Management in the Farmgate Area of Dhaka North City Corporation

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How to cite this paper: Mirmotalebi, S., Rahman, S., Tithi, M.R. and Apu, I.K. (2024) Assessment of Municipal Solid Waste Management in the Farmgate Area of Dhaka North City Corporation. *World Journal of Engineering and Technology*, 12, 1-23.
https://doi.org/10.4236/wjet.2024.121001

Received: November 12, 2023
Accepted: December 25, 2023
Published: December 28, 2023

Abstract

This investigation is focused on conducting a thorough analysis of Municipal Solid Waste Management (MSWM). MSWM encompasses a range of interdisciplinary measures that govern the various stages involved in managing unwanted or non-utilizable solid materials, commonly known as rubbish, trash, junk, refuse, and garbage. These stages include generation, storage, collection, recycling, transportation, handling, disposal, and monitoring. The waste materials mentioned in this context exhibit a wide range of items, such as organic waste from food and vegetables, paper, plastic, polyethylene, iron, tin cans, deceased animals, byproducts from demolition activities, manure, and various other discarded materials. This study aims to provide insights into the possibilities of enhancing solid waste management in the Farmgate area of Dhaka North City Corporation (DNCC). To accomplish this objective, the research examines the conventional waste management methods employed in this area. It conducts extensive field surveys, collecting valuable data through interviews with local residents and key individuals involved in waste management, such as waste collectors, dealers, intermediate dealers, recyclers, and shopkeepers. The results indicate that significant amounts of distinct waste categories are produced daily. These include food and vegetable waste, which amount to 52.1 tons/day; polythene and plastic, which total 4.5 tons/day; metal and tin-can waste, which amounts to 1.4 tons/day; and paper waste, which totals 5.9 tons/day. This study highlights the significance of promoting environmental consciousness to effectively shape the attitudes of urban residents toward waste disposal and management. It emphasizes the need for collaboration between authorities and researchers to improve the current waste management system.

Keywords

Solid Waste Management, Dhaka North City Corporation, Sustainable Growth, Integrated Waste Management Practice, Waste Recycling

1. Introduction

Waste constitutes an inherent and unwelcome facet of human existence, and within the context of Dhaka city, Municipal Solid Waste Management (MSWM) emerges as a prominent environmental predicament [1] [2]. The escalation in demand, production, and consumption has led to a steady increase in the production of substantial quantities of solid waste, and for developing countries, such as Bangladesh, efficacious waste management remains a formidable challenge essential for the attainment of institutional sustainability [3] [4] [5]. Within Dhaka North City Corporation's 26th Ward, colloquially known as the Farmgate Area, an approximate population of 64,240 individuals from diverse backgrounds resides [6] [7]. Inhabitants generate a diverse array of waste, with notable contributions from food and vegetable waste, plastic, bottles, paper, iron, and tin cans [8] [9] [10]. Multiple waste management strategies have been proposed and scrutinized, with the current practice involving waste collection by DNCC and its disposal in inadequately managed sites, leading to adverse environmental consequences, including malodorous emissions, groundwater contamination from leachate, and surface water contamination through run-off [11]. In some cases, it results in slope failure in the locality [12] [13]. A substantial proportion of waste is haphazardly deposited in unplanned locations, compounding environmental hazards [14] [15] [16] [17] [18]. Unplanned deposition of waste deteriorates the top layer of soil and may result in earthquake induced liquefaction threat [19]-[24]. Food waste is predominantly landfilled, while limited composting efforts are undertaken by local authorities [25] [26] [27]. The private sector is engaged in recycling activities, which represent a crucial avenue for mitigating environmental risks [28] [29]. In contemporary times, harnessing energy recovery from solid waste management has emerged as an indispensable pursuit, underscoring the critical role of MSWM in preserving environmental hygiene and mandating its integration into comprehensive environmental planning [30] [31] [32].

Additionally, integrating a circular economy approach into solid waste management is essential for reducing environmental impact, conserving resources, and creating a more sustainable system [33] [34] [35]. The circular economy focuses on minimizing waste and maximizing the reuse, recycling, and repurposing of materials, thus aligning with sustainable waste management. Renewable energy in solid waste management systems can significantly enhance sustainability and mitigate the environmental impact of waste disposal [36] [37] [38] [39] [40]. For instance, installing solar panels on landfill sites, waste processing facilities, or other available areas to generate electricity from sunlight presents an effective means of utilizing solar energy to reduce the carbon footprint of the system [41] [42]. In pursuit of advancing the environmental sustainability of municipal solid waste management, process improvement strategies present a promising path forward [43] [44] [45]. The approach begins with collaborative efforts on reducing waste generation through source reduction and adopting sustainable materials, setting the foundation for a more structured eco-friendly waste management system [46]. By implementing process improvement methodologies, optimizing waste collection and resource utilization becomes a focal point, thus enhancing the overall operational efficiency of the system [47] [48]. Establishing strong collaborations between municipalities and stakeholders serves as a key catalyst for developing closed-loop systems that endorse material reuse and recycling, thereby contributing to reducing waste in landfills [49], [50]. The introduction of additive manufacturing further amplifies the system's capabilities, allowing for the on-site production of essential parts and tools, aligning with sustainable practices [51] [52] [53]. Furthermore, embracing human-robot collaboration within the waste management process offers a means to achieve efficient waste sorting and processing, reducing labor costs and elevating the recycling rate, reducing the overall environmental footprint [54] [55] [56] [57]. Finally, implementing extended producer responsibility (EPR) programs ensures accountability for waste generation, leading to collective efforts that solidify a more environmentally sustainable municipal solid waste management system [58] [59].

Some coastal communities in different regions grapple with the looming threat of displacement caused by rising sea levels; the resultant shifts in living conditions and practices may yield secondary consequences concerning air quality and hospital waste management [60] [61], highlighting the intricate web of interconnected environmental challenges [62] [63]. Notably, solid waste serves as a principal contributor to the formation of leachate, which, in turn, contaminates surface runoff and stormwater with both dissolved and suspended materials, inflicting substantial harm on infrastructure. The presence of chloride in water poses risks to aquatic life and corrodes construction materials, exceptionally mild steel reinforcing bars [64] [65]. Furthermore, the integrity of roadway infrastructure, encompassing both concrete and flexible pavement, is adversely affected by high mineral concentrations in surface runoff [66]. Recognizing the potential of solid waste as a valuable resource for energy conversion, researchers are increasingly driven by the imperative to mitigate the detrimental environmental impacts associated with fossil fuels and foster the development of environmentally sustainable renewable energy sources [67] [68].

Effective solid waste management is the linchpin for preserving the cleanliness and well-being of the local environment, particularly in the DNCC area [69], [70]. Accurate forecasting and the implementation of integrated waste management improvements take center stage as top priorities to ensure the proper handling of municipally generated waste [71] [72] [73] [74]. An example of a sustainable approach is the conversion of waste into biogas, which not only addresses waste issues but also contributes to local energy needs, making it an integral part of the solid waste management strategy [75]-[80]. Equally critical are wastewater and landfill leachate treatments to prevent contamination and safeguard the area's water resources and ecosystems [81] [82]. The recycling of cotton dust is a significant waste reduction component, promoting responsible resource utilization in alignment with overall solid waste management goals [68] [83] [84]. Simultaneously, the quality of water in slum areas and roadside restaurant establishments directly affects the health and well-being of the local population [85] [86] [87]. Implementing green manufacturing, such as using waste materials in concrete production, enhances sustainability, reflects a commitment to responsible waste management, and supports environmental stewardship in the region [67]. Research on household water treatment (including filtration, chlorination, UV disinfection, and coagulation) is in line with larger initiatives to address environmental concerns as they work to promote environmental consciousness and sustainable practices [88] [89] [90]. The aims of this study encompass the following objectives: to ascertain the daily aggregate of waste production across various categories within this region; to quantify the composition and current disposal & management practices; and to formulate a comprehensive and precise solution for effectively managing the solid waste generated in this locality.

2. Methodology

2.1. Study Area

Dhaka is the world's most densely populated city and ranks among the world's most populous urban centers. The population density within DNCC for the 2021-2022 period was estimated at approximately 52,920 residents per square kilometer. Several wards exhibit significantly higher population densities than the overall DNCC average. Ward-36, situated in the Noyatola area of Mogbazar, claims the highest population density at 110,863 individuals per square kilometer, while Ward-19 records the lowest population density at 22,300 persons per square kilometer. Furthermore, the top ten most densely populated wards within DNCC include Wards 3, 5, 11, 13, 14 in the Mirpur area, Wards 30 and 31 in the Mohammadpur area, Ward 25 in Nakhal Para, and Ward 22 in the Rampura Area.

This research was conducted within Ward no. 26, situated in the Farmgate area (coordinates: 23.7561˚N, 90.3872˚E). **Figure 1** and **Figure 2** displays the DNCC and study area map. Notably, this ward boasts a population density of 42,200 individuals per square kilometer, rendering it one of Dhaka city's most bustling and densely populated regions. The Farmgate area has a population density of 36,500 people per sq. Km with a area of 1.76 sq·Km. Farmgate has ascended to significant commercial prominence and emerged as a pivotal transportation hub, facilitating access to all corners of the city and the entire country.

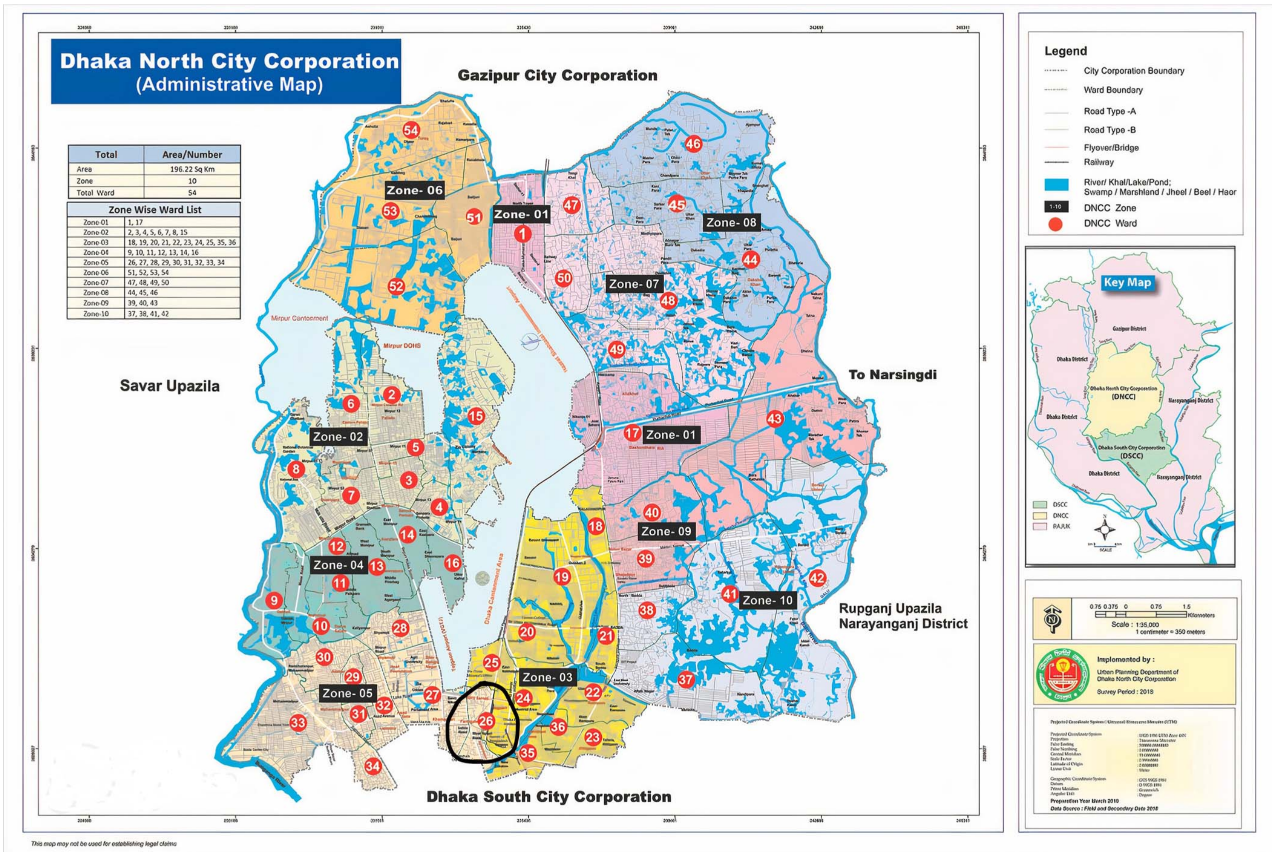

Figure 1. DNCC administrative map (source: DNCC).

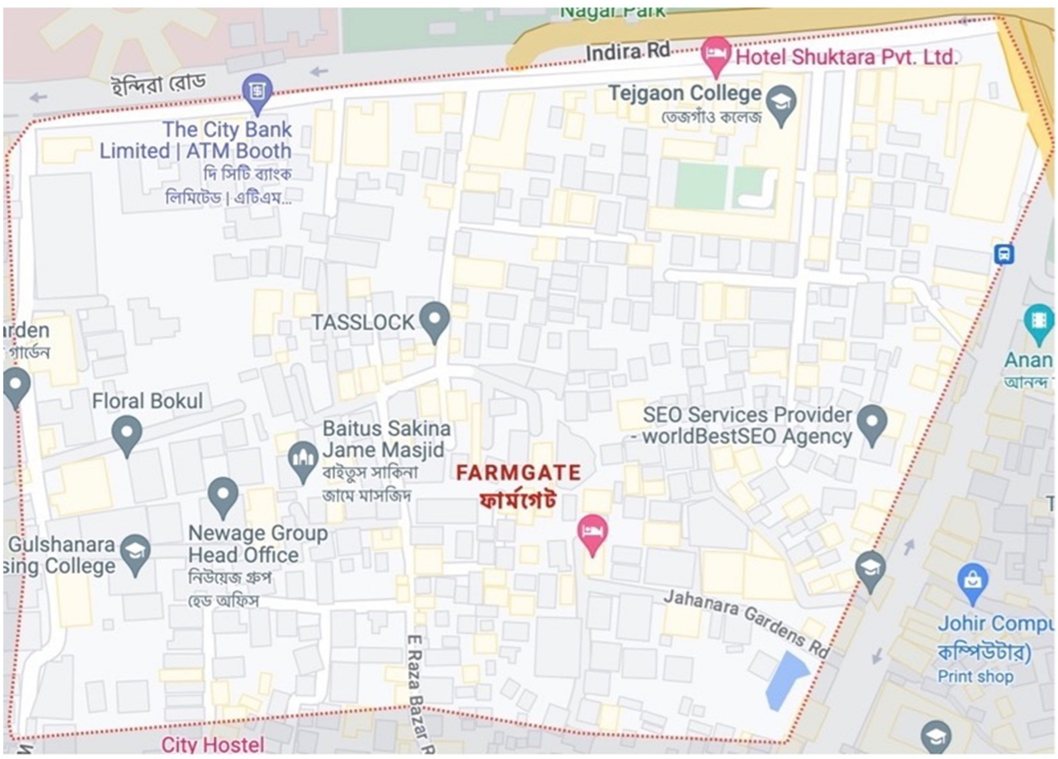

Figure 2. Study area map (source: Google map).

Over the years, this area has witnessed a notable surge (approximately 24%) in waste generation, aligning with population growth. The waste collected from Farmgate finds its way to the Boliarpur landfill in Savar. The DNCC has mostly been dealing with MSW, but other types of waste like medical, electronic, industrial, and construction waste also come up in this area. All of these types of waste are harmful to the environment and people's health, so they need to be thrown away in an eco-friendly way. However, DNCC lacks the organizational capacity to enforce regulatory oversight over these diverse waste categories. Furthermore, the regulatory framework often falls short of addressing the unique challenges posed by each waste category. It's worth noting that the per capita waste collection per day for 2020-2021 and 2021-2022 stood at 0.391 kg and 0.523 kg, respectively, within the context of DNCC, where "waste" encompasses all discarded materials transported to the landfill. A significant development in waste management for this area has been the construction of 52 secondary transfer stations (STS), alleviating the presence of numerous waste containers and open dumping sites on the streets, a relief greatly appreciated by the local residents.

2.2. Data Collection

Primary data were collected through a random sampling method to investigate the SWM practices within the Farmgate area, engaging a diverse range of respondents. The primary data acquisition involved administering questionnaires to individuals from different social categories, including day laborers, rickshaws and van pullers, businesspersons, students, employees, and homemakers. This comprehensive approach allowed for a direct field assessment of the prevailing solid waste management conditions. Personal visits and observations of the waste collection processes and chosen dumping sites also helped gather primary data. To incorporate expert insights, key informant interviews were conducted with various stakeholders possessing expertise in and affiliations with solid waste management practices in the city. The DNCC also provided secondary data on population numbers, the amount of waste being made, and the activities already happening in the Farmgate area to deal with solid waste.

2.3. Data Collection Approaches

This study encompasses the utilization of both primary and secondary data sources. The research was conducted over a span extending from April 15, 2021, to October 30, 2022. Its primary emphasis rested on appraising the current state of solid waste management practices, specifically within the Farmgate area under the DNCC jurisdiction. The data collection process encompassed a comprehensive examination of the designated region's solid waste collection, transportation, storage, and disposal systems. The findings of this investigation have pinpointed deficiencies within the waste management system, offering valuable insights into areas requiring improvement and informing the future management strategies to be pursued by the governing authorities. During this research, 314 respondents were selected across different strata for the questionnaire survey, facilitating a multifaceted analysis of solid waste management practices within the area. Within the cohort of 314 respondents, totaling 100 were drawn from DNCC officials and workers. At the same time, the remaining participants were sourced from households and individuals working in various industries, ensuring a diverse and representative sample for a comprehensive assessment of solid waste management practices.

2.4. Types of Respondents

The sample size for this survey was determined using Solvin's formula, considering the maximum degree of variability and a confidence level of 92%, resulting in a total sample size of 214 respondents. The characteristics of the respondents were as follows: a) Sex: Among the participants, 83 were male, and 131 were female. b) Education: The education level of the respondents was distributed as follows—postgraduate 24, graduate 36, HSC 31, SSC 56, secondary 24, primary 21, and 22 were illiterate. c) Age: Respondents were categorized into different age groups—1.5% were teenagers, 7.1% were adults, 49.2% were middle-aged, and 42.2% were senior citizens. d) Profession: The professions re-presented among the respondents included 98 housewives, 11 day laborers, 5 shopkeepers, 53 service holders, 30 in business, 11 students, and 6 retired individuals. e) Family Income: The family income of the respondents was divided into three categories—35.4% had low income, 48.6% had medium income, and 16% had high income. In addition to the questionnaire survey, a physical composition survey was conducted to determine the composition of the generated waste.

3. Results and Discussions

3.1. Solid Waste Generation

The data presented in **Table 1** illustrates the solid waste generation in the Farmgate area, which falls under the jurisdiction of the DNCC, over the period from 2007 to 2022. Upon careful analysis of the table, it becomes evident that the solid waste generation rates in both the residential and commercial sectors exhibited a steady and consistent growth of approximately 10% annually between the years 2007 and 2017. A significant transition took place between 2018 and 2022, during which the generation rates in these two sectors underwent a notable increase, with annual growth ranging from 24% to 28%. The significant change observed can be ascribed to the simultaneous influences of rapid population growth and the expansion of commercial activities in the area.

On the other hand, there was consistent stability observed in the generation of solid waste within the industrial sector, exhibiting a gradual annual growth rate of approximately 12% over the entire duration spanning from 2007 to 2022. In the interim, the waste generation rate in hospitals and clinics exhibited an initial incremental growth of 11% between 2007 and 2016, followed by a more moderate increase of 18% from 2017 to 2022. These figures indicate a notable change in the trajectory of waste production within this particular waste classification.

Table 1. Waste generation rate in different sectors from 2007 to 2022 at Farmgate area.

Year	Residential (Tons/Day)	Commercial (Tons/Day)	Industrial (Tons/Day)	Hospital & Clinical (Tons/Day)
2007-2008	13.2	6.6	7.2	1.6
2009-2010	15.1	7.2	8.2	1.9
2011-2012	16.6	8.4	9.3	2.1
2013-2014	18.4	9.2	10.6	2.4
2015-2016	20.3	10.1	12.09	2.7
2017-2018	22.9	11.2	13.8	3.3
2019-2020	25.5	12.6	15.6	4.1
2021-2022	33.6	15.8	17.8	4.9

Figure 3 presents a graphical depiction of the quantity of solid waste generated in kilograms per capita per day (kg/capita/day) in the Farmgate region during the period of 2021-2022. The estimated population of this region is approximately 64,240 individuals. It is worth mentioning that the rates of waste generation per capita are as follows: 0.523 kg/capita/day for the residential sector, 0.246 kg/capita/day for the commercial sector, 0.277 kg/capita/day for the industrial sector, and 0.076 kg/capita/day for the hospital and clinical sectors. The data reveals that the residential sector contributes approximately 50% of the overall waste generation in the Farmgate region.

3.2. Physical Composition of Solid Waste

Figure 4 provides a comprehensive overview of the physical composition of the generated and collected solid waste in the Farmgate area. Notably, the preeminent component of this solid waste stream is food and vegetable waste, constituting a substantial 72.3%. This predominance is attributed to the rising number of households in the area and the significant population of industrial workers whose daily sustenance generates a considerable volume of food and vegetable waste. The second most prominent component is paper and paper products, contributing to 8.2% of the waste stream. The presence of five paper industries, two large-scale, and three smaller enterprises, significantly contributes to this waste category. Furthermore, paper's wide utility across households and various establishments plays a crucial role in elevating its share in the waste composition. Polythene and plastic materials account for 6.3% of the waste stream, with their widespread use across industries, local shops, and households for daily purposes. Textile materials & wood, and rubber & leathers comprise 3.3% and 2.5% of the waste composition, respectively. The dust, ash, and mud category represents the smallest share, comprising just 0.97% of the generated waste in this area.

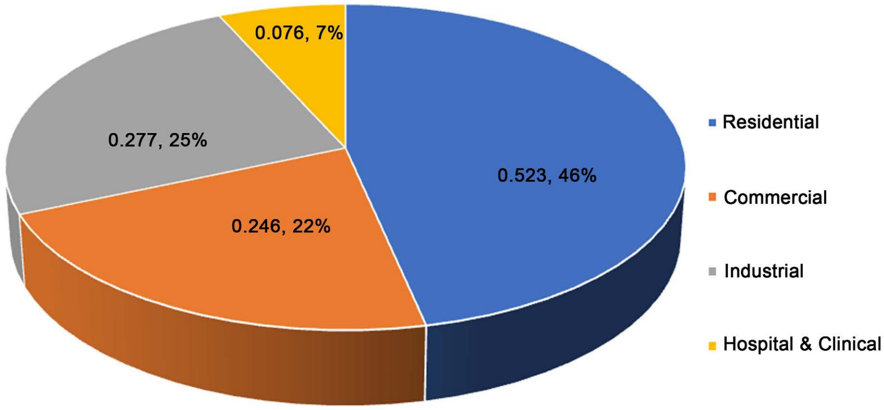

Figure 3. Daily per capita waste generation in different sectors of the Farmgate area.

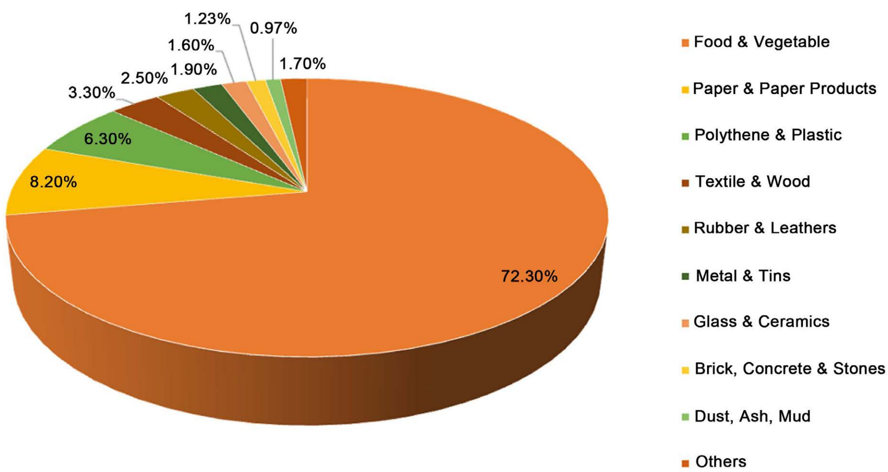

Figure 4. Graphical representation of the solid waste composition at Farmgate area.

3.3. Solid Waste Storing Receptacles in Farmgate Area

3.3.1. Basket, Bin, and Plastic Bucket in Primary Household

Baskets are commonly positioned in room corners, kitchens, or at the main entrance of a dwelling, serving as primary containers for waste storage or disposal. They are typically of a manageable size, facilitating manual handling. Many of these baskets feature vented walls that allow the passage of air and gases, rendering them suitable for solid waste containment. However, they are not well-suited for liquid waste or sharp waste items such as broken glass. In numerous households, bins and plastic buckets are favored for the storage of both dry and liquid waste, with a specific emphasis on the containment of kitchen, vegetable, and food waste. Some households employ plastic sacks or bags within the baskets, not for hermetic waste containment but rather to protect the basket from contact with the waste. Plastic bags are sometimes employed as an alternative when baskets or bins are not available. **Figure 5** offers an illustration of various primary waste storage receptacles in use.

3.3.2. Secondary Transfer Station (STS)

DNCC has recently introduced secondary transfer stations (STS), strategically

Figure 5. Different waste storage receptacles in primary households in the Farmgate area.

positioned throughout the city. These STS serve as intermediate facilities where waste is temporarily stored before its final disposal in the landfill. DNCC has established a network of 52 STS, each situated in one of the 36 wards. Ward 26 hosts one such STS, dedicated to storing waste from the Farmgate area before its ultimate disposal. Before STS was implemented, waste collection involved containers placed alongside the roads, with garbage collectors depositing waste there. This system resulted in unsightly and unhygienic conditions marked by filth, odors, and unpleasant stenches. The STS facilities, on the other hand, are enclosed areas with robust structures featuring thick tin sheets for roofs and walls. They are equipped with an effective ventilation system, allowing for the free circulation of air and light. Dedicated laborers and cleaners maintain the STS, ensuring it is clean and undergo regular cleaning procedures. DNCC has plans to construct 2 - 4 STSs in each of the 36 wards. Figure 6 provides a visual representation of an STS established by DNCC in the Farmgate area. In the primary waste collection areas, the Primary Waste Collection Service Provider (PWCSP), an NGO, coordinates the collection process, collecting waste from households and transporting it to the STS. In the years 2021-2022, the PWCSP registered a total of 440 private operators for waste collection. Additionally, unregistered operators are involved in collecting waste from households for the STS.

3.4. Solid Waste Transportation System

The transportation of solid waste from the Farmgate area to the STS and subsequently to the landfill employs a variety of vehicles. These vehicles include garbage vans and waste collection trucks (open trucks, dump trucks, compactor trucks, and container trucks). Figure 7 visually represents the diverse solid waste transportation system implemented by DNCC in the Farmgate area.

Garbage vans are conventional, manually driven vehicles that play a pivotal role in waste transportation [91]. They serve as the second medium for waste transportation, with the first being the waste collector, who personally conveys waste buckets from households to the van. Once the waste collector loads the van, it is driven to the nearest STS where it is unloaded. DNCC operates a fleet of 42 open trucks for waste transportation, with 34 of them having a 3-ton

Figure 6. STS in ward 26 (Farmgate area) of DNCC.

Figure 7. Different types of the waste transportation system in the Farmgate area implemented by DNCC.

capacity and 8 equipped with a 5-ton capacity. On average, all these trucks complete two trips per day. Within the Farmgate area, a 3-ton and a 5-ton open truck are utilized to transfer waste. DNCC operates a fleet of 34 dump trucks, with the majority having a capacity of 3 tons. Within the Farmgate area, two dump trucks with a 3-ton capacity are currently operating for waste transportation. There are also 25 compactor trucks in operation at DNCC, with 20 having a 5-ton capacity and 5 having a 2-ton capacity. In the Farmgate area, one 5-ton capacity compactor truck is actively used for waste transportation. DNCC also employs 31 container carriers that are operated by diesel. Of these, 2 have a 3-ton capacity, 22 have a 5-ton capacity, and 7 have a 7-ton capacity. Additionally, DNCC also operates 14 container carriers powered by compact natural gas (CNG), with 3 having a 3-ton capacity and 11 having a 5-ton capacity. Currently, two diesel-driven and two CNG-driven container carriers with a 5-ton capacity are operating.

3.5. Solid Waste Disposal

3.5.1. Landfill Operation

The landfill in Boliarpur, Savar, commonly called the "backyard" of DNCC, plays a pivotal role in waste management. This landfill, established on a 52-acre plot of land by Dhaka City Corporation (DCC) in 2005, is critical for waste disposal, serving as the primary destination for waste from the Farmgate area and other regions. Given the current trajectory of waste generation, it is projected that DNCC will need to manage approximately 6 million tons of waste in the next five years. In the face of this mounting challenge, acquiring land on the outskirts of DNCC for waste disposal is anticipated to become exceedingly difficult. In such a critical scenario, incineration is a potentially viable solution for reducing waste volume. Incineration can reduce waste volume by 80% - 90% [92]. Furthermore, using resulting ash in the cement industry can further decrease waste volume by 90% - 95%, offering a sustainable approach to waste management. **Figure 8** provides visual depictions of the Boliarpur landfill.

3.5.2. Landfill Operation Cost

Table 2 outlines the cost associated with the operation of the Boliarpur landfill as of the year 2021-2022. Notably, the fuel cost for the landfill equipment is the most substantial expenditure for the DNCC in running the landfill. An increase in fuel costs may lead to a two- to three-fold rise in landfill operation expenses within the next five years. Additionally, infrastructure costs represent another significant outlay associated with the landfill's operation.

3.6. Environmental Impact of Illegal/Improper Dumping

While the DNCC plays a crucial role in waste management within the Farmgate area to uphold environmental standards, the issue of illegal dumping has emerged as a significant concern. In defiance of proper waste disposal practices, individuals engage in the unauthorized dumping of household and other waste in open spaces, along roadsides, and within drainage systems. This illicit activity has severe environmental and health consequences for the residents of the Farmgate area, posing a pressing challenge to maintaining a clean and safe environment. **Figure 9** visually depicts instances of illegal waste dumping along roadsides and within drainage systems in the Farmgate area, illustrating the gravity of the issue.

Air and Water Pollution

The improper disposal of waste in open areas, gives rise to major environmental issues, primarily air and water pollution. These problems manifest because of various factors. The decomposition of waste materials during dumping generates

Figure 8. Dumped waste for disposal in the Boliapur landfill by DNCC.

Table 2. Boliapur landfill operation cost by DNCC.

Item of Expenditure	Million Bangladeshi Taka (BDT)
Fuel cost for landfill equipment	65 M
Equipment depreciation cost	14 M
Outsourcing and infrastructure cost	41 M
Staff salary	22 M
Miscellaneous	15 M
Total	157 M
Waste Handled	913,394
Landfill operation cost per ton	172

Figure 9. Illegal dumping of the waste; (a) open spaces; (b) roadside.

foul odors and emissions of volatile organic compounds, leading to air pollution [93]. Additionally, burning waste in open spaces further exacerbates air pollution, particularly during the summer when combustible and flammable gases are produced from the biodegradation of organic waste. Notably, carbon dioxide and methane emissions, both byproducts of solid waste, pose significant harm to the environment [94]. Illegal dumping or improper use of various industrial wastes, such as Styrene Butadiene Styrene (SBS) [95], Ground Granulated Blast-furnace Slag (GGBS) [96], and food waste like crash bone [97], and several other compounds, have the potential to contaminate air or groundwater. Furthermore, the contamination of surface water is a direct consequence of improper solid waste dumping in open areas, ultimately resulting in water quality degradation within the affected region.

3.7. Present Recycling Scenario

Waste recycling practices in the Farmgate area encompass two key stages. Firstly, residents, including housewives, servants, and maidservants, engage in separating valuable items like old newspapers, used writing paper, empty bottles, and containers, which are subsequently sold to street hawkers. This recycling activity is common in households with low to average incomes. Furthermore, items such as used clothing, shoes, and old utensils are exchanged for new crockery. The second stage of recycling is undertaken by a group known as "Tokai," which primarily consists of children from slum dwellers. They engage in sorting and collecting waste with lower market value, including broken glass, cans, paper, cardboard, plastic, rubber, rags, and metal, from street-sweeping accumulation points and open dumps to earn a modest income.

A questionnaire survey revealed the presence of approximately 52 recycling shops in the Farmgate area (the recycling shop numbers were found through the questionnaire survey), with roughly 490 individuals involved in recycling activities. Despite generating an estimated 10 - 12 tons of recycled solid waste daily in this area, the DNCC manages only about 4.8 tons of recycled waste. The impediments to recycling lie in improper management and a lack of awareness among laborers. Approximately 75 private shops in the area purchase recyclable waste from street hawkers (Tokai), including materials like polythene, metal, tin, and plastic. A limited number of individuals earn money by selling these recyclable materials. Notably, no biogas plants are identified in the study area or the landfill area for the utilization of putrescible organic waste.

4. Conclusions and Recommendations

In conclusion, the waste management landscape in the Farmgate area, under the aegis of the DNCC, presents a multifaceted challenge with both commendable efforts and notable shortcomings. The Farmgate area exhibits a solid commitment to waste separation and recycling, with residents actively engaging in practices that salvage valuable items and reduce the overall waste stream. The involvement of children known as "Tokai" in the collection of lower-value waste underscores the community's commitment to waste reduction and resource recovery. DNCC plays a pivotal role in waste management within the area, with secondary transfer stations and a dedicated fleet of vehicles for waste transport to the Boliarpur landfill. However, the increasing operational cost, particularly fuel expenses, poses a significant financial challenge that may escalate over time. Illegal waste dumping in open spaces, along roadsides, and drainage systems remains a grave concern, leading to air and water pollution, detrimentally impacting the environment and public health. Recycling practices are evident in the Farmgate area, with a substantial number of recycling shops and individuals engaged in recycling activities. Nonetheless, a gap exists between the volume of recyclable waste generated and what DNCC effectively manages, primarily due to challenges in recycling management and a lack of awareness among laborers. As waste generation continues to rise and land for dumping becomes scarce, the discussion presents incineration as a promising waste reduction method. Incineration, capable of reducing waste volume by 80% - 90%, offers a viable solution to address the mounting waste issue while minimizing the burden on landfills. In summary, the Farmgate area faces commendable efforts and considerable challenges in waste management. The engagement of the community in recycling practices, the presence of secondary transfer stations, and the prospect of waste-to-energy solutions demonstrate a proactive approach by DNCC. However, the detrimental effects of illegal dumping, rising operational costs, and better recycling management underscore the urgency of holistically addressing waste management to safeguard the environment and public health.

To address the ongoing issues with SWM in this area, several measures can be considered: 1) Expand the door-to-door waste collection services across the entire Farmgate area to ensure comprehensive coverage. 2) Increase the number of dustbins and initiate timely repairs and maintenance for concrete dustbins to improve waste disposal infrastructure. 3) Implement a systematic approach to street sweeping, ensuring that waste is promptly transported for final disposal, maintaining cleanliness. 4) Install odor-reduction systems, such as covered doors, for cylindrical plastic dustbins on streets to mitigate unpleasant odors. 5) Collaborate with non-governmental organizations (NGOs) to actively engage in SWM practices, encouraging community participation. 6) Launch comprehensive public awareness campaigns to educate residents about responsible waste management and its environmental significance. 7) Provide financial support to local bodies to strengthen their capacity to manage waste effectively. 8) Ensure the separate collection, transportation, and careful disposal of hazardous waste to mitigate potential risks. 9) Promote awareness initiatives aimed at reducing solid waste generation among the population. 10) Educate the public about the potential for resource recovery from solid waste, encouraging recycling and sustainable practices.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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