Changing Trends and Challenges in Solid Waste Management in Chennai Metropolitan Area – An Empirical Evidence

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Abstract

Solid waste management has been significant role of the urban development, because locality have been extending and merging between rural and urban areas is challenge nature in general, especially for urban is major causes and sustained of the solid wase management vital role and decided for the good governance of the nation. In most of the urban areas has been facing civic problem is general, especially solid waste management particular. It is most of the urban area have been adequate infrastructure like road, communication, transport and pure drinking water has challenges due to improper disposal of the household waste into management practices is major causes. The present study has been specific objectives are; i) to examined the challenges and trends in solid waste management system; ii) to analysed the solid waste management system and sustainable practices in respective study area; iii) to suggest suitable policy measures and improve of the good governance to upgradation of the solid waste management system. The present study has been based on both qualitative and quantitate nature of the sources. The required data have been collected with help of the questionnaire and published reports will be used. The study concluded that the effectively at gross root level for the such manner like good governance with coordination of the government and people together aware about sustainable solid waste management practices should be clean urban reached at significant goals of the nations.

Keywords: Solid waste management, Urbanization, Chennai Metropolitan Area, Sustainable practices, and Programme.

1. Introduction

Solid Waste Management (SWM) is a significant environmental and public health challenge for rapidly growing cities worldwide. In the Chennai Metropolitan Area—one of India's largest are populated urban centres due to the rapid economic growth, corporate expansion, and urban migration have driven a sharp rise in daily waste generation, intensifying the challenge of safe disposal and sustainable environmental management. Despite policy reforms and technological interventions, solid waste management system remains strained by inadequate segregation at source, over-reliance on landfills, and limited recycling infrastructure. The rapid urbanization has outpaced the capacity of municipal systems, leading to environmental degradation, public health risks, and mounting pressure on existing disposal sites. The environments demand a shift towards integrated, sustainable waste management solutions that combine efficient collection, processing, recycling, and community participation to safeguard the city's environmental future generation is challenges in respective study area. According to the Greater Chennai Corporation (GCC) have been produces between 5000 and 5500 metric tonnes of solid waste every day with per capita waste generation steadily increasing due to lifestyle changes, economic growth and urban migration. In the earliest solid waste management practices from traditional methods non-technology methods like non-technology and landfilling to modern technology integrated, decentralized systems, composting, recycling and waste-to-energy technologies in regulated of the solid waste management system.

2 Research Problem

Solid Waste Management (SWM) has been challenges and unbale to maintain green areas because not much aware of the environment like in proper manner dispose, open place deposit, empty land through wastes, sewage water disposes and

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end of the empty plot disposes it major causes from the civil sides and other side for the good governance communication In Greater Chennai Corporation Area is experiencing a rapid and sustained increase in municipal solid waste generation driven by population growth, economic expansion, and changing consumption patterns. Despite the introduced of progressive policies such as the Solid Waste Management Rules, 2016, and various municipal initiatives, the gap between policy design and on-ground implementation remains significant. The low levels of solid waste source segregation, over-dependence on overflowing landfills in Perungudi and Kodungaiyur, inadequate recycling and composting infrastructure, and limited public participation continue to hinder effective waste management. Moreover, weak enforcement mechanisms, insufficient capacity-building for municipal staff, and the absence of robust monitoring systems exacerbate these challenges. The Chennai corporation has been vulnerability to floods and cyclones further disrupts waste collection and disposal processes, amplifying environmental and health risks. The above-mentioned causes for the require an empirical understanding of the evolving trends in solid waste management, the structural and operational bottlenecks, and the socio-economic and institutional factors influencing sustainable practices in Chennai.

3. Review of Literature

Solid Waste Management (SWM) in Chennai has undergone significant transitions, moving from reliance on open dumping and municipal-led collection to privatized contracts, decentralized recovery initiatives, and judicially monitored remediation projects. These shifts have been driven by rapid urbanization, population growth, increasing per-capita waste generation, and policy interventions such as the Solid Waste Management Rules (2016) and the Tamil Nadu plastic ban (2019). Despite institutional reforms, challenges remain in segregation, recycling, informal sector integration, and sustainable disposal (Global Cities Profile, 2022; Shankar et al., 2021). In Chennai generates approximately 5,000–6,500 tonnes of municipal solid waste per day, divided between its two principal dump yards—Kodungaiyur and Perungudi (Greater Chennai Corporation,2021). The study found that the nearly double by 2040 if consumption and demographic trends persist (Kaza et al., 2018). Even though the waste stream is dominated by organic matter, studies reveal inadequate source segregation. In similar study found that the 12.5% wet, 7.4% dry, and 0.07% hazardous waste segregated at source, reflecting systemic inefficiencies (Saranya & Arul, 2024). The GCC has increasingly privatized door-to-door collection and transportation, outsourcing 14 of its 15 zones to contractors under performance-linked models (The Hindu, 2023a). In contrast of the study the broader scale, Tamil Nadu's ban on 19 categories of single-use plastics in 2019 aimed to reduce plastic leakage. However, empirical research shows enforcement gaps and limited adoption of alternatives, particularly during COVID-19, when medical and packaging waste surged (Karthikeyan et al., 2020; Njeru, 2021). In similar study of the legacy dumps and biomining. Judicial oversight, particularly from the National Green Tribunal (NGT), has mandated biomining and remediation at Kodungaiyur and Perungudi (NGT, 2021). Even though Perungudi has seen significant progress, large-scale remediation remains incomplete, with challenges in leachate management and disposal of bio-mined residues (Subramanian, 2022). Materials recovery. The other study found that the Chennai has established Resource Recovery Centres (RRCs) and Material Recovery Facilities (MRFs), their effectiveness is hampered by low-quality input streams due to poor segregation (Shankar et al., 2021). In similar study for the waste-to-Energy. The GCC has initiated tenders for Waste-to-Energy (WtE) facilities; however, literature emphasizes risks such as unsuitable feedstock (due to high organic and moisture content), emissions management, and financial sustainability (Gupta & Kumar, 2019). In environment protection of the concerned study Court interventions have significantly influenced Chennai's SWM. The NGT has repeatedly directed the city to accelerate biomining, prevent fresh dumping of mixed waste, and submit compliance reports (NGT, 2021). The law engagement has compelled municipal accountability but highlighted systemic delays in execution (Subramanian, 2022).

The most of the studies had been converges on the view that source segregation is the linchpin for sustainable SWM in Chennai. Infrastructure investments—MRFs, composting plant still remain underutilized unless segregation improves. Furthermore, legacy waste remediation must address environmental safeguards for post-reclamation land use, while plastic policies must adopt systemic approaches combining Extended Producer

Responsibility (EPR), viable alternatives, and stricter enforcement. Finally, conceding and integrating the informal sector into formal waste governance remains a pressing research and policy gap in need an hour.

4. Material and Methods

4.1 Objectives

The specific objectives of the study are;

i) to examined the challenges and trends in solid waste management system;
ii) to analysed the solid waste management system and sustainable practices in respective study area; and
iii) to suggest suitable policy measures and improve of the good governance to upgradation of the solid waste management system.

4.2 Data Collection

The present study has been based on both qualitative and quotative nature of the sources. The required data have been collected with help of the questionnaire and published reports will be used and analysed.

4.3 Tools and Techniques

Present study has been a simple statistical tool used like mean, median, mode, coefficient variation, and necessary for the used regression analysis.

5. Analysis and Discussion

In Greater Chennai Corporation Area (GCC), covering about 1,189 sq. km, is the fourth-largest metropolitan region in India with a population of over 10 million (World Population Review, 2024). It is located on the Coromandel Coast, Chennai has a tropical wet and dry climate and is highly vulnerable to floods, cyclones, and climate risks (IMD, 2023). In economically, Chennai is the industrial and service hub of South India, contributing significantly to state GDP, with strong sectors such as automobiles, IT, and trade (Tamil Nadu State Planning Commission, 2022). However, about 28% of its population lives in slums, reflecting socio-economic disparities (MoHUA, 2020). The city generates 5,000–6,500 tonnes of solid waste daily, largely disposed of at Perungudi and Kodungaiyur dumpsites, both of which face issues of leachate, fires, and pollution (GCC, 2021; Chokshi, 2018). There are reforms and policy implemented like privatized collection, biomining of legacy dumps, decentralized waste recovery, and proposed Waste-to-Energy plants have been introduced, but challenges persist—particularly low source segregation (<15%), plastic leakage, and limited community participation (Saranya and Arul, 2024; Subramanian, 2022).

Table 1: Socio-Economic Profile of Respondents

Variable	Category	Frequency (N=105)	Percentage (%)
Gender	Male	57	54.3
	Female	48	45.7
Age Group	18–30 yrs	23	21.9
	31–50 yrs	52	49.5
	Above 50 yrs	30	28.6
Education Status	Illiterate	12	11.4
	School level	38	36.2
	Graduate	42	40.0
	Postgraduate	13	12.4
Monthly Income	Below ₹15,000	31	29.5

	₹15,001–₹30,000	40	38.1
	₹30,001–₹50,000	22	21.0
	Above ₹50,000	12	11.4

Source: Primary Data from 1 to 4.

The above table 1 shows that the socio-economic characteristics of the 105 respondents in respective study area. The sample shows a balanced gender distribution, with 54.3 percent male and 45.7 percent female. The majority of the respondents in 49.5 percent are aged between 31 and 50 years. In terms of education in 40.0 percent are graduates, while 11.4 percent are illiterate. The most of the respondent's monthly income in 38.1 percent earn between ₹15,001 and ₹30,000, indicating a predominantly lower-middle-income group. The socio-economic profile helps contextualize the study findings by highlighting the typical demographic and economic background of the participants.

Table 2 Regression Results on the Solid Waste Management Awareness of the Respondents

Independent Variable	Coefficient)	S.E.	Odds Ratio	p-value
Education Status	0.482	0.178	1.62	0.008**
Monthly Income	0.315	0.141	1.37	0.025**
Awareness of SWM Rules	0.704	0.256	2.02	0.005**
Constant	-2.341	0.712	–	0.001

*Dependent variable: Waste segregation practice (1 = regular segregation, 0 = otherwise)
**Independent variable: Education status (years of schooling), Monthly income (in ₹) and Awareness of SWM rules (1 = aware, 0 = unaware).
***Significance level: $p < 0.05$)

The above table 2 shows that the regression result shows that solid waste management awareness of the respondents. The education status of the respondents has been positive and significant coefficient ($p=0.008$) indicates that higher education levels strongly improve to adopting regular practices for the education has been significant role of the solid waste management practices. The income of the respondents has been positive effect ($p=0.025$) for the households with income above 30000 thousand showed higher compliance should be provide for the affordable rates like storage bins, alternatives to plastic and paid services. The awareness of solid waste management rules for the creation of the awareness doubles the probability of practicing such as information, education and communication have been significant role of the solid waste management practices.

Table 3 Environmental Attitudes of Respondents

Variables	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Mean Score	Interpretation
Waste segregation is necessary for a clean city	58 (55.2%)	34 (32.4%)	7 (6.7%)	4 (3.8%)	2 (1.9%)	4.35	Positive
Individual responsible for reducing household waste	52 (49.5%)	36 (34.3%)	10 (9.5%)	5 (4.8%)	2 (1.9%)	4.25	Positive
Environmental protection is more important than convenience	43 (41.0%)	38 (36.2%)	15 (14.3%)	6 (5.7%)	3 (2.8%)	4.07	Positive
Paying a small user fee for better waste collection is acceptable	39 (37.1%)	34 (32.4%)	16 (15.2%)	10 (9.5%)	6 (5.7%)	3.86	Moderate
Refuse avoids plastics and use eco-friendly alternatives	30 (28.6%)	33 (31.4%)	24 (22.9%)	12 (11.4%)	6 (5.7%)	3.66	Moderate

The above table 3 shows that the environmental attitudes of the respondents in Chennai metropolitan area. The most of the respondents strongly agreed that waste segregation mean value is 4.35, personal responsibility for the waste reduction in mean 4.25, environmental protection in 41 percent has been convenience for the minor group in 8.5 percent disagreed and remaining for the practical barriers. The most of the respondents have been user fee acceptance and willingness to pay for better collection services had a moderate mean score 3.86. The plastic use behaviour has been agreed on using eco friendly alternatives for the mean score 3.66 in actual adoption is not significant relationship of the awareness. The result findings that the respondents have been a favourable attitude towards environmental protection especially in relation to waste segregation.

Table 4: ANOVA Results – Education and Environmental Attitude

Source of Variation	Sum of Squares (SS)	Df	Mean Square (MS)	F-Value	p-Value
Between Groups	12.84	2	6.42	5.67	0.004**
Within Groups	115.76	102	1.13	–	–
Total	128.60	104	–	–	–

Note: $p < 0.05$ is significant.

The above table 4 shows that the ANOVA results in education and environment attitudes. The F-value 5.67 with p-0.004 indicates has been statistically significant relation between environmental attitude and education level such as post graduates had significantly higher mean scores in 4.32 compared with school level of the respondents 3.72 and under graduates 4.01 showed moderate scores, not significantly different from either group from Tukey test. The study findings that the higher education fosters stronger environmental awareness and responsibility in waste management practices.

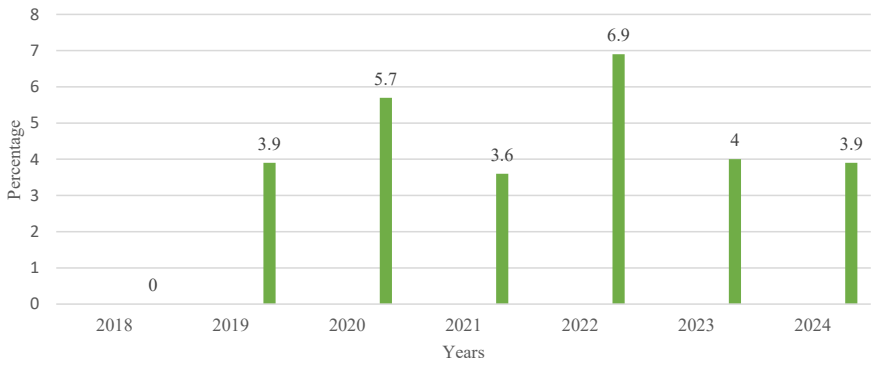
Table 5 Statistical Results on Performance and Growth Solid Waste Management in Chennai Period from 2018 to 2024

Year	Waste Generated (TPD)	Collection Efficiency (%)	Source Segregation (%)	Recycling (%)	Composting & Biomining (TPD)	Growth Rate of SWM (%)
2018	5,100	87.2	9.5	6.2	310	–
2019	5,300	89.0	11.8	7.6	360	+3.9
2020	5,600	90.5	13.1	8.4	420	+5.7
2021	5,800	92.3	14.5	9.1	480	+3.6
2022	6,200	93.8	15.2	10.3	610	+6.9
2023	6,450	94.1	16.7	11.6	750	+4.0
2024	6,700	95.4	18.9	12.8	890	+3.9

Source: Official website.

The above table 5 shows that the growth and performance of the solid waste management with statistical analysed. The solid waste generation growth has been increased 5,100 TPD in 2018 to 6,700 TPD in 2024 with an average annual growth of 4.3 percent. The collection efficiency has been improved steadily from 87.2 percent to 95.4 percent, solid waste segregation has been still low and gradually improved from 9.5 percent to 18.9 percent, recycling and composting rate double over 6 years between 6.2 percent and 12. 8 percent, when composting biomining showed strong expansion from 310 TPD to 890 TPD and overall solid waste management annual compound growth rate in 4.7 percent in performance indicators. The result findings that the solid waste management capacity reflects policy reforms, privatization of collection, biomining initiatives, and legal boards directives and infrastructure growth has outpaced for behavioural changes among citizens.

Fig 1. Growth of Solid Waste Management System in Chennai



6. Conclusion

Solid waste management has been significant role of the urban development, because locality have been extending and merging between rural and urban areas is challenge nature in general, especially for urban is major causes and sustained of the solid wase management vital role and decided for the good governance of the nation. The study findings by highlighting the typical demographic and economic background of the participants the awareness of solid waste management rules for the creation of the awareness doubles the probability of practicing such as information, education and communication have been significant role of the solid waste management practices. higher education fosters stronger environmental awareness and

responsibility in waste management practices. solid waste management capacity reflects policy reforms, privatization of collection, biomining initiatives, and legal boards directives and infrastructure growth has outpaced for behavioural changes among citizens. The study concluded that the effectively at gross root level for the such manner like good governance with coordination of the government and people together aware about sustainable solid waste management practices and solid audit should be clean urban reached at significant goals of the nations.

7. Future Research

The study has focused on analysing the solid waste management system and sustainable practices in the Chennai metropolitan area. In solid waste management remains a major challenge in most urban areas due to a lack of environmental awareness and the absence of strong environmental laws. It is suggested that the central and state governments should coordinate and work together to improve solid waste management practices across the nation. This joint effort will help achieve the Sustainable Development Goals (SDGs) and ensure the preservation of natural resources for future generations.

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Disclosure and Interests

There are no conflicts of interest or competing financial interests associated with this work. The study did not involve any experiments with human participants or animals, and all ethical standards were duly followed. The respondents participated voluntarily after being fully informed about the purpose of the study, and their responses were treated with complete confidentiality. The data supporting the findings of this research are available from the corresponding author upon reasonable request. Dr. Thamilmani R. conceptualized and designed the study, carried out data analysis, and prepared the manuscript. Dr. Saravanan M. contributed to data collection, literature review, and manuscript revision. Both authors have read and approved the final version of the paper.

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