SOLID WASTE GENERATION, CHARACTERISTICS AND MANAGEMENT WITHIN THE HOUSEHOLDS IN SRI LANKAN URBAN AREAS

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Abstract

Municipal Solid Wastes are becoming a multidimensional threat to the Sri Lankan environment. Especially the solutions are needed to reduce the amount of the environmental problem caused by haphazard solid wastes disposal done by the local governments and the public Even though the country's Solid Waste Management (SWM) strategy is aimed to reduce the amount of final disposal by introducing reuse trends, proper collection methods, source segregation and improved recovery of recyclables still needed to be established. But there should be the knowledge of the amount of waste generation and their composition to guide for the appropriate solutions which the methods can be implemented.

Solid Wastes generation from the urban households would cause many problems than in the rural. The consumption rates and the patterns are different from each High, Middle and Low income levels in the urban areas and as well as from the urban areas to the rural areas, so that the waste generation pattern also different from each other. This study discusses the consumption of consumer goods and the solid wastes generation at Gampola UC area, Sri Lanka. Data were obtained through a Waste Amount and Composition Survey which was done throughout 7 consecutive days of a particular week in August, 2012 with consideration of different income levels of the households and a Non-Collection area from the UC limits. Household wastes consisted of kitchen wastes, garden wastes, paper & cardboard, plastics, textiles, rubber & leather, metal, glass, ceramics, hazardous wastes and E- wastes, the proportion of each waste was approximately 61.5%, 8.92%, 3.02%, 3.25%, 0.71%, 0.25%, 0.58%, 0.97%, 0.04%, 0.23% and 1.26%, respectively. The waste generation rates for High, Middle, Low levels and Non-Collection areas are respectively 0.44, 0.31, 0.27 and 0.55 kg/pers/day. It has indicated that there is a relationship between the household income and the total waste generation.

Key Words: *Solid Waste Management, Waste Generation, Solid Waste Composition, Consumption pattern*

1. Introduction

Sri Lanka is a tropical island located in Indian Ocean with a total land area of 65,610 km^2. The total population is 20.38 million people (Census of Population and Housing, 2011). The urban population is around 16.3 % while the rural population is at 83.7 %. The population growth rate is at 0.7 % (Census of Population and Housing, 2011)). The country has 9 major provinces and 25 districts. In 2010, the Gross Domestic Product (GDP) value was US$ 2,399 (Sri Lanka Socio-Economic Data), 2011).

Despite the fact of economic and other problems, many developing countries are experiencing environmental related matters owing to serious environmental pollutions occurred with high population growth and the rapid urbanization. With the development of industries and infrastructures they tend to harm their own Surrounding without a virtuous knowledge. Therefore the environmental issues like water pollution and air pollution have become serious issues within the developing countries. Sri Lanka is among one of the developing countries which those environmental issues are now becoming threats to the countries well-being. Resembling many developing countries, Sri Lankan Solid Waste Management (SWM) is mainly focused on waste collection other than that of proper waste treatment or a sanitary final disposal. Most of the Sri Lankan Local Authorities (LAs) have continuously disposed their wastes without any proper segregation or treatment to open bare lands or environmental sensitive areas like river banks and marshy lands, for the convenience and the economic benefits.

The possible common reasons for these haphazard waste disposals are such like inadequate financial resources, lack of appropriate solid waste legislations, lack of political will, and public commitment, inadequate technical expertise and lack of planning on the available resources can be presented. Yet there are only limited solutions were generated through the studies which were done during the past decades (Muller, 2002). More importantly economically viable solutions should be provided rather giving expensive ways. Still many of the LAs especially in urban areas are incompetent to provide environmentally sound SWM services which can obviously be seen through haphazard solid waste disposal, non-collected and scattered wastes in the streets, water ways and marshes. Some wealthy and populated LAs are maintaining higher waste collection coverage than others. Even though the collection service is up to a better land mark, environmentally and socially acceptable disposal system is still not being achieved by many. Most of the LAs are still searching for lands to do the open dumping without interested in seeking for sustainable SWM solutions.

The beginning of a better SWM should be focused on the initial stage that is the solid waste generation point. Generation of Solid Wastes is an in-evitable consequence of production and consumption activities (Mahees et al, 2011). Therefore the growth of population is nearly proportional to the growth of waste generation. However the waste generation can also vary with the urbanization trends, cultural variations, level of income, social and lifestyle changes, the food habits and seasonal variations (Mahees et al, 2011).

Though it is simple as selecting, purchasing and using them, consumption of goods cannot be addressed simply. Certain other additional factors may seem to affect the consumption differences, such like distinguish socio-cultural significance of consumption leads for symbolic activities like cultural festivals

especially for different cultures. Even these symbolic consumptions may also change with the financial background of the consumer. Eventually these symbolic consumptions, due to the various Socio-Economic forces are more harmful to the environment than the regular consumption of goods and services.

This paper discusses and presents the research findings of a recent study conducted in Gampola Urban Council (GUC) to investigate the generation amount of solid wastes, composition and the final disposal amount. The measurement of the solid waste composition directly affects the density of the wastes. It is also important to propose a proper disposal method and for the implementing re-use, reduction and recycle of wastes. Using those data it can be suggested to implement a proper waste management plan which will be environmentally, economically and technically worthwhile with the present, existing conditions. By the obtained data the possible solutions are discussed for an appropriate solid wastes treatment and final disposal.

Fig 01 A Map of Sri Lanka which shows the 25 Districts

3. Materials and Methods

3.1 Study Area

The Selected local Authority (LA) Gampola UC is located in Kandy district, Sri Lanka. Total land area is about 8.9 km^2 with a total population of 41,069 (Gampola GN division data, 2010) and the population

density is higher like 4,615 (P/km^2). The UC is sub divided in to 21 "Grama Niladhari" Divisions (GN Divisions). According to the (Census of Population and Housing, 2011, there are 9,297 families are living within the city limits. Gampola is a multi-national and multi religious city where mixes of Sinhalese, Tamils and Muslims along with few other religious groups are living harmony. The peak of Gampola city is called Ambuluwawa which is around 1,095 m above mean sea level. The forest area belongs to that peak is now declared as a bio-diversity complex.

Due to the high population density and the high variation of religions and the races, Gampola UC is generating large amounts of solid wastes. The increasing amounts of solid wastes cause slowing down the development of the city where the UC needs to spend considerably large sum from their total budget. During the recent past the UC had to struggle a lot for finding an appropriate disposal location. Within one year time (From April 2011 to September 2011) the disposal location was changed three times. Currently the solid wastes are disposed at a location closer to Ambuluwawa bio-diversity complex which is also not a permanent place for dumping.

3.2 Methodology

Determination of the waste amount and the composition is not an easy task due to the heterogeneous nature of solid wastes. Therefore the determination of the composition of solid wastes has been evolved with the base of random sampling techniques and the common sense.

The UC area was majorly divided in to two major sections as solid wastes collection area and the non-collection area. The collection area was again sub-divided in to another 3 groups according to their income level. The 3 major income levels were selected as High income, Middle income and Low income levels according to their property tax values. Since the real income of a family cannot be obtained from any governmental data base, the property tax value was used (Bandara et al, 2007).

The samples were selected from 4 wards evolving the random sampling techniques (Tchobanoglous et al., 1993), correspondingly the selected samples are representing High, Middle, Low income levels and the non-collection areas. 30 samples of each category were taken. The samples were selected by the property tax values and the simple structured questionnaire. While doing the questionnaire the family income was roughly enquired or estimated with the consideration of the number of occupants of the family and their occupations.

At each and every household the waste amount and composition were measured continuously over 1 week period. The households were provided 2 different coloured polythene bags, one for kitchen and food wastes and the other one is for the other wastes like plastics, polythene and paper etc. All the collected wastes samples including garden wastes were weighed daily and also the bulk density measurements were done. The bulk density was measured by filling a container of known volume with wastes and then weighing the loaded container. The bulk density is calculated by dividing the net weight of the refuse (weight of loaded container minus weight of empty container) by its volume. The result is expressed as kg/m^3.Then the composition of each component was determined on a weight basis.

The disposal amounts of the wastes were estimated using the measurement of disposed waste volume and the total bulk density of the wastes. The tractor tailor volumes were measured and the number of tractor

loads was counted at the disposal site for 7 days. The total weight of the wastes was calculated with the aid of the average total volume per a day and the total bulk density.

The total disposed waste (kg) = Total volume of disposed wastes (m^3) * Total bulk density (kg/m^3)

The obtained data were analyzed to predict the total household waste generation within Gampola UC. The computations were performed using the data analysis tool in MS Excel 2010.

4. Results

4.1. Solid Waste Generation

The waste generation is different when the economic level of the waste generators is varying (Table 1). When the income level is high, the waste generation amount is higher as well.

Table 1 Residential Solid Waste Generation Amount

Residential Category	**Income level**	**Waste Generation Rate (kg/person/day)**
Collection Area	**High Income Level**	0.44
	Middle Income Level	0.31
	Low Income Level	0.27
	Average	0.34
Non-Collection Area		0.55
Average Generation of the UC Area		0.39

From these calculated waste generation rates, the total residential waste generation for Gampola UC was estimated to be 17 tons per day. When considering the non-collection area the amount of waste generation per day was estimated to be 7.6 tons per day. So it should be only 9.4 tons per day collected by the UC.

4.2. Solid Waste Composition

Table 2 Residential Waste Composition (%, Wet Basis)

Waste Type	**Residential Waste (%)**				
	High Income Level	Middle Income Level	Low Income Level	Non-Collection Area	Average
Kitchen	87.8	84.7	87.2	61.5	80.3
Garden	1.6	4.7	3.1	26.3	8.9
Paper & Cardboard	4.1	4.3	2.6	1.1	3.0
Soft Plastic	3.0	2.8	2.5	2.4	2.7
Hard Plastic	0.2	0.7	1.0	0.4	0.6
Textiles	0.4	1.1	1.0	0.4	0.7
Rubber & Leather	0.1	0.2	0.5	0.2	0.3
Metal	0.6	0.4	0.5	0.8	0.6

Glass	1.4	0.5	0.8	1.2	1.0
Ceramics	0.0	0.0	0.0	0.2	0.05
Hazardous	0.4	0.1	0.1	0.5	0.2
E Wastes	0.0	0.1	0.1	4.9	1.3
Miscellaneous	0.5	0.4	0.6	0.3	0.5

The significant high amount of waste generation was recorded from the non-collection area because of the garden waste generation within the non-collection area is so high compared to the collection area. The primary components on a weight basis are compostable are compostable organics (food and garden wastes, 89.2%), Paper and Cardboard (3.0%) and plastics (3.2%). So the average recyclable and compostable content is 97.0% where recyclable wastes could include: plastic, paper and cardboard, metal and glass. This provides a significant potential for waste recovery. It seems that the high level income households producing more kitchen wastes than anyone else and when the income level reduces, the per capita waste generation rate is decreased too. Low level income households producing more kitchen wastes than the non-bio degradable wastes but yet the amount is lesser than the middle income according to the weight.

4.3 Solid Waste Disposal

Waste disposal is another functional element of Solid Waste Management where there can be seen many major short-comings in the LAs (Sujauddin M., et al, 2007). The wastes generated in the city are disposed of in an open dump used as a temporary dumping site approximately 6 km away from the city center in the reservation of Ambuluwawa. This site is an open area about 2000 m^2 located in a mountain slope. The dumping area was leveled and cut trenches to avoid rolling the wastes to the downwards of the slope. The wastes are not separated prior to dumping, resulting in a variety of waste from residential, commercial (Small scale manufacturing, trades and crafts) and institutional. Due to the restrictions of the UC, dead animals or particles, industrial wastes and bio hazardous materials from hospitals are not disposed in this dumping site. There are no systems to prevent air and ground water pollution and waste is sometimes burnt in open air inevitably or intentionally. The waste eventually ends up in an open un-sanitary site.

According to the study conducted for the waste disposal amount at the dumping site, the amount of waste disposal was estimated as 13.85 tons per day. The attributed difference with the generation and the disposal, due to the presence of commercial and institutional wastes including market wastes. Even the wastes were collected from the commercial, institutions, markets and other establishments the wastes are mainly consisted of organic wastes. The disposal amount could be high if the industrial wastes were also disposed which were not accepted by Gampola UC due to their larger amounts and the hazardousness. They were informed to dispose their wastes by their own territories under the inspection of UC.

This dumping ground is not sanitary (Tchobanoglous G., et al, 2002); they are not covered daily and open pit burning and open pit dumping often. Odors, rodents, flies and vectors are common and scavenging is in practice. Random dumpsites can be a greater threat to the groundwater and public health and to find suitable landfill sites for implementing Sanitary Landfill. The licensing of landfills is made difficult due to environmental and political barriers that limit the choices for disposal alternatives, since the land environmentally suitable and available for landfill construction, the prescribed guidelines are lacking the design criteria for the local conditions.

4.4 Waste Management practices of households in non-collection areas

It was identified that about 40% of the generated wastes are not been collected by the UC waste management services from some limited area of the UC. Many of the households in the non-collection area have larger land areas so the generated wastes within the households are being disposed in their own back yard. The majority of the dumped wastes are kitchen wastes than the other wastes. Many people reuse the polythene, ragged clothes and plastics, for household purposes and some people use coconut shells, polythene, paper and cardboards to fire up the hearth of the kitchen. Even some of them use egg shells and used tea leaves as plant feedings. Therefore only a very little amount of wastes are being remaining. It was also observed that the pet animals like cats and dogs are mostly fed by the food wastes of the households and the disposal of food wastes are too limited by those factors.

Most of the empty glass bottles are being reused and the excess amounts are being sold. Another most common method is burning the wastes. Very few among these areas are doing home composting by using home composting bins or the pit method or the piling method.

5. Discussion

The generation of wastes and their composition are crucial gears in development planning and continuous monitoring of waste management strategies. It is now clear that the waste characteristics are different from each level that they are being generated and the lifestyles of the people. These data are more important for the LAs when they tend to come up with the plans for proper waste management and the data should have to be continuously updated for the timely important matters they will be facing.

The non-collection area is located away from the main city and the residents of those areas have much larger lands than the people who are living in the collection area. Therefore the amount of garden wastes is high compared to the collection area. Therefore the expansion of the collection area is much essential now. By the way the collection stream should be immediately expanded and the existing collection irregularities should be avoided through frequent monitoring and proper planning with the use of accurate statistical data. The collection vehicles should be maintained properly in order to provide a regular service to the public and also the labor shortage should be overcome through updating the SWM plan.

Food waste as animal feed in already practiced in some extent, mainly in the non-collection area. Other advantageous alternatives include compost or energy recovery via anaerobic digestion (Bio Gas generation) that would reduce landfill waste and possibly collection and transportation costs.

The public cooperation and the public participation are the other important facts. A proper SWM can start in the household level by the implementation of Reduce/Reuse/Recycle hierarchy to give an effort to minimize the wastes. The public cooperation in that factor will reduce the amount of problems from the LAs. Already the recycling materials are bought by some collectors but the major problem hasn’t seemed

to be smaller. Reduce and Reuse practices should be built within the public through awareness programs and health related workshops. The poor public awareness and poor sense of civil responsibility cause many problems for the LAs. The Recycling practices can be more developed by distributing home composting units among the general public and monitoring the progress.

6. Conclusion

The daily per capita household waste generation according to this survey was 0.39 kg/pers/day, of which organic wastes accounted for the highest proportion (Approx. 89.2%), and ceramics accounts for the least (Approx. 0.042%). No of household members had a proportional relationship with the rate of total household wastes, kitchen wastes, waste paper and plastics generated. Also the family income had a proportional relationship with the total household wastes, kitchen wastes and soft plastic. However reduction of solid waste disposal in the landfill is highly dependent on source segregation of wastes, currently not in practice.

Further research is necessary to establish reliable information on household waste generation and composition as well as the relationship between socio-economics and household waste generation rate in the entire UC area, including surveys at the different climatic conditions and during the special festival seasons to generate a model which can use for most of the urban cities in Sri Lanka. Also not only within a one geographical area but representing the whole country and confirm the proportion of household waste in urban solid wastes.

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