Factors affecting waste generation and segregation behaviour. An analysis using data from the educated communities in the Western and the North-Western provinces of Sri Lanka

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Abstract

The study intends to identify the factors influencing the waste generation and segregation behaviour of households. An online survey was conducted with more than 400 residents in the North-western and Western provinces of Sri Lanka who have obtained a tertiary educational qualification. It was identified that family income level, local governmental authorities' involvement in waste collection, age of the household head, and house type significantly affect the waste segregation behaviour of households of educated communities. Further, age of household head, family size, attitude, land area, household ownership, family income and involvement of local governmental authorities in the waste collection were observed to affect the household solid waste generation. The results could support developing influential policies in the local governmental authority levels to further strengthen and improve the solid waste management practices in Sri Lanka. It could also shed light on the formulation of appropriate strategies focussed on different communities to encourage the practice of waste segregation at source in Sri Lanka.

Keywords: Waste management; waste segregation at source; waste generation; households; recycling

1. Introduction

Solid Waste Management (SWM) has become a universal issue owing to the continuous adverse effects on human health and the environment. The UN-member countries identified SWM as an essential requirement for achieving Sustainable Development Goals (SDGs) by including target 5 of SDG Goal-12: ‘‘substantially reduce waste generation through prevention, reduction, recycling and reuse (3Rs)”. Per capita waste generation increases with the progress in a country's population and the movement of populaces from rural areas to urban areas. Further, due to technological advancement and the expansion of the middle class in developing countries, an emerging trend of electronic waste could be identified (Nnaji, 2015). There is a significant change in the composition of solid waste generation due to the global pandemic of COVID 19 as well. For instance, there is a substantial increase in medical waste and plastics (Yousefi et al., 2021). The plastic waste generated during the COVID 19 outbreak was estimated at 1.6 million tonnes per day globally, and approximately 3.4 billion single used face masks were discarded per day (Yousefi et al., 2021).

The growing trend in solid waste generation is a critical problem in developing country settings. Global statistics state that 2.01 billion tonnes of municipal solid waste had been produced in 2016, and it is projected to be 3.4 billion tonnes by 2050 (Kaza et al., 2018). With rising solid waste generation, the local administration authorities confer a high expenditure for urban waste management activities. Therefore, a proper solid waste management system is vital to overcome the adverse effects due to increased-solid waste. Waste segregation at the source is identified as a critical process (Chen & Lee, 2020) of proper waste management. In addition, reducing solid waste generation is a prerequisite in overcoming the solid waste problem. Previously, researchers found that knowledge, attitude, social norms, situational and socio-economic factors influence the waste

segregation behaviour of the households (Alhassan et al., 2018; Ayob et al., 2017; Karim Ghani et al., 2013; Dai et al., 2017; Owusu et al., 2013). Another strand of literature studied the determinants of waste generation behaviour of households (Wang & Qiu, 2013; Sarica et al., 2020; Cusano, 2016).

The educational level of the residents has been identified as a significant factor influencing waste management practices in many works of literature. Higher education levels have made individuals aware of the external effects of their day-to-day behaviours and are involved with greater social welfare (Meyer, 2015). With the growth in the educational level of the residents, the general knowledge on waste management practices was found to be augmented, enhancing the responsibility towards the environment (Babaei, et al., 2015). Moreover, willingness to recycle, recycling efficiency, and recycling behaviour are revealed to be significantly influenced by the level of education (Guerin, Crete, & Mercier, 2001; Saphores, Nixon, Ogunseitan, & Shapiro, 2006; Owens, Dickerson, & Macintosh, 2000). Therefore, the study focuses on examining the educated-communities that have received tertiary education or an educational level above schooling, particularly university degrees or vocational training courses, etc., and explores the factors that influence the waste generation and segregation behaviour in their households.

In Sri Lanka, approximately 7000 metric tonnes of solid waste is generated per day. More than 50% of the waste is generated in the Western province. The waste generation per person amounts to 0.4-1.0kg of solid waste per day (Environmental Foundation Ltd, 2017). Inevitably, Sri Lanka also faces major municipal solid waste management problems in urban areas similar to many other developing countries. Despite having a multi-level governing structure such as national, provincial and local government to manage solid waste, many solid waste-related problems are still not adequately addressed. For instance, Dharmasiri (2020) has identified some issues prevailing in the

current waste management system of Sri Lanka. Our focal area of study, the waste segregation issue, has been highlighted, as a proper system for waste segregation is not prevalent in Sri Lanka. Furthermore, it was stated that Sri Lanka's waste management system has issues with outdated waste management practices, inefficient handling, collection, transportation and inefficient disposal of hospital waste and hazardous waste.

With this backdrop, the study intends to identify the factors that influence the waste segregation decision of the households in Sri Lanka. Educated communities in the Western and North-Western provinces in Sri Lanka are selected for the study as relatively higher waste generation rates are recorded in these provinces. This study explores those respondents' waste generation and waste segregation behaviour by using primary data collected from more than 400 households.

The rest of the paper is organised as follows. Section 2 reviews the literature on solid waste generation and segregation behaviour. Section 3 will describe the methodology used in the paper. Section 4 and 5 will present the results and discussion on the analysis. Finally, section 6 will conclude with explaining policy implications.

2. Literature Review

2.1 Solid waste management practices

Solid waste management is a widely acknowledged subject among nations as the solid waste amount continues to proliferate (Kaza et al., 2018). Numerous research efforts have examined the extent and nature of SWM practices in different countries and situational settings (Fernando, 2019; Dharmasiri, 2020; Kumara & Pallegedara, 2020; Yousefi et al., 2021). Significant factors,

particularly the administrative factors that influence the successful implementation of solid waste management practices, have been explored by Fernando (2019). The remuneration to the staff in the local government authorities, support from the political leadership and contribution of the business communities and society are found to have a more significant influence on the successful implementation of solid waste management practices (Fernando, 2019). Furthermore, Kumara and Pallegedara's study (2020) reveals that Sri Lankan households have transferred to waste collection arrangements over the past decade rather than burning, dumping and composting. The waste disposal methodology transfer is shown to create more challenging tasks for the leading service providers (Kumara & Pallegedara, 2020).

With the outbreak of the COVID-19 pandemic situation in recent years, it is revealed by Yousefi et al. (2021) that the quantity and composition of solid waste had been rapidly changed. Increased production and consumption of specific equipment such as face masks, disposable gloves and certain personal protection equipment (PPE) for the community health needs and the behavioural and lifestyle changes on the created situation have caused the sudden change in the composition of the solid waste during the pandemic situation. The increased home delivery services during recent years and home cooking during travel restriction periods have contributed significantly to increased paper packaging and household waste generation (Yousefi et al., 2021). The authors identify the waste segregation into infectious and hazardous waste as a better practice to prevent a further widespread pandemic.

Municipal solid waste management is realised to incur higher costs and expenditures in the present world if the management practices are poor and weakly administered. Unlike developed countries, the allocation of huge funds for solid waste management is unbearable in the long term (Balasooriya et al., 2015). Therefore, more sustainable practices should be formulated and

implemented by these institutions. Furthermore, local government and national authorities are requested to use various political and economic instruments to involve the households in sustainable development (Berglund, 2006). It is also revealed that most municipal solid waste is generated from households, followed by waste from commercial areas (Dikole & Letshwenyo, 2020; Dharmasiri, 2020). Moreover, a higher proportion of the global solid waste generated goes to the food waste category or biodegradable category (Nnaji, 2015; Dikole & Letshwenyo, 2020; Karim Ghani et al., 2013).

Food habits, culture and specific traditions, climatic conditions, income level, are identified as factors influencing the composition of the solid waste generated. Dikole & Letshwenyo (2020) have conducted a study on the composition of solid waste in Botswana. It was revealed that the composition of household solid waste was dominated by food waste in the lower, middle- and high-income level households during the weekdays and weekends. Food, paper and plastic waste characterised the composition of lower-income households. The middle-income families were represented with additional glass and tin waste, whereas the high-income household waste composition consisted of different textile and timber waste (Dikole & Letshwenyo, 2020). In Sri Lanka, the primary component of solid waste is dominated by food and garden waste, paper and cardboard and plastic waste (Wijerathne et al., 2012).

A few researchers have identified the challenges and opportunities associated with SWM practices. Nnaji (2015) has identified poor funding, inefficient human resources, inaccessibility to collection centres, inadequate equipment and dumping sites as significant challenges to the waste management system in Nigeria. Similarly, Dharmasiri (2020) and Fernando (2019) have identified the challenges such as lack of institutional setup and a proper regulatory framework, lack of adequate waste collection and transport facilities, lack of a proper system for waste segregation,

142 lack of appropriate instrument and modern technology as significant challenges affecting the SWM
143 practices in the Sri Lankan context.

144

145 **2.2 Solid waste generation**

146 Knowledge in the waste generation and composition of solid waste could be considered crucial in
147 planning and formulating continuous monitoring strategies (Dikole & Letshwenyo, 2020;
148 Wijerathne et al., 2012). Dikole and Letshwenyo (2020) have examined the waste generation rate,
149 composition and characteristics of solid waste generated in Botswana according to the income
150 level of the households. It was revealed that the waste generation rate in low-income families'
151 increases on the weekdays, and the rate decreases in the middle and higher-income homes on the
152 weekdays.

153 Extant literature has identified income as an important determinant of the amount of solid waste
154 generated (Balasooriya et al., 2015; Wijerathne et al., 2012; Wang & Qiu, 2013; Sarica et al.,
155 2020). Wang and Qiu (2013) reveal that discharge of solid waste is related to the socio-economic
156 development in China. And the per capita solid waste is found to increase with the income of the
157 rural households. However, the amount of waste generated deteriorated after rising to a certain
158 level. After the specified income level, the per capita solid waste generated decreases owning to
159 residents choosing more environmentally friendly and responsible products. Furthermore, Cusano
160 (2016) and Sarica et al. (2020) identify income as an important factor for food waste generation.

161 The solid waste generation in the Sri Lankan context has been identified to vary with the
162 employment, land availability and economic level (Wijerathne et al., 2012; Balasooriya et al.,
163 2015). In particular, Balasooriya et al. (2015) surveyed Galle and Hambanthota districts in Sri

164 Lanka and discovered that residential solid waste contained a significant proportion of
165 biodegradable waste and an insignificant proportion of non-biodegradable waste. Commercial
166 waste was identified to have substantial proportions in both types of waste. Moreover, the amount
167 of waste generated in Galle district was lower than that in the Hambanthota district, owing to the
168 high employment and lower land availability in Galle. Perhaps, residents spending more time in
169 the workplace and having small home gardens have decreased solid waste generated in the Galle
170 district (Balasooriya et al., 2015).

171

172 **2.3 Solid waste segregation**

173 The research related to waste segregation behaviours has been based on the Theory of Planned
174 Behaviour (TPB). The TPB is a framework that explains human behaviour is triggered by the
175 intention to change and influenced by attitude, subjective norms and perceived behavioural control
176 (Ayob et al., 2017). Consequently, the waste segregation behaviour at the source is triggered by
177 waste segregation intention. The intention would be created based on the attitude to separate waste,
178 the social group pressures on waste segregation, and the personal confidence in the ability to
179 separate waste. Considering the aforesaid theory, many other researchers have also found similar
180 determinants; namely, attitude, subjective norms, and perceived behavioural control, as the
181 determinants of the waste segregation behaviour (Alhassan et al., 2018; Ayob et al., 2017; Karim
182 Ghani et al., 2013; Chen & Lee, 2020).

183 Attitude for waste segregation is identified to have a positive and significant effect on the waste
184 segregation behaviour (Alhassan et al., 2018; Ayob et al., 2017; Karim Ghani et al., 2013; Chen
185 & Lee, 2020). The research-based TPB collectively suggests a stronger correlation between the

186 attitude factor (whether the segregation is time-saving or wasting, whether to participate or not in
187 segregation) and the solid waste segregation behaviour. Moreover, some studies identify the
188 perceived behavioural control factor as a significant influence on waste segregation behaviour
189 (Ayob et al., 2017; Karim Ghani et al., 2013). Ayob et al. (2017) state that being highly confident
190 about the waste segregation practices increases waste segregation. However, the results concerning
191 the influence from subjective norms relating to the pressure from social groups may vary according
192 to the research settings and country settings. Alhassan et al. (2018), Chen and Lee (2020), Karim
193 Ghani et al. (2013) have identified subjective norms as a determinant of waste segregation
194 behaviour. Nonetheless, Ayob et al. (2017) have identified subjective norms as having an
195 insignificant relationship with waste segregation in the Malaysian context.

196 Besides identifying determinants based on TPB, situational factors (limited space, time,
197 cooperation, etc.) and socio-economic or demographic factors are identified as determinants for
198 waste segregation behaviour. Educational level has been identified as a determinant of household
199 waste segregation behaviour, indicating that people with a higher education qualification engage
200 more in waste segregation activities (Dai et al., 2017; Alhassan et al., 2018). Saphores et al.(2006)
201 have concluded that the absence of a college education could decrease the willingness to drop the
202 waste generated at recycling centres.

203 Furthermore, gender and age are identified to positively relate to the waste segregation behaviour
204 (Dai et al., 2017; Owusu et al., 2013), indicating that females are more inclined to separate waste
205 than males, and the older residents are keen on separating waste more than younger residents.

206

3. Methodology

This study used a quantitative research approach to discover determinants of waste generation and segregation behaviour at the household level. The educated communities residing in the Western and North-Western provinces were considered for the analysis. Primary data were collected using an online questionnaire.

With the rapid technological developments, the web user population is observed to have an increasing trend. However, the usage of internet facilities for informational needs or internet penetration is still not widespread in the case of developing countries compared to developed countries (Vasantha Raju & Harinarayana, 2016). A sample of educated communities who have received tertiary education or an educational qualification above schooling were selected for the study. The online survey methodology was selected for the focused-group as the internet adaption is best explained and acknowledged on the educational levels (Billon et al., 2021). In brief, an online survey tool was employed for the sample data collection since educated communities are more accessible and have a thorough knowledge of adapting to internet facilities. The sample consists of 408 households: 57.60% from the Western Province and 42.4% from the North-Western Province.

3.1 Dependent Variables

As the focus of the study is on waste generation and segregation behaviour, the study's dependent variables are chosen to be the amount of waste generated (in grams) and waste segregation choices of each household on a daily-basis.

229 Waste generated by each household is the total amount of waste collected in grams in three waste
230 categories; food waste, polythene waste, and paper waste. Prior research on the household waste
231 composition and generation has shown that household waste primarily consists of food waste,
232 polythene and plastic material (Burnley, 2007; Edjabou, et al., 2015; Boer, Jedrczak, Kowalski,
233 Kulczycka, & Szpadt, 2010). The respondents were given multiple-choice questions to select the
234 range of weights of each three waste types. The mid-point of the weight range chosen by
235 respondents was taken as the amount of waste generated under each category, and thus, it is a
236 continuous variable. Subsequently, the average weights of the three types of wastes, food,
237 polythene and paper, were summed up to obtain the total waste generated per household.

238 The second dependent variable in the analysis, waste segregation behaviour, takes the form of a
239 binary variable taking the value of 1 if the residents practise waste segregation in their households
240 and 0, otherwise.

241

242 **3.2 Explanatory variables**

243 Several socio-economic characteristics were taken into consideration. For instance, categorical
244 variables were used to identify the respondents' characteristics according to age, house type and
245 ownership status, and family income, while provincial category, local governmental authority
246 mediation in waste collection and land segmentation status were binary variables. More details of
247 the categorical variables can be found in Appendix I. The factors such as family size, attitude score,
248 knowledge score and land area were identified as continuous variables.

249 The attitude of each respondent was measured using the responses received from four attitude-
250 related sub-questions. Scores were assigned according to the responses based on a Likert scale,

where the “strongly agree” choice was given a maximum score of 5 and the “strongly disagree” response was given a score of 1. Appendix II shows the assigned scores for each question according to the scale. The scores obtained for each of the four-attitude related questions were summed up, and the average value was then obtained and multiplied by two to obtain the attitude score out of ten.

Using three related questions, a scoring method was developed to quantify each respondent's waste segregation-related knowledge score. Based on the responses for the three questions, a maximum score of ten was assigned if the respondent answered all three questions correctly. If the answers for two questions were given correctly, the respondent was assigned a knowledge score of six, while in the case of one correct answer, the respondent was assigned a score of three. If the respondent gave wrong answers for all three questions, a score of 0 was assigned. Appendix II provides the questions forwarded to respondents to measure the extent of their knowledge on waste segregation.

3.3 Estimation methods

3.3.1 Determinants of household waste segregation

The waste segregation choice variable is a binary categorical variable. Hence, binary Logistic Regression Model (LRM) was used rather than using the simple Ordinary Least Square (OLS) regression as the waste segregation behaviour is a dichotomous (binary) criterion (Cohen, Cohen, West, & Aiken, 2003). The model specifications are given in equation (1).

$$\boldsymbol{Log}\left(\frac{\boldsymbol{Pi}}{\boldsymbol{1-Pi}}\right)=\boldsymbol{\beta}_0+\boldsymbol{\beta}_1\boldsymbol{Xi}+\boldsymbol{e} \quad (1)$$

Where P_i =1 if the respondent practises waste segregation at households; P_i =0, otherwise; X_i representing the explanatory variables as described above; β_0= constant term; βi= coefficient of explanatory variables; e= error term and i=1,2,3…, n which represents the number of independent variables.

The coefficients in the LRM are estimated through the Maximum Likelihood (ML) method after converting the outcome variable to logit variable (Begum, Siwar, Pereira, & Jaafar, 2009; Al-Khateeb, Al-Sar, Al-Khatib, & Anayah, 2017) Accordingly, the LRM model used for the analysis is as follows;

$$\begin{aligned} \textit{Log Odds (waste\_segregation)} = {} & \boldsymbol{\beta_0 + \beta_1 age + \beta_2 familysize + \beta_3 attitude +} \\ & \boldsymbol{\beta_4 knowledge + \beta_5 lgacollection + \beta_6 familyincome + \beta_7 landarea +} \\ & \boldsymbol{\beta_8 housetype + \beta_9 houseownership + \beta_{10} landsegmentation +} \\ & \boldsymbol{\beta_{11} province} + e, \end{aligned} \tag{2}$$

where,

waste_segregation=1, if the respondent practises waste segregation at households; 0 otherwise

age is the categorical variable denoting the age

familysize is the number of members in the household

attitude is the score obtained for the attitude of the respondents on waste management

*knowledg*e is the score obtained for knowledge of the respondents on waste management

lgacollection is a binary variable where the local government authorities come to collect waste from households or otherwise

familyincome is the monthly income of the household

landarea is the total land area of the household

housetype is a categorical variable on the house type

houseownership is a categorical variable on the ownership status of the house

Landsegmentation is a binary categorical variable on whether the land has been segmented

province is a binary categorical variable whether the respondent is from the North-Western or Western Province

The coefficient (β) in the logit model represents the effect of a unit increased in the explanatory variable on the log odds [$\ln(\frac{P}{1-P})$]. For simpler representation in the results through the logit model, the marginal effect of each independent variable (x_i) could be calculated on the predicted probability as follows (Daniels & Minot, 2018);

$$\Delta \boldsymbol{P}/\Delta \boldsymbol{x_i} = \boldsymbol{\beta_i P(1-P)} \quad \textbf{(3)}$$

Where the marginal effect of the explanatory variable (x_i) on the probability P that Y=1 is equivalent to the multiplicity value of the coefficient of on x_i and $P(1-P)$.

When a model is fitted to the data, how well the model fits must be checked. The Pearson statistic and the Hosmer–Lemeshow goodness of fit test was calculated to determine whether the model fits. The calculation of the Pearson statistic is given below,

$$\boldsymbol{\chi^2} = \sum_{\boldsymbol{j=1}}^{\boldsymbol{A}} \frac{\boldsymbol{y_j - a_j p_j)^2}}{\boldsymbol{a_j p_j (1-p_j)}} \quad (4)$$

Where A is the total number of covariates patterns within B observations, and a_j is the total covariates having the covariate patterns j and y_j is the total number of positive outcomes in j covariate patterns where j=1,2,…., B. p_j is the probability predicted in j covariate patterns.

Hosmer–Lemeshow statistic (Hosmer & Lemeshow, 2000) is calculated similarly, using quantities rather than covariate patterns. The model is well fitted if the probability of checking significance is higher than the threshold value (0.05) in both tests.

3.3.2 Determinants of the amount of waste generated

The effect of the potential determinants on the amount of waste generated is estimated by employing the following multiple regression model:

$$\boldsymbol{Y = \beta_0 + \beta_1 X_i + e} \quad (5)$$

Where Y= the amount of waste generated in the household per day; X_i Representing the explanatory variables as described above; β_1, representing the set of coefficients of the explanatory variables; βo representing the constant term and e, representing the error term.

Specifically, the multiple regression model with potential covariates is as follows:

$$\boldsymbol{waste\_amount = \beta_0 + \beta_1 age + \beta_2 familysize + \beta_3 attitude + \beta_4 knowledge + \beta_5 lgacollection + \beta_6 familyincome + \beta_7 landarea + \beta_8 housetype + \beta_9 houseownership + \beta_{10} landsegmentation + \beta_{11} province + e} \quad (6)$$

Where,

waste_amount is the amount of waste generated per day

age is the categorical variable denoting the age

familysize is the number of members in the household

attitude is the score obtained for the attitude of the respondents on waste management

*knowledg*e is the score obtained for knowledge of the respondents on waste management

lgacollection is a binary variable where the local government authorities come to collect waste from households or otherwise

familyincome is the monthly income of the household

landarea is the total land area of the household

housetype is a categorical variable on the house type

houseownership is a categorical variable on the ownership status of the house

landsegmentation is a binary categorical variable on whether the land has been segmented

province is a binary categorical variable whether the respondent is from the North-Western or Western Province

The diagnostic tests were conducted to check the precision of the model. The omitted variable tests (Ramsey, 1976) and multicollinearity tests using centred variance inflation factor (VIF) were conducted to check the model's goodness of fit, while heteroscedasticity was also controlled in the study.

4. Results

4.1 Characteristics of the respondents of North-Western and Western provinces

According to the descriptive statistics shown in Table 1, most respondents were from the Western province (57.6%). A higher percentage of respondents belonged to the working-age group aged 25-54 years. The average number of members in the household was four. Most of the respondents (62.01%) stated that the local governmental authorities do not collect the waste from their households. A majority of the respondents state that they separate waste in their households (86.27%), and the average waste collected was 851.4 grams per day in households in the North-Western and Western provinces.

Table 1: Summary of the variables used in the analysis

Variable Type	Description	%	Mean	Standard deviation
categorical independent variables	*Segregation decision*			
	Separated	86.27		
	Not separated	13.73		
	Province			
	Western	57.6		
	North-Western	42.4		
	Age of the respondent			

15-24 years (Youth)	47.55
25-54years (working-age population)	49.26
55-64 years	2.21
above 65 years	0.98
LGA waste collection facility	
Yes	37.99
No	62.01
Family Monthly Income	
0-50,000	38.97
50,000-100,000	23.77
100,000-200,000	20.34
Above 200,000	16.91
house type	
Single storied	71.57
Two storied or higher	26.96
Other	1.47
house ownership	
Fully owned	93.38

	On rental	4.17	
	Other	2.45	
	Land segmented		
	Yes	22.79	
	No	77.21	
Continuous variables	Total waste generated per day (grams)	851.41	559.93
	Family size	4	1.44
	Attitude score	8.53	1.07
	Knowledge Score	8.32	2.60
	Land area (perch)	104.64	614.70

4.2 Determinants of household waste segregation

Table 2 summarises the estimated odd ratios and marginal effects of determinants of waste segregation behaviour. The working adult age category (25-54 years) and the elderly age category (above 65 years) were identified to have reduced the probability of household waste segregation by 8.1 and 48.5 percentage points, respectively, compared with the youth age category (15-24 years). Further, when the local government authorities engaged in the waste collection from households, the probability of household waste segregation increased by 15.3 per cent than when the authorities did not collect waste. Residing in a two or more storied house decreased the probability of household waste segregation by 12.8 per cent compared with living in a single-story

house. Obtaining a monthly income of 100,000 - 200,000 LKR by the household increased the probability of household waste segregation by 15.1 per cent compared with households with a family income of 0 - 50,000 LKR.

Table 2: Logistic Regression Model estimated coefficients for waste segregation

VARIABLES	Odd Ratio	Marginal Effects (dy/dx)
Provincial category (base category: North Western province)		
Western province	0.0842	0.0106
	(0.3458)	(0.0436)
Age (base category: 15-24 years)		
25-54 years	-0.5504	-0.0706
	(0.3480)	(0.0455)
Above 65 years	-2.6820**	-0.4758**
	(1.1763)	(0.2182)
Family size	0.1169	0.0147
	(0.1235)	(0.0155)
Attitude	-0.1110	-0.0140
	(0.1628)	(0.0205)
Knowledge	0.0293	0.0037
	(0.0594)	(0.0075)

If local government authority involved in the waste collection	1.4958***	0.1571***
(base category: otherwise)	(0.4800)	(0.0405)
Land area	-0.0003	0.0000
	(0.0003)	(0.0000)
House Type (base category: single storied house)		
Two or more stories house	-0.7490	-0.1066
	(0.4755)	(0.0738)
House ownership (base category: Fully owned house)		
On rental	-1.1326	-0.1820
	(0.7785)	(0.1462)
Other	0.1545	0.0183
	(1.1278)	(0.1279)
Monthly family income (base category: 0-50,000LKR)		
50,000 – 100,000LKR	0.3103	0.0449
	(0.3904)	(0.0553)
100,000 – 200,000LKR	1.5899***	0.1611***
	(0.5589)	(0.0465)
If land is segmented (base category: otherwise)	0.1983	0.0243
	(0.3916)	(0.0466)
Constant	1.5314	
	(1.4953)	
Observations		322

Note: Standard errors are given in parentheses

*, **, *** indicates statistical significance at 10%, 5% and 1% level, respectively.

The model is well fitted with reference to the Pearson test (p= 0.4894) and Hosmer Lemeshow test (p=0.3537) for the goodness of fit.

4.3 Determinants of the amount of waste generated

Table 3 presents the OLS regression model results for the amount of waste generated. It is evident that the elements, namely, the age, family size, respondents' attitude towards waste management, the local government authority mediation in waste collection, total land area, ownership status of the household and family income, significantly influence the total amount of waste generated at the household-level.

The elderly age category (above 64 years) generated 382 grams less waste than the youth age category (15-24 years). When the number of family members in a household increased by one unit, the daily amount of waste generation increased by 38.14 grams daily. Moreover, a positive attitude with the household on waste management practices decreased the amount of waste generated. Still, knowledge about waste has not shown a significant relationship with the amount of waste generated. The waste collected by local government authorities positively influenced the amount of waste generated. An increase in the land area of the household has shown to decrease the amount of household waste. In contrast, a decrease of 230 grams of waste was observed in houses operating on a rental basis, compared with self-owned houses. The households having an income of more than Rs. 200,000 were observed to generate an additional 202 grams of waste daily compared with households with a monthly income of less than Rs. 50,000.

389 Table 3: OLS regression results for the determinants of the amount of waste generated at the

390 household level

VARIABLES	*Coefficients*
Provincial category (base category: North Western province)	
Western province	17.83
	(59.11)
Age (base category: 15-24 years)	
25-54 years	-56.39
	(81.43)
55-64 years	-122.7
	(234.2)
Above 65 years	-382.3***
	(119.0)
Family size	41.47**
	(20.80)
Attitude	-68.97**
	(32.26)
Knowledge	5.528
	(11.19)
If Local government authority involved in the waste collection (base category:	170.1**
otherwise)	(70.76)
Land Area	-0.0644***
	(0.0125)
House Type category (base category: single storied house)	

Two or more stories house	-5.160
	(74.88)
Other	454.1*
	(233.2)
House ownership category (base category: Fully owned house)	
On rental	-230.0*
	(124.0)
Other	-170.4
	(111.7)
Monthly family income category (base category: 0-50,000LKR)	
50,000 – 100,000LKR	98.36
	(77.82)
100,000 – 200,000LKR	80.24
	(93.02)
Above 200,000 LKR	202.0*
	(108.3)
If the land is segmented (base category: otherwise)	-0.0785
	(69.83)
Constant	1,055***
	(307.7)
Observations	398
Probability	0.000
R-squared	0.099

391

Note: Robust standard errors are given in parentheses

*, **, *** indicates statistical significance at 10%, 5% and 1% level, respectively.

The test for omitted variables by Ramsey (1976) to tests for omitted variables (p=0.1107) proves that there is no omitted variable bias

The variance inflation factor (VIF) of all variables was less than 10, suggesting that multicollinearity is not a serious issue in the present analysis (See Appendix III).

5. Discussion

5.1 Waste segregation behaviour

The present analysis suggests that the age, type of the house, family income and the local government authority service availability in the waste collection are the significant factors affecting the waste segregation behaviour among the educated-community in the Western and the North-Western provinces of Sri Lanka.

The categories of the working adult group of 25-54 years, elderly heads above 65 years, and the youth age category of 15-24 years are identified as the age groups less engaged in household waste segregation practices. These results contradict the results of Al-Khateeb et al. (2017) and Agwu (2012). For instance, Al-Khateeb et al. (2017) state that the older generation is more likely to separate waste than the youth in the case of Palestine, while Agwu (2012) has identified a positive relationship between age and solid waste management practices in the Nigerian context. However, a negative relationship was identified between the age and intention for payment for household waste segregation in Sweden (Berglund, 2006). Thus, it could be justified that the older generation

might be less keen on separating waste than the younger generation due to various factors such as lack of time, awareness and efforts on waste segregation and long-term dissatisfaction caused due to improper waste management by government authorities.

Two or more storied houses are less engaged in waste segregation than single-storey houses. These results contrast with the findings of Zakianis & Djaja (2017), where they specified that when the surface area of the household is relatively higher, the waste sorting among those households is more likely. His study also identified that luxury houses had increased waste sorting practices in the Indonesian context (Zakianis & Djaja, 2017). Usually, the two-storied dwellings are built in semi-urban and urban areas due to the problem of space limitation. Our results could be justified because households are less engaged in waste segregation in two-storied houses as less space is available for waste segregation activities. A positive relationship is identified between the family income and the household waste practices, similar to findings of other researchers (Zakianis & Djaja, 2017; Alhassan,, Asante, Oteng-Ababio, & Bawakyillenuo, 2018). Household Income level is identified as a significant determinant by most studies and has produced mixed results in the context of different countries and regions.

The service of local government authorities in Western and North-Western provinces for waste collection is identified to have an increased-effect on household waste segregation. As the local government authorities request the houses to separate the waste when they are handed over to the compactors and waste collections tractors, the waste segregation likelihood among the households may have increased compared with the households where authorities have no waste collection services.

The attitude of the household head was not identified as a significant variable affecting the waste segregation decision in the analysis. These results contradict the prior revelation of attitude

437 influencing positively on the waste segregation intension, where the attitude was found to be a
438 major factor influencing the intension pertaining to the theory of planned behaviour (Alhassan,,
439 Asante, Oteng-Ababio, & Bawakyillenuo, 2018; Ayob, Low, Jalil, & Chin , 2017; Chen & Lee,
440 2020; Al-Khateeb, Al-Sar, Al-Khatib, & Anayah, 2017; Zakianis & Djaja, 2017).

441

442 **5.2 Waste generation behaviour**

443 According to the results, age of the household head, attitude on waste management, land area and
444 house ownership conditions are identified to have a significant negative relationship with the
445 amount of waste generated, whereas family size, local governmental authority's waste collection
446 service, and family income factors are identified to have a significant positive impact on the
447 household waste generation.

448 The older age category of above 65 years is identified to have generated less waste than the youth
449 age category. Irwan et al. (2013) have stated that the relationship between age and household waste
450 generation is unclear. The results are similar to the findings of Struk and Soukopová (2016), where
451 the older age residents are found to generate more solid waste than younger age residents in the
452 case of Czech municipalities. The older generation's reason for generating more solid waste is
453 recognised as older people's households are being renovated by refitting and replacing the
454 equipment and practising with new equipment and methodologies. The younger generation is
455 found to generate less solid waste with their knowledge in waste recycling and segregation.

456 Moreover, a positive attitude towards waste management practices has been shown to have
457 decreased the amount of waste generated. Allegedly, the households having a better attitude
458 towards the waste management practices tend to decrease the amount of waste generated. A

459 negative relationship is identified between the land area and the amount of waste generated.
460 Furthermore, a decrease in the amount of waste generated is also observed with living in places on
461 a rental basis compared to living in self-owned houses. Our results align with the findings of Kala
462 et al. (2020). They also conclude that self-owned houses have a positive relationship with
463 household waste generation in the case of India.

464 Household size or family size is also identified as a positive influencing factor on the amount of
465 waste generated. Our results are in line with the results of Kala et al. (2020) and Trang et al. (2017)
466 in the case of Indian and Vietnamese households, respectively. Moreover, the family income level
467 is shown to positively affect the amount of waste generated within households. The high-income
468 level with a monthly family income above Rs. 200,000 is identified to have generated increased-
469 food waste, compared with the households with relatively lower income levels. These results align
470 with the findings of the following studies (Dikole & Letshwenyo, 2020; Wang & Qiu, 2013;
471 Sarica, Demircan, Erturk, & Arslantas, 2020; Kala, Kala, & Sushil, 2020). The high-income levels
472 are found to lead to rapid lifestyle changes. The change in consumption patterns due to the moving
473 to a more sophisticated lifestyle leads to increased-waste production within households.

474 A significant positive relationship was observed between the local government waste collection
475 and the amount of waste generated. A reason for the increase in the amount of waste in places
476 where local governmental authorities come to collect waste could be elaborated as the sense of
477 relief that households experience due to the disposal of waste by authorities daily or weekly.
478 Moreover, as the authorities collect the waste from households and are in service in more populated
479 and urban areas, the urban and semi-urban residents' spending patterns may have led to increased
480 household waste.

481

6. Conclusion

Solid waste management practices could be considered one of the grave issues globally, and household waste is an indispensable aspect of it. Waste segregation is an initial step in managing the waste at the source, and an integral part of the waste management process. The level of education is identified to significantly affect the waste management practices as per the prior work of literature. The objective of the present study was to identify the determinants of solid waste segregation decision and household solid waste generation in the Sri Lankan context, considering the educated communities that have received a higher level of education than schooling. Thus, the educated communities in the North-Western and Western provinces were selected for the study to find the factors influencing a household waste generation and segregation behaviour.

A logistic regression analysis was used to determine the factors influencing the household waste segregation decision. It was identified that household income levels and the involvement of local governmental authorities in waste collection positively affect waste segregation behaviour. Moreover, a significant negative relationship was identified with the age categories and the type of house. A multiple regression model was estimated to determine the factors influencing the amount of solid waste generated within the households. The socio-economic factors such as age, family size, attitude, land area, household ownership, family income, and involvement of local governmental authorities in the waste collection were considered the main determinants of the amount of waste generated in households in the Western and North-Western provinces of Sri Lanka.

In Sri Lanka, despite having a national plan on solid waste management practices at the local governmental authority levels, the existing regulatory framework was fragile (Fernando, 2019).

Thus, the improper segregation of solid waste within households lead to garbage mountains in the dumpsites that cannot be further refined for a helpful state. The findings of this study would aid in the formulation of strategies for improving the existing solid waste management practices of Sri Lanka considering specific communities. Waste segregation decisions and waste generation were influenced by the fact that local government authorities' involvement in the waste collection from households in the study. This reflects that the decision for waste segregation of educated communities relies primarily on the government policy regulations and demands of the local government waste collection services to separate the waste at the source. It was also found in the study that most households did not get the services from local government waste collection services in the North-Western and western provinces. Therefore, the local authorities need to significantly expand the waste collection services to fulfil the demand for household waste collection and to increase the policy regulations concerning the household's waste segregation practices.

Implementing a proper regulatory framework and policy strategies on waste segregation practises at the local governmental authority level, focussing on the characteristics of the communities, would be beneficial in managing the higher amounts of waste generated and further aid in reducing the costs of waste disposal. Insufficient land for final dumping, recycling and composting, poor regulatory framework and lower labour productivity and quality were considered as significant challenges affecting the successful policy implementation in Sri Lanka (Fernando, 2019). Accordingly, the local government authorities allegedly need the central government's support in expanding the infrastructure facilities and to provide incentives to implement a proper waste management mechanism. Further, as implied by the results, it could be anticipated that the households with a higher family income would be willing to afford the cost of implementing a

528 proper waste collection service by the local government authority level. The local authorities could
529 mediate in implementing strategies such as executing attractive, profitable models through
530 recycling and getting the private sector's involvement in the waste collection activities, which will
531 lead to a better management of the waste generated in the areas under their purview. Further, it
532 could be suggested to provide them incentives such as waste bins and proper maintenance of the
533 waste containers and conducting awareness programmes for waste segregation at source at the
534 local government authority level to improve the municipal solid waste segregation process (Chen
535 & Lee, 2020).

536

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541

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