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An Analysis of Socio-economic Factors Affecting the Quantity and Composition of Domestic Solid Waste in the Kandy Municipal Area

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ABSTRACT. *The generation of about 80 tons of domestic solid waste (DSW) per day, requiring a substantial expenditure to dispose, has become a problem within the Kandy municipal area. This study analyzed the socio-economic factors that determine the quantity and composition of DSW, presuming that the socio-economic factors could either be influenced to minimize the generation of solid waste or be used in designing of management strategies to dispose DSW.*

A sample of 100 households was selected from four areas, namely, Mahaiyawa, Suduhumpola, Lewella and Aniwatte, within the Kandy municipal area, using stratified random sampling. The DSW of each household was analyzed daily, for a period of three months. Questionnaire based interviews were done to collect socio-economic information of households.

The study revealed that the average quantity of DSW generated per household was 857 grams per day. The main components of DSW were: bio-degradable material including food 80.26%, paper 12.11% and cloth 1.37%, and non-biodegradable material including plastics 3.89%, regiform 0.19%, leather 0.17%, glass 0.55% and metal 1.46%. Significant relationships were found between the quantity of DSW generated, household income, household size and age structure. The higher income households generated more non-biodegradable DSW.

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INTRODUCTION

Domestic solid waste generation in large quantities is causing problems to people, and to the Kandy municipal council, which is responsible for disposal of DSW (Jayathilake, 1993). Such problems have been realized in Colombo (MEIP,1993) and in cities of other developing countries (Shrestha, 1994). This study was conducted to find the quantity and composition of DSW and to examine the socio-economic factors that determine the quantity and composition of DSW. The research findings could be used to guide the design of technologies and management strategies to minimize the problem of DSW generation and disposal.

The following hypotheses, which were developed based on previous studies (Richardson and Havliek, 1978), were tested. The quantity of DSW generated is positively related with household income, household size and age structure. The non-degradability of DSW is positively related to household income.

MATERIALS AND METHODS

The study was done in four areas, namely, Mahaiyawa, Suduhumpola, Lewella, and Aniwatte within the Kandy municipal area. These areas were selected to represent high (>Rs. 15,000), middle (Rs. 2,501-15,000) and low (Rs. 2,500 and below) income household groups. A sample of 100 households was selected using stratified (based on household income) random sampling. Due to refusal to participate in the study, the sample was reduced to 84. The number of households selected from each area and the distribution of the sample by income groups is given Table 1.

Table 1. Distribution of the sample by area and income groups.

Area	No of Households (Population)	No of Households (Sample)	Distribution by income		
			Low	Middle	High
Aniwatte	941	18	1	6	11
Lewalla	894	21	2	14	5
Mahaiyawa	733	24	8	13	3
Suduhumpola	831	21	5	15	1

The DSW of each household was collected in bins, sorted and weighed daily, for a period of three months. A questionnaire was used to gather socio-economic information related to consumption patterns. The DSW data were quantitatively analyzed using simple statistics and regression analysis. The factors associated with consumption patterns were qualitatively interpreted.

The following regression models were used to test the hypothesis.

Model I:

$$W = B_0 + B_1Y + B_2F + B_3A + E$$

where;

W = quantity of DSW (g/household)
Y = monthly income of the households (Rupees)
F = household size (number of inhabitants)
A = average age of the household inhabitants (Years)
E = error term

Model II:

$$D = C_0 + C_1Y + E$$

where;

D = degradability of DSW (ratio between quantity of non-biodegradable DSW and total DSW of the household)
Y = monthly income of the household (Rupees)
E = error term

RESULTS AND DISCUSSION

It was found that the average quantity of DSW generated by a household was 857 grams per day. Thus based on the total population of the Kandy municipal area, about 80 tons of DSW is generated in the Kandy municipal area. The components of DSW are reported in Table 2.

Table 2. Components of Domestic solid waste.

Type of DSW	Components
Bio-degradable material	
Food	Scraps of vegetables and fruits; food scrapings; left over food.
Paper	Scraps of paper; bills; wrappers; used paper serviettes and plates; cardboard boxes.
Cloth	Remnants of old cloth; pieces of dress materials.
Wood	Small pieces of fire wood; pieces of broken furniture; boxes; ornaments; coir; match sticks.
Non-biodegradable materials	
Plastics and polythene	Pieces of broken toys and ornaments; powder; shampoo and other empty cosmetic containers; pieces of plastic oil cans; used ball point pens; pieces of PVC pipes; polythene bags; shopping bags; biscuit wrappers and other ornamental wrappers.
Regiform	Packing material; pieces of models and decorations.
Glass	Pieces of broken tumblers, plates, dishes bottles and ornaments.
Metal	Stoppers of soft water bottles; salmon tins; other food products and fruits; broken pieces of toys; ornaments; old nails; nuts and bolts; padlocks; wiremesh and automobile parts.

The quantified composition of domestic solid wastes by income groups is shown in Table 3.

Table 3. Composition of DSW by income groups.

Components	Percentage values of DSW			
Type of DSW	Low Income Households	Middle Income Households	High Income Households	Sample
Bio degradable				
Food	75.90	87.16	77.75	80.26
Papers	21.06	6.53	8.73	12.11
Cloth	1.22	1.29	1.54	1.37
Non-biodegradable				
Plastics	1.39	3.08	7.22	3.89
Regiform	0.00	0.06	0.52	0.19
Leather	0.00	0.15	0.37	0.17
Glass	0.21	0.52	0.92	0.55
Metal	0.23	1.21	2.95	1.46

It is evident, vide table 3 that the highest proportion (more than 75%) of DSW is bio-degradable irrespective of household income level. The use of processed food is low in Sri Lanka, thus the quantity of DSW produced by peeling and chopping *etc*, of fresh vegetables and fruits *etc*, is high.

The high percentage of bio-degradable DSW suggests the potential to use the DSW to produce compost. Such methods of DSW disposal would be a "win-win" management strategy, where DSW would be hygienically and effectively disposed with the production of an economical and environmentally valuable fertilizer. The economic feasibility of composting of DSW in the Kandy municipal area has been examined by Fernando (1995).

The percentage of bio-degradable DSW is highest in the middle income households. The observation on consumption patterns revealed that this was due to the middle income households preparing their meals at their own homes. Whilst the poor consume less amount of food, the rich consume more of processed foods and also tend to have meals in hotels, thus generating less bio-degradable DSW (Fernando, 1995).

The middle income households had the highest percentage of cloth (1.29%) in DSW. This was due to dresses being prepared by household members themselves and dress making was done as a business in some houses.

The quantity of non-biodegradable DSW, particularly plastics were found to be relatively high (7.22%) in high income households. This is because more products packaged in plastic containers were purchased by them. Regiform (0.52%), leather (0.37%) and glass (0.92%) were also found in high proportions in high income household DSW. This was attributed to use of more glassware, leather and metal goods and also to the purchase of these goods more frequently. The current practices of recycling non-biodegradables and its commercial potential in the Kandy municipal area has been studied by Fernando (1995). The commercial potential for recycling and re-use of non-biodegradable DSW is substantial.

A variation in the quantity and composition of DSW was found in low and middle income groups during the period of the study. In low income groups there was a substantial fluctuation in the quantity and composition. This is due to the high fluctuations in their income. In middle income groups the quantity of DSW increased during the period of their salaries and wages. In high income groups there was no such variation. High variation in the quantity and composition of DSW would constrain the effective implementation of commercial recycling.

Given below are the results of the regression analysis done to test the hypothesis mentioned above.

Model I

$$W = -0.4530 + 3.5567Y^{**} + 1.3487F^{**} - 0.9368A^{*}$$
$$(0.0987)\ (0.0808)\qquad (0.0233)\qquad (0.0428)$$

$$r^2 = 0.9136$$

The above regression result confirms the hypothesis that the quantity of DSW is significantly related to household income, size and age structure. The signs of the co-efficients show the direction of the relationship. High income households generate more DSW.

Model II

$$D = -1.9685^{**} + 3.5567Y^{**}$$
$$(0.0487)\quad (0.0808)$$

$$r^2 = 0.9436$$

The results of regression model II confirm that high income households generate more non-biodegradable DSW. Results of both models I and II justify discriminatory DSW municipal charges, where high income households could be required to pay more for DSW disposal.

CONCLUSIONS

The study has quantitatively estimated that about 75% of the DSW is bio-degradable and could be disposed by compost production. The higher income households produce more DSW and also higher proportion of non-biodegradable than poor. This justifies an income discriminatory DSW disposal charge system.

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