SRI LANKA JOURNAL OF GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT

SLJGEM (2024), Vol. 01 (02)

Journal homepage: www.sab.ac.lk/sljgem

ECONOMICS OF SOLID WASTE MANAGEMENT WITH SPECIAL REFERENCE TO COLOMBO MUNICIPAL AREA

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ARTICLE INFO

Article History:
Received 15 Aug 2024
Accepted 28 Sep 2024
Issue Published Online 23 Dec 2024

SLJGEM (2024), Vol. 01, Issue (02), pp. 110-127

KEYWORDS

Household Behavior
Waste Generation
Willingness to Pay
Socioeconomic Factors

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ISSN 3051 5335 (Online)

Published by:

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ABSTRACT

The 'Willingness to Pay' (WTP) for improvements in waste management services, the interaction between waste components in different zones, and the influence of household behaviour on garbage creation and management are some of the important aspects of waste management that this study seeks to investigate. In the Colombo district municipal council area, 432 households were taken into consideration. The per-capita waste generation is 0.29 kg. /person/day in all the zones of the city. The per capita waste generation is found to be the lowest in Zone One and highest in Zone Three. However, the results show that as there are more open spaces to throw the waste people tend to generate more and more waste. The waste component relationship shows that the size of the household and income are the major factors determining the total quantity of waste in all the zones. More than 75b per cent of the households are willing to pay for a better waste management system. On average, they are willing to pay Rs.72 per month. The willingness to pay differs from zone to zone. On the other hand, income is the main factor which determines willingness to pay. It was also found that waste generation is negatively associated with education. They might not want to pay because they believe it is not their problem to deal with the waste management issue. It might be wise to reconsider the municipality's involvement in offering this service in light of the major findings. Without compromising public access, implementing a cooperative model with shared expenses and duties could improve sustainability.

How to Cite this Article: *Gunarathna, AMI. (2024). Economics of Solid Waste Management with Special Reference to Colombo Municipal Area. SLJGEM, 01(02), pp. 110-127.*

1. INTRODUCTION

The roots of solid waste management (SWM) can be found in prehistoric societies that used simple techniques for getting rid of waste like landfills. Nonetheless, waste generation increased significantly as a result of the Industrial Revolution and the ensuing urbanization. Solid waste was deemed a public health hazard by the 20th century which led governments to create regulatory frameworks.

Fifty years ago there was hardly any problem of SWM in Sri Lanka. The solid waste was managed locally in all the urban and rural areas of Sri Lanka as well as in the Colombo Municipal Council (CMC) area. Almost all wastes were organic and were used as compost. Traditionally, there was hardly a special case involved in waste management actions. In the olden days, people used primitive methods to collect waste from settlements. Such primitive methods include using buffalo ribs to lift the waste and shoulder baskets to carry the waste. The rubbish that was gathered using such archaic methods was dumped in open fields or on the banks of adjacent rivers. Because organic garbage was thrown in modest quantities back then, the water flow in rivers was able to degrade it. The growing urban population densities made it impossible for these customary activities to continue. The amount of waste produced by people has increased as a result of population density growth. Because effective SWM has not been implemented, this has caused a serious hazard to public health.

Over time, Colombo Municipality's SWM issue has gotten worse. Currently, concerned municipalities assist with the task of managing solid waste. With the help of money that the towns have available, the service is rendered virtually without cost. The SWM accounts for almost one-third of the Metropolis's overall spending. However, according to the view of the professionals on the subject, unmanaged waste disposal is considered to be one of the main causes of environmental problems in the CMC area followed by unmanaged sewage. However, this problem is not just confined to the CMC area but almost all highly populated cities of Sri Lanka suffer from this problem. As a result, SWM is becoming a more pressing problem in light of Colombo's urban environmental degradation. The population of Colombo is growing at the fastest rate of any Sri Lankan city, at over six per cent (Alwis, 2000). Over time, there has been a rise in both the quantity and the volume of non-biodegradable trash due to the rapid population growth and rising consumption of packaged goods. More than half of all rubbish produced in Sri Lanka comes from Colombo alone. Merely a minor portion of the whole urban waste is being gathered in containers and sent to the landfill.

Since SWM is hard to isolate from the dynamics of the general market, it is likewise a non-excludable good. One method of managing non-excludable goods or services is by a combination of command and control, internalization of costs, or both. For this, government action is required. When the costs of creating an item or service decrease as more of it is produced and when its usage or production has "externalities" like pollution of the environment, then the government's action is prudent.

According to one of the Central Environment Authority (CEA)'s research, improper waste management is the primary factor contributing to environmental issues in Colombo and its surrounding areas. Unmanaged sewage is the next growing problem and SWM. Over time, there has been a rise in both the quantity and the volume of non-biodegradable trash due to the rapid population growth and rising consumption of packaged goods. More than half of all garbage produced in Colombo comes from the city itself.

1.1 Objectives of the study

In this study, the specific objectives are;

- to investigate the willingness to pay for changes in the provision of waste management services,
- to analyze the relationship between the waste components in different zones, and
- to explore home behaviour-related garbage generation and management are the main goals of this study.

2. LITERATURE REVIEW

The SWM which includes the gathering, moving, processing and discarding of different waste materials is an essential part of urban sustainability. The difficulties of efficiently managing waste have increased as industrialization and urbanization continue to grow. Through an analysis of important studies and reports this literature review seeks to investigate the developments innovations difficulties and prospects for SWM practices.

2.1 Classification of Solid Waste

Usually, solid waste is divided into multiple streams, such as Municipal Solid Waste (MSW) and Industrial waste. MSW management is a term used to describe waste that is generated in homes and businesses. It typically consists of organic materials paper plastics metals and glass (Hoornweg & Bhada-Tata, 2012). Industrial waste is produced by manufacturing and other industrial operations frequently, and hazardous materials are present (Hickman, 2017). Biomedical waste refers to medical and clinical waste that needs to be disposed of according to certain guidelines because it may pose health risks (WHO, 2018).

The term E-waste is used to describe abandoned electronic equipment that contains hazardous materials like lead and mercury which present serious environmental risks (Forti et al., 2020). It is essential to comprehend these categories to create customized management plans.

2.2 Current SWM Strategies

Modern SWM has progressed towards more sustainable and integrated methods that emphasize waste reduction, recycling, and reuse. Key strategies include waste hierarchy which is the waste management hierarchy that promotes practices that prioritize waste prevention, followed by reuse, recycling, energy recovery, and finally disposal in landfills (UNEP, 2015). Waste-to-energy (WTE) is the conversion of waste materials into energy is a method gaining prominence. Literature by Kothari et al (2010) notes that WTE technologies, such as incineration and anaerobic digestion, help in reducing waste volumes while generating energy.

Recycling and Resource Recovery: Many cities have implemented recycling programs aimed at recovering valuable materials such as plastics, metals, and paper, which contribute to reducing the strain on landfills and conserving natural resources (Hopewell et al., 2009).Composting: Organic waste management through composting has become a widely adopted method for handling food and garden waste, as evidenced by studies conducted by de Bertoldi et al (2017). Landfilling: While landfilling remains a prevalent waste disposal method, recent advancements have focused on the development of sanitary landfills designed to minimize environmental impacts (Rada et al., 2013). Modern SWM prioritizes reuse, recycling, and waste reduction as part of more sustainable and integrated approaches. The Waste Management Hierarchy, a set of guidelines established by UNEP (2015), emphasizes waste prevention as the top priority, followed by reusing, recycling, energy recovery, and finally, landfill disposal.

2.3 Technological Advancements

Important technical advancements have been made in the SWM field. Reduced operational costs and optimized waste collection routes have resulted from the integration of smart waste management systems which make use of sensors data analytics and the Internet of Things (Caggiani et al., 2019). Research on Material Recovery Facilities (MRFs) shows that sorting technologies have become much more automated which has increased recycling efficiency (Dijkgraaf & Gradus, 2016). Furthermore, the Ellen MacArthur Foundation (2019) suggests that waste generation should decrease as a result of developments in biodegradable materials and circular economy models.

2.4 Challenges in Solid Waste Management

Despite these developments, SWM still faces the difficulties of Urbanization and Population Growth, Public Participation and Policy and Regulation. Cities face increasing waste because of rapid population growth and inadequate infrastructure, particularly in developing nations (Gupta et al.,2015). Public Participation in the success of recycling and waste segregation programs depends on public cooperation and awareness. Research by Afroz et al (2011) demonstrates that two common obstacles are a lack of knowledge and engagement. Policy and Regulation: Many nations continue to lack thorough laws and appropriate procedures for enforcing them. According to Guerrero et al. (2013), there is frequently a lag between the creation of policies and their implementation. Financial constraints: According to Wilson et al (2015), municipalities located in low-income regions frequently do not have the necessary funds to invest in sophisticated waste management technologies or even basic waste collection services.

2.5 Environmental and Health Impacts

There are serious health and environmental hazards associated with improper waste management. As a result of gas emissions from landfills groundwater pollution disease transmission through vermin and insects and open dumping sites landfills can also cause air pollution. Research like that done in 2009 by Giusti, highlights how landfills have long-term effects on the environment generating leachate and emitting greenhouse gases. The literature documents the health risks, especially for scavengers and waste workers Agarwal et al (2007) emphasizing the dangers of exposure to chemicals and unhygienic surroundings.

2.6 Sustainability and the Future of SWM

Governments and organizations are trying to match waste management strategies with environmental objectives so sustainability in

SWM is becoming more and more crucial. In-depth descriptions of the circular economy provided by Kirchherr et al. (2017) advocate for minimizing waste by reusing materials and incorporating waste back into production cycles is gaining popularity. Expanding in significance are Extended Producer Responsibility (EPR) initiatives which mandate that producers oversee the elimination of their goods. Such initiatives encourage businesses to cut waste and create products that are safer to recycle or dispose of according to research by Bouvier & Wagner (2011).

2.7 Economies of SWM

Hickman (2017) uses an economic lens to look at how municipal solid waste is generated and managed. According to the author, two-thirds of a kilogram of waste per person per day, or 1.3 billion metric tons, was generated globally in 1990 as a result of municipal solid waste. In comparison to their percentage of the global population, industrialized nations produce a disproportionately large amount of garbage, whereas developing nations produce a disproportionately large amount of waste about their share of global revenue. Studies conducted both nationally and over time show that the amount of municipal solid trash generated is positively correlated with changes in per capita income and that, in nations with similar per capita income, the amount of municipal solid waste generated per person is not affected by population size.

In an Indian case Qazi et al (2018), deal with a cost-benefit analysis of landfill systems with gas recovery for municipal SWM. The advantages and disadvantages of alternatives for urban SWM are studied in this analysis. The recovery and reuse of landfill gas generated in MSW landfills is economically viable in most situations. A case study of cost-benefit analysis of landfill systems with gas recovery options has been carried out for Port Blair City, Andaman Islands, and India. A saying of about Rs 0.09 billion per annum regarding an existing system of MSW disposal is evaluated.

Qiao and Alam's (2020) 'Appraisal of Solid Waste Collection Following Private Sector Involvement in Dares Salaam City, Tanzania' discusses the results of research that was conducted in the city to evaluate the solid waste collection and disposal process after it was partially privatized. Before the assessment, fieldwork research showed that the city's current rate of solid waste generation is 0.4 kg/cap/day and that its daily total garbage generation is between 2425 tons and less.

According to this study, out of the total waste generated, 957 tons are collected daily by the three city municipalities (231 tons/day, or 10 per cent of the total generation), private solid waste collection contractors (592 tons/day, or 24.4 per cent of the total generation), and recycling (134 tons/day, or 5.5 per cent of the total generation). According to these results, solid waste collection in Dar es Salaam city has improved since it was privatized in 1994, rising from 10 per cent of total waste generated in the city per day to 40 per cent in 2001.

Since garbage recycling and composting are thought to be the best ways to achieve sustainability in waste management, the report suggests that these initiatives be supported.

According to Yukalang et al. (2018), Yala is an 80,000-person city in southern Thailand that is renowned for its cleanliness and orderliness. It has, however, encountered issues with garbage disposal and has looked for alternate methods, such as recycling, to deal with these. A set of new procedures were implemented, one of which is explained here ('Garbage for Eggs'). At monthly exchanges held in local communities, residents were urged to provide recyclable materials in return for eggs, with a focus on impoverished populations.

In addition to reducing trash, the project sought to empower communities via self-sufficiency and build new, more equal, and less dependent connections between impoverished communities and the local government. The experiment was initially successful in encouraging the removal of a backlog of wasted items, particularly glass, which improved the communities' environments. However, over a year of monitoring, the quantities brought in for exchange steadily decreased to much lower levels.

A systems study has been conducted to examine several possibilities for treating municipal solid waste. Anaerobic digestion and composting, materials recycling of segregated plastic and cardboard containers, and biological treatment (composting and cremation) of biodegradable trash were investigated and contrasted with landfilling. The assessment included information on energy resource utilization, environmental effects, and financial and environmental expenses. Aurnob & Kazi's (2019) study made use of a calculating model (Orware) that was built using the Life Cycle Assessment technique. Three Swedish municipalities - Uppsala, Stockholm, and Alvdalen - were the subjects of case studies. The study demonstrates that decreased landfilling in favour of enhanced material and energy recycling reduces the impact on the environment, lowers energy resource use, and lowers economic expenditures. Energy-rich trash should not be disposed of in landfills as much as feasible, primarily due to the low resource recovery rate associated with landfilling in addition to its detrimental effects on the environment. There are not many differences between incineration, nutrient recycling, and material recycling; but, generally speaking, plastic recycling is somewhat better than incineration and biological treatment.

When planning waste management, it's critical to understand how the method of waste treatment you choose will impact operations that take place outside the waste management system, like the production of energy, district heating, car fuel, plastic, cardboard, and fertilizer.

For more than ten years, managing solid waste in the Kathmandu Valley of Nepal has been difficult, particularly when it comes to landfill location. A significant environmental and public health issue has been brought about by the existing practice of illegally disposing of solid garbage along riverbanks. The purpose of this study was to evaluate Nepal's solid waste management system using data that had been published. According to the data, 70 per cent of Nepal's solid waste is organic. Therefore, the ideal method of disposing of solid waste is to compost it and use it on the land. This will lengthen the landfill's life and decrease the volume of rubbish that is delivered there Kinnaman & Fullerton (1997).

Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis based on stakeholders for effective management of solid waste in Lucknow, India's municipal system, Waste Management, February 2005.

The largest city in Northern India, Lucknow, is the subject of this investigation's case study since it suffers greatly from a serious issue with municipal solid garbage and its management. This community participation research is a successful application of a qualitative inquiry employing the SWOT. This qualitative study highlights how the municipal corporation's resources are inadequate to facilitate Municipal Solid Waste Management (MSWM) services in Lucknow without community involvement. To create strategic action plans for MSWM to mobilize and utilize both municipal corporation and community resources, a SWOT analysis was conducted. It has made it possible to implement a participative strategy for improved community and Municipal Corporation cooperation in Lucknow, India. Using a stakeholder-based SWOT analysis, an attempt was made to investigate how a community-based MSWM program would be able to turn potential 'threats' into 'opportunities' and turn potential 'weaknesses' into 'strengths'. Concrete strategic action plans were created as a result of this inquiry to enhance MSWM in Lucknow for the Municipal Corporation as well as the community (Bhatia & Pal, 2022).

3. MATERIALS AND METHODS

Secondary data from the CEA and the CMC were used in this investigation. There are 47 wards in the CMC area and when it comes to patterns of land use and population density, wards are not homogeneous.

Zone one (C21, C23, and C30), Zone two (C17), and Zone three (C33) can be used to group all the wards based on factors such as land use, settlement density, and population density. Out of the 47 wards, 5 wards (10%) were chosen for field research. Zones one, two, and three were covered by the wards that were chosen to increase the sample's representativeness. Consequently, one ward from zone two (C17), one from zone three (C33), and three from zone one (C21, C23, and C30) were chosen. Table 1 provides information on the sample size and the chosen wards.

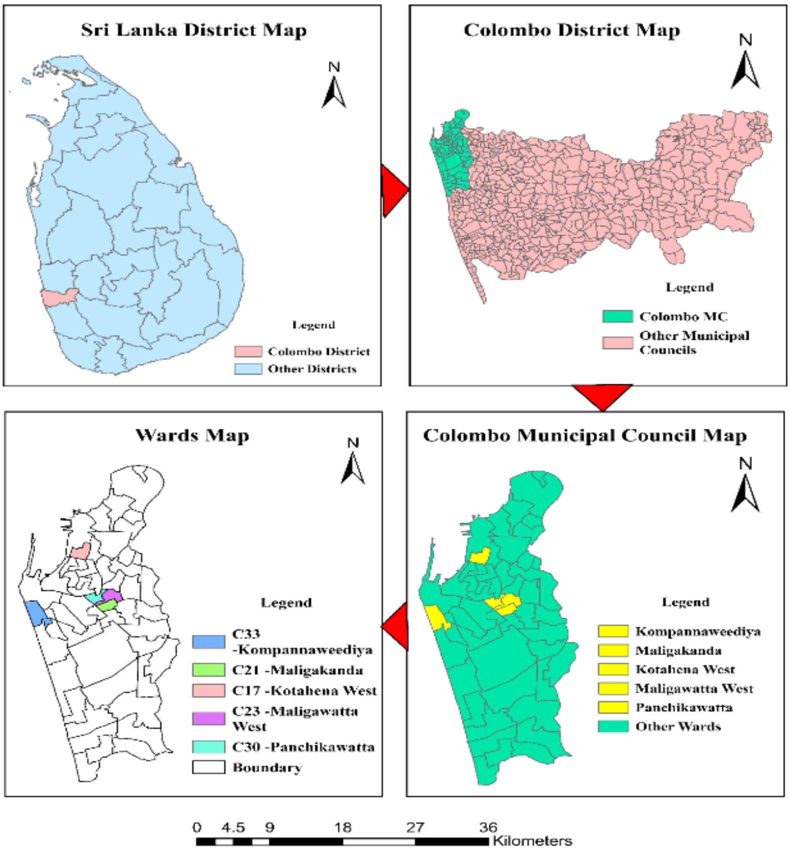

Figure 1: Study Area
Source: Prepared by Author Based on 1:50,000 Digital Data, Survey Department of Sri Lanka, 2024

Table 1: Sample households

Ward	Total HH (Num)	Sample HH (Num)	Total HH %	Area Covered by sample(Sq. Km)	Total Population	Population Density Per Sq. Km)
C 21	3,460	173	5	0.49	12,826	148,624
C 22	775	41	5	0.67	6,506	9,710
C 30	1,122	57	5	0.19	8,587	45,194
C 17	385	31	8	0.55	10,068	183,069
C 33	2,486	130	5	0.26	10,915	41,980
Tot	8,228	432	5.25	2.15	48,902	428,577

Source: Field Survey 2023, Developed by author

Out of the households in the chosen wards, about 5 per cent of the households were chosen. As a result, 432 households in all were chosen from the five wards that were chosen. Using the list of electors, the households were chosen at random. Within the ward, an effort was made to cover the entire locality.

3.1 Willingness to Pay and its Relationship with Other Variables

The SPSS was used to create a regression analysis. Regression analysis was performed on "Willingness to Pay" using the following variables: Total Income of the Household (TOTI), Travel Time to the Municipal Collection Center (TTR), Additional Land Area Around the House (EXTLA), and Members of the Household who Sat for GCE A/L or Above (EDU). COTR, or Consciousness Training, was considered a dummy variable. Regarding the independent variable's coefficient, a few assumptions were made.

Hypothesis 1

It is anticipated that as income rises, so will consumer demand for commodities that include convenience elements and services. For any kind of waste, the coefficient's sign should be positive.

Hypothesis 2

The Willingness to Pay (WTP) will be positively impacted by the Quantity of Waste per Household per Day (TOTW), meaning that more income will boost WTP to improve waste management.

3.2 Waste Generation and its Relationship with Socio-Economic Variables

The data for household waste components, broken down by the kind of material deemed potentially recyclable, form the basis of the analysis. Waste typically results from consumption. It is possible to express the connection between waste and consuming activities (Nanda, & Berruti, (2021).

$$W = \beta C$$

Were,

W = vector of components of solid waste

β = vector of technical waste transformation coefficients relating the types and quantities of solid waste to each consumption activity

C = is a vector of consumption activities selected by the households

The consumption of more than one commodity may result in the generation of any specific waste. In this case, there is no attempt to determine the technical waste transformation coefficients connected to the specific items. It primarily attempts to compare how various waste generation kinds and socioeconomic factors influencing trash quantity are related to each other.

Environmental consciousness influencing household consumption activities is thought to be monthly household income (TOTI), household size (TOTPOP), household education level (EDU), and additional land area in the hue compound (EXTLA). The waste component's model is as follows:

$$TOTW = \beta_o + \beta_1(TOTI) + \beta_2(TOTPOP) + \beta_3(EDU) + \beta_4(EXTLA)) + \beta_5(CS) + \varepsilon$$

.... ***Equation 1***

Where,

TOTW is the quantity of waste per household per day (Kg)

TOTI is the Monthly income of the household (Rs.)

TO TOP is Household size (number of persons)

EDU is Educational status (number of household members who sat for G.C.E A/L or above)

EXTLA is Extra land area within the compound of the selected household (ha.)

Here household is assumed as a production unit producing solid wastes.

4. RESULTS AND DISCUSSION

Regression results of the waste production function defined above are reported in Table 2. Figures given in parentheses are t-stats indicating the two-way level of significance. Results are reported for the entire sample and each zone separately. Except for EXTLA and EDU, all other coefficients are statistically significant at 5 per cent and with the expected signs. All the models indicate that family income and the size of the household contribute positively to waste production. Rich people and larger families produce more waste than the others. An increase in family income by one rupee will increase waste production by 0.25kg in general. This varies among different segments of the sample. For example, the relationship between income and waste generation is strongest in zone 3 and lowest in zone 1.

Table 2: The estimated coefficient

Waste Component	Intercept	HH Income (TOTI)	HH Size (TOTPOP)	Extra Land (EXTRA)	Education (EDU)
TOTW (all zones)	-2.68 (7.60)	0.25 (6.24)	0.50 (8.50)	0.07 (1.58)	-1.06 (2.70)
TOTW (zone one)	-2.17 (-3.80)	0.18 (2.79)	0.53 (5.80)	-0.80 (-1.90)	-0.02 (-0.37)
TOTW(zone two)	-2.6 (-3.60)	0.25 (3.04)	0.51 (5.50)	0.03 (0.47)	-0.30 (-3.72)
TOTW(zone three)	-3.88 (-6.20)	0.39 (6.08)	0.40 (2.79)	0.07 (1.04)	0.04 (0.58)

Source: Field Survey 2023, Developed by author

The effect of household size on waste production is greater than that of family income. According to Table 2, an increase of households by one member will increase waste production by half a kilogram. Variation of household size on waste production varies over different zones. In that smallest coefficient is reported for zone 3. For all others, it is nearly 0.50 indicating each additional household member produces half a kilogram of waste.

The effects of extra land and education have mixed results. In many cases, regression coefficients are statistically insignificant. Perhaps, this may represent the complex nature of the relationship between waste production and the relevant variables. In the case of extra land, is not waste production affected. Extra land would affect waste disposal. Households with the same amount of extra land would have disposed of waste at different proportions. Mixed results in that variable would be an indication of that.

The effect of education on waste production is also complex. There are arguments for both sides. Educated people are busy with their day-to-day employment activities and therefore, their consumption pattern would have contributed to increased waste (in terms of packing waste). If this is true, we expect a positive relationship. However, at the same time, one can also argue that educated people are more careful and concerned about environmental factors and therefore they try to produce and dispose of minimum waste. This suggests a genitive relationship.

4.1 Willingness to Pay for SWM Services

Finding out the residents' "WTP" for trash management was one of the questionnaire's components. Most of them ignore how the waste is eventually disposed of. Table 3 displays the individuals' willingness to pay as well as their involvement in the fee collection mechanism. For the collection of their waste, 68 per cent of families that take part in the fee-based collection scheme pay an average of Rs. 75 per month. Nonetheless, the rate of engagement varies depending on the zone. In Zone Two and Zone One, about 70 per cent of people are involved, compared to just 40 per cent in Zone Three. Better waste management is something that 47 per cent of households are willing to pay for, with an average monthly WTP of Rs. 63.

Table 3: Participation in Fee Collection System and Willingness to Pay

Zone	People participating in the fee collection system			People ready to pay and amount of willingness to pay			Total WTP includes a willingness to additional pay and the monthly income fee		
	Number of HH	Avg. fee in Rs.	Tot. Avg.	Num. of HH	Avg. WTP in Rs.	Tot. Avg.	Num. of HH	Avg. amount in Rs.	Tot. Avg.
All Zones	250 (68)	75	40	220(47)	63	30	340 (76)	80	70
Zone one	124 (70)	30	26	98 (69)	71	46	98 (80)	70	72
Zone two	145 (70)	82	55	50 (27)	60	20	135 (78)	72	75
Zone thee	60 (40)	89	34	72 (51)	62	36	87 (69)	75	70

Source: Field Survey 2023, Developed by author

The zone-by-zone situation varies here as well. Most of the homes paying fees for waste collection were content to pay the amount they were paying because they did not perceive any issues with the rubbish being collected. In addition, those who chose not to engage in the fee collection system were only willing to contribute a portion of what their neighbours were. Since the question concerns readiness to pay more than the current charge for improved waste management, the total willingness to pay includes both the actual fee and the amount of desire to pay. The average amount that 78% of the sample households are willing to pay for trash management is Rs. 80, but the amounts in Zones 1, 2, and 3 are Rs. 70, Rs. 72, and Rs. 77.

The total willingness to pay's average value does not match the sum of the willingness to pay's and fee's average values. The majority of the willing-to-pay homes are those that do not use the fee-based door-to-door collecting method. They were questioned about their readiness to pay extra for improved trash management, and several of them said they would be willing to pay.

Some said they were only able to afford the current amount. As a result, rather than dividing all of the households, just the applicable number is divided to get the average amount. Table 3 displays the overall mean. Merely Rs. 57 is the average total willingness to pay. The average willingness to pay is merely Rs. 30, whereas the average total charge is Rs. 40.

When asked how much their WTP for waste management was, several of the households responded with extremely low amounts, starting at Rs. 50. Although there is a regular municipal collection system in the Zone One city region, families are only ready to pay a little sum to have their waste collected. Typically, the waste is collected by municipal staff who also get a small tip from the homeowners.

According to the price structure, households in the Zone One city region make up the majority of those paying fees under Rs. 25. They provide the municipal worker a very little money in exchange for the rubbish being collected. Because they received a bonus, the municipal employees are likewise content.

There is a marginal difference between the number of homes using a fee-based door-to-door collection system and the number of households with a door-to-door collection system. The reason for this is that, although being quite close to the collection location, Zone One city households have reported having a door-to-door collection system without having to pay any fees.

4.2 Socio-Economic Determinants of Willingness to Pay

Table 4 displays the regression findings. Equation 1's conclusion demonstrates the positive relationship between WTP and total revenue. The WTP will grow by 26% for every 1% increase in income, or, to put it another way, the income elasticity of WTP is 0.26. This is indicated by the 0.26 positive coefficient of income. There is a strong and positive correlation between the amount of time required to dispose of waste at the public collection point and the willingness to pay. More time spent disposing of rubbish indicates a higher price individuals are prepared to pay for improved waste management.

The coefficient of time is 0.08, meaning that an increase of 100% in time will result in an increase of 8% in willingness to pay for improved waste management. Although it is relatively small, household members who took the GCE A/L or higher (EDU) have a positive link with WTP. Extra land areas owned by households have small but beneficial benefits. According to the study, even if the trash has a high organic content, most wealthy households prefer to dispose of it on their spare land (see Eq. No. 1 in Table 4). Similarly, COTR is negative, which also defies the hypothesis and the presumptions.

The poor calibre of the instruction could be the culprit. According to the study, attending any program that even only talked about environmental issues or waste management qualified as consciousness training. The primary organizations or clubs providing the instruction had the sole goal of forcing the homes to employ the fee-based collecting mechanism. As a result, the training may not be of the appropriate quality and may not be able to have the expected positive impact. The adjusted R^2's total explained fraction is 0.31, and the extremely significant F value is above 8.

Table 4: Willingness to Pay and its Relationship with Socio-Economic Variables

Eq. No.	Dep. variable	Independent Variables						
		Const.	TOTI	EDU	TTR	EXTLA	COTR	TOT W
1	TWTP	1.93	0.26	0.04	0.08	0.01	-0.16	-
	't value'		4.95	0.40	2.46	0.38	-2.35	
2	TWTP	1.62	0.26	0.03	0.06	0.001		-
	't value'		4.75	0.256	1.96	-0.036		
3	TWTP	1.65	0.33	-	0.05	0.05	-	-0.13
	't value'		5.31	-	1.31	1.33	-	1.91
4	TWTP	1.56	0.23	0.40	0.13	-0.04	-	-
	't value'		2.44	1.32	2.16	-0.96	-	-

Source: Field Survey 2023, Developed by author

Equation 2, Table 4 displays the regression result if one variable is removed, specifically the variable COTR. The amount of land other than houses and schools has little bearing on willingness to pay, even though the overall revenue and travel time to the municipal collection centre are substantial.

A correlation between total waste and total willingness to pay was attempted to be seen. After including total waste (TOTW) as an independent variable, the regression result reveals a negative relationship with willingness to pay. This demonstrates that the amount and volume of trash have very little bearing on willingness to pay.

Given that the ability to pay is a crucial component of willingness to pay, it appears to be true in this situation. Given that waste volume and quantity are closely correlated with population size, wealthy individuals may produce less garbage than impoverished individuals (Equation 3, Table 4). An analysis of the link between total willingness to pay (TWTP) and wealth was conducted. Having various assets was considered a stand-in for wealth.

A household with a TV alone is deemed impoverished, while one with a vehicle, computer, motorcycle, refrigerator, etc. is deemed wealthy; those in the medium income range belong to the middle class. Regression analysis was thus conducted using families that own only televisions. The relationship between TWTP and the independent variables in the case of those families with only a TV is displayed in Equation No. 4 (Table 4). The results of the regression demonstrate that, as predicted, there are positive and statistically significant relationships between Total Income (TOTI) and the amount of time needed to dispose of waste at the public collection centre (TTR).

Here extra land area has a negative coefficient, which indicates that poor people use their waste in the kitchen garden as a soil conditioner and are not willing to pay for waste management. The total explained portion of the regression (i.e. adjusted R^2) is 0.32. The value of F is around 4 and highly significant (Equation 4, Table 4).

4.3 Relationship of WTP with Other Variables in Different Zones

Table 5 shows the zone-by-zone association between WTP and the factors. According to the regression results, TWTP is harmed by the additional land area in the zone. It demonstrates that garbage is used more as compost and that people are less willing to pay for waste management the more additional land area there is. The number of household members who passed the GCE A/L or higher, total income, and the amount of time spent disposing of waste are all significantly positively related to the willingness to pay, as predicted.

In the Zone One and Zone Two sectors, however, there is a positive correlation between more land area and willingness to pay. There are very few (about 12% of homes in the core area) with additional land. A kitchen garden is not guaranteed to be available in the Zone One area despite the additional land space. The property is used for parking or other purposes.

Table 5: Willingness to pay and its relationship with other variables by the zones

Zone	Dep. Var.	Adj.R^2	DW	F	Const.	Coefficient of Independent Variable			
						LEXTRA	LTIR	LTOTI	LEDU
Total	LTWTP	0.26	1.44	8.5	1.62	-0.02	0.06	0.29	0.03
Zone 1	LTWTP	0.55	0.97	2.4	-0.14	-0.04	0.11	0.48	0.04
Zone 2	L TWTP	0.60		4	2.96	1.30	0.30	0.53	-0.82
Zone 3	LTWTP	0.24	1.93	2.76	2.88	0.02	0.02	0.17	0.22

Source: Field Survey 2023, Developed by author

Therefore, the garbage won't be utilized in the additional land area, and our assumption could not be accurate. The coefficient of the variable extra land area has a positive sign in the zone one area as well, which contradicts the theory. The fact that the space is so tiny and isn't utilized for kitchen gardens could be the reason. Therefore, it may be preferable to dispose of the garbage outside rather than using it as compost on the additional land. Except for one instance in the zone one area, the coefficient of household members who took the GCE A/L or higher had a positive sign in every instance.

Though the value is insignificant, it indicates that though people are household members who sat for GCE A/L or above, they do not take the case of waste management seriously. It also may be because the respondents may not be members who sat for GCE A/L or above even if the house members are household members who sat for GCE A/L or above. Thus, though many household members are members who sat for GCE A/L or above, the handling of garbage is unimportant to them. They might not want to pay because they believe it is not their problem to deal with the waste management issue. Since the municipality has been in control of it for a long period without charging the generator a fee, they might believe that it is their responsibility.

4.4 Causes of Not Willing to Pay

The data set included inquiries about the households' reluctance to make payments. Families have provided several justifications for their unwillingness to pay for waste management services. Table 6 demonstrates that the majority of families (53%) did not want to pay because their rubbish was picked up and they had no issues with it. Since they have enough room to dispose of their waste outside or within their compound, some of them (21%) do not feel that there is a problem with the waste. Few households could not afford to pay because of their extremely low income.

Just 12% of the hesitant households - or 8% of all the households surveyed - are made up of them. They believe that surviving hand-to-mouth comes before wasting. Few homes are ready to pay because they believe that the government and the municipality should be responsible for it.

Table 6: Causes of Not Willing to Pay

Causes	**Total Num. of HH**	**Zone 1**	**Zone 2**	**Zone 3**
It is the duty of the Municipality	14 (5)	1 (2)	6 (4)	7 (8)
It is the duty of the government	2 (1)	0	2 (1)	0
Income is very low and could not afford	35 (12)	6 (12)	7 (4)	22 (25)
My house's waste had not made any problem to me	62 (21)	8 (17)	28 (17)	26 (30)
Waste collection is continued in one or another way and no other problem	158 (53)	31 (65)	103 (64)	24 (28)
Volume and quantity are very low	7 (2)	2 (4)	1 (1)	4 (4.5)
The majority of waste is reusable and applicable to own self	19 (6)	0	15 (9)	4 (4.5)

Source: Field Survey 2023, Developed by author

All of the city's zones generate 0.29 kg of waste per person each day on average. Zone 3 has a marginally higher number. It appears to be marginally higher than the results of the most recent municipality research and somewhat lower than those of the previous investigations. Because paper and bottles are easily marketed, there may be a rise in household sorting of these materials at the site of generation, contributing to the low per capita waste generation. Zone One has the lowest per capita garbage generation, whereas Zone Three has the greatest. Additionally, compared to other zones, zone one has the highest rate of segregation practices.

Therefore, households in Zone One sort may waste more thoroughly than in other zones, which accounts for the reduced per capita waste creation in Zone One. This may also be the case because, in contrast to Zone Three and Zone Two, where there is open space and no trash disposal issue, Zone One residents have long faced waste management issues. People therefore tend to produce more when there is greater open space, and vice versa.

Among many other factors, family size and family income are identified as two major factors determining waste production. Rich families and families with more members contribute to waste production than others. Estimates in this study show that each additional member of a family produces half a kilogram of waste. Currently, the natural growth rate of Sri Lanka's population is at a replacement level. Therefore, family size might not be a crucial variable for policymakers' concerns. However, specially, Colombo district has with highest rate of in-migration. Therefore, the increasing population in the Colombo district will have an enormous effect on waste production. This warns the local governments because one would expect increasing net migration to the Colombo district and thereby more production of waste in future. In this context, local governments should be more instrumental in designing and implementing an effective waste management mechanism.

A positive relationship between income and waste generation was also observed. Our interpretation of this finding is that this is a result of the lifestyle enjoyed by rich families. They produce more packing waste.

By paying a specific amount, about 57% of households take part in door-to-door collection. People do not, however, have a great awareness of environmental issues or appropriate garbage disposal practices. It continues to demonstrate the sense of "not in my backyard" that Colombo residents have. Roughly 75% of city dwellers are unaware of the location of the collected waste's disposal. Residents of Zone One appear to be less aware of other zones than themselves.

This demonstrates that although individuals are aware of the garbage issue in their community, they could care less about the location and method of disposal of the waste. Few individuals are aware of where the collected rubbish is disposed of. Even yet, people who are familiar with the disposal location may not be aware of how environmentally safe the disposal method is. In zone one, over 90 per cent of waste collectors are employed by municipalities; in other zones, their share is minuscule.

One home in the zone manages its waste primarily by throwing it on the streets; it does not take part in the door-to-door pickup system. In contrast, the majority of homes in zones two and three dispose of their waste by burning or burying it on their property. In the compound, they also prepare compost.

The waste component connection demonstrates that the primary determinants of the overall amount of garbage in each zone are household size and income. Research has also shown that education reduces trash production. Those in the household with GCE A/L or higher scores don't give waste management much thought. Even though the members of the home are educated, it's also possible that the respondent is not a household member who took the GCE A/L or above.

They might not want to pay because they believe it is not their problem to deal with the waste management issue. Since the municipality has been in control of it for a long period without charging the generator a fee, they might believe that it is their responsibility.

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