Environ Monit Assess (2021) 193:838
https://doi.org/10.1007/s10661-021-09633-7

Factors affecting household solid waste generation and management in Sri Lanka: an empirical study

Yuhuan Zhao · Hemantha Premakumara Diunugala · Claudel Mombeuil

Received: 15 March 2021 / Accepted: 12 November 2021

Abstract This study examines the effect of "waste management" factors (Knowledge, Motivation, Time, Awareness, Contribution, Attitudes) on household waste generation (HWG), more precisely the measured weight of waste generated at households for a week (MWWGHW) while controlling for the socioeconomic factors such as family size, monthly family income, education level, and occupation. It also examines the moderating effects of the geographic location (urban versus rural areas) on the relationships between waste management factors and MWWGHW while controlling for the aforementioned socioeconomic factors. The overall results show that socioeconomic factors such as *Family Size* ($\beta = 0.134$; $p < 0.001$) and *Monthly Family Income* ($\beta = 0.301$; $p < 0.001$) significantly and positively influence MWWGHW, whereas the *Occupation* factor ($\beta = -0.106$, $p < 0.05$) significantly and negatively influences MWWGHW. Furthermore, the results show that the Knowledge ($\beta = -0.129$, $p < 0.05$), Motivation ($\beta = -0.161$, $p < 0.001$), Contribution ($\beta = -0.111$, $p < 0.05$), and Awareness ($\beta = -0.189$, $p < 0.001$) factors significantly and negatively influence MWWGHW. While the results show that the geographic location *Urban Area* moderates significantly the relationship between the *Motivation* factor and MWWGHW ($\beta = -0.129$, $p < 0.05$), the same results show, however, that the geographic location *Rural Area* moderates significantly but negatively the relationships between *Knowledge* factor and MWWGHW ($\beta = -0.187$, $p < 0.01$); *Motivation* factor and MWWGHW ($\beta = -0.390$, $p < 0.001$); *Contribution* factor and MWWGHW ($\beta = -0.154$, $p < 0.10$); and *Awareness* factor and MWWGHW ($\beta = -0.285$, $p < 0.001$). Based on these results, implications for policy orientations and future research are provided.

Keywords Socioeconomic factors · Solid waste · Waste generation · Household waste generation · Waste management · Sri Lanka

Introduction

Waste generation and management are serious environmental issues facing developed and developing countries alike. The existence of a poor waste management system is often cited as the main reason behind the practice of dumping or burning waste in the open. Moreover, this practice often triggers public health concerns as the waste abandoned in the open can become a hub for the transmission of certain diseases and also cause serious respiratory problems when they

Y. Zhao · H. P. Diunugala · C. Mombeuil (✉)
Beijing Institute of Technology, Beijing, China
e-mail: claudelmombeuil@bit.edu.cn; claudelmombeuil@uniq.edu

Y. Zhao
e-mail: zhaoyuhuan@bit.edu.cn

H. P. Diunugala
e-mail: hemantha@sjp.ac.lk; 3820182090@bit.edu.cn

C. Mombeuil
Rezo Inovasyon Edikatif Ayisyen, Mirebalais, Haiti

Published online: 24 November 2021

are being burned. Taking globally, there are nearly 2.01 billion tons of municipal solid waste that are generated annually, and this number is expected to reach 3.40 billion tons by 2050 (Kaza et al., 2018). Currently, East Asia and Pacific regions produce the largest share (34%) of the global waste compared to nearly 6% of waste generated by the Middle East and North Africa combined (Kaza et al., 2018).

Since households are the main contributors to municipality waste generation, their commitment to proper waste management practices, and their waste disposal behavior, remains critical to effective waste management policies (Kumara & Pallegedara, 2020). The influence of demographic and socioeconomic factors on household recycling behavior has been used in recent studies (see, for example, Alhassan et al., 2020; Kumara & Pallegedara, 2020). Also, several studies have examined the influence of sociopsychological factors on household recycling behavior (e.g., Khan et al., 2019; Srun & Kurisu, 2019). In many regards, factors such as social pressure can influence household waste management behavior (Srun & Kurisu, 2019) similar to factors like convenience and space (e.g., Saphores et al., 2006; Sorkun, 2018). However, we believe that socioeconomic factors, demographic characteristics, social pressures, waste management policies, and practices are likely to vary from one country to another which thus may lead to different results on waste generation and household behaviors.

This study is carried out with two main objectives. First, it develops a structural equation model to assess the influence of "waste management" factors (Knowledge, Motivation, Time, Awareness, Contribution, Attitudes) on household solid waste generation (HSWG) and household solid waste (HSW) components while controlling for the socioeconomic factors such as family size, monthly family income, education level, and occupation. Second and last, it explores the moderating effects of the geographic location of the households, that is urban areas and rural areas, on the relationships between "waste management" factors and household solid waste (HSW) generation and HSW components while controlling for the socioeconomic factors such as family size, monthly family income, education level, and occupation. Several reasons support the significance of this study. As a developing country, Sri Lanka is facing a serious waste management challenge, which necessitates more research interests on the influence of solid waste management factors and the socioeconomic on household solid waste generation. Moreover, most previous studies carried out on waste management in Sri Lanka have focused on understanding the problems, challenges, and opportunities related to waste generation (Kumara & Pallegedara, 2020), leaving a gap in household behaviors, and how socioeconomic factors affect their behaviors toward proper waste management practices upfront.

Empirical findings on solid waste generation at household level

A growing body of waste management literature has investigated different factors that affect waste generation at the household level in developed countries and in emerging and developing countries alike. In this summary of the literature, however, we focus on waste generation at the household level in developing countries, as doing so is more relevant to the context of Sri Lanka. Cross countries empirical studies have investigated the underlying socioeconomic factors affecting household waste disposal behavior (e.g., Adzawla et al., 2019; Alhassan et al., 2020; Sorkun, 2018; Srun & Kurisu, 2019). For instance, previous studies showed that gender, age, and education significantly influence the choice of waste disposal option (e.g., Adzawla et al., 2019; Alhassan et al., 2020).

Similarly, previous studies indicated that demographic and socioeconomic characteristics such as income, gender, and education significantly influence household recycling behavior (e.g., Alhassan et al., 2020; Dwivedy & Mittal, 2013; Ekere et al., 2009; Kumara & Pallegedara, 2020). Also, several empirical studies have shown social norms and individual attitudes as two (2) sociopsychological factors affecting the contribution of households to proper waste management through their recycling behavior (e.g., Khan et al., 2019; Meneses & Palacio, 2005; Srun & Kurisu, 2019). In a recent study, Srun and Kurisu (2019) found that social pressure either from family, friends, or government influences significantly household waste management behavior. Furthermore, studies have cited convenience among the factors that affect household waste management behavior (e.g., Saphores et al., 2006; Sorkun, 2018).

Trang et al. (2017) examined household solid waste (HSW) generation and composition and also

the underlying socioeconomic factors that influence HSW generation in Thu Dau Mot city of Vietnam. The results of their study showed a significant effect of income, household size, and environment on HSW generation. Similarly, Maskey and Singh (2017) investigated household waste generation factors and composition in Nepal and found that household size and income positively and significantly impact waste generation. Also, Astane and Hajilo (2017) investigated both the quantity and quality of rural domestic waste generation in Iran. The results of their study showed households' "income," "assets," "age," and "personal attitude" as the most important factors affecting waste generation. Based on these results, Astane and Hajilo (2017) concluded indigenous knowledge on efficient use of materials and households' attitudes as two important factors that could help reduce waste generation at the household level.

In an earlier study, Thanh et al. (2010) explored the quantity and composition of HSW generation in Vietnam. Their study showed that the HSW generation rate per capita per day positively correlates with urbanization level and population density, but negatively correlates with household size. Afroz et al., (2011a, 2011b) examined the factors influencing solid wastes generation and willingness to minimize these wastes in Dhaka city. The results of their study showed income groups, environmental consciousness, and willingness to separate waste generation as three significant factors affecting household waste generation. Furthermore, the results of their study showed environmental consciousness, middle-income group, the existence of storage facility, and young adults age group category (25 to 35 years) as significant factors affecting willingness to minimize solid waste.

Studies have established the nexus between socioeconomic factors and household waste generation. For example, Sankoh et al. (2012) examined socioeconomic factors affecting both HSW generation and composition in Sierra Leone. The results of their study showed monthly income, family size, employment status, and the number of room(s) occupied by households as significant factors that influence HSW generation and composition. In a similar study, Irwan et al. (2013) examined the influence of income level and age on per capita HSW generation in Malaysia. They found that HSW is higher in the case of affluent households. Nevertheless, they found no conclusive result concerning the relationship between age and HSW generation. Jadoon et al. (2014) investigated factors affecting HSW generation and composition in Gulberg Town and Lahore's case in Pakistan. Their study revealed that the rate of HSW generation varies with the household's income level. Based on this summary of the literature, we formulate the following hypotheses and build the following research model:

Hypothesis 1a: Lack of Knowledge about waste management will increase household waste generation; inversely, sufficient knowledge about waste management will decrease household waste generation (HWG). Similarly, we formulate the following hypotheses:

Lack of Motivation factors (*Hypothesis 1b*), Contribution factors (*Hypothesis 1c*), Time factors (*Hypothesis 1d*), Awareness factors (*Hypothesis 1e*), and Attitudes factors (*Hypothesis 1f*) will increase HWG; inversely, sufficient Motivation factors, Contribution factors, Time factors, Awareness factors, and Attitudes factors will decrease HWG.

Hypothesis 2a: Lack of knowledge will increase household waste generation in urban areas; inversely, sufficient knowledge about waste management will decrease household waste generation in urban areas. Similarly, we formulate the following hypotheses:

Lack of Motivation factors (*Hypothesis 2b*), Contribution factors (*Hypothesis 2c*), Time factors (*Hypothesis 2d*), Awareness factors (*Hypothesis 2e*), and Attitudes factors (*Hypothesis 2f*) will increase HWG in the urban areas; inversely, sufficient Motivation factors, Contribution factors, Time factors, Awareness factors, and Attitudes factors will decrease HWG in the urban areas.

Hypothesis 3a: Lack of knowledge will increase household waste generation in rural areas; inversely, sufficient knowledge about waste management will decrease household waste generation in rural areas. Similarly, we formulate the following hypotheses:

Lack of Motivation factors (*Hypothesis 3b*), Contribution factors (*Hypothesis 3c*), Time factors (*Hypothesis 3d*), Awareness factors (*Hypothesis 3e*), and Attitudes factors (*Hypothesis 3f*) will increase HWG; inversely, sufficient Motivation factors, Contribution factors, Time factors, Awareness factors, and Attitudes factors will decrease HWG in the rural areas.

We have built Fig. 1 to show the relationships between the variables of interest. In this figure, motivation, knowledge, contribution, time, awareness, and attitude factors are considered as the independent variables and household solid waste (HSW) generation as the dependent variable while socioeconomic factors and geographic location (urban areas and rural areas) are considered as control variables and moderating variables, respectively.

Data and methods

Data collection method

To meet the objectives of this study, we used a sample survey approach with a fully structured questionnaire. The first and second sections of the questionnaire captured the households' demographic and socioeconomic characteristics and background information on household solid waste (HSW) generation and the fraction of HSW generation, respectively. The third and last sections were designed to collect data on attitudes, behaviors, and actions toward waste management at the household level. Respondents' income was categorized as 11 monthly household income levels using pre-identified categories. Respondent's education level, occupation, and the number of individuals per household were also recorded as factors that affect HSW generation. Further, data were collected to identify management factors of the HSW generation based on six dimensions, namely "knowledge" (6 items), "motivation" (7 items), "contribution" (3 items), "time" (3 items), "awareness" (3 items), and "attitudes" (3 items). All these 25 items were measured using a five-point Likert scale. A pilot survey

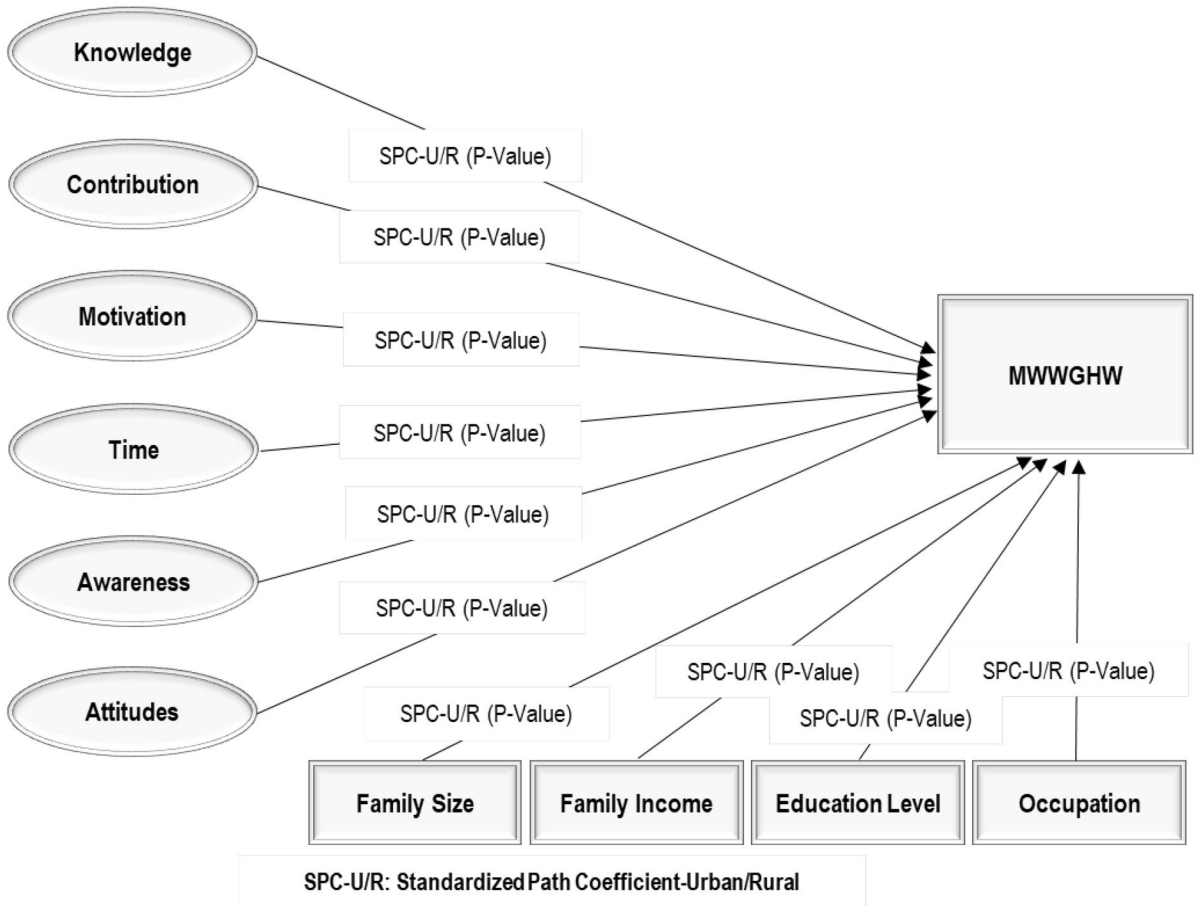

Fig. 1 Conceptual model for evaluating waste management factors at household level

was conducted with 40 respondents drawn from the sample representing households living in urban and rural areas. The feedback from the pilot testing has resulted in minor amendments to the questionnaire (Appendix).

We distributed the final questionnaire to 403 households living in urban and rural areas in Colombo district, Sri Lanka. As a protocol for the data collection, each household was instructed to measure the weight of the waste generated during the subsequent week they received the questionnaire and categorized all the waste generated into food residues, polythene/plastic, paper/carton, and mixed waste before filling it (questionnaire) out. In total, we retrieved 335 copies of the questionnaire that were correctly filled out.

Data analysis

In this study, we used a structural equation modeling to evaluate the influence of waste "management" factors (Knowledge, Motivation, Time, Awareness, Contribution, Attitudes) on waste generation at the household level. As the household waste generation is subjected to vary by the residential area or geographic location (that is "urban areas" versus "rural areas") of the respondents, we tested separately these relationships without including the moderating effect of geographic location (urban area versus rural area) first and then added these two moderating factors, that is, urban area versus rural area, in the next analyses. Structural equation modeling (SEM) was used to test the hypotheses of this study.

SEM involves path analysis and measurement models and also uses statistical models and computer programs to examine the structural connections between latent variables underlying the actual variables taken from observed data (Kline, 2016). The advantages of using SEM are that it allows the employment of multiple measures to represent the underlying constructs and addresses the problem of measure-specific errors in ways that cannot be done with other general linear models, where measurement errors are not modeled and constructs may be represented with one measure (Weston & Gore, 2006). These aforementioned advantages are particularly significant as using SEM allows scholars to establish the construct validity of the studied factors (Hoyt et al., 2006). Different from the standard multiple regression approaches, SEM allows for model estimation with several dependent variables and their interconnections (Chin, 2010; Gooderham et al., 2011). Furthermore, SEM helps to estimate and tests simultaneously causal relationships among the construct of interest (Gefen et al., 2000). Though there is no consensus over the appropriate sample size for SEM analysis, some studies have established that a sample size between 100 and 150 to be sufficient for conducting SEM (Ding et al., 1995; Tabachnick & Fidell, 2001; Tinsley & Tinsley, 1987) while others have suggested sufficient sample size equal or higher than 200 as the rule of thumb (Boomsma & Hoogland, 2001; Iacobucci, 2010; Kline, 2005), which thus support the size of our sample.

Measurement model, validity, and reliability analysis

In this study, household solid waste generation, more specifically the *measured weight of waste generated at households for a week* (MWWGHW), is considered as the dependent variable, categorizing into kitchen waste fraction generated for a week (KWFGW), plastic/polythene waste fraction generated for a week (PPWFGW), paper/carton waste fraction generated for a week (PCWFGW), and other waste fraction generated for a week (OWFGW) as dependent variables. The control variables are *family size, family monthly income, educational level*, and *occupation*. Apart from that *knowledge*, *motivation*, *contribution*, *time*, *awareness*, and *attitudes* factors, are identified under six dimensions as waste management factors. Further, geographic locations such as urban areas and rural areas were considered in the study as the moderating variables.

Convergent validity and reliability test

The items of the questionnaire were tested for convergent validity, reliability, and discriminant validity. As the rule of thumb suggests, the test for convergent validity of the items associated with any latent variables should have a loading factor equal to or higher than the cutoff value of 0.50 (Hair et al., 2010). As shown in Table 1, the measurements for convergent validity are confirmed as each item has a value higher than 0.50. We employed composite reliability (CR) and average variance extracted (AVE) to assess the reliability of the items. The reliability test is also supported as CR for each item exceeded the suggested cutoff value of 0.6 and all AVE

Table 1 Results of the convergent validity test

Construct	No. of items	Standardized factor loadings		Average variance exacted	Composite reliability
		Min	Max		
Knowledge	6/7	0.604	0.810	0.695	0.947
Motivation	7/7	0.699	0.935	0.697	0.971
Contribution	3/4	0.809	0.995	0.865	0.965
Time	3/4	0.926	0.992	0.791	0.927
Awareness	3/4	0.910	0.944	0.859	0.965
Attitudes	3/4	0.660	0.992	0.795	0.964

was above the suggested value of 0.5 (see Bagozzi & Yi, 1988). Furthermore, the value for the KMO indicator should be equal to or higher than 0.5; factor loading should be equal to or higher than 0.6; Eigenvalue should be higher than 1; and Cronbach's alpha (α) should be equal to or higher than 0.60 for the reliability and validity of the variables (see Bagozzi & Yi, 1988; Field, 2009; Kaiser, 1974). As shown in Table 2, all the variables have a value higher than the minimum recommended value.

Goodness of Fit

As shown in Table 3, the minimum discrepancy per degree of freedom (CMIN/DF) equals 2.250 and the Goodness of Fit Index (GFI) equals 0.868. The results also show that the Normed Fit Index (NFI) equals 0.937, and the Comparative Fit Index (CFI) equals 0.964, suggesting an overall good fit for our model (see Hu & Bentler, 1999). Furthermore, the Adjusted Goodness of Fit Index (AGFI) of 0.835 is higher than the suggested value of 0.80 while the root mean square residual (RMR) and root mean square error of approximation (RMSEA) indicate a value of 0.061 and 0.030, respectively. These results show no decline in the fit indexes of the constrained model, indicating a shred of satisfactory evidence for metric invariance (Hair et al., 2006; Steenkamp & Baumgartner, 1998).

Discriminant validity test

We conducted a discriminant validity test to ensure that the square root of the AVE for each variable is greater than the inter-construct correlations. Table 4 compares the squared inter-construct correlations estimates with the AVE for all constructs. Diagonal entries in bold are the AVE for all constructs and sub-diagonal entries are the squared inter-construct correlations estimates among constructs. As indicated in Table 4, the AVE value of each construct is higher than the squared correlations between that construct and other constructs, suggesting the existence of discriminant validity between the underlying constructs (Fornell & Larcker, 1981).

Table 2 Results of reliability and validity test

Construct	No. of items	Cronbach's alpha	KMO measure of sampling adequacy	Bartlett's test of sphericity approx. chi-square (df)	*P*-value	Extraction sums of squared Loadings	
						Total	Percentage of variance
Knowledge	6/7	0.930	0.893	1615.032 (15)	0.000	4.471	74.524
Motivation	7/7	0.940	0.926	2109.592 (21)	0.000	5.163	73.763
Contribution	¾	0.946	0.709	1282.931 (3)	0.000	2.712	90.415
Time	¾	0.901	0.648	1260.646 (3)	0.000	2.512	83.724
Awareness	¾	0.948	0.774	974.389 (3)	0.000	2.719	90.637
Attitudes	¾	0.900	0.655	1196.275 (3)	0.000	2.529	84.289

Table 3 Results of the Goodness of Fit of the measurement model

The Goodness of Fit Index		Observed value	Acceptable value
Absolute fit indices	CMIN/DF	2.250	< 3
	GFI	0.868	0–1
	AGFI	0.835	0–1
	RMR	0.061	< 0.1
	RMSEA	0.030	< 0.1
Incremental fit indices	TLI	0.958	0–1
	CFI	0.964	0–1
	RFI	0.928	0–1
	NFI	0.937	0–1
Parsimony fit indices	PGFI	0.835	0–1
	PRATIO	0.867	0–1
	PNFI	0.812	0–1
	PCFI	0.835	0–1

Results and discussion

The descriptive analysis depicts the difference between the level of education (Fig. 2) among the heads of the households living in rural and urban areas of the Colombo district. The results of the descriptive analysis also show that there is no significant difference between the level of education of the head of households in the urban and rural areas except for 20.2% of the respondents with "up to a secondary level" living in a rural area compared and 10.8% of this same level of education who are living in the urban area. The results show that 38.1% of the respondents live in the rural area and have graduate or above qualifications (such as Masters, M.Phil., and Ph.D.) compared to 41.8% of the same education level for those who live in the urban area. The results also show that 11.9% of respondents who live in the rural area have vocational training levels while 14.7% of the same training level live in the urban area. Furthermore, our result shows that 25% of respondents living in the rural area have reached "Up to upper secondary education," whereas 27.5% have reached the same level of education in the urban area. Moreover, the rural area of the Colombo district counts 1.2% of head households who did not attend a formal education program in contrast to 0.8% in the urban area. When considering vocational training, the rural area has less representation (11.9%) than the urban area (14.7%).

As demonstrated by the descriptive analysis, the distribution of occupation of the heads of the households indicates a significant difference between rural and urban areas. For example, most of the head-households in the Colombo district work in the public sector, representing 48% in the rural area compared to 31% in the urban area. In the rural area, there are fewer private-sector employees (19%) and people who do business (8%).

As per Fig. 3, the range of the size of the households in the rural area varies from 2 to 7 individuals compared with the range of 1 and 8 individuals in the urban area. Households with four members share the highest percentage both in the rural area (32%) and

Table 4 Comparison of squared inter-construct correlations with AVE

	Knowledge	Motivation	Contribution	Time	Awareness	Attitudes
Knowledge	**0.695**					
Motivation	0.364	**0.697**				
Contribution	0.371	0.229	**0.865**			
Time	0.241	0.180	0.180	**0.791**		
Awareness	0.494	0.409	0.372	0.320	**0.859**	
Attitudes	0.510	0.413	0.456	0.207	0.530	**0.795**

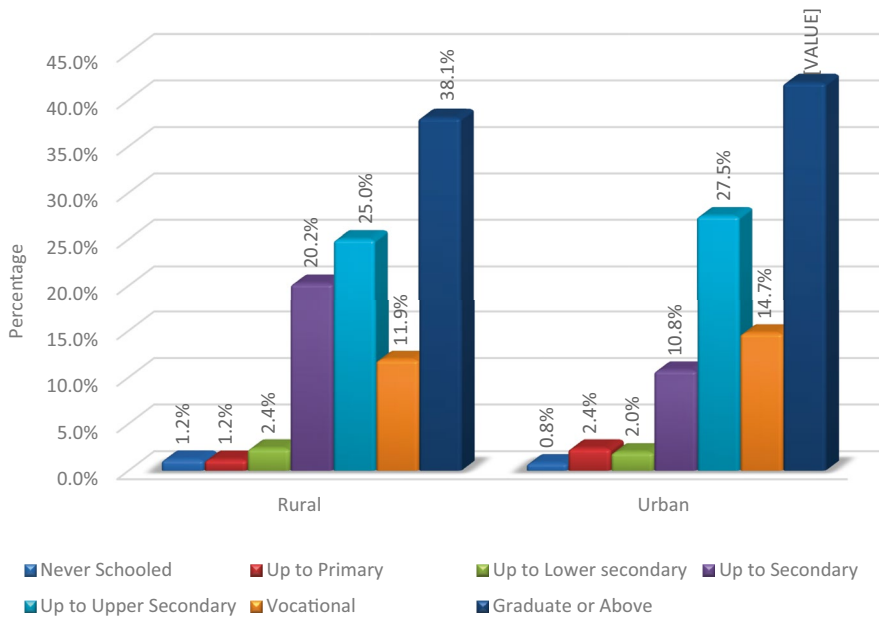

Fig. 2 Distribution of education levels of the head of the households

the urban area (38%). Households with five members have the highest disparity between those living in the rural area (29%) and urban area (20%). However, households with seven (7) members are tied between the rural and urban areas.

Furthermore, Fig. 4 shows that households in the rural areas have a higher income disparity than households living in the urban areas. For the monthly income lower than Rs. 10,000, households in the rural areas make up 25% of that threshold while those in the urban areas count for 18% of that same income category. On the other end, the highest monthly income (above Rs. 100,000) is registered among 7% of the households in rural and urban areas. Except for monthly income in the range between Rs.60,000–Rs.70,000 (14%) and Rs.70,000–Rs.80,000 (13%), all the other income categories are below 10% for households living in the rural areas. When considering the monthly income for households living in the urban areas, 12% of them are within the monthly income range of Rs.10,000–Rs.20,000, and 11% are within the monthly income range of Rs.60,000–Rs.70,000. Overall, the urban area has fewer fluctuations in the household head's income, even if the income in the rural area varies (in the categories above the monthly income range of Rs. 80,000–Rs. 90,000) in high and low ends.

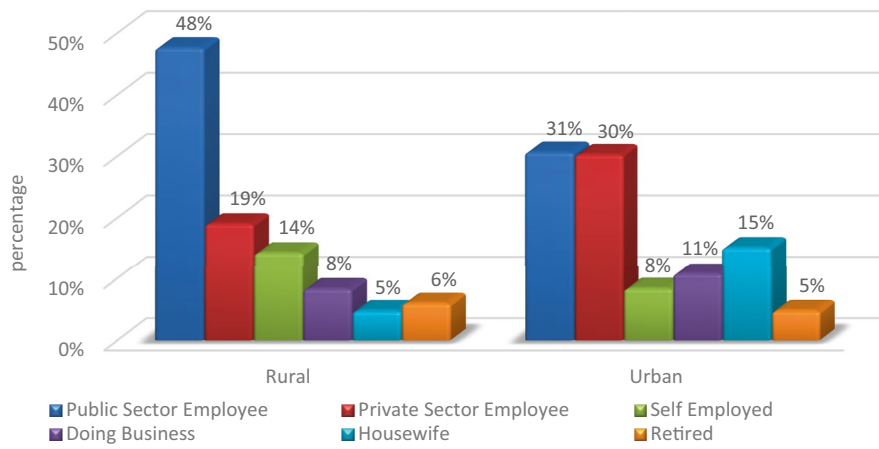

Fig. 3 Distribution of occupation of head of the households

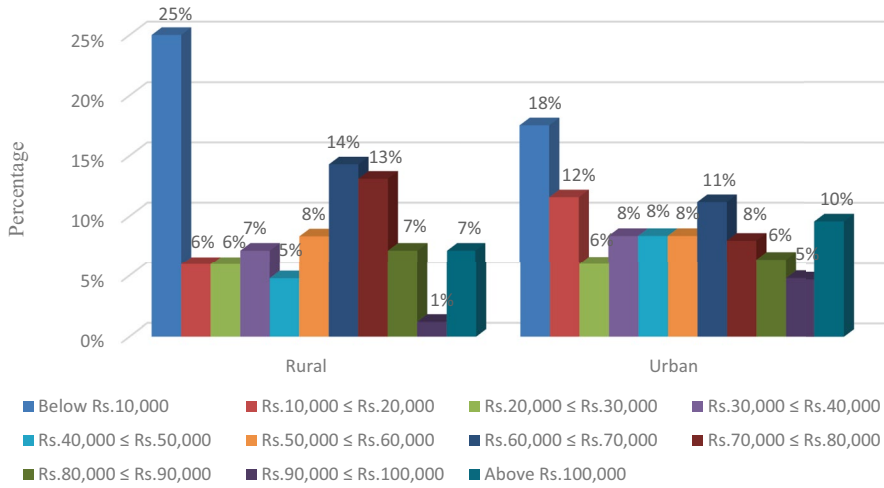

Fig. 4 Distribution of monthly income of head of the households

More importantly, the descriptive analysis shows that the *Knowledge* factor is relatively low in urban (mean = 2.21) and rural (mean = 1.945) areas while the *Motivation* factor remains weak in urban areas (mean = 1.92) and strong in the rural areas (mean = 4.18) as shown in Table 5. However, the mean value for the other factors is relatively equal among respondents living in rural areas and urban areas as well.

Results of the path analysis

Path analysis is one type of general linear model that is also comparable to multiple regression in that it allows to measure the effect of several independent variables on a dependent variable (Allen, 2017). In this regard, the results from path analysis were mainly obtained in two levels, without and with the moderating effect of the respondents' geographic location (urban versus rural areas). To identify the significant factors affecting household solid waste generation, more specifically the measured weight of waste generated at households for a week (MWWGHW), a structural model without the moderating effect of the households' geographic location was developed. As shown in Table 6 and the final empirical model shown in Fig. 5, Knowledge ($\beta = -0.129$, $p < 0.05$), Motivation ($\beta = -0.161$, $p < 0.001$), Contribution ($\beta = -0.111$, $p < 0.05$), and Awareness ($\beta = -0.189$, $p < 0.001$) significantly and negatively associated with MWWGHW. These findings, especially knowledge factors, are different from other findings showing that knowledge factors can influence households to reduce waste generation (e.g., Gökdere, 2005; Jereme et al., 2016). This is because the overall *Knowledge* factor (mean = 2.14) is relatively low in the context of Sri Lanka (see Table 5). Therefore, we can conclude that lack of knowledge about proper waste management may result in higher household waste generation regardless of the level of motivation, contribution, and awareness of household members to support waste management initiatives.

Table 5 Descriptive statistics of the waste management factors

Indicator	Urban		Rural		Overall	
	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation
Knowledge	2.21	0.89	1.95	0.73	2.14	0.87
Motivation	1.92	0.70	4.18	0.66	2.49	1.20
Time	3.41	0.93	3.45	1.01	3.42	0.95
Awareness	3.93	0.80	2.14	0.84	3.48	1.12
Contribution	3.69	0.80	3.62	0.84	3.67	0.81
Attitudes	3.95	0.60	4.01	0.67	3.97	0.62

Table 6 Results of the regression weights of the structural model without the moderating effect

Endogenous variable	MWWGHW			KWFGW			PPWFGW			PCWFGW			OWFGW		
Construct/controlled variable	SPC	Critical ratio	Decision	SPC	Critical ratio	Decision	SPC	Critical ratio	Decision	SPC	Critical ratio	Decision	SPC	Critical ratio	Decision
Knowledge	−0.129	−2.569 **	**Supported**	0.001	0.020	Not significant	0.073	1.328	Not significant	0.021	0.393	Not significant	−0.069	−1.293	Not significant
Motivation	−0.161	−3.286 *	**Supported**	0.057	1.072	Not significant	−0.013	−0.234	Not significant	−0.147	−2.829 *	**Significant**	0.043	0.828	Not significant
Contribution	−0.111	−2.275 **	**Supported**	0.073	1.361	Not significant	−0.057	−1.062	Not significant	0.027	0.522	Not significant	−0.072	−1.390	Not significant
Time	−0.040	−0.829	Not supportive	−0.050	−0.935	Not significant	0.032	0.598	Not significant	0.095	1.814 ***	Not significant	−0.038	−0.730	Not significant
Awareness	−0.189	−3.823 *	**Supported**	0.066	1.217	Not significant	0.059	1.091	Not significant	−0.150	−2.854 *	**Significant**	−0.006	−0.112	Not significant
Attitudes	0.031	0.642	Not supportive	0.075	1.406	Not significant	−0.030	−0.568	Not significant	−0.027	−0.529	Not significant	−0.061	−1.177	Not significant
Family size	0.134	2.758 *	Note 1	−0.076	−1.418	Note 1	0.028	0.522	Note 1	0.059	1.132	Note 1	0.041	0.794	Note 1
Family income	0.301	6.194 *		−0.081	−1.524		−0.049	−0.928		−0.183	−3.548 *		0.278	5.385 *	
Education level	0.015	0.318		−0.131	−2.461 **		0.156	2.934 *		0.122	2.359 **		−0.029	−0.559	
Occupation	−0.106	−2.182 **		0.029	0.552		0.099	1.859 ***		0.027	0.518		−0.127	−2.462 **	

SPC, standardized path coefficients

*, **, and *** denote the significance of the hypothesis at 1%, 5%, and 10% respectively

Results are controlled for socioeconomic factors; family size, family income, education level, and occupation of the head of the household

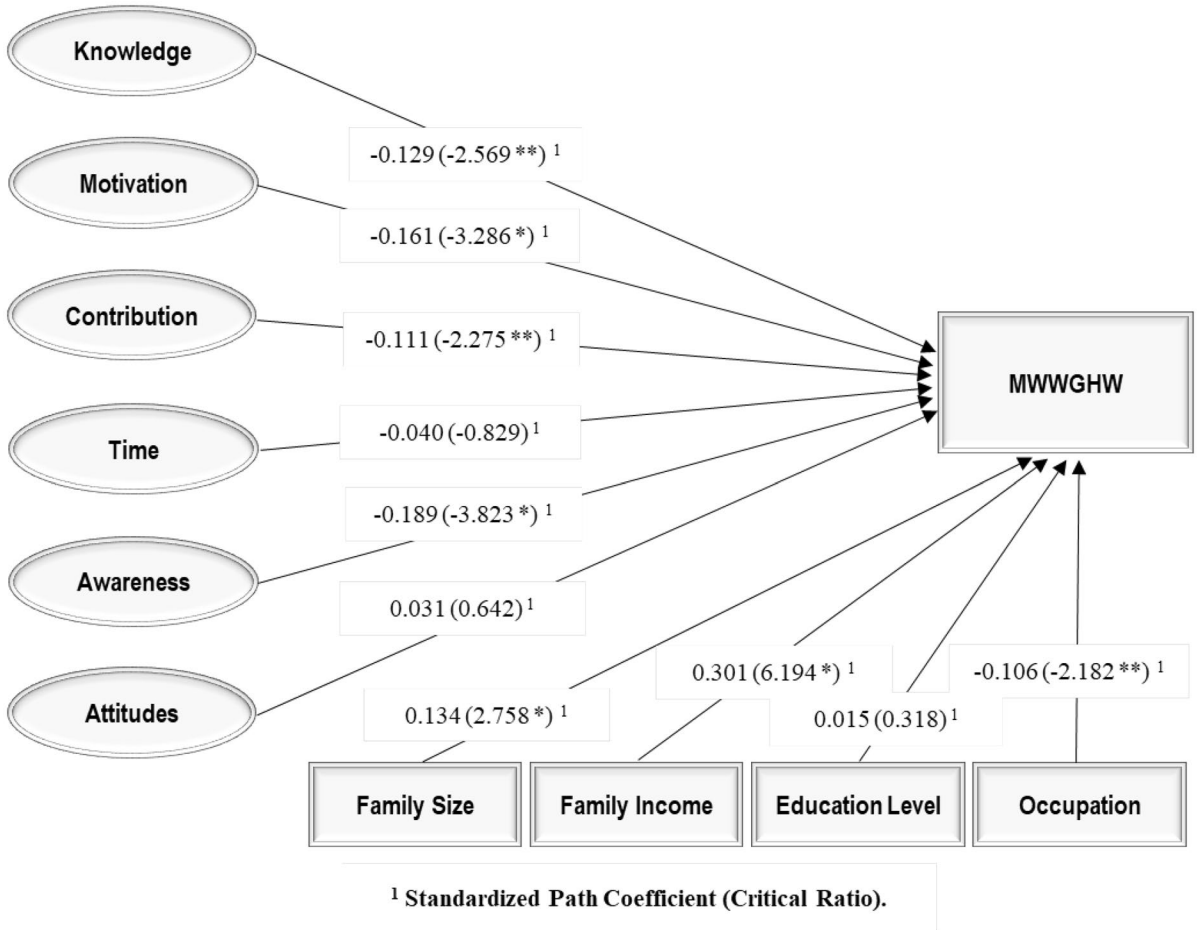

Fig. 5 Results of the empirical model**.** *, **, and *** denote the significance of the hypothesis at 1%, 5%, and 10% respectively

Moreover, the results of this study show only two factors are significantly and negatively associated with one of the components of MWWGHW. This is the case of the relationship between the *Motivation* factor and paper/carton waste fraction generated for a week (PCWFGW) ($\beta = -0.147$, $p < 0.05$) as well as the case of the relationship between the *Awareness* factor and PCWFGW ($\beta = -0.150, < 0.001$), as indicated in Table 6. As households' attitudes and knowledge on the proper and efficient use of materials were found to be two (2) contributing factors to the reduction of waste generation (Astane & Hajilo, 2017), this suggests the need to increase motivation, awareness, and attitude factors as well as the knowledge factor relative to waste management of households to better support waste management.

Furthermore, Table 6 indicates that socioeconomic factors such as *Family Size* ($\beta = 0.134$; $p < 0.001$) and *Monthly Family Income* ($\beta = 0.301$; $p < 0.001$) are significantly and positively associated with MWWGHW while *Occupation* factor ($\beta = -0.106$, $p < 0.05$) is significantly and negatively associated with MWWGHW. These results (e.g., Family Size and income level) are consistent with previous studies showing a significant influence of these socioeconomic factors on household waste generation (e.g., Bandara et al., 2007; Buenrostro et al., 2001; Jadoon et al., 2014). This suggests that an increase in the number of individuals per household and monthly income will increase the amount of waste generated per week per household. Moreover, the negative association

between the *Occupation Factor* and MWWGHW, therefore, indicates that a change of occupation from permanent/stable job positions to temporary/unstable positions may result in less waste generation per week at the household level. Surprisingly, the relationship between the *Education Level* factor is insignificantly associated with MWWGHW as shown in Table 6. This result is inconsistent with prior studies showing that education of households on solid waste management is essential to increase households' decision into collecting wastes other than open dumping or burning (e.g., Adzawla et al., 2019), but consistent with other results indicating households' education level has an inverse relation with the waste generation rate (e.g., Kumar & Samadder, 2017).

When we explore the relationships between socioeconomic factors and some components or fractions of the Weight of the Waste Generated at the Household for a Week (MWWGHW), we found out that the results vary to a certain degree (see Table 6). For example, the *Family Monthly Income* factor is positively associated with paper/carton waste fraction for a week (PCWFGW) ($\beta = -0.183$, $p < 0.001$) and positively associated with other waste fraction generated for a week (OWFGW) ($\beta = 0.278$, $p < 0.001$). Also, the *Education Level* factor is significantly and negatively associated with kitchen waste fraction generated for a week (KWFGW) ($\beta = -0.131$, $p < 0.05$), but significantly and positively associated with plastic/polythene waste fraction generated for a week (PPWFGW), ($\beta = 0.156$, $p < 0.001$) and paper/carton waste fraction generated for a week (PCWFGW), ($\beta = 0.122$, $p < 0.05$) while the *Occupation* factor is significantly and positively associated with PPWFGW ($\beta = 0.099$, $p < 0.01$) and OWFGW ($\beta = -0.127$, $p < 0.05$).

N.B.

This empirical model presents the results only with the endogenous variable of MWWGHW without the effect of the moderator variable. However, this empirical model is applicable for all the components (MWWGHW, KWFW, PPWFW, PCWFW, and OWFW) with and without the effect of the moderating variable geographic location (urban areas and rural areas).

To assess the moderating effect of the geographic location (urban areas versus rural areas) on the relationships between waste management factors and MWWGHW, a structural model of the respondents was developed. Table 7 shows the results of the structural model with the moderating effect of the geographic location *Urban Area* on the relationships between the independent variables and the dependent variable. Interestingly, the results in Table 7 show that only the relationship between the *Motivation* factor and MWWGHW ($\beta = -0.129$, $p < 0.05$) is influenced significantly, but negatively by the geographic location *Urban Area*. These results are inconsistent with prior findings showing knowledge and attitude as significant predictors of positive recycling behavior at the household level (Babaei et al., 2015), which in turn influences solid waste generated at the household level.

One of the important results of this study is the fact that that the relationships between several of the independent variables and components of MWWGHW are moderated by the geographic location *Urban Areas*. This is the case of the relationships between the *Motivation* factor and *kitchen waste fraction generated for a week* (KWFGW) ($\beta = 0.170$, $p < 0.001$), *paper/carton waste fraction generated for a week* (PCWFGW) ($\beta = -0.145$, $p < 0.05$), *other waste fraction generated for a week* (OWFGW) ($\beta = -0.141$, $p < 0.05$); the relationships between the *Contribution* factor and KWFGW ($\beta = 0.131$, $p < 0.05$), OWFGW ($\beta = -0.114$, $p < 0.01$); and the relationships between the *Attitudes* factor and KWFGW ($\beta = 0.135$, $p < 0.05$) and PCWFGW ($\beta = -0.167$, $p < 0.001$).

Additionally, Table 7 indicates that the Geographic Location *Urban Area* factor positively and significantly moderates the relationships between the *Family Size* and MWWGHW ($\beta = 0.182$, $p < 0.001$) and *Family Monthly Income* factor and MWWGHW ($\beta = 0.331$, $p < 0.001$). The results for the household size in this study are consistent with the findings of several other studies (e.g., Dangi et al., 2011; Sujauddin et al., 2008). It means that an increase in the family size and an increase in their monthly income will increase the amount of waste generated for households living in urban areas. This result for the influence of monthly family income on the amount of waste generated is consistent with results found by Sankoh et al. (2012), Irwan et al. (2013), and Afroz et al. (2011a, 2011b) when considering the moderating effect of *Urban*

Table 7 Results of the regression weights of the structural models with the moderating effect of the geographic location-urban areas

Endogenous variable	**MWWGHW**			**KWFGW**			**PPWFGW**			**PCWFGW**			**OWFGW**		
Construct/controlled variable	SPC	Critical ratio	Decision	SPC	Critical ratio	Decision	SPC	Critical ratio	Decision	SPC	Critical ratio	Decision	SPC	Critical ratio	Decision
Knowledge	−0.056	−0.955	Not supported	−0.026	−0.425	Not supported	0.027	0.425	Not supported	−0.015	−0.251	Not supported	0.026	0.423	Not supported
Motivation	−0.129	−2.222 **	**Supported**	0.170	2.746 *	**Supported**	0.037	0.583	Not supported	−0.145	−2.365 **	**Supported**	−0.141	−2.324 **	**Supported**
Contribution	−0.072	−1.268	Not supported	0.131	2.154 **	**Supported**	−0.041	−0.655	Not supported	−0.039	−0.652	Not supported	−0.114	−1.903 ***	**Supported**
Time	−0.044	−0.770	Not supported	−0.039	−0.640	Not supported	0.018	0.294	Not supported	0.081	1.343	Not supported	−0.035	−0.595	Not supported
Awareness	−0.082	−1.419	Not supported	−0.072	−1.167	Not supported	0.079	1.253	Not supported	0.025	0.412	Not supported	0.031	0.513	Not supported
Attitudes	0.063	1.106	Not supported	0.135	2.198 **	**Supported**	−0.089	−1.423	Not supported	−0.167	−2.729 *	**Supported**	−0.003	−0.042	Not supported
Family size	0.182	3.204 *	Note 2	−0.051	−0.839	Note 2	−0.027	−0.430	Note 2	0.024	0.398	Note 2	0.076	1.285	Note 2
Family income	0.331	5.826 *		−0.070	−1.158		−0.017	−0.273		−0.186	−3.106 *		0.258	4.349 *	
Education level	−0.004	−0.065		−0.081	−1.338		0.118	1.908 ***		0.090	1.500		−0.040	−0.669	
Occupation	−0.124	−2.188 **		0.008	0.129		0.073	1.180		0.041	0.681		−0.102	−1.725 ***	

SPC, standardized path coefficients

*, **, and *** denote the significance of the hypothesis at 1%, 5%, and 10% respectively

Results are controlled for socioeconomic factors; family size, family income, education level, and occupation of the head of the household

Area factor. Also, the result of the economic status of the households is supported by the finding of Khan et al. (2016), Ojeda-Benítez et al. (2008), and Zhang et al. (2018) showing a higher amount of waste generated by the wealthier households living in urban areas.

The results in Table 7 also indicate that the geographic location *Urban Areas* factor influences negatively and significantly the relationship between the occupation of the heads of the household and MWWGHW ($\beta = -0.124$, $p < 0.05$). Therefore, this result suggests that a change in occupation from permanent and stable job positions to temporary and unstable job positions will decrease the weekly amount of waste generated per household in the urban areas. This result is not in line with the findings of the study by Babaei et al. (2015) showing a positive influence of occupation on solid waste generation at the household level. Interestingly, Table 7 shows no significant influence on geographic location *Urban Area* on the relationship between the *Education Levels* factor and MWWGHW, which is partially inconsistent with findings of a study by Mattar et al. (2018) showing education reduces the amount of household waste generation. This result is very meaningful as a higher level of education does not necessarily imply pro-environmental behavior or a higher level of environmental awareness (De Feo & De Gisi, 2010). Moreover, this statement and the result of our study contrast the findings that show a higher level of education yield a negative pro-environmental attitude (e.g., De Feo & De Gisi, 2010; Padilla & Trujillo, 2018) in opposition to findings showing the inverse influence, meaning a higher level of education generates pro-environmental attitudes (e.g., Zen et al., 2014).

Table 8 shows the moderating effect of the geographic location *Rural Area*. From this *table*, one can remark that four out of the six relationships between the independent and dependent variables are significantly and negatively moderated by geographic location *Rural Area* (*Knowledge* and MWWGHW ($\beta = -0.187$, $p < 0.01$); *Motivation* and MWWGHW ($\beta = -0.390$, $p < 0.001$); *Contribution* and MWWGHW ($\beta = -0.154$, $p < 0.10$); *Awareness* and MWWGHW ($\beta = -0.285$, $p < 0.001$)). Furthermore, the results in Table 8 show that the relationships between most of the independent and some components of MWWGHW are either positively or negatively moderated by the *geographic location Rural Area. For instance, the Rural Areas factor moderates* significantly and positively *the relationships between Knowledge and* MWWGHW *plastic/polythene waste fraction generated for a week (PPWFGW) ($\beta = 0.179$, $p < 0.01$); Knowledge and* MWWGHW-*PCWFW ($\beta = 0.242$, $p < 0.05$); Contribution and* MWWGHW-*PCWFW ($\beta = 0.151$, $p < 0.01$); Attitudes and plastic/polythene waste fraction generated for a week* (PPWFGW) *($\beta = 0.180$, $p < 0.01$) while* significantly and negatively moderates the relationships between *Motivation factor PPWFGW ($\beta = -0.167$, $p < 0.01$); Awareness* and *paper/carton waste fraction generated for a week* (PCWFGW) *($\beta = -2.224$, $p < 0.05$);* and *Attitudes* and *other waste fraction generated for a week (OWFGW) ($\beta = -0.230$, $p < 0.05$).*

Also, Table 8 indicates that the geographic location *Rural Area* does not moderate the influence of the four socioeconomic factors (family size, family income, education level, and occupation) and MWWGHW. However, the geographic location *Rural Area* moderates significantly and negatively the influences of the *Family Income* factor on PPWFGW ($\beta = -0.197$, $p < 0.05$); PCWFGW ($\beta = -0.309$, $p < 0.001$). Furthermore, our results show that the geographic location *Rural Area* moderates significantly and negatively the influence of *Education Level* factor on KWFGW ($\beta = -0.241$, $p < 0.05$), but positively *Education Level* factor on PPWFGW ($\beta = 0.288$, $p < 0.001$) and PCWFGW ($\beta = 0.192$, $p < 0.05$). This result thus suggests the need to promote sustainable development practices and attitude change through education and continuous awareness campaign throughout the rural areas.

Conclusions and policy implications

In this study, we have attempted to examine the effect of waste management factors on household solid waste generation and solid waste fraction or components in Sri Lanka while controlling for the socioeconomic factors, namely family size, education, monthly family income, and occupation. We have also attempted to examine the extent to which the geographic locations of *Urban areas* and *Rural areas* moderate the influence of the independent variables as well as the influence of the control variables on the dependent variable (household solid waste generation). The results of this study show

Table 8 Results of the regression weights of the structural model with the moderating effect of the geographic location-rural areas

Endogenous variable	**MWWGHW**			**KWFW**			**PPWFW**			**PCWFW**			**OWFW**		
Construct/controlled variable	***SPC***	***Critical ratio***	***Decision***	***SPC***	***Critical ratio***	***Decision***	***SPC***	***Critical ratio***	***Decision***	***SPC***	***Critical ratio***	***Decision***	***SPC***	***Critical ratio***	***Decision***
Knowledge	−0.187	−1.868 ***	**Supported**	−0.130	−1.164	Not significant	0.179	1.719 ***	**Significant**	0.242	2.373 **	**Significant**	−0.145	−1.357	Not significant
Motivation	−0.390	−4.128 *	**Supported**	0.102	0.966	Not significant	−0.167	−1.716 ***	**Significant**	−0.105	−1.125	Not significant	0.036	0.254	Not significant
Contribution	−0.154	−1.695 ***	**Supported**	−0.069	−0.675	Not significant	−0.084	−0.889	Not significant	0.151	1.655 ***	Significant	0.013	0.131	Not significant
Time	−0.102	−1.106	Not significant	−0.035	−0.339	Not significant	0.028	0.290	Not significant	0.091	0.982	Not significant	−0.050	−0.501	Not significant
Awareness	−0.285	−2.988 *	**Supported**	0.104	0.969	Not significant	−0.163	−1.645	Not significant	−2.224	−2.349 **	**Significant**	0.149	1.459	Not significant
Attitudes	0.044	0.481	Not significant	0.073	0.703	Not significant	0.082	0.861	Not significant	0.180	1.910 ***	**Significant**	−0.230	−2.251 **	**Significant**
Family size	0.009	0.103	Note 3	−0.093	−0.904	Note 3	0.133	1.398	Note 3	0.026	0.281	Note 3	0.000	0.000	Note 3
Family income	0.115	1.262		0.047	0.461		−0.197	−2.074 **		−0.309	−3.377 *		0.289	2.935 *	
Education level	0.102	1.122		−0.241	−2.342 **		0.288	3.032 *		0.192	2.103 **		−0.055	−0.557	
Occupation	−0.043	−0.470		0.062	0.605		0.130	1.364		−0.034	−0.376		−0.121	−1.225	

SPC, standardized path coefficients

*, **, and *** denote the significance of the hypothesis at 1%, 5%, and 10% respectively

Results are controlled for socioeconomic factors; family size, family income, education level, and occupation of the head of the household

knowledge, motivation, and contribution as the only waste management factors that significantly and negatively influence solid waste generation at the household level in Sri Lanka. The results of this study also show that *Family Size*, *Family Monthly Income*, and *Occupation* significantly and positively affect household solid waste generation at the household level. Furthermore, the results of this study show that only the relationship between the *Motivation* factor and MWWGHW is moderated by the geographic location of the *Urban Area*. However, the relationships between Contribution factors and Attitudes factors and several other components of MWWGHW are moderated by the geographic location of the *Urban Area*. Interestingly, the results show that only the *Time* factor and MWWGHW as well as the relationship between the *Attitudes factor and* MWWGHW are not significantly moderated by the geographic location *Rural Area* while mixed results are found when using different components of MWWGHW. It is important to note that the relationships between Knowledge, Motivation, Contribution, Time, Awareness, Attitudes factors, and the components of MWWGHW seem to be unique insights as we did not come across other studies that were consistent with our findings during our literature search. Interestingly, we found positive and significant relationships between Family Size, Monthly Family Income, Occupation, and measured weight of waste generated at households for a week (MWWGHW), and these relationships are significantly moderated only by the geographic local Urban Area.

During the last decade, households in Sri Lanka have progressively changed the old practice of burning and dumping waste to a more pro-environmental behavior of "waste collection arrangements." The fact that Sri Lanka has known some improvement in its socioeconomic conditions and has increased the rate of its urbanization, one should expect higher waste generation at the household level in rural and urban areas. To keep up with the pace of the growing demand for household waste collection services, the central government of Sri Lanka needs to support local governments to develop a reliable waste management system by developing an adequate infrastructure and by investing in waste collection equipment.

As local governments often face budget allocation constraints, they can urge the central government to increase their budget allocation (Kumara & Pallegedara, 2020) or charge a direct household waste collection fee. To meet the demand for household waste collection, municipalities in Sri Lanka must opt to conduct a cost–benefit analysis in order to meet the challenges of household waste collection and management (Kumara & Pallegedara, 2020). By conducting a cost–benefit analysis, local governments would likely have more insights on encouraging waste separation at the household level and recycling at the municipality level (Lavee & Nardiya, 2013). Thereby, the central government of Sri Lanka and local authorities at the municipality level would be able to promote pro-environmental behavior and influence their citizens accordingly.

Following the suggestions of Padilla and Trujillo (2018), the government of Sri Lanka is encouraged to incentivize its citizens to reuse some of the household waste generated through a tax-deductible system. While governments need to take these actions, they also need to educate their citizens regarding the consequences of anti-environmental behaviors. Also, governments of Sri Lanka need to ensure that households have enough knowledge about pro-environmental practices, such as sorting waste and transforming waste into compost. Following Babaei et al. (2015), governments of Sri Lanka are encouraged to increase awareness of their citizens by promoting and developing recycling programs to develop effective campaigns and household behavior-changing interventions. More importantly, the governments of Sri Lanka are encouraged to foster the development of sustainable entrepreneurial start-ups that aim at solving the issues related to household waste collection, management, and transformation of this waste into a product such as compost that could be used by households in the rural areas who are largely depending on agriculture. It should be noted that the central government of Sri Lanka may not be able to increase the budget of all municipalities. Therefore, municipalities can take prompt action by introducing garbage-burning ovens as suggested by Kumara and Pallegedara (2020).

Appendix

Q/No.	
Date	

Factors Affecting Household Solid Waste Generation and Management in Sri Lanka: An Empirical Study

This study aims to collect primary data to assess factors associated with household waste generation. Furthermore, the study intends to improve the general understanding of the household solid waste generation and its subcategories impact on the environment and human health and the requirement of solid waste management practice in Sri Lanka.

Please note that:

- Participation in the survey is entirely voluntary.
- The questionnaire is to be answered by the head of the household.
- Before starting to provide answers, please read and make sure you understand the instructions relevant to each question and provide the correct answer to each question.
- After recording relevant data for one week, please answer Part III of the questionnaire.

The data you provided will be used only for purpose of this study. Furthermore, we are bound to keep the collected data at utmost confidentiality.

Thanks for your time and contribution

Name of the MC/UC/PS:	MC / UC / PS			
Sector/Residential Area of the Household:	Urban		Rural	

Part I - Respondent's Demographic and Socioeconomic Data

1. Please tick ('✓') in the relevant box/boxes and if needed comment on your answer.

1.1 Number of persons currently living in the house: ☐

1.2 Highest educational qualifications of head of household (H/H):

Education Level		Tick ('✓') in the relevant box
1	No schooling	
2	Up to grade 5	
3	From grade 5 to grade 10	
4	Passed O/L or equivalent	
5	Passed A/L or equivalent	
6	Vocational Training	
7	Graduate or above	

1.3 Occupations of the head of the household (H/H):

□ Public sector employee; □ Private sector employee; □ Self-employed

□ Doing Business □ House-wife □ Retired

1.4 Family monthly income range:

□ Below Rs.10,000 □ Rs.10,000 ≤ Rs.20,000 □ Rs.20,000 ≤ Rs.30,000

□ Rs.30,000 ≤ Rs.40,000 □ Rs.40,000 ≤ Rs.50,000 □ Rs.50,000 ≤ Rs.60,000

□ Rs.60,000 ≤ Rs.70,000 □ Rs.70,000 ≤ Rs.80,000 □ Rs.80,000 ≤ Rs.90,000

□ Rs.90,000 ≤ Rs.100,000 □ Above Rs.100,000

Part II - Respondent's Responses on Solid Waste Management Factors

Please select the most appropriate response for the below factors relating to the impact on your behavior of solid waste management and put a '√' mark under the corresponding number.

Rank	5	4	3	2	1
	⬆	⬆	⬆	⬆	⬆
Level of the Agreement	Agree	Some What Agree	Neither Disagree or Agree	Some What Disagree	Disagree

1 - Factors Influencing Solid Waste Management						
1 - Knowledge		5	4	3	2	1
1	I have good knowledge about my responsibility on solid waste generation and management at home.					
2	I have good knowledge about controlling solid waste generation at home.					
3	I have a good understanding of timely neediness for solid waste source separation at home.					
4	I know that solid waste can be transformed into a valuable resource of income after source separation and recycling at home.					
5	I have good knowledge about the nearest waste collection centers established for collecting source-separated wastes at home.					
6	I have good knowledge about problems that may occur due to inappropriate ways of disposing of solid waste at home.					
7	I have good knowledge about proper solid waste disposal methods at home.					

2 - Motivation		5	4	3	2	1
1	I always feel motivated to control unnecessary waste generation inside my home.					
2	I always feel motivated to start proper waste management from my household.					
3	I always feel motivated to recycle my wastes.					
4	I always feel motivated to dispose of waste properly.					
5	I always feel motivated to make compost from kitchen waste.					
6	I always feel motivated to pay additional money to buy substitute products for polythene and plastic.					
7	I always feel motivated to dispose of waste in separate bins.					
3 - Contribution		5	4	3	2	1
1	I often contribute to or participate in waste management programs.					
2	I know that my contribution to waste management will increase the standard of living in my household.					
3	I always encourage my family members to participate in the proper management of waste generated at home.					
4	I often try to influence my friends and neighbors to try to control their household solid generation.					
4 - Time		5	4	3	2	1
1	I always have enough time to engage in waste management activities at home.					
2	I always take time to control unnecessarily solid waste generation at home.					
3	Managing my time would make it convenient to separate solid waste at home.					
4	I have enough time to dispose of your waste properly.					
5 - Awareness		5	4	3	2	1

1	I am well aware of the environmental harm that can stem from inappropriate waste separation and disposal practices of household solid waste					
2	I have learned a lot from the local authorities about waste management and how households can help manage can contribute to					
3	I am well aware of the approved polymerization of ethylene (PE) value when purchasing polythene.					
4	I am well aware of national policies and laws regarding solid waste generation and waste management at home.					
6 - <u>Attitudes</u>		5	4	3	2	1
1	I always show positive attitudes towards controlling and managing solid waste generated at home.					
2	I am open and willing to encourage my neighbors to follow the best household waste management practices.					
3	In my opinion, separate and dispose of solid household waste in a proper way is a good practice.					
4	I am willing to contribute to solid waste reduction (minimizing solid waste generation) programs at the household level.					

Part III – Measuring of Wastes Generated at Household for a Week

Please fill the following table for a week for seven consecutive days from Monday to Sunday providing data for the physical composition of waste generated at your household.

(Please note that daily measures are needed only for food wastes) *

Composition		Weights in Grams (For a week with seven days)							Total Weight	
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Kilos	Grams
1	Kitchen / Food Wastes*									
2	Plastic/Polythene									
3	Paper/Carton									
4	Other Miscellaneous									
	Total									

Note: Please use the scale provided to take the weight measurements of the wastes.

Thank you very much for your contribution.

Data availability The data that support the findings of this study are available from the corresponding author (CM) upon reasonable request.

References

Adzawla, W., Tahidu, A., Mustapha, S., & Azumah, S. B. (2019). Do socioeconomic factors influence households' solid waste disposal systems? Evidence from Ghana. *Waste Management & Research*, 37(1_suppl), 51–57. https://doi.org/10.1177/0734242x18817717

Afroz, R., Hanaki, K., & Tudin, R. (2011a). Factors affecting waste generation: A study in a waste management program in Dhaka City. *Bangladesh. Environmental Monitoring and Assessment*, 179(1–4), 509–519

Afroz, R., Tudin, R., Hanaki, K., & Masud, M. M. (2011b). Selected socio-economic factors affecting the willingness to minimise solid waste in Dhaka city, Bangladesh. *Journal of Environmental Planning and Management*, 54(6), 711–731

Alhassan, H., Kwakwa, P. A., & Owusu-Sekyere, E. (2020). Households' source separation behaviour and solid waste disposal options in Ghana's Millennium City. *Journal of Environmental Management*, 259, 110055. https://doi.org/10.1016/j.jenvman.2019.110055

Allen, M. (2017). *The SAGE encyclopedia of communication research methods* (Vols. 1–4). SAGE Publications. https://doi.org/10.4135/9781483381411

Astane, A. R. D., & Hajilo, M. (2017). Factors affecting the rural domestic waste generation *Global Journal of Environmental Science and Management*, 3(4), 417–426. https://doi.org/10.22034/gjesm.2017.03.04.007

Babaei, A. A., Alavi, N., Goudarzi, G., Teymouri, P., Ahmadi, K., & Rafiee, M. (2015). Household recycling knowledge, attitudes and practices towards solid waste management. *Resources, Conservation and Recycling*, 102, 94–100. https://doi.org/10.1016/j.resconrec.2015.06.014

Bagozzi, R., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Sciences*, 16, 74–94. https://doi.org/10.1007/BF02723327

Bandara, N. J., Hettiaratchi, J. P. A., Wirasinghe, S., & Pilapiiya, S. (2007). Relation of waste generation and composition to socio-economic factors: A case study. *Environmental Monitoring and Assessment*, 135(1), 31–39

Boomsma, A., & Hoogland, J. J. (2001). The robustness of LISREL modeling revisited. *Structural equation models: Present and future. A Festschrift in honor of Karl Jöreskog*, 2(3), 139–168

Buenrostro, O., Bocco, G., & Cram, S. (2001). Classification of sources of municipal solid wastes in developing countries. *Resources, Conservation and Recycling*, 32(1), 29–41

Chin, W. W. (2010). How to write up and report PLS analyses. In *Handbook of partial least squares* (pp. 655–690). Springer

Dangi, M. B., Pretz, C. R., Urynowicz, M. A., Gerow, K. G., & Reddy, J. (2011). Municipal solid waste generation in Kathmandu. *Nepal. Journal of Environmental Management*, 92(1), 240–249

De Feo, G., & De Gisi, S. (2010). Public opinion and awareness towards MSW and separate collection programmes: A sociological procedure for selecting areas and citizens with a low level of knowledge. *Waste Management*, 30(6), 958–976

Ding, L., Velicer, W. F., & Harlow, L. L. (1995). Effects of estimation methods, number of indicators per factor, and improper solutions on structural equation modeling fit indices. *Structural Equation Modeling: A Multidisciplinary Journal*, 2(2), 119–143

Dwivedy, M., & Mittal, R. (2013). Willingness of residents to participate in e-waste recycling in India. *Environmental Development*, 6, 48–68

Ekere, W., Mugisha, J., & Drake, L. (2009). Factors influencing waste separation and utilization among households in the Lake Victoria crescent, Uganda. *Waste Management*, 29(12), 3047–3051. https://doi.org/10.1016/j.wasman.2009.08.001

Field, A (2009). *Discovering statistics using SPSS*. Introducing Statistical Methods Series. Sage publications, London

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39–50

Gefen, D., Straub, D., & Boudreau, M.-C. (2000). Structural equation modeling and regression: Guidelines for research practice. *Communications of the Association for Information Systems*, 4(1), 7

Gökdere, M. (2005). A study on environmental knowledge level of primary students in Turkey. Asia-Pacific Forum on Science Learning and Teaching

Gooderham, P., Minbaeva, D. B., & Pedersen, T. (2011). Governance mechanisms for the promotion of social capital for knowledge transfer in multinational corporations. *Journal of Management Studies*, 48(1), 123–150

Hair, J., Black, W., Babin, B., Anderson, R., & Tatham, R. (2010). *Multivariate data analysis New Jersy: Pearson Education*. Pearson Education

Hair, J. F. Jr., Black, W. C., Babin, B. J., Anderson R. E., & Tatham, R. L. (2006). Multivariate Data Analysis (6th ed.), Upper Saddle River, NJ: Prentice Education, Inc.

Hoyt, W. T., Warbasse, R. E., & Chu, E. Y. (2006). Construct validation in counseling psychology research. *The Counseling Psychologist*, 34(6), 769–805

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1–55.

Iacobucci, D. (2010). Structural equations modeling: Fit indices, sample size, and advanced topics. *Journal of Consumer Psychology*, 20(1), 90–98

Irwan, D., Basri, N. E. A., Watanabe, K., & Abushammala, M. F. M. (2013). Influence of income level and age on per capita household solid waste generation in Putrajaya, Malaysia. *Jurnal Teknologi*, 65(2)

Padilla, J. A., & Trujillo, J. C. (2018). Waste disposal and households' heterogeneity. Identifying factors shaping attitudes towards source-separated recycling in Bogotá, Colombia. *Waste Management*, 74, 16–33. https://doi.org/10.1016/j.wasman.2017.11.052

Jadoon, A., Batool, S. A., & Chaudhry, M. N. (2014). Assessment of factors affecting household solid waste generation and its composition in Gulberg Town, Lahore, Pakistan.

Journal of Material Cycles and Waste Management, 16(1), 73–81

Jereme, I. A., Siwar, C., Begum, R. A., & Talib, B. A. (2016). Addressing the problems of food waste generation in Malaysia. *International Journal of Advanced and Applied Sciences*, 3(8), 68–77

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, 39(1), 31–36. https://doi.org/10.1007/BF02291575

Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). *What a waste 2.0: A global snapshot of solid waste management to 2050*. The World Bank

Khan, D., Kumar, A., & Samadder, S. R. (2016). 2016/03/01/). Impact of socioeconomic status on municipal solid waste generation rate. *Waste Management*, 49, 15–25. https://doi.org/10.1016/j.wasman.2016.01.019

Khan, F., Ahmed, W., & Najmi, A. (2019). Understanding consumers' behavior intentions towards dealing with the plastic waste: Perspective of a developing country. *Resources, Conservation and Recycling*, 142, 49–58. https://doi.org/10.1016/j.resconrec.2018.11.020

Kline, R. B. (2005). Principles and practice of structural equation modeling. 2005. *New York, NY: Guilford*, 2

Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed ed.)

Kumar, A., & Samadder, S. R. (2017). An empirical model for prediction of household solid waste generation rate – A case study of Dhanbad, India. *Waste Management*, 68, 3–15. https://doi.org/10.1016/j.wasman.2017.07.034

Kumara, A. S., & Pallegedara, A. (2020). Household waste disposal mechanisms in Sri Lanka: Nation-wide survey evidence for their trends and determinants. *Waste Management*, 114, 62–71

Lavee, D., & Nardiya, S. (2013). A cost evaluation method for transferring municipalities to solid waste source-separated system. *Waste Management*, 33(5), 1064–1072

Maskey, B., & Singh, M. (2017). Household waste generating factors and composition study for effective management in Gorkha municipality of Nepal. *Journal of Sustainable Development*, 10(6). https://doi.org/10.5539/jsd.v10n6p169

Mattar, L., Abiad, M. G., Chalak, A., Diab, M., & Hassan, H. (2018, 2018/10/10/). Attitudes and behaviors shaping household food waste generation: Lessons from Lebanon. *Journal of Cleaner Production*, 198, 1219–1223. https://doi.org/10.1016/j.jclepro.2018.07.085

Meneses, G. D., & Palacio, A. B. (2005). Recycling behavior: A multidimensional approach. *Environment and Behavior*, 37(6), 837–860

Ojeda-Benítez, S., Armijo-de Vega, C., & Marquez-Montenegro, M. Y. (2008). Household solid waste characterization by family socioeconomic profile as unit of analysis. *Resources, Conservation and Recycling*, 52(7), 992–999

Sankoh, F. P., Yan, X., & Conteh, A. M. H. (2012). A situational assessment of socioeconomic factors affecting solid waste generation and composition in Freetown, Sierra Leone. *Journal of Environmental Protection*, 2012

Saphores, J.-D. M., Nixon, H., Ogunseitan, O. A., & Shapiro, A. A. (2006). Household willingness to recycle electronic waste: An application to California. *Environment and behavior*, 38(2), 183–208. https://doi.org/10.1177/0013916505279045

Sorkun, M. F. (2018). How do social norms influence recycling behavior in a collectivistic society? A case study from Turkey. *Waste Management*, 80, 359–370. https://doi.org/10.1016/j.wasman.2018.09.026

Srun, P., & Kurisu, K. (2019). Internal and external influential factors on waste disposal behavior in public open spaces in Phnom Penh. *Cambodia. Sustainability*, 11(6), 1518

Steenkamp, J.-B.E., & Baumgartner, H. (1998). Assessing measurement invariance in cross-national consumer research. *Journal of Consumer Research*, 25(1), 78–90

Sujauddin, M., Huda, S., & Hoque, A. R. (2008). Household solid waste characteristics and management in Chittagong. *Bangladesh. Waste Management*, 28(9), 1688–1695

Tabachnick, B. G., & Fidell, L. S. (2001). *SAS for windows workbook for Tabachnick and Fidell using multivariate statistics*. Allyn and Bacon

Thanh, N. P., Matsui, Y., & Fujiwara, T. (2010, Nov). Household solid waste generation and characteristic in a Mekong Delta city, Vietnam. *Journal of Environmental Management*, 91(11), 2307–2321. https://doi.org/10.1016/j.jenvman.2010.06.016

Tinsley, H. E., & Tinsley, D. J. (1987). Uses of factor analysis in counseling psychology research. *Journal of Counseling Psychology*, 34(4), 414

Trang, P. T. T., Dong, H. Q., Toan, D. Q., Hanh, N. T. X., & Thu, N. T. (2017). The effects of socio-economic factors on household solid waste generation and composition: A case study in Thu Dau Mot. *Vietnam. Energy Procedia*, 107, 253–258

Weston, R., & Gore, P. A., Jr. (2006). A brief guide to structural equation modeling. *The Counseling Psychologist*, 34(5), 719–751

Zen, I. S., Noor, Z. Z., & Yusuf, R. O. (2014). The profiles of household solid waste recyclers and non-recyclers in Kuala Lumpur, Malaysia. *Habitat International*, 42, 83–89. https://doi.org/10.1016/j.habitatint.2013.10.010

Zhang, H., Duan, H., Andric, J. M., Song, M., & Yang, B. (2018). Characterization of household food waste and strategies for its reduction: A Shenzhen City case study. *Waste Management*, 78, 426–433. https://doi.org/10.1016/j.wasman.2018.06.010