Assessment of Municipal Solid Waste in Kaduwela, Sri Lanka: Composition Analysis and Policy Implications

N De Silva
Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka
M. Senanayake
Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka
M.R. Herath
Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka
S.Karunaratne*
Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka *shiromi.k@sliit.lk

***Abstract*—Municipal solid waste has become a huge challenge in Sri Lanka, especially in urban areas. The Kaduwela Municipal Council area is facing increasing pressure due to rapid urbanization, population growth, and rising living standards. Ineffective waste management practices have resulted in notable environmental degradation. Therefore, it emphasizes the growing necessity of sustainable and efficient approaches. This research focuses on evaluating the volume and types of municipal solid waste generated in Kaduwela, and attention is given to investigating the relationship between household income levels and the quantity of waste produced. A self-completion questionnaire and field observations were used for over one month to find out the waste management practices. SPSS and Excel were used for data analysis. According to the findings, three main disposal methods, such as municipal collection (50%), home garden pits (26%), and a mix of both (24%) were found. While 96% of respondents reported awareness of waste separation, 80% engaged in composting, and 64% burned some of their waste. There is a clear relationship between monthly income and waste generation. Higher income households generated more paper, plastic, polythene, and rubber waste, while lower income households produced more food, glass, metal, and other organic waste. These results indicate the importance of income-based waste management planning. Even though public awareness is relatively high, well organized support system has not been implemented yet. To address this, new technical and financial strategies should be implemented by local authorities. Programs such as "pay-as-you-throw" could be implemented to encourage responsible waste disposal. Incentives for home compost preparation, Waste separation before dumping, etc., along with strict enforcement of illegal dumping regulations, can promote better practices. Therefore, it needs better public engagement and institutional support to improve solid waste management in order to reduce environmental impacts, especially in rapidly urbanizing areas.**

Keywords: Waste composition, Income-level analysis, Waste disposal practices, Urban waste, Household behavior, Policy strategies

I. Introduction

Sri Lanka consists of a total land area of 62,710 km² (24,212 square miles) and is divided into 9 provinces and 25 districts. Sri Lanka has a current population of approximately 23.2 million, with 18.05% (around 4.19 million people) living in urban areas (Worldometers.info, 2025). Rapid population growth, rise in living standards and economic development have contributed to an increase in municipal solid waste generation which ultimately contributes for significant environmental and public health challenges.

Municipal solid waste generally includes non-toxic waste from households, institutions, commercial establishments, light industries, and agriculture, as well as non-hazardous hospital and laboratory waste. Globally, municipal solid waste generation reached 1.3 billion tons in 2012 and is expected to exceed 2.2 billion tons annually by 2025 (World Bank, 2017). In Sri Lanka, per capita waste generation is estimated at 5.1 kg per day (Weeraratne, 2017), translating to approximately 23,028 tons of daily waste from over one million households relying on local authorities for waste collection.

The composition of municipal solid waste varies by socio-economic factors. Studies show that household size, lifestyle & income level significantly influence the quantity and type of waste generated (Medina, 2002; Wijerathna et al., 2017). High-income resident areas tend to generate more recyclable materials such as paper and plastics, while lower-income residential areas produce more organic waste.

However, municipal solid waste management in Sri Lanka is obstructed by poor waste collection systems and limited technical capacity (Gunaruwan & Gunasekara, 2016). The tragic Meethotamulla landfill collapse in Colombo, which claimed 28 lives, underscored the implications of ineffective waste regulation (Gellers, 2017). Research, which was done based on surveys in Malabe, Battaramulla, and Kaduwela areas, reveals positive public attitudes toward waste separation and reuse, but also highlights barriers such as lack of awareness, institutional support,

and proper disposal facilities (Herath et al., 2015; Liyanage et al., 2015). Therefore, this study aims to investigate the composition of municipal solid waste in the Kaduwela area with a particular focus on how socio-economic factors such as household income influence waste generation and disposal practices. As the nature of waste continues to evolve and its presence becomes increasingly pervasive, effective management demands a holistic strategy.

Such an approach must be rooted in community participation, decentralized systems, appropriate technical interventions, strong institutional backing, and shifts in public attitudes, all aimed at safeguarding environmental integrity and public health.

II. METHODOLOGY

This research study utilized both structured questionnaire surveys and field observations to gather quantitative data. The selected methodology aims to investigate waste generation, composition, and the disposal practices of municipal waste within a specific urban area, which is kaduwela Municipal Council in Sri Lanka.

A. Literature Survey

Municipal solid waste consists of a variety of materials like paper, food waste, plastics, glass, etc. in common, and there are a few special types of waste in some households. Table 1 below outlines the breakdown of municipal solid waste in the United States for the year 2014, a dataset that is cited in international studies for comparison purposes (Encyclopedia, 2017).

Table 1. Total MSW generation in the US by type of waste

Waste type	Percentage
Paper	26.60%
Food waste	14.90%
Yard trimmings	13.30%
plastics	12.90%
Rubber, lather and textiles	9.50%
Metals	9.00%
Wood	6.20%
Glass	4.40%
Other	3.20%

In the Sri Lankan context, food and garden waste are the dominant components of household waste. Studies such as Sivakumar & Sugirtharan (2012) and Wijerathna et al. (2017) reported that over 85% of waste generated in urban and peri-urban households is organic. These findings justify the detailed segregation of waste in this study, particularly with a focus on compostable categories.

Socio-economic characteristics such as household income and access to municipal services significantly influence waste generation patterns and disposal (Senzige et al., 2014; Gunaruwan & Gunasekara, 2016). In general, higher-income households are more tends to discard greater quantities of packaging materials like paper, plastic, and polythene. And the lower-income groups often produce more organic waste, including food scraps and garden debris. These observed trends informed the inclusion of household income and family size as key variables in this study.

Study caried out by Herath et.al. regarding waste disposal in Malabe and Battaramulla Area indicate that many residents express a willingness to participate in waste sorting and composting, but their efforts are frequently constrained by insufficient infrastructure, low public awareness, and the absence of consistent institutional backing. Such gaps highlight the importance of combining survey responses with direct observation to capture a more complete picture.

Therefore, the methodological framework of this study, featuring a structured questionnaire and observational waste categorization, was directly informed by established research. The research design integrates both self-reported practices and direct analysis of waste composition and also allows for a comprehensive understanding of municipal solid waste (management within the selected urban setting.

B. Study Area Description

The study area is located within the jurisdiction of the Kaduwela Municipal Council, a suburban area located about 16 kilometers east of central Colombo. Kaduwela spans 87.7 km² and comprises 27 administrative wards and 57 Grama Niladhari (GN) divisions. According to GN division data, the total population was 260,341. The area exhibits a mix of socio-economic and educational backgrounds, offering a representative sample for studying urban waste generation behavior in a developing country context. Figure 1 shows the administrative divisions of the Kaduwela Area.

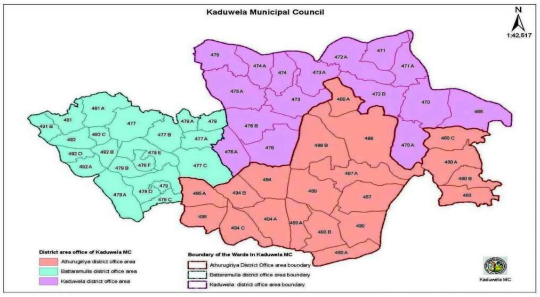

Figure 1. Administrative divisions of the Kaduwela

C. Sampling Strategy

This study has adopted a combined method with a structured questionnaire survey, together with direct field observations. The methodological framework of this study has facilitated the collection of both qualitative and quantitative data on solid waste generation patterns and waste composition. The research was conducted across 15 Grama Niladhari (GN) divisions governed by the administration of the Kaduwela Municipal Council. To ensure geographical and socio-economic representation, all 15 GN divisions were included in the sampling frame.

- Questionnaire Survey Sampling

The total population of the study area comprises 21,062 households. The standard statistical formula used has an error margin of 0.1% with a 95% confidence level. A sample size of 100 households was selected for the survey using the mathematical equation given (Eq.1), where N is the number of households and n is the sample size, with an error margin (α).

$$n = \frac{N}{1 + N(\alpha^2)} \quad (1)$$

To ensure even representation of households across all 15 GN divisions, a segmented random sampling method was used to select participants and households. Each respondent completed a self-administered structured questionnaire designed to capture information on household demographics, income levels, and solid waste management practices.

- Field Observation Sampling

For the field observation component, a subsample of 45 households was selected three households per GN division. Selection was made based on income stratification, according to past literature studies regarding income levels and composition to waste generation relationship, the income categories were divided as below in table 2. (Medina, 2002; Senzige et al., 2014; Wijerathna et al., 2017).

Table 2. Income stratification according to monthly income.

Income stratification	
Income type	Monthly Income
High-income households	> Rs.100,000
Middle-income households	Rs. 10,000–100,000
Low-income households	< Rs. 10,000

This categorization enabled comparative analysis across socio-economic groups. Selected households in this study were asked to separate their waste into 11 sub categories like food, paper, polyethylene, glass, metal, garden waste, plastic, rubber, textiles, leather, and miscellaneous items. Data collection has been conducted over a four-week period. The food waste was measured daily, whereas the remaining categories were recorded once a week. These two graded measurements have been helped to improve data accuracy and minimize biasing in sample handling.

D. Data Analysis

All collected data were processed using Microsoft Excel and analyzed with SPSS Statistics software. Descriptive statistics were applied to summarize the quantities of waste generated, while correlation and multiple regression analyses were used to explore the relationship between household income and waste generation patterns. The General Linear Model (GLM) multivariate test was conducted for the field observation data to analyze waste types and compositions

III. Discussion & Conclusion

This study examined municipal solid waste generation patterns, composition, and disposal behaviors across 15 Grama Niladhari divisions in the Kaduwela Municipal Council area. Data were collected through a questionnaire survey of 100 households and field observations of 45 households over four weeks, and the results have been interpreted and discussed below.

A. Household Waste Disposal Practices

The questionnaire survey included 100 households across all GN divisions, aiming to identify common waste disposal practices and they have been analyzed and represented graphically in this section.

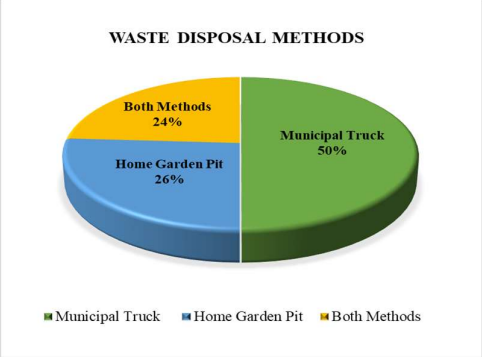

Figure 2. Waste disposal methods of households

According to the result representation in figure 2, out of the waste disposal methods in the area, 50% of households relied solely on the municipal collection service, 26% disposed of waste in garden pits, and 24% used both methods. This reveals a strong dependence on informal disposal strategies when municipal services are unavailable or unreliable.

Households using the municipal waste collection system displayed significantly higher levels of participation in waste separation compared to other disposal groups.

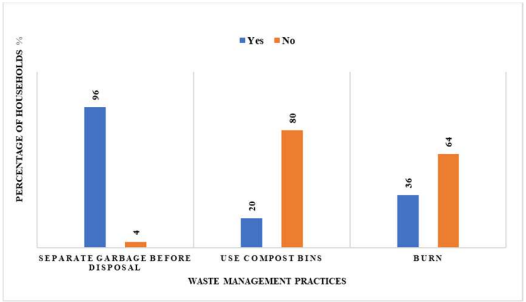

Figure 3. Waste disposal practices of people who dispose waste to municipal truck.

Figure 3 above shows that 96% of the households using municipal waste collection services has selected the option that they separate their waste. This justifies that many people are following formal waste guidelines, possibly due to greater awareness from public institutions. However, there's a clear gap when it comes to what happens with other practices because only 20% of these households actually compost their organic waste. This disconnect could be due to common urban issues like not having enough space, limited access to composting facilities, or simply a lack of motivation or rewards for composting. On top of that, around 36% of these households admitted they sometimes burn their waste. This might be because collection services aren't always reliable, or they need to get rid of things like garden clippings or items that aren't collected. These findings mirror earlier studies (e.g., Herath et al., 2015), which showed that access to formal services alone does not guarantee holistic, sustainable behavior. While municipal collection enables better sorting, community composting systems and regulation of open burning are necessary to advance waste management solutions.

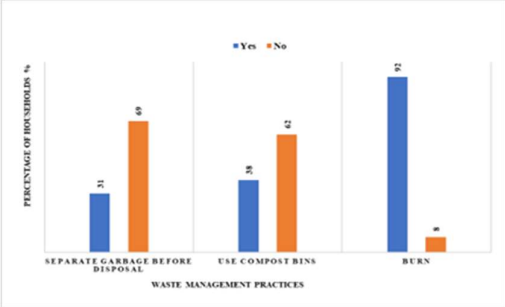

Figure 4. Waste disposal practices of people who dispose waste to home garden pits.

As per Figure 4, this shows deviated behavior compared to people who use municipal collection for their waste disposal. The analysis revealed that only 31% of surveyed households practiced waste separation, while a significant majority (69%) did not engage in any form of source segregation. Although composting was adopted by 38% of respondents, suggesting moderate uptake it remained underutilized, especially given the high organic content of household waste. A particularly concerning finding was that 92% of households reported burning their waste. There is a strong dependence on open burning as a disposal method, which poses serious threats to the environment, air quality, and public health. These human practices show the lack of awareness of sustainable waste practices, with the barriers in infrastructure adequacy. The results are consistent with prior studies (e.g., Herath et al., 2015; Wijerathna et al., 2017), reinforcing the urgency of targeted interventions like backyard composting initiatives, expanded waste collection services, and stricter controls on open burning.

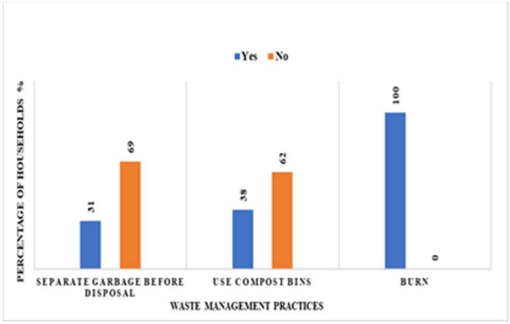

Figure 5. Waste disposal practices of people who dispose of waste using both methods.

Figure 5 represents the waste disposal practices of the households that utilized both municipal collection services and home garden pits for their waste disposal. It shows that only 31% of respondents reported separating their waste, while the majority (69%) did not engage in source segregation, likely due to confusion arising from having multiple disposal options. Composting was adopted by 38% of households, a rate slightly higher than that observed among municipal-only users. However, this figure still falls short of its potential, given the high possibility of household waste containing organic-rich waste. 100% of them use burning, which is the most disconcerting finding that all households practiced regardless of whether they had access to formal collection services or composting facilities. This burning process poses significant risks to both environmental quality and public health and highlights serious shortcomings in existing waste management support and oversight systems. The findings make clear that using different disposal methods does not improve waste management, but there should be Regulatory frameworks from the government sector. It can be started with public education to prevent the continuation of harmful practices like open burning. Addressing this requires targeted community-level engagement and stricter enforcement of anti-burning policies, as well as investment in decentralized composting infrastructure to reduce organic waste at the source.

B. Waste Composition and Income-Based Variation

As illustrated in Figure 6, food waste accounted for the highest share, contributing to 85.4% of total household waste generated per day. This overwhelming dominance of organic waste aligns with previous findings in Sri Lankan urban and semi-urban areas (Visvanathan, 2006; Sivakumar & Sugirtharan, 2012), where diets and disposal practices result in significant biodegradable output.

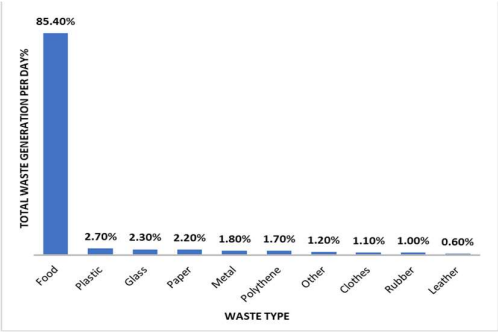

Figure 6. Waste Composition of households per 1-month period

Compared to waste composition, leather comprise 0.6% of the total waste composition, which is the least percentage of the total. Other significant contributors included plastic, glass, paper, metal, polythene, rubber, clothes, and miscellaneous waste in percentages of 2.7%, 2.3%,2.2%, 1.8%,1.7%,1.0%,1.1% & 1.2% respectively.

In order to examine the relationship between income and waste generation, a General Linear Model (GLM) was applied. The analysis showed that only glass waste has statistically significant variation with income level ($p = 0.01$). Despite the limited statistical significance, as per the multiple regression model value of $R^2 = 0.643$ with strong explanatory power reveals that the composition of household waste is influenced by household income in considerable extent and will vary according to income type.

Visvanathan (2006) identified food waste as the dominant category in the region, while Sivakumar and Sugirtharan (2012) reported that in Sri Lanka's Batticaloa District, waste composition comprised 88% food waste, followed by 3.6% paper, 2.3% glass, 2.1% polythene, 2.1% metal, and 1.9% plastic. These findings are consistent with the current study, which also observed food waste as the most prevalent category.

During the assessment of the relationship between waste generation and socio-economic variables such as income and family size, the results of the general linear model (GLM) indicated that none of the waste categories exhibited statistically significant correlations with the selected socio-economic variables ($p > 0.05$). But glass waste ($p = 0.010$) shows significance compared to other types. Consequently, the reason for not having established a strong statistical relationship between income levels and household size from the General Linear Model (GLM) may be the relatively small sample size ($n = 45$). suggesting that future studies should adopt larger sample sizes or expand the range of independent variables to improve model accuracy.

Table 3. Model summery of the multiple regression

Model	R	R^2	Adjusted R^2	Std. Error
1	.802[a]	.643	.524	.570

a. Predictors: (Constant), other, food, plastic, lather, paper, metal, glass, clothes, polythene, rubber, depending on the R value, 0.8, which is close to 1, it can be said that this model is strongly correlated. So that it can be said that the income level is strongly correlated with the generation of waste.

Table 4. Independent Variables of the multiple regression method

S2	FOOD	food
S3	PAPER	paper
S4	POLYTHENE	polythene
S5	GLASS	glass
S6	METAL	metal
S7	PLASTIC	plastic
S8	RUBBER	rubber
S9	CLOTHES	clothes
S10	LATHER	lather
S11	OTHER	other

Table 4 shows the variables of the model and the model is given as ;

$$Y=c+\alpha_2S_2+\alpha_3S_3+\alpha_4S_4+\alpha_5S_5+\alpha_6S_6+\alpha_7S_7+\alpha_8S_8+\alpha_9S_9+\alpha_{10}S_{10}+\alpha_{11}S_{11}+\varepsilon$$

According to the coefficients of multiple regression analysis, the model can be developed as,

$$Y=-7.406E\text{-}5S_2+6.510E\text{-}5S_3+.002S\_4\text{-}.001S_5-4.216E\text{-}5S_6+7.508E\text{-}5S_8\text{-}6.171E\text{-}5S_{10}\text{-}.001S_{11}+1.232$$

The correlation analysis has both positive and negative relationships between income and waste type. Positive correlation coefficients were found for polythene, paper, plastic, and rubber waste. It indicates that these waste types are mostly used by higher-income households with high consumption of packaged foods of high quality, which are typically associated with higher living status, producing more synthetic and non-biodegradable waste.

Negative correlations were observed for food, glass, metal, leather, and miscellaneous waste, indicating that these waste types reduce the usage with the increase of income. For example, lower-income households may produce more food waste due to a lack of management in their households, such as bulk purchases and limited storage. Similarly, increased residual waste from firewood furnace use in their kitchen instead of using Gas cookers. Firewood use may account for higher levels in the "other" category among these households.

These correlations underscore that income influences both the volume of waste and the composition of household waste. Lower-income households often have low family standards

characterized by limited education and limited access to waste management services due to other households also practicing the same ways of waste disposal. They also demonstrate lower levels of awareness regarding waste disposal and sustainability concepts. This can contribute to the increased generation of large amounts of organic and residual waste. In contrast, higher-income households, though more inclined to separate waste, produce greater volumes of waste such as plastic and packaging due to their luxury life, even though they are knowledgeable about sustainability and waste management practices. These findings highlight the importance of designing waste reduction strategies specifically depending on these socio-economic parameters in order to have well organized waste management system.

C. Implications for Waste Management Policy

The findings of the study align with Sri Lanka's National Policy on Waste Management and the Urban Waste Management Guideline No. 01/2025, which emphasize source separation and a circular-economy approach; high awareness of segregation among Kaduwela households indicates policy messages are reaching communities. Although most people surveyed, around 96%, knew about separating their waste, many of them still resorted to burning it. This suggests that knowing what to do doesn't always lead to action. The issue seems to lie more with the lack of proper facilities and infrastructure than with public awareness. Similar problems were seen in Malabe, as noted by Herath and colleagues in 2015. This aligns with Fernando and Tsuji (2024), who, in their comparative study of Sri Lankan and Japanese waste management systems, identified weak community participation, inadequate legislation, low stakeholder engagement, and significant institutional capacity gaps in Sri Lanka.

To improve waste management, solutions need to be tailored to each community's needs. Wealthier neighborhoods might benefit more from better recycling systems, especially for paper and plastics. On the other hand, lower-income areas may need more support in handling organic waste and increasing awareness about its proper disposal. Introducing policies like "pay-as-you-throw" and expanding regular municipal waste collection services could help people follow through with environmentally friendly practices.

In conclusion, the study shows that while public awareness of waste management is relatively high, there is a need for improved institutional support, infrastructure, and policy enforcement to translate awareness into consistent practice. Future research could expand the sample size and include additional socio-economic variables to refine predictive models for waste generation. Ultimately, a combination of policy reform, community participation, and technical innovation will be critical to developing a resilient and sustainable waste management system for rapidly urbanizing areas such as Kaduwela.

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