Volume 10, Issue 7, July – 2025 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

Urban Waste Challenges and SDG Compliance: Evaluating Municipal Solid Waste Management in CBC Karachi

Syed Majid Ali Zaidi[1]; Sobia Sultan[2]

[1;2]NED University of Engineering and Technology, Karachi

Publication Date: 2025/07/23

Abstract: This study assesses the performance and sustainability of municipal solid waste collection in the Clifton Cantonment Board (CBC), Karachi, Pakistan, across residential, commercial, and industrial phases. Five research objectives guided the inquiry: (RO1) evaluate current collection methods—frequency, coverage, efficiency; (RO2) assess adequacy of service delivery; (RO3) identify drivers of inefficiency; (RO4) examine operational and policy challenges and discretionary improvement options; and (RO5) evaluate alignment with sustainability goals and related training needs. A mixed-methods approach combined service log review, fleet and equipment audits, key-informant interviews with CBC officials and contractors, GIS-supported coverage mapping, and resident surveys. Findings show highly uneven spatial and temporal coverage: densely populated residential sectors experience irregular or missed pickups, while some commercial/industrial generators receive scheduled service. Operational constraints—including an aging, poorly maintained and undersized vehicle fleet, manpower shortages, access difficulties in narrow streets, and weak route planning—undermine intended collection frequencies. Limited source segregation, low public awareness, and contamination of waste streams further reduce efficiency and recycling potential. Institutional gaps—fragmented planning, inadequate data systems, weak regulatory enforcement, and constrained financing—impede performance and hinder progress toward circular and climate-aligned waste strategies. Targeted interventions are recommended: phased fleet renewal and right-sizing of collection equipment; digital route tracking and complaint reporting; community segregation and composting campaigns supported by incentives; structured staff training in modern handling, safety, and data reporting; strengthened bylaws with enforcement mechanisms; and a dedicated waste management fund to co-finance infrastructure and public-private partnerships. Improving these dimensions can reduce service inequities, divert recoverable materials, and better align CBC waste management with local sustainability objectives.

Keywords: *Municipal Solid Waste; Clifton Cantonment Board; Service Coverage; Collection Efficiency; Source Segregation; Sustainability; Karachi.*

How to Cite: Syed Majid Ali Zaidi; Sobia Sultan (2025) Urban Waste Challenges and SDG Compliance: Evaluating Municipal Solid Waste Management in CBC Karachi. *International Journal of Innovative Science and Research Technology*, 10(7), 1732-1744. https://doi.org/10.38124/ijisrt/25jul923

I. INTRODUCTION

The densely populated region of Clifton Board Cantonment (CBC), Karachi, Pakistan about planning for a sustainable environment. As a result of increased population and growth in urban areas, there has been enhanced coming up with better waste collection, disposal, and management methods. However, there are some problems with using the current waste management mechanism in CBC such as; there is no proper infrastructure to collect and transport wastes, there is no appropriate way to define the routes for the collection of wastes, there are few empty management and segregation of wastes, and there is no much awareness about recycling or reusing wastes. These are not only nuisances and triggers of unhygienic environment and production of environmentally sensitive structures but also have numerous negative impacts on the physical environment. (Ahmed et al.,2024)

The CBC area is considered a populated area and includes residential as well as commercial locations. The population density in such a region is high, it also generates large wastes which include domestic, retail, industrial, and hospital wastes. The current waste management system needs to be capable of meeting the demand for waste services to the people while at the same time being environmentally friendly. However, the current system looks overburdened and can result in missed waste collections, bins being overfilled, and poor disposal of waste. These issues point to the need to assess the current mechanism of addressing waste management.

Notably, unlike other aspects of CBC's operations, waste management lacks adequate infrastructure, has no

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

systematic waste separation at source and insufficient recycling projects. Improper waste disposal can also mean that the recyclable material will end up in a landfill due to a scarcity of useful resources and the deterioration of the natural environment. In addition, its disposal in wrong ways leads to pollution of the ground and water sources which is a health danger to the inhabitants and a menace to the environment. In this regard, the reasons that led to the stated deficiencies in the existing waste management system need to be identified, as well as possible measures to enhance the effectiveness of waste collection, separation, and disposal (Korai et al.,2024).

The objective of this study is to analyze the efficiencies of the waste collection and management system in the CBC area considering the main deficiencies and propose upgrades for the mechanism. It main areas of emphasis include streamlining of waste collection; improvement of waste disposal procedures and; encouraging waste sorting, recycling and reusing by households and commercial entities. An important characteristic of proper waste management is waste sorting; this is because it makes sorting of waste materials that can be recycled or further processed through composting easier. However, waste segregation as a mechanism is not well practiced in CBC hence contributing to the worsening situation of the waste disposal system despite the known advantages.

From the perspective of the method used in the research, this study employs both qualitative appreciation and quantitative techniques in the overall assessment of waste management in CBC. Anonymous questionnaires addressing workers of waste collection companies, and commercial establishments will be used to evaluate people's satisfaction with the existing system; semi-structured surveys with CBC officials and environmental experts will give more detailed information on workflow problems. Also, field studies will be carried out to measure waste collection, disposal, and recycling (Korai et al.,2024).

As this study seeks to establish gaps that can be enhanced to offer recommendations for appropriate waste collection routes, source segregation, and other related recycling activities in the CBC area. The final vision is to establish a better waste management process that will be more organized, and friendly to the environment as well as cater to the rising population of the world protecting the environment locally and globally.

➢ *Problem Statement*

The solid waste management of Clifton Board Cantonment (CBC) area has been under immense pressure due to its population rise, increased waste production in the area, outdated facilities, inefficient collection routes, and unproper waste sorting & recycling (Ahmed et al.,2024). This has made waste collection and disposal to be ineffective, bins to overflow, collection to be delayed, and disposal methods to be wrong. The nonchalant attitude to segregation and recycling in the public domain adds onto the problem, leading to compounding of resource depletions equally accompanied by undue landfilling. In the current system, requirements of sustainable waste management are not being adequately met, so that recyclable and non-recyclable wastes are mixed up, recycling is made difficult, and the environment is harmed. Collection issues such as routes and timings have proven to be a major problem leading to unhygienic practices and over dependence on litter bins or dumpsites. Consequently, it becomes important to assess and properly evaluate the current waste collection and management system to reveal its problems and options.

➢ *Objectives*

- RO 1: To evaluate the current methods used for waste collection in the Clifton Board Cantonment including frequency, coverage, and efficiency.
- RO 2: To evaluate the adequacy of waste collection in the CBC area.
- RO 3: To analyze the factors contributing to the inefficiency of the waste collection process in the CBC area.
- RO 4: To examine the challenges and discretionary functions to enhance sustainable waste management within the CBC area.
- RO 5: To evaluate the alignment of waste management practices with sustainability goals across different phases within the CBC area and need of training.

II. METHODOLOGY

This study evaluates the waste collection and management system in Clifton Cantonment Board (CBC), Karachi, focusing on inefficiencies and sustainable solutions such as segregation, recycling, and reuse. The overall aim is to improve waste management practices and promote awareness and training aligned with Sustainable Development Goals (SDGs).

A mixed-methods design was adopted, combining quantitative surveys and qualitative interviews with CBC officials, waste management workers, and community representatives. Surveys assessed operational efficiency, adequacy of resources, governance issues, and alignment with sustainability objectives. Interviews and focus groups provided context on policy gaps, coordination challenges, and improvement opportunities.

Data collection included structured surveys with CBC staff and observations of waste collection points, vehicle conditions, and route planning. Observations captured practical challenges like irregular pickups, inadequate bins, and evidence of poor segregation.

Sampling employed purposive methods targeting CBC Waste Management officials, Sindh Solid Waste Management Board representatives, collection workers, and environmental activists. A total of 45 surveys were conducted to ensure depth and representativeness.

Data analysis used descriptive statistics (percentages, frequencies, charts) to summarize findings. Responses from non-operational stakeholders were excluded to maintain

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

focus on operational realities. The analysis assessed CBC's alignment with SDGs, particularly goals on sustainable cities (SDG 11), responsible consumption (SDG 12), and climate action (SDG 13).

➢ *Demographic Analysis*

- *Sector-Wise Participants Distribution*

In figure 1 chart displays the number of participants from various areas within the Cantonment Board Clifton (CBC) sectors. It highlights the representation of each sector in the study. As total sample size was 45. Clifton Block 8 & 9 had the highest number of participants, with 7 respondents, indicating significant input from this area. This was followed by Phase 6 and Phase 7, which also showed relatively high participation. Other areas, such as Phase 4 and Phase 7 Extension, had lower participation levels, indicating a disparity in representation across sectors.

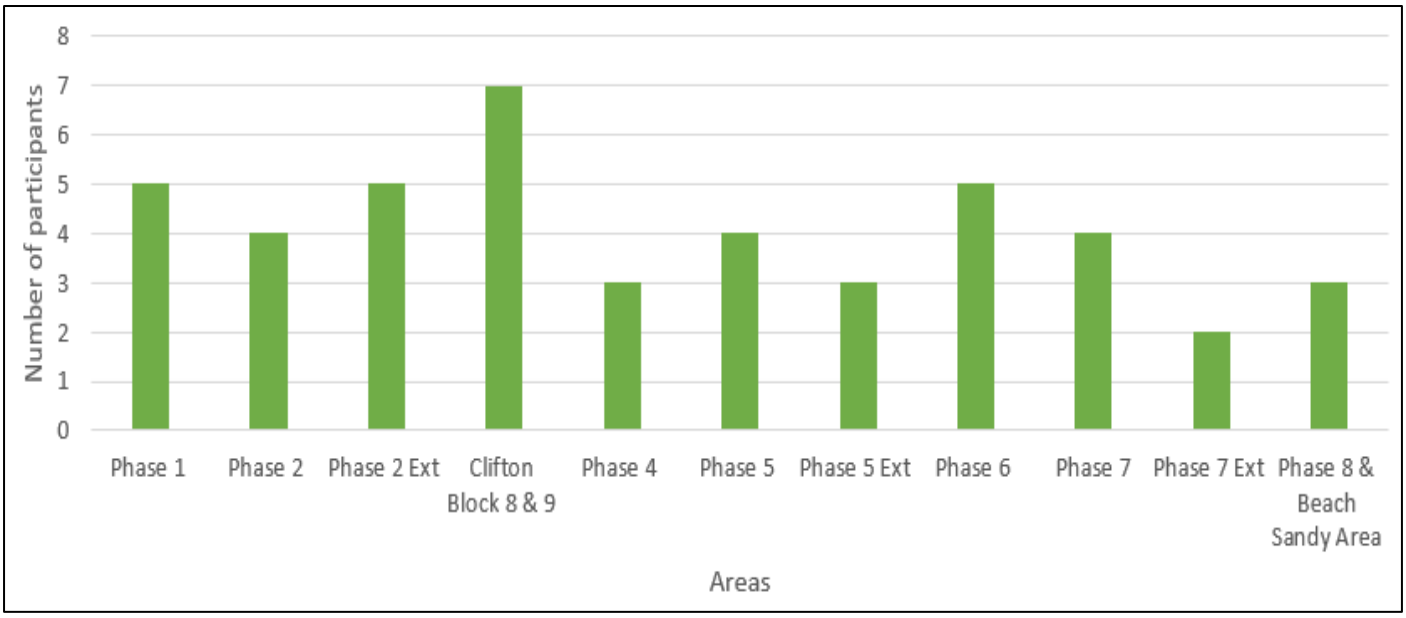

Fig 1 Sector wise Participants Distribution

- *Work Schedule*

The descriptive statistics for the variables "Work Days per Week" and "Working Hours per Day" provide insights into the work schedules of respondents, shown in Table 1.

Table 1 Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Work Days per week	45	5	7	5.214	0.4
Working Hours per day	45	5	10	8.48	2.1

For workdays, the data reveals a minimum of 5 days and a maximum of 7 days, with a mean of 5.214 days per week. The standard deviation is 0.4, indicating very low variability, which suggests that most respondents adhere closely to a standard 5- to 7-day work schedule with minimal deviation.

For working hours per day, the data shows a range of 5 to 10 hours, with a mean of 8.48 hours per day. The standard deviation of 2.1 indicates moderate variability, reflecting some differences in daily working hours across respondents. This variability could stem from factors such as job roles, overtime requirements, or flexible working arrangements. Overall, these statistics suggest that while the number of workdays is relatively consistent among respondents, daily working hours exhibit more variation.

➢ *Coverage of the Waste Collection System*

The table 2 provides a structured summary of the coverage percentages and corresponding frequencies for waste collection across various phases under the Clifton Board Cantonment (CBC) jurisdiction.

Table 2 Waste Coverage Based on Area

CBC Phase	Waste Coverage %	Frequency type
Phase 1	50%	Daily
Phase 2	25%	Weekly
Phase 2 Ext	30%	Daily
Clifton Block 8 & 9	40%	Daily
Phase 4	55%	Daily
Phase 5	70%	Daily

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

Phase 5 Ext	25%	2 Days after
Phase 6	50%	Daily
Phase 7	30%	Daily
Phase 7 Ext	40%	Daily
Phase 8 & Beach Sandy Area	60%	Daily

Table 2 illustrates how waste collection practices differ between areas and the frequency at which waste is collected. For example, Phase 1 has a 50% coverage with daily collection, indicating a frequent waste management service. In contrast, Phase 2 has only 25% coverage with weekly collection, suggesting less frequent waste management. The Clifton Block 8 & 9 area also has a 40% coverage rate with daily collection, similar to Phase 4 and Phase 6, which also have a high percentage of coverage (55% and 50%, respectively) with daily collection. This data highlights variations in waste management service frequency across different CBC areas, emphasizing the need for tailored solutions to address waste collection challenges in each phase.

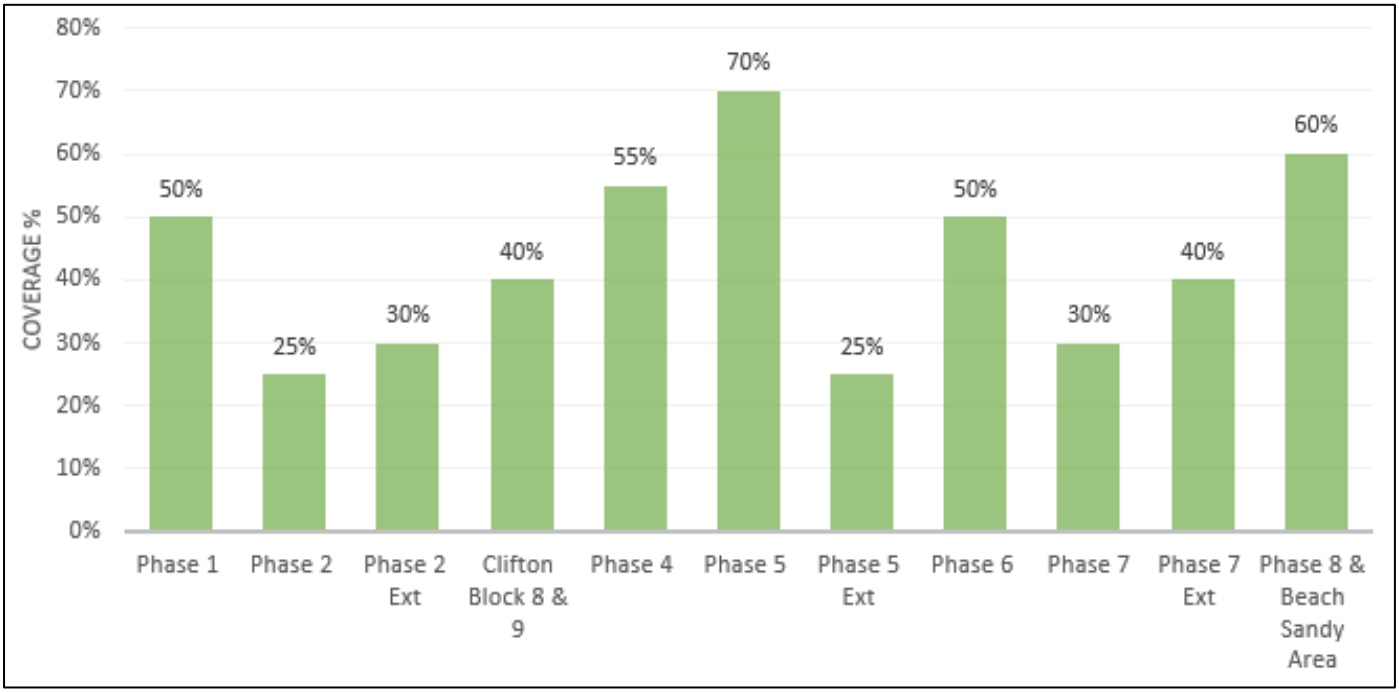

Fig 2 Frequency of Waste Collection System Coverage across CBC Sector

Figure 2 updated data on the waste collection system coverage percentages under the CBC jurisdiction provides a clearer picture of the distribution and effectiveness across different areas. Phase 1 at 50% coverage indicates that half of the area is served adequately, suggesting moderate access to waste management services. Phase 2 at 25% coverage reflects a lower service level, highlighting potential gaps in the waste collection network. Phase 2 Ext at 30% coverage indicates limited waste management services compared to other areas, possibly due to a need for more comprehensive infrastructure or resources. Phase 4 at 55% coverage demonstrates a relatively good level of service, but still leaves room for improvement. Phase 5 at 70% coverage shows a higher level of waste collection coverage, suggesting better access to waste management services in this area. Phase 6 at 50% coverage highlights a moderate level of service, with some areas still lacking adequate services. Phase 7 at 30% coverage suggests significant gaps in waste collection service, indicating areas that require further attention. Phase 7 Ext at 40% coverage suggests a moderate level of service, though still lower than some other phases. Phase 8 & Beach Sandy Area at 60% coverage indicates a relatively higher level of service, but not sufficient for complete waste management across the area.

➢ *Waste Management Capacity across the CBC Areas*

Figure 3 illustrates the distribution of waste containers used across different CBC phases, categorized into four groups: 1–5 containers, 6–10 containers, 11–20 containers, and more than 20 containers.

Phase 1 shows a fairly even distribution, with two responses each for 1–5 and 6–10 containers and one for 11–20 containers, while no respondent reported using more than 20 containers. Similarly, Phase 2 Ext and Phase 8 & Beach Sandy Area exhibit a higher frequency of respondents utilizing larger container capacities, with more responses in the "More than 20 containers" category. Clifton Block 8 & 9 has the largest share of respondents using "More than 20 containers" (5 responses), while smaller container use is more prevalent in Phases 1, 4, and 5. Phase 6 shows a balanced spread across the 6–10 and 11–20 container categories. These findings highlight differences in waste management capacity across the CBC areas, suggesting some variation may influence the efficiency of waste collection and disposal practices in these areas.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

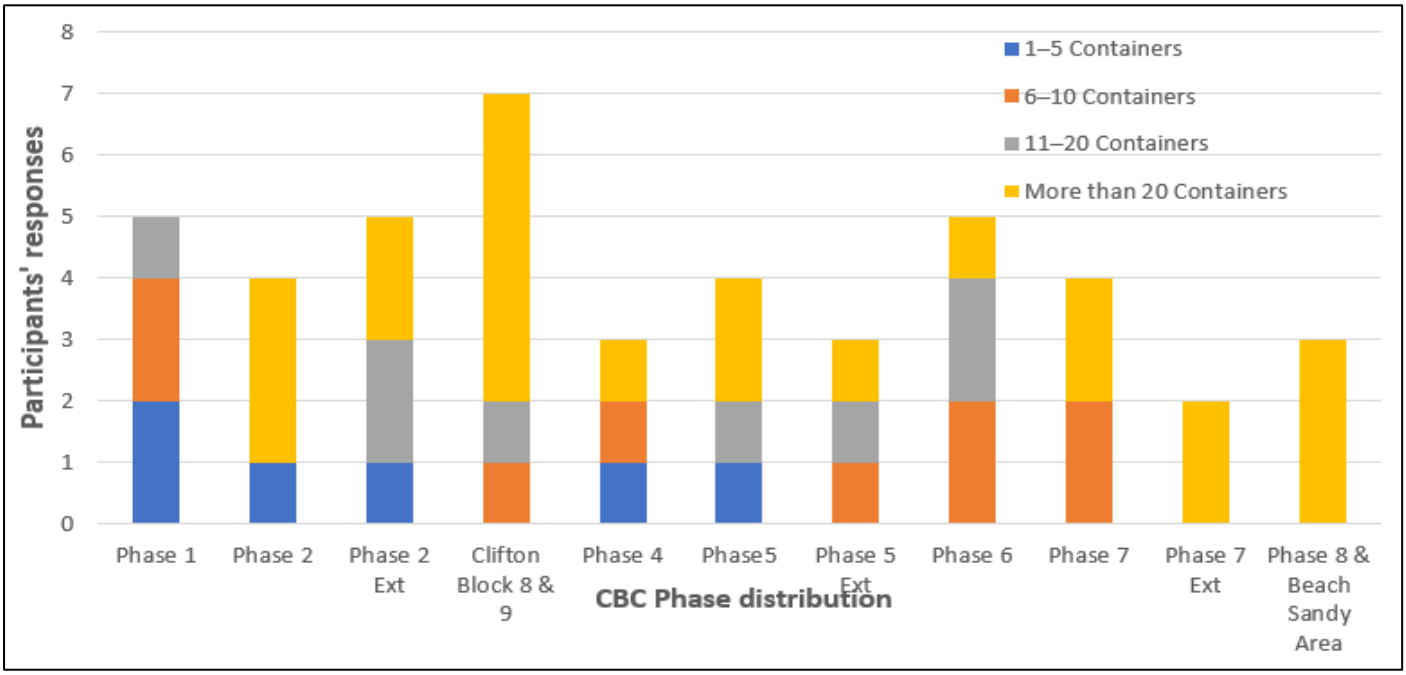

Fig 3 Waste Management Capacity in CBC

➢ *Responses to Trash Bin Installation for Waste Segregation*

Figure 4 provides insights into the installation of different types of trash bins used for waste segregation in the CBC area. For the Recyclable Waste Bin, only 5% of participants reported having it installed, while a significant majority (85%) indicated that they do not have this type of bin in their workplace. A small portion (10%) of respondents were unsure about the availability of this bin.

In terms of Non-Recyclable Waste Bins, 50% of participants confirmed that they have these bins installed, indicating a moderate prevalence of waste segregation practices. However, 40% reported not having this bin, and 10% were unsure. This suggests that while there is a reasonable proportion of workplaces equipped with non-recyclable waste bins, there is still room for improvement in widespread adoption.

Regarding Organic Waste Bins, only 5% of participants said they have this bin installed, which is notably low compared to other types of bins. A larger portion (70%) stated that they do not have an organic waste bin, and 25% were unsure. This highlights a significant gap in organic waste management practices, emphasizing the need for increased awareness and resources to promote the installation of these bins.

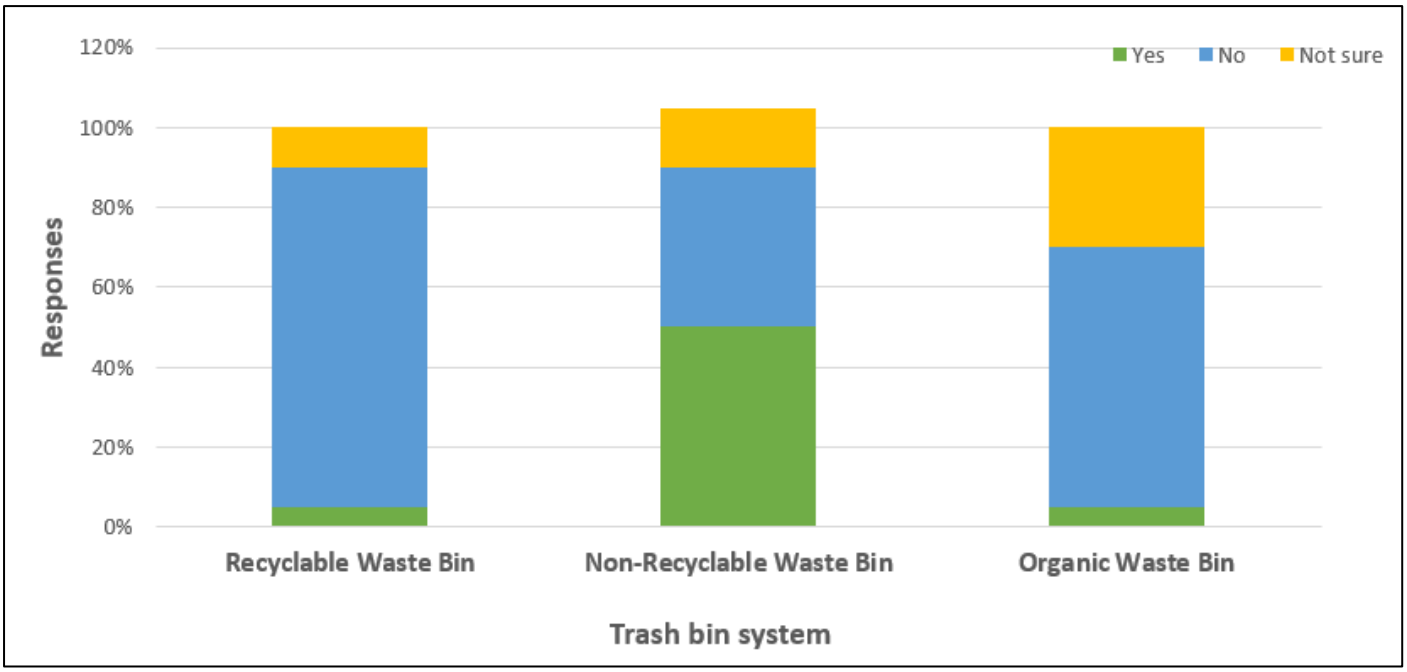

Fig 4 Trash Bin Installation

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

Overall, the data reflects that while some workplaces have made progress in installing waste bins for recycling and non-recyclable waste, there remains a considerable gap in the adoption of organic waste bins. This points to a need for more targeted interventions and educational campaigns to improve waste segregation practices across the CBC area.

➢ *Rating the Efficiency of the Waste Collection Process*

The responses to how participants rate the efficiency of the waste collection process provide a mixed picture of the current system's effectiveness, shown in Figure 5.

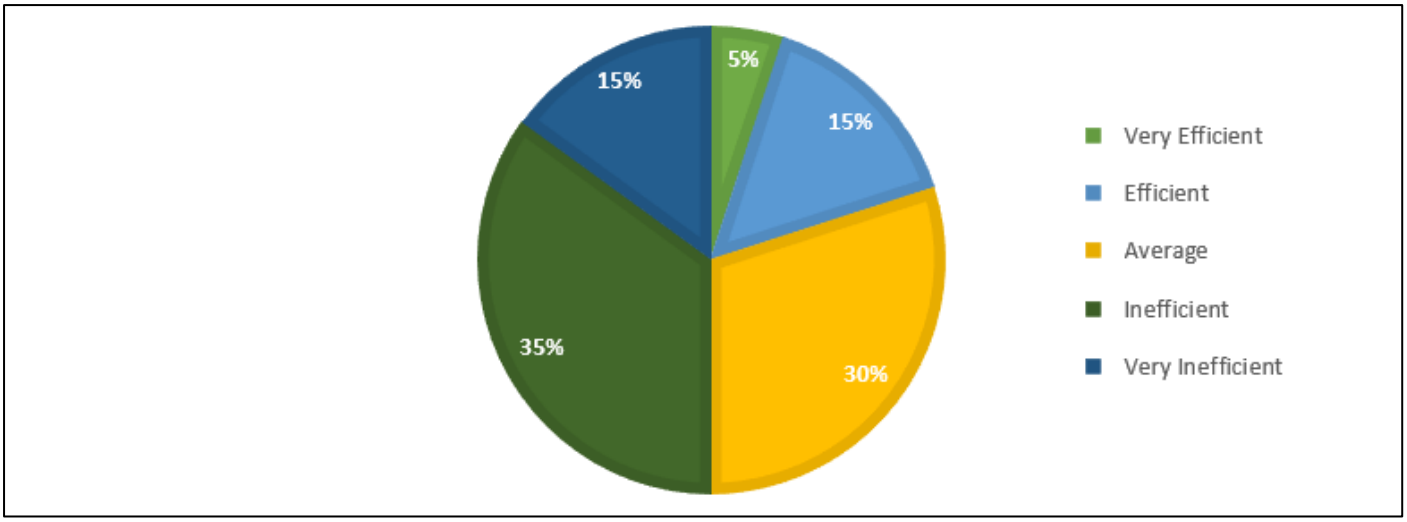

Fig 5 Rate the Efficiency of the Waste Collection Process

A small percentage (5%) of respondents described the process as very efficient, suggesting that these individuals are satisfied with how waste is collected in their area and believe it meets their needs effectively.

A larger proportion of participants (15%) rated the process as efficient, indicating that they find it generally meets expectations but may not be perfect.

The majority of respondents (30%) gave a rating of average, suggesting a mixed experience with the process. While not overwhelmingly negative, this rating reflects that many participants feel the waste collection service does not consistently meet their expectations.

A significant portion (35%) rated the waste collection process as inefficient, highlighting concerns about delays, poor coverage, or other issues that impact the effectiveness of the system.

Finally, 15% of participants found the process to be very inefficient, pointing to significant dissatisfaction with the service.

➢ *Reasons for Inefficiency in the Waste Collection Process*

Figure 6 listing the reasons for inefficiency in the waste collection process provides a comprehensive overview of the key challenges faced in maintaining an effective system.

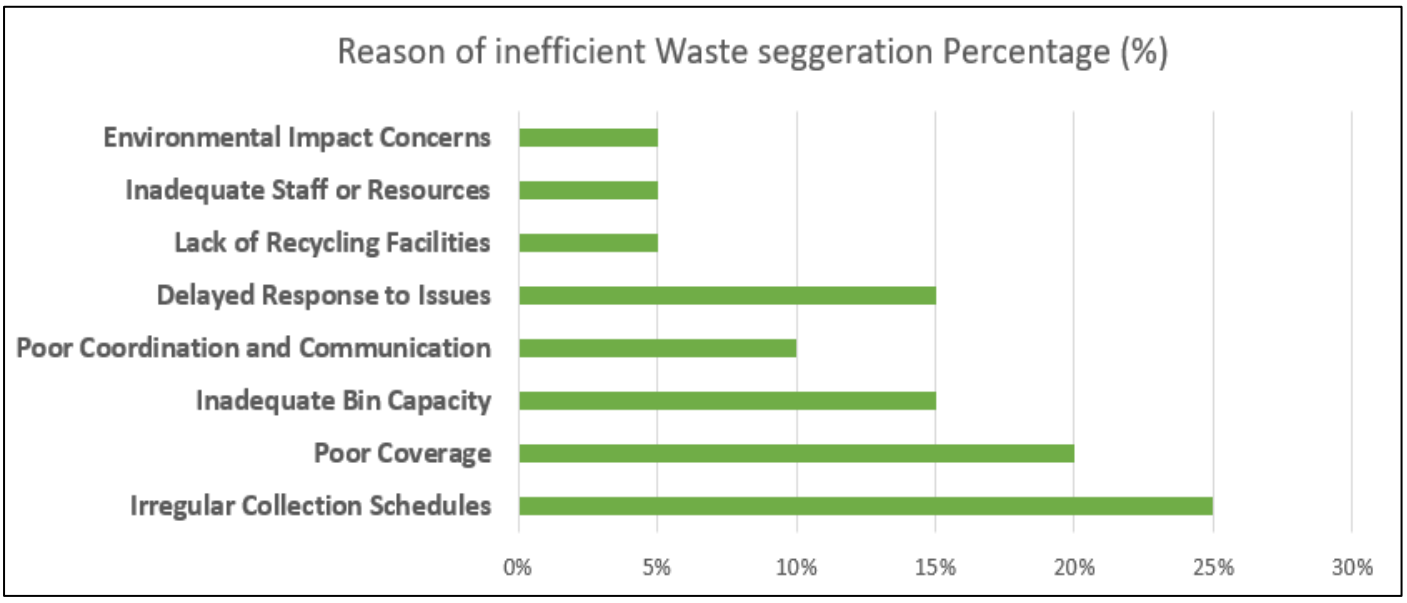

Fig 6 Reasons for Inefficiency in the Waste Collection Process

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

Irregular collection schedules were the most frequently cited issue, with 25% of respondents noting that waste is collected inconsistently, leading to delays and accumulation of waste. Poor coverage was also highlighted by 20%, indicating that certain areas within the jurisdiction do not receive regular or adequate service, resulting in overflowing bins and unsanitary conditions. Inadequate bin capacity was another significant concern, mentioned by 15%, which points to the bins being too small to handle the volume of waste produced, causing overflow and inefficient management. Poor coordination and communication, as reported by 10%, suggest issues with the clarity of collection schedules and routes, often leading to confusion among residents and missed collections. Delayed responses to problems were noted by 15%, reflecting a slow turnaround in addressing issues like overflowing bins or blockages, exacerbating inefficiency. Lack of recycling facilities was cited by 5%, emphasizing the need for more specialized bins to manage recyclable waste effectively and reduce contamination. Inadequate staff or resources was also mentioned by 5%, indicating that there might not be enough personnel or equipment to handle the waste collection needs, further contributing to inefficiency. Lastly, concerns over environmental impact were raised by 5%, pointing to issues like littering, illegal dumping, and pollution as outcomes of an inefficient waste collection system. These factors combined illustrate the multifaceted challenges in waste management and highlight areas where improvements are needed to enhance efficiency and sustainability in the waste collection process.

- *Evaluation of the Adequacy of Equipment and Vehicles for Waste Collection*

The responses regarding the adequacy of equipment and vehicles used for waste collection reveal a generally positive outlook, with 70% of participants considering them adequate. However, only 10% rated the equipment and vehicles as highly adequate, indicating room for improvement in meeting optimal standards. Meanwhile, 20% of respondents believe the equipment and vehicles are inadequate, highlighting potential gaps in functionality or availability.

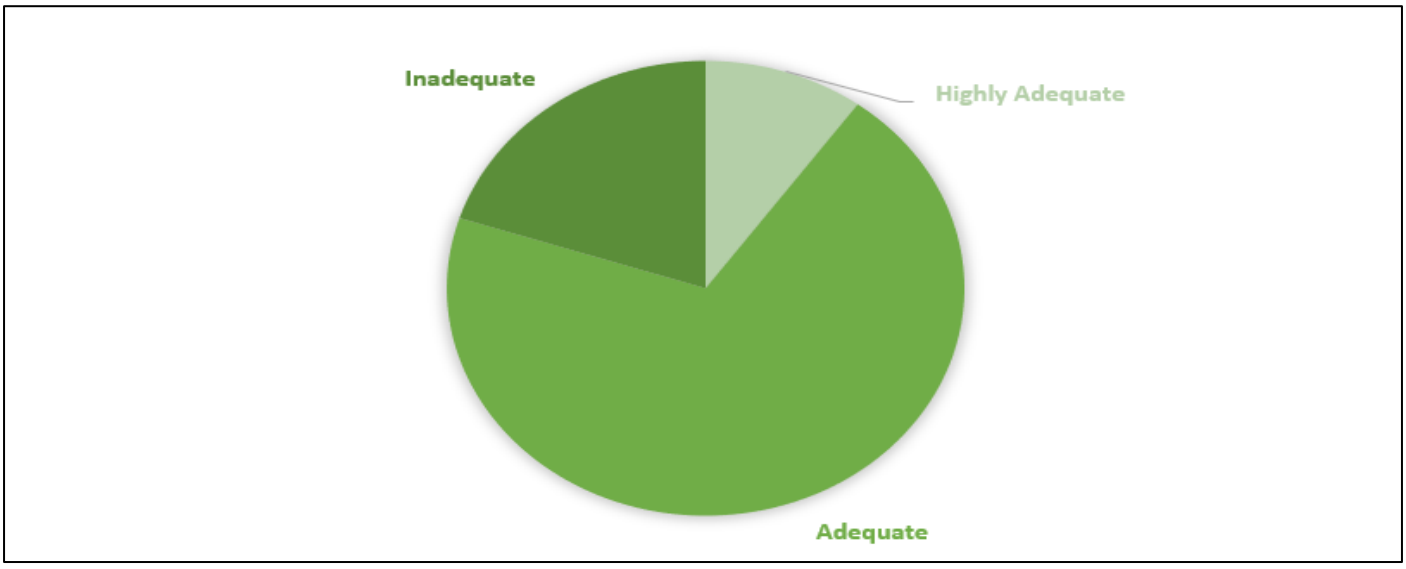

Fig 7 Adequacy of Equipment and Vehicles for Waste Collection

Figure 7 pie chart would effectively illustrate this distribution, emphasizing that while the majority find the equipment sufficient, there is a notable segment that perceives inadequacies, necessitating targeted enhancements to improve waste collection efficiency.

- *Discretionary Functions for Sustainable Waste Management by CBC*

The table 3 outlines the preferred discretionary functions that participants believe should be prioritized by the Clifton Board Cantonment (CBC) to achieve sustainable waste management.

By prioritizing these discretionary functions, CBC can make strides toward improving waste management practices, increasing recycling rates, and ultimately contributing to environmental sustainability within the community.

Table 3 Functions for Sustainable Waste Management

Discretionary Function	Frequency	Percentage (%)
Improved collection frequency	15	33%
Expansion of recycling facilities	7	17%
Introduction of advanced waste technologies	4	11%
Enhanced public awareness on waste segregation	10	22%
Provision of guidelines and incentives for waste reduction	3	8%
Enhanced infrastructure for waste collection	3	8%
Regular audits and monitoring of waste collection routes	3	7%

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

Figure 8 explains most frequently selected function is Improved collection frequency, which received 15 votes, accounting for 33% of the total responses. This reflects a strong desire among residents for more consistent and timely waste collection services, possibly to minimize inconvenience and improve sanitation in residential areas.

The Expansion of recycling facilities was the second most preferred function, with 7 responses (17%). This suggests that respondents recognize the importance of accessible recycling facilities to facilitate waste segregation and recycling processes, thus contributing to a reduction in overall waste going to landfills.

The Introduction of advanced waste technologies was the third priority with 4 votes (11%). This indicates an awareness of technological solutions that can optimize waste management processes, reduce waste volume, and enhance the recycling rate.

Enhanced public awareness on waste segregation was selected by 10 respondents (22%). This emphasizes the need for ongoing education campaigns to improve understanding and compliance with waste separation practices, which is crucial for effective recycling and waste reduction.

Provision of guidelines and incentives for waste reduction received 3 votes (8%), suggesting that some respondents view policy-driven motivation as a way to encourage responsible waste disposal behaviors.

Enhanced infrastructure for waste collection and Regular audits and monitoring of waste collection routes each garnered 3 votes (8% and 7%, respectively). These functions highlight the necessity for robust systems and regular checks to ensure efficient and effective waste collection processes, which are essential for maintaining cleanliness and hygiene standards in residential areas.

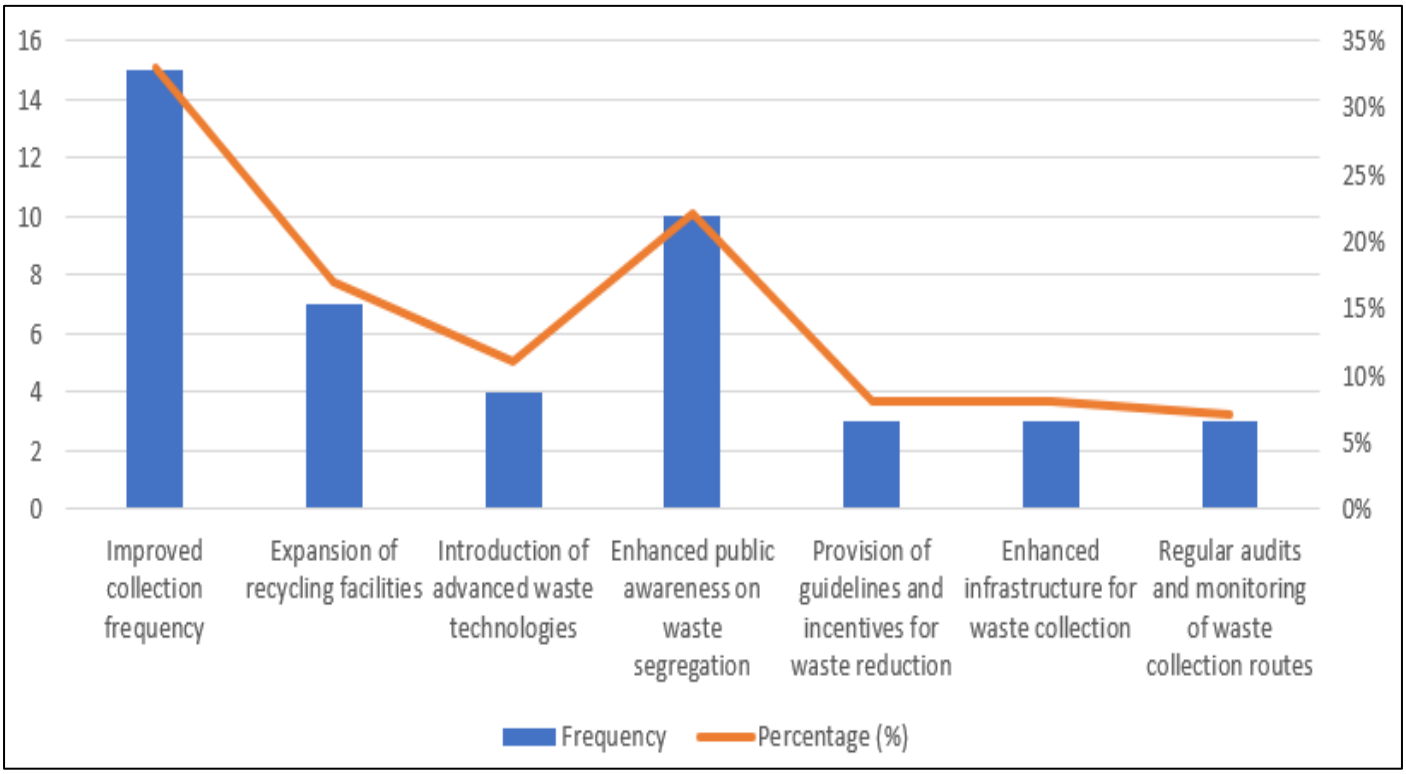

Fig 8 Discretionary Functions for SWM

➢ *Alignment of Waste Management Practices with SDGs Across CBC Phases*

Figure 9 highlights the variation in the alignment of waste management practices with sustainability goals across CBC phases. Certain phases show stronger alignment than others. For instance, Phase 8 & Beach Sandy Area demonstrates the highest proportion of strong alignment (35%) and moderate alignment (35%), indicating a relatively robust adherence to sustainability principles. Conversely, Phases 2 and 6 have significant proportions of poor alignment, at 50% and 60%, respectively, suggesting notable challenges in implementing sustainable practices in these areas.

Phases 1 and 2 Ext also show a higher percentage of poor alignment (40% and 30%), reflecting gaps in sustainability integration. Moderate alignment is consistently low across most phases, except for Clifton Block 8 & 9 and Phase 8, where it reaches 20% and 35%, respectively. Overall, the graph reveals uneven progress across phases, emphasizing the need for targeted improvements to enhance sustainability alignment in waste management.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

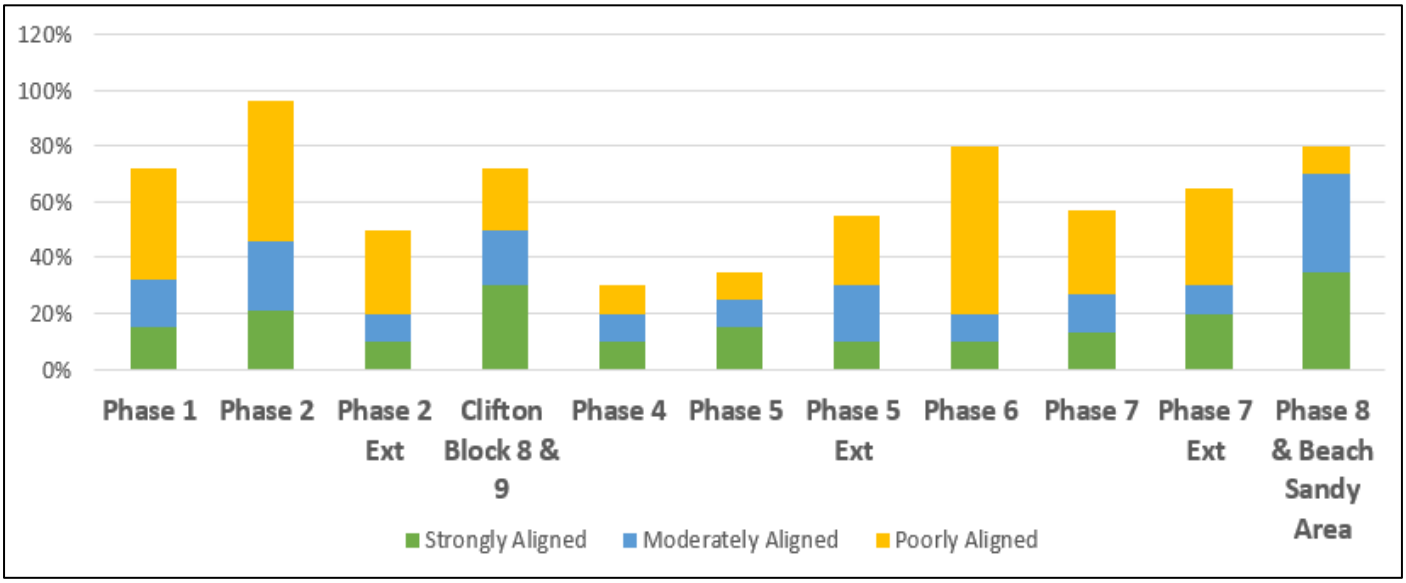

Fig 9 Current Waste Management Practices Alignment with SDGs

➢ *Analysis of CBC's Waste Management Practices and SDG Contributions*

According to survey responses provide insight into how CBC's waste management practices align with Sustainable Development Goals (SDGs), shown in Figure 10.

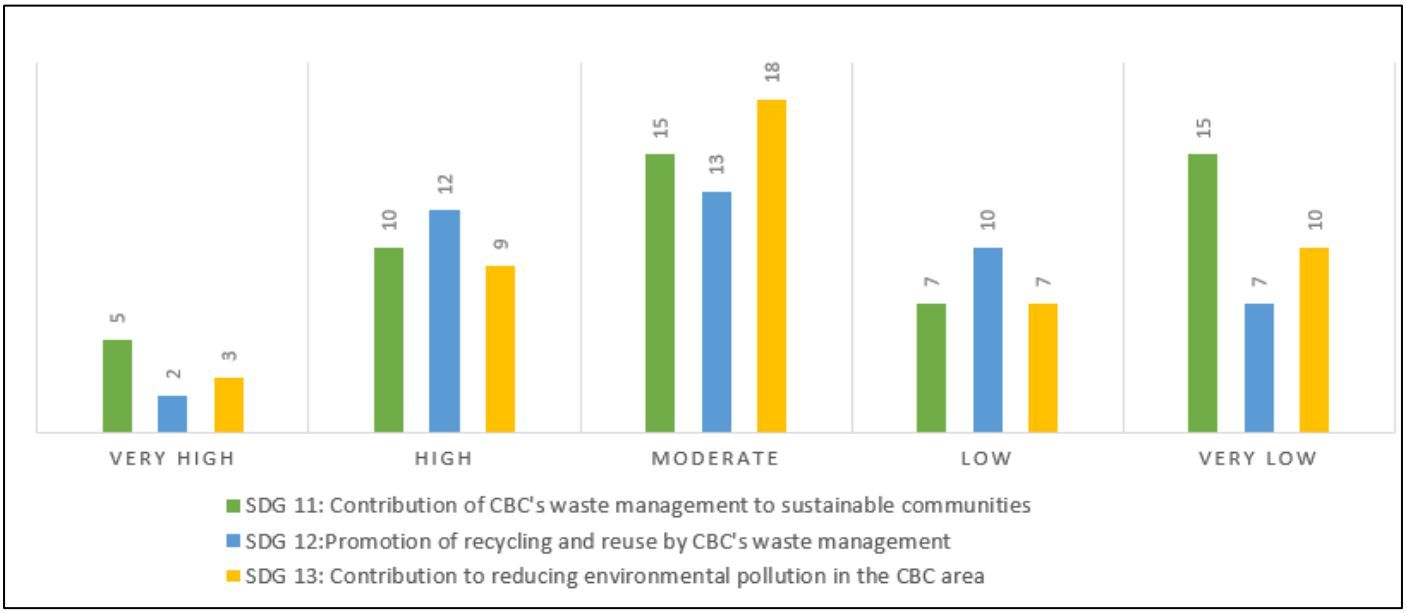

Fig 10 Relation among Waste Management Practices and SDG Contributions

- *Regarding SDG 11:*

Contribution to Sustainable Communities, 18% of participants rated CBC's efforts as "Very High," and 22% as "High," indicating some recognition of positive impact. However, the largest proportion (33%) rated it as "Moderate," and 27% collectively rated it as "Low" or "Very Low," highlighting room for improvement in making waste management practices more community-focused and resilient.

- *For SDG 12:*

Promotion of Recycling and Reuse, only 4% of participants rated the contribution as "Very High," while 27% rated it "High." The majority (29%) considered it "Moderate," and a significant 38% viewed it as "Low" or "Very Low." This underscores a critical need for stronger initiatives to encourage recycling and reuse, particularly through public engagement and infrastructure development.

- *Regarding SDG 13:*

Contribution to Reducing Environmental Pollution, while 13% and 20% of participants rated the efforts as "Very High" and "High," respectively, the majority (40%) viewed it as "Moderate," and 27% rated it "Low" or "Very Low." This suggests that while CBC's waste management efforts contribute to reducing pollution, there is a clear demand for enhanced policies, technologies, and monitoring to strengthen their impact on environmental sustainability.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

Overall, the results reveal that CBC's contributions are acknowledged to some extent but need substantial improvements to fully align with the objectives of SDG 11, 12, and 13.

➢ *Evaluation of CBC Staff Training on Sustainability Integration in Waste Management*

The responses in Figure 11 indicate significant room for improvement in CBC staff training regarding sustainability principles in waste management. Only 12% of respondents believe the staff are adequately trained, while 30% feel they are not trained. The majority, 58%, suggest that training programs need improvement to effectively integrate sustainability practices. This highlights a clear gap in capacity-building initiatives, emphasizing the need for enhanced training programs to align with sustainable waste management goals. A pie chart would visually depict this distribution, with the largest portion representing the "Need Improvement" category.

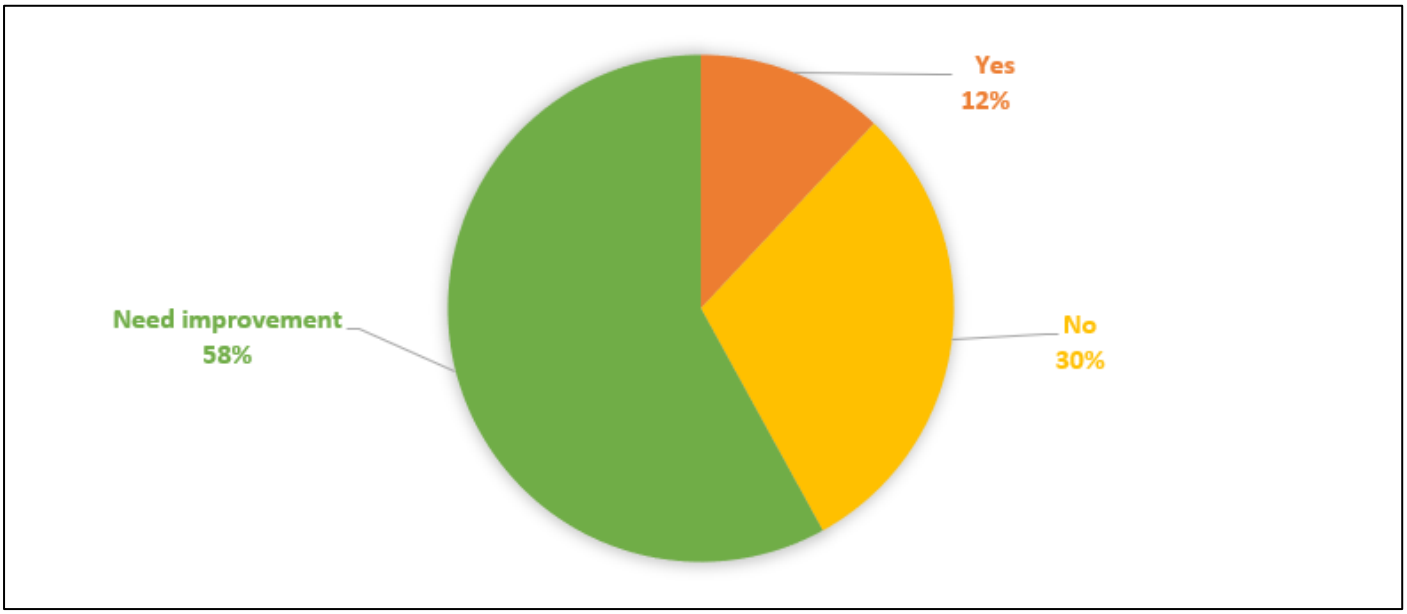

Fig 11 Training on Sustainability Integration in Waste Management Practices

➢ *Comparison with Other Cities in Underdeveloped Countries: A Case Study Analysis*

Comparison with Other Cities in Underdeveloped Countries: A Case Study Analysis The survey indicates that SWM is still a major problem in cities in the underdeveloped countries and it continues to hit hurdles especially in the areas of collection, disposal and recycling. This paper tries to compare and contrast Clifton Board Cantonment's (CBC) waste management to other cities in developing countries and identify some similarities and possibilities for change.

- *Experiences and Dissection of Other Cities*

According to Guerrero, Maas and Hogland, (2013) problems related to SWM for the underdeveloped countries' cities include inefficient infrastructure, low or lack of proper policies on SWM, and poor funding. For instance, in these cities such as Nairobi and Accra, there is a low access to waste collection as well as the disposal relying on informal waste pickers. Like all the set companies, CBC has a major problem of the lack of infrastructure for, amongst others, the following types of recycling, and a conspicuous low recycling rate as highlighted below.

Municipal solid waste management systems in Indian cities are discussed by Sharholy et al. (2008) who noted that urbanization and rising population rates compromise SWM processes. Congestion in Indian cities also observed high levels of dumping waste without segregation which also applies to CBC's low implementation of wasted segregation at source through separate bins for recyclable waste, organic waste and non-recyclable waste. Similarly, lack of public awareness and insufficient staff education in India corresponds to the results of CBC matrices, in which the sustainability training and implementation that are still in their infancy stages.

Wilson et al. (2012) did a comparative assessment of 20 cities in developing world and found that the cities which had more systematic system of SWM like Indonesia and South Africa, the SWM system has public consciousness drive and some of the IWWs are legally recognized formally. Though CBC needs to enhance its interventions to improve public awareness on recycling and waste reduction, the use of such approaches is likely to enhance the efficiency of waste segregation and recycling.

- *Main Similarities and Differences*

It was evident from the research that like many other cities in the world including those in India and Kenya, CBC still uses ineffective means of waste collection and lack coherent waste disposal. But experience of such cities as Curitiba of Brazil and Dhaka of Bangladesh have shown that the activation of community members' participation and development of public and private partnership will enhance the efficiency of SWM. CBC could use similar models for the development of the waste collection infrastructure and

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

improvement of the current recycling statistics.

This means that although some cities as pointed out by Wilson et al. (2012) has started implementing complex technologies to handle waste conversion to energy, CBC has not done so. In addition, issues of inadequate funds and poor compliance with environmental standards are familiar issues in the developing cities including those in the CBC's waste management system.

III. DISCUSSION

Waste collection services in the CBC area are not equally provided for different phases; consequently, the coverage of waste management services is inconsistent. While some industries dispose of their waste at fixed and frequent intervals others dispose of their wastes at random intervals. This has mainly arisen from lack of vehicles and enough manpower to cover the places, which results in either skipping some areas or frequenting them after a long time. The inefficiencies that are evident have been worsened by lack of proper planning and coordination in the efforts that the waste collection teams put in their daily undertakings.

The CBC area comprises the residential, commercial, and industrial areas, all of which produce different types of waste and require different collection modes. Residential sectors have numerous problems with the frequency and punctuality of waste collection, and therefore wastes may pile up on the streets because of the sector's density of population. This has been quite irksome amid the varying service demands especially due to high traffic or event days, or when there is a concern regarding the vehicles used thus the strong call to make schedules and the cars better than what they are today.

There is fairly serious issue of adequacy of equipment and vehicles required for waste collection within the CBC area. The majority of vehicles used is old and cannot accommodate the current and future type and quantity of waste produced in the CBC.The few number of modern automated trucks also slows down the rate at which wastes are collected.

Speaking to the officials of waste management, one realized that not only are many of these vehicles old, but they lack maintenance too. Frequent breakdowns mean that there is less coverage, and trucks are off the road for repairs for most of the time. This hampers the proposed frequency of waste collection thus meaning that there are areas within the CBC where waste has piled up. Another constraint relates to vehicle adequacy which are mainly not designed for use in the tight networked, narrow and highly populated residential areas.

There are many reasons for the ineffective waste collection in the identified CBC area that influence the final result. This indicates the absence of a coherent vision in waste management and more specifically a poor integration plan of new technologies and procedures. Current technology mainly uses conventional methods, which are not effective to address the complexity of present day waste stream, including the recycled and hazardous waste. Lack of public awareness on the need to sort their waste also add positives to contamination of waste streams thus contributing to recycling.

The fourth factor includes lack of labor resources with inadequate staff strength that would implement waste management and operation of the waste collection vehicles. This is particularly seen in waste management where the staff changes often due to different reasons, which(create)s a problem of succession by creating gaps in service delivery. The issues of inefficient, outdated methods and technologies as well as the lack of practice in state of the art waste processing and handling techniques and inadequate training of staff also contribute to a reduced productivity, mistakes and inefficiency.

Also, the current CBC area regulatory framework for waste management is not strong enough to compel compliance with the segregation and disposal of wastes. Lack of robust democracy and an accompanying enforcement framework assertion that deters provisions regarding stiff penalties for non-compliance and mechanisms for inspecting and punishing non-compliance fosters poor waste disposal and dumping. The use of the advanced tracking technology that would enable the tracking of collection routes and or schedules could highly enhance the functionality of the system.

Waste segregation practices recommended in managing wastes within the Commonwealth of the Bahamas in general, and CMC especially, is poorly practiced hence adding to inefficiencies. Despite the fact that people are aware of segregation, there is not much of it in practice among residents. The leading contributors to this include; Absence of proper markets for waste segregation, the few bins available and those meant for the recyclable wastes, absence of the implementation of the requirements that called for segregation of wastes. The problem of segregation and segregation practices because the waste stream of the CBC area is a challenging one.

Community mobilization and awareness creation is important if there will be compliance to wastes segregation procedures. People want to know how to divide waste appropriately and what is effective in doing so and all the advantages and disadvantages. CBC should look into acquiring more structures like more recycling bins or areas in residential attribute that will enhance segregation. Furthermore, offering incentives to sort wastes, include reduction of wastes collection fees or reward for recycling could help to enhance practice of proper wastes sorting among residents.

From the discussion of discretionary functions to improve sustainable waste management within the CBC area, some of the following opportunities were identified. Starting with waste reduction campaigns to encourage composting, and increasing interaction through waste reports almost entirely digital and optimizing the use of digital scheduling

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

aids could become realistic goals. For instance, programs involving community base composting can go along way in ensuring proper disposal of the organic wastes thus relieving pressure on the waste disposal services. One of the benefits of technological advancements is that it has become easy for the residents of a given area to notify authorities in case of missed collections in real time.

The CBC area should also establish a waste management fund for specific projects and programs in waste management as derived from landfill taxes and fines for violation of waste laws. They can be used for the subsidizing of the acquisition of modern waste management equipment and for covering the costs of community waste reduction initiatives. Need to tap more expertise with Waste Management companies in the private sector in order to come up with improvement in the present dispensation especially in the area of use of modern approaches in waste management.

Currently there is no harmony between waste management strategy and sustainability objectives in the CBC area. The regular waste disposal system of the CBC is still fragmented from an effective recycling disposal or waste reduction or even sustainability. This is evidenced with poor recycling rates and high amounts of waste ending up in the landfill. In order to meet sustainable development objectives in waste management there is a dire need to seek changes in policies to adopt improved methods of recycling and developing techniques of waste treatment through technology.

The concepts which enable integration of sustainability in waste management are circular economy, which sees wastage as an opportunity. This approach includes the establishment of incineration plants or developing opportunities to convert wastes into energy, encourage the usage of biodegradable material, and employ the efficient waste management maps that would show real time routes and collection times. The CBC also needs to initiative the public to participate in making the community sustainable in order to include the residents and business organizations.

CBC waste collection and management in Canada has revealed areas of inadequacy, inefficiencies and lack of compliance with sustainability objectives. To remedy these problems, the CBC needs to increase spending on up-to-date equipment, enhance personnel handbook, and enhance planning-organizing controlling processes. It is also high time and of paramount importance that there improved legal measures as well as public participation in improving waste segregation systems and over waste management systems as well. The CBC can design an innovative solution to the problem through the optimization of the current practices and thus make waste management more effective, efficient, sustainable and responsive to the populations needs.

IV. CONCLUSION

CBC faces critical issues: unequal coverage, outdated fleet, insufficient manpower, poor planning, and minimal public participation. Integrating technology, updating laws, and training staff are crucial for efficient waste management. Public awareness, segregation infrastructure, and funding mechanisms must be strengthened to align with sustainability objectives.

RECOMMENDATIONS

➢ *Local Council:*

- Formulate a comprehensive waste management plan with GPS-based tracking and predictive scheduling.
- Strengthen regulatory frameworks and enforce segregation compliance.
- Launch public awareness campaigns through social media, local forums, and schools.

➢ *Waste Management Authorities:*

- Acquire new automated collection vehicles and install smart tracking systems.
- Optimize routes and adjust schedules for peak waste generation periods.
- Provide continuous staff training and certification programs.

➢ *Residents and Communities:*

- Adopt segregation practices with proper bins and clear labeling.
- Report missed collections and other concerns through dedicated channels.
- Support and participate in awareness programs.

➢ *Private Sector:*

- Implement sustainable disposal and recycling programs.
- Engage in Public-Private Partnerships for waste-to-energy and composting projects.
- Promote CSR activities targeting community waste management.

REFERENCES

[1]. Abbasi, H. N., Lu, X., & Zhao, G. (2015). An overview of Karachi solid waste disposal sites and environs. Journal of Scientific Research and Reports, 10, [pages]. https://doi.org/10.1234/jsrr.2015.12345
[2]. Afzal, A., Afsar, S., & Lahori, A. H. (2021). Solid waste management practice in Karachi through GIS techniques. Pure and Applied Biology (PAB), 10(4), 1258-1277. https://doi.org/10.19045/bspab.2021.100127
[3]. Ahmed Khan, H., Naqvi, S. S., Alharbi, A. A., Alotaibi, S., & Alkhathami, M. (2024). Enhancing trash classification in smart cities using federated deep learning. *Scientific Reports*, *14*(1), 11816.
[4]. Ahmed, K. (2017). Mastering the world of waste. Dawn News. https://www.dawn.com/news/1321525
[5]. Ali, M., & Hasan, A. (2001). Integrating recycling and disposal system for solid waste management in

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul923

Karachi. Urban Resource Centre.
[6]. Arif, H., Ahmed, N., Raza, M., Sadiq-Polack, A., Ahmed, S., & Sarwar, M. B. (2015). Karachi: Land issues. Oxford University Press.
[7]. Asif, M., Laghari, M., Abubakar, A. M., Suri, S. K., Wakeel, A., & Siddique, M. Review on Municipal Solid Waste, Challenges and Management Policy in Pakistan.
[8]. Grey, A. (2017). Germany recycles more than any other country. World Economic Forum. https://www.weforum.org/agenda/2017/12/germany-recycles-more-than-any-other-country/
[9]. Guerrero, L. A., Maas, G., & Hogland, W. (2013). *Solid waste management challenges for cities in developing countries.* Waste Management, 33(1), 220-232.
[10]. Habitat, U. N. (2010). Solid waste management in the world's cities. Gutenberg Press.
[11]. ishwarya, R. (2021). Assessment of spatial distribution of physico-chemical parameters of groundwater around Kodungaiyur dump yard. Journal of Physics: Conference Series, 2070(1), 012215. https://doi.org/10.1088/1742-6596/2070/1/012215
[12]. Jilani, S., & Rashid, R. (2020). Municipal solid waste dumping and its impact on soil quality in Karachi. *EQA-International Journal of Environmental Quality*, *36*, 9-14.
[13]. Kamal, F. M. (2019). Efforts for solid waste management during his tenure. (Personal communication).
[14]. Khan, D. M. (2016). Historical patterns of demographic transformation in post-colonial Karachi: Analysis of causes and impacts on urban growth and governance. Unpublished manuscript, University of Karachi, Pakistan.
[15]. Khan, S., Alvarez, L. C. M., & Wei, Y. (2018). Sustainable management of municipal solid waste under changing climate: A case study of Karachi, Pakistan. Asian Journal of Environmental Biotechnology, 2(1), 23-32. https://doi.org/10.21608/ajeb.2018.30519
[16]. Korai, M. S., Mahar, R. B., Ali, M., Sajjad, S., Mahar, Q. U., Loyal, A., & Panhwar, M. A. (2024). Household solid waste management practices and resource recovery potential in Pakistan. *International Journal of Environmental Science and Technology*, 1-16.
[17]. Mahmood, H., & Khan, M. M. (2019). Urban solid waste management in Karachi, Pakistan. International Journal of Economic and Environmental Geology, 10(1), 78-83. https://doi.org/10.36909/jer.IEEG.1077
[18]. Mahmood, M. (2019). History of solid waste management in Karachi. (Personal communication).
[19]. Pakistan Bureau of Statistics. (2017). Retrieved from http://www.pbs.gov.pk/
[20]. Paracha, N. F. (2017). A history of Karachi's garbage outbreaks. Dawn News. https://www.dawn.com/news/1320851
[21]. Sabata, J. M. C., Torras, A., Elies, E. G., & Martell, M. (2005). Urban solid waste management: Municipal waste and its management. Treballs Grafics.
[22]. Sabir, W., Waheed, S. N., Afzal, A., Umer, S. M., & Rehman, S. (2016). A study of solid waste management in Karachi city. Journal of Education & Social Sciences, 4(2), 151-163. https://doi.org/10.1234/jess.2016.045
[23]. Sohoo, I., Ritzkowski, M., Guo, J., Sohoo, K., & Kuchta, K. (2022). Municipal solid waste management through sustainable landfilling: In view of the situation in Karachi, Pakistan. International Journal of Environmental Research and Public Health, 19(2), 773. https://doi.org/10.3390/ijerph190200773
[24]. Sharholy, M., Ahmad, K., Mahmood, G., & Trivedi, R. C. (2008). *Municipal solid waste management in Indian cities–A review.* Waste Management, 28(2), 459-467.
[25]. Sureshkumar, M., Sivakumar, R., & Nagarajan, M. (2016). Impact of municipal solid waste dump yard on groundwater: A case study of Kanchipuram municipality, Tamilnadu, India. International Journal of ChemTech Research, 9(9), 571-579. https://doi.org/ISSN: 0974-4290, 2455-9555
[26]. Uma, R. N., Prem Sudha, R., & Murali, K. (2016). Analysis of physico-chemical characteristics of soil and SQI around municipal solid waste dumpyard in Vellalore-Coimbatore, Tamilnadu, India. International Journal of Chemical Sciences, 14(4), 3265-3276. Sadguru Publications. https://doi.org/ISSN 0972-768X
[27]. Wilson, D. C., Rodic, L., Scheinberg, A., Velis, C. A., & Alabaster, G. (2012). *Comparative analysis of solid waste management in 20 cities.* Waste Management & Research, 30(3), 237-254
[28]. Zabaleta, A. (2008). Sustainability indicators for municipal solid waste treatment: Case study - The city of Stockholm: Landfill vs. incineration. Royal Institute of Technology.