Composition of Household Waste and the Constructive Management of Its Disposal (District Based)

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Abstract- *Municipal solid waste management is a major concern all over the world, including Sri Lanka. This municipal solid waste has become a major concern not only because of the health and environment issues but also because of the massive amounts of waste generated. A sample from the Kurunegala district was selected to carry out a quantitative assessment of the composition of household waste. The purpose was to study the possible methods for its constructive management and disposal. Separation of waste, door to door waste gathering, knowledge with regard to waste handling, landfill disposal problems and technical removal procedures were considered in the study. The required data pertaining to waste such as weight and volume of different household waste[1] categories were collected. The households selected for the study was obtained from the Kurunegala Municipal Council. Further information with regard to waste generation and disposal were obtained from interviews and discussion with the people of the area and with the officials of the municipal council. This included data from solid waste dumping sites. An objective of this effort was to seek methods to reduce and recycle the quantity of household waste. A further objective was to seek improvements to effective waste collection and efficient waste transportation which could encompass all households within the study area.*

Indexed Terms- *Municipal waste, Recycle, Municipal council, Waste management, Waste reduction, Disposal, Waste collection, Household, Composition.*

I. INTRODUCTION

Kurunegala city remains as an important regional trade center situated in north western province. It is the capital of north western province of Sri Lanka. It is situated about 116km from Colombo, and 42km from Kandy. The district covers an area of 4816km2 which is 7% of the total land area of Sri Lanka. Kurunegala comprises of 30 divisional secretariats and 47 Grama Niladari divisions, of which 12 are within the Municipal council. The Municipal council area is 11.34km2. the Kurunegala Municipal council consists of a population of approximately 37,500. It has nearly 7500 households and the total population is more than 200,000.

The main issues of municipal solid waste[2] are the discharge, storage, collection and transport. Currently, unplanned and improper ways of dumping of solid waste have become the most significant environmental issue. The Kurunegala Municipal Council dumps 75 tons of solid wastes per day, collected twice from its territory and transported to the dumping yard at Sundarapola (2 km from Kurunegala City). The areaof the dumping site is 12 acres. The main issue faced by the municipal council of Kurunegala district is the administration of the solid waste[3] generated on a daily basis through human activities. So, doing a research on the topic 'composition of household waste and the constructive management of its disposal'.

Bags were distributed to 10 households within the study area. Solid waste was separated and collected over a period of 1 week. The bags containing the separated waste products were weighed towards making an assessment of household waste generation. This information was used to propose methods to manage dispose household solid waste. Then select 10 houses from my area and distribute bags to separate and collect solid waste during in 1 week of period and measure the weight of the waste and going to do a calculation to give a proposal how to manage the solid waste or how to dispose it. The country has 9 main provinces and 25 districts. According to Sri Lanka Sustainable Authority, waste generation per capita ranges between 0.4 – 0.85kg per day. The certain area for this study is an area of Kurunegala city in

Kurunegala District, North Western Province, Sri Lanka. It is situated about 116 km from Colombo. Kurunegala Municipal Council area includes with one main town. Kurunegala – the main town.

II.   LITERATURE REVIEW

Solid waste management has become a major concern in environment issues (Mazzanti & Zobili, 2008). This is mainly correct to urban areas where population is quickly increasing and volume of waste produced is increasing similar never before (Kathiravale & Mohd yunus, 2008). Waste generation rise correspondingly to this population amount and revenue, generating the need of actual administration (Mazzanti & Zobili, 2008).

Sub urbanization and development primes to different life style and performance which also disturbs waste configuration since largely organic to artificial material that last longer such as plastic and additional packet materials (Idris et al, 2004). E- waste that hardly existed before was produced as much as 20-50 metric tons a year (UNEP, 2006).

The administration of waste is multifaceted and the conveniences provided cannot manage the growing demand and requirements. Consequently, best approach needs to be applied proximately while considering environmental, social and economic characteristics (Aye & Widjaya, 2006).

The drivers of maintainable waste management were simplified by Agamuthu et al (2009), which include human, economic, official and environment characteristic. The study recommends that each driving group should be considered in local background as managing solid waste for a certain society may differ from the others.

III.   METHODOLOGY

A. Research Design
The research included of two dynamic components; the first component comprised of a questionnaire survey. Four different questions including number of members in the house, number of elders in the house, number of children in the house and monthly income were included in the questionnaire. The questionnaire survey was carried out among 10 randomly selected households within the municipal area of Kurunegala district to get primary data about their income and number of household members. Also collected some other information required for this study such as methods of waste disposal and types of solid waste being generated from their houses. The second component comprised of collection and analysis of solid waste from households. This exercise was carried out to determine the waste generation and waste composition of households in kurunegala municipal area.

Bags were issued to each family (5 bags/family) for the collection of different types of solid waste such as food and garden waste, paper, polyethylene, plastic, glass and metal. All families were instructed to collect these different types of solid waste[4] in separate bags. Collected solid wastes were weighed at regular intervals. Food waste was weighed daily and other types of waste were weighted once a week for a period of one month. Collected data were charted and average amounts of different types of waste generated in a month were determined.

According to the research topic ten number of houses in the Kurunegala district were selected for the study. Garbage bags were provided for the ten houses and suggested them to separate waste into four categories namely food waste and garden waste, paper, polythene, metal and glass. The weight was measured weekly. Kurunegala district municipal council was selected to collect the weekly garbage collection data required for my research.

As mentioned earlier this research was performed based on a field observation. The selected Kurunegala area was sub divided in to groups according to the income level. The 3 major income levels were selected as High income, Middle income and Low-income levels (monthly income less than Rs 50000, between Rs 50000-Rs 100000, more than 100000). Then the sample size selection will be determined by using a mathematic function.

After selected the sample size, the income level was categorized through a questionnaire survey. Then the selected households were advised to measure their solid waste[5] before disposal for one-week period by

weekly basis. After one week each and every household was given three garbage containers to separate their waste into food, paper, metal, garden waste and polythene and advised them to measure the three containers weekly for one month and collect those data weekly. Then those collected data were analyzed and tabulated clearly. For that used Microsoft Excel. After analyzed the tabulated data, compared the waste generation and composition according to high, middle and low-income levels. Then used those data to improve future solid waste[6] management plans and ongoing solid waste management and disposal practices.

B. Sample Size Calculation

Yamane (1967:886) provides a simplified formula to calculate sample size. This formula was used to calculate the sample size. A 95% confidence level and +/-5% precision was used. The number of households in Kurunegala municipal area is 11500 households.

$$n = \frac{N}{1 + N(e^2)}$$

'n' is the sample size.
'N' is the number of households.
'e' is the level of precision.

$$n = \frac{N}{1 + N(e^2)}$$
$$= \frac{11500}{1 + 11500(0.05^2)}$$
$$= 386.55$$
$$= 387 \text{ Households}$$

The calculated sample size was 387 households. As this is the first research as an undergraduate it was difficult to reach a sample size of 387 within one-month period. So, the sample size was reduced to ten households in Kurunegala municipal area.

C. Questionnaire Survey

The collected data was based on the monthly income and the waste generated per month.

Have considered less than Rs. 50000 as low-income level, between Rs. 50000-100000 as middle-income level and more than Rs. 100000 as high-income level. (The income levels assumed to be less than Rs. 50000 as low-income level, between Rs. 50000-100000 as middle-income level and more than Rs. 100000 as high-income level).

- Income level

Income level[7] was one of the main factors considered in the selection of households. The income levels were separated into three main categories. This table shows the number of families falling into each category.

Table I: Number of households according to income level

	Income level (SL rupees)	Number of households
Low income	Less than 50000	03
Middle income	50000 - 100000	03
High income	More than 100000	04
Total		10

- Family size

According to questionnaire survey, 10 households were selected with variation in family size. This table shows the frequency distribution and number of household members per family.

Table II: Number of members in a household

Number of household members	Frequency distribution
Three members	03
Four members	03
More than four members	04
Total	10

- Residential solid waste generation in study area

The below table shows the average total waste generation per month among 10 households studied, waste generation per household per month, composition of different categories of wastes generated and per capita waste generation[8] for each category.

- Residential solid waste generation in Kurunegala municipal area are shown in table 3
- When income level is less than 50000 (Low income) are shown in table 4

Total number of houses – Three number of houses were selected

- When income level is between 50000 - 100000 (Middle income) are shown in table 5

Total number of houses – Three number of houses were selected
- When income level is more than 100000 (High income) are shown in table 6

Total number of houses – Four number of houses were selected
- Waste Collecting, Transporting and Handling in Kurunegala Municipal Area

Municipal council (MC) have different times, different days, different roads and different waste types to collect garbage in the municipal area.

If people need to give garden waste like big branches and other tree parts, they can give money and handover those waste to the municipal council.

The Sundarapola garbage dumping yard area is 12 acres and the daily waste generation which brings to the yard is 75 tons. The waste which generates in the Pradeshiyasaba also brings to the Sundarapola waste dumping yard. There are about 60ft of height waste in kurunegala dumping yard only, which the waste is not separated. So, this has become a big problem to the municipal council.

- Labour requirement

There are only 13 tractors are there for waste collect and also only 115 labours are there (But the required amount is about 190) so these are a main problem in waste collection. The excavator cost with labour for one day is Rs 30000.

- Waste recycles

67% of waste are organic waste. 70% of organic waste are reused by preparing compost (about 35 tons). There are 17% of waste which could not recycle. They are Fabric, shoes, wood, tiles etc. 20% of waste can be recycle. Paper and Metal are sent to India to recycle. Polythene and plastic are recycled. But before recycle have separate them according to various temperature values that they heat.

- Preparing composte

It takes three months to make composte. After making a composte pile should turn it twice a week. And should do it seven or eight times. Then should check the temperature and it is done by using hand. The temperature should be about 60^0C. Thermophylic bacteria lives in composte and helps to make composte. If the temperature or the water content is high should do it again. After doing this in three months can have composte.

TABLE III: HOUSEHOLD SOLID WASTE GENERATION

Types of waste	Mean waste generation/Month (Kg) (10 households)	Mean waste generation/Household/Day (Kg)	composition% (wt)	Mean waste generation/Person/Day (Kg)
Food waste and garden waste	1118.99	3.73	95.91	8.67
Paper	15.945	0.05	1.37	0.12
Polythene	12.37	0.04	1.06	0.09
Plastic	10.51	0.04	0.90	0.09
Metal/ Glass	8.89	0.03	0.76	0.07
Total	1166.705	3.89	100	9.05

Table IV: Household solid waste generation according to low income level

No of Low-income houses	Food and Garden waste (Kg)	Paper (Kg)	Polythene (Kg)	Plastic (Kg)	Metal/Glass (Kg)

1	70.920	1.170	0.870	0.740	0.860
2	115.390	1.880	1.345	1.170	0.620
3	74.010	1.010	1.000	0.800	0.620
Total	260.32	4.06	3.215	2.71	2.10
Average from one household	86.773	1.353	1.072	0.903	0.7

Table V: Household solid waste generation according to middle income level

No of Middle-income houses	Food and Garden waste (Kg)	Paper (Kg)	Polythene (Kg)	Plastic (Kg)	Metal/Glass (Kg)
1	98.430	1.440	1.210	0.780	0.815
2	89.070	0.930	0.920	1.135	0.860
3	86.860	1.215	1.125	1.145	0.845
Total	273.36	3.585	3.255	3.06	2.52
Average from one household	91.12	1.195	1.085	1.02	0.84

Table VI: Household solid waste generation according to high income level

No of High-income houses	Food and Garden waste (Kg)	Paper (Kg)	Polythene (Kg)	Plastic (Kg)	Metal/Glass (Kg)
1	157.860	2.725	1.760	1.280	0.690
2	155.500	2.310	1.490	1.050	1.480
3	119.040	1.465	1.050	1.190	1.060
4	153.930	1.800	1.600	1.220	1.040
Total	586.33	8.300	5.900	4.740	4.270

IV. RESULTS

With reference to table IV the mean total waste generation from ten households was 1166.705 kg/month. Food and Garden waste generation (1118.99 kg) was greater than other types of waste whereas Metal/Glass waste generation was very much lower (8.89 kg) than all other types of waste studied in this area. Based on these results, every person generates 8670 g (8.67 kg) of food waste and Garden waste per day and food and garden waste contributes nearly 96% of the total waste generated in the study area. Average waste generation per household and per capita waste generation were 3.89 kg/day and 9.05 kg/day respectively.

Reference to table V, table VI and table VII in high income the overall composition was, food and garden waste (96.19%), paper (1.36%), plastic (0.97%), polythene (0.78%), metal/glass (0.7%). In middle income the overall composition was, food and garden waste (95.65%), paper (1.25%), plastic (1.14%), polythene (1.07%), metal/glass (0.88%). In low income the overall composition was, food and garden waste (95.56%), paper (1.49%), plastic (1.18%), polythene (0.99%), metal/glass (0.77%).

V. DISCUSSION

According to the income level high amount of waste generated in high income level households. According to above tables we can see the amount of waste difference between high income, middle income and low-income families. According to the income level the amount of waste increasing. So, to reduce the amount of waste[9] generated in a household we have to consider the income level and according to my research have to start it from high income families. Because they are the people who generate high amount of waste other than middle income and low-income

families. Not only garden and food waste but also paper, polythene, plastic and metal/glass.

- Comparative analysis of solid waste management based on the current research

The goal of this research was to minimize the solid waste generation in kurunegala municipal area. According table 04 the total amount of produced household solid waste in Kurunegala municipal area was 3.89 Kg/Household/Day. The high amount of waste comes from food and garden waste.

Reference to table V, table VI and table VII income wise society showed variations in terms of waste composition and characterization. In all income group the food and garden waste amount are the highest. In high income the overall composition was, food and garden waste (96.19%), paper (1.36%), plastic (0.97%), polythene (0.78%), metal/glass (0.7%). In middle income the overall composition was, food and garden waste (95.65%), paper (1.25%), plastic (1.14%), polythene (1.07%), metal/glass (0.88%). In low income the overall composition was, food and garden waste (95.56%), paper (1.49%), plastic (1.18%), polythene (0.99%), metal/glass (0.77%). The majority of household have more than 4 persons/household. There was great variation in the quantity of waste generation in different family size in the municipal area.

According to table IV, table V and table VI it shows how solid waste generates according to income level in Kurunegala Municipal area.

The Sundarapola garbage dumping yard area is 12 acres and the daily waste generation which brings to the yard is 75 tons. Due to the lack of space for dumping the solid waste in Kurunegala district it is possible to encourage people to make compost within the household without discharge waste to the municipal council, try to recycle non-organic waste within the household.

Due to the lack of labor requirement can introducing an automated garbage truck which has the capability to do all the processes done by the labors.

Daily brings 75 tons of waste to the damping yard for disposal. From them about 50% of waste can be utilized. From the waste which brings to the dumping yard, 67% of waste are organic waste. 70% of organic waste are reused by preparing compost (about 35 tons). There are 17% of waste which could not recycle. They are Fabric, shoes, wood, tiles etc. 20% of waste can be recycle. Paper and Metal are sent to India to recycle. Polythene and plastic are recycled. But before recycle have separate them according to various temperature values that they heat. Sundarapola dumping yard is 2 km away from the Kurunegala City and there doesn't have any other locations nearby to dispose garbage due to lack of space. When it rains the bad smell of the dump is high so this is a main problem which people face who live near the dumping yard. Animals like Rats and crows are increasing so diseases like rat fever can be spread and diseases like dengue can be spread due to high waste generation. Waste generation amount is increasing day by day. The dumping yard is almost 60ft in height which the waste cannot be separated. There doesn't have any solution to reduce it. According to the analyzed data food and garden waste generation amount is high. Food and garden waste can be used for compost preparation. But non-organic materials cannot be recycled easily so we have to minimize usage of other non-organic materials.

- Problems can be happened

The Meethotamulla Waste Dump site is located about 4.0 km East of Colombo. Initially, the site had received waste only from the Kolonnawa area. But, due to the closure of the Bloemendhal solid waste dump, the waste of Colombo Municipal Council area was also dumped at the site. According to the Colombo Municipal Council, at the time of disaster, approximately 800- 900 tons of waste were being dumped at the site daily. Meethotamulla garbage dumping yard is 21-acre (85,000 m^2) and the garbage dump site reached a height of 48.5 m (159 ft) when it collapsed. 60 houses have been completely destroyed and 27 houses partially damaged while 32 bodies have been recovered from the damaged area. Meethotamulla garbage dump collapsing was a big tragedy which happens in our country year 2017. The waste generation amount of Kurunegala municipal area is increasing day by day and the dumping height is almost 60ft in height which the waste cannot be separated and doesn't have any solution to reduce it. And also, the area of the dumping yard is 12 acres

only. So, if we didn't find a solution for this case one-day Sundarapola dumping yard also will have to face a situation like meethotamulla. So, we have to find a solution to reduce the daily waste generation[10] amount in households and should find a solution to reduce the garbage dump in the sundarapola dumping yard. So, if we find solutions for this matter, we can prevent such an accident happen in future.

• Waste reduce, reuse and recycle

Food and garden waste, we can use for compost preparation. But non-organic materials we cannot recycle easily so we have to minimize usage of other non-organic materials. High income families mostly use high amount of plastic and polythene. So, without using Disposable goods: paper plate, paper bowl, Styrofoam cup, plastic spoon, roll of paper towels, paper napkin; we can use Durable goods: ceramic/plastic plate, metal spoon, glass/plastic drinking cup, dish towel, cloth napkin. Instead of buying new containers from the market, use the ones that are in the house. And also, without throwing away the soft drink can or bottles we can cover them with homemade paper or paint on them and use them as pencil stands or small vases. Also, we can use shopping bags made of cloth which can be used over and over.

In the dumping yard food and garden waste are separated for compost preparation. And the non-organic materials like paper, polythene, plastic and metal/glass are separated for recycle. The waste which cannot be separated are taken for disposal. Kurunegala sundarapola dumping yard uses the above ground landfill (area landfill) method for waste disposal.
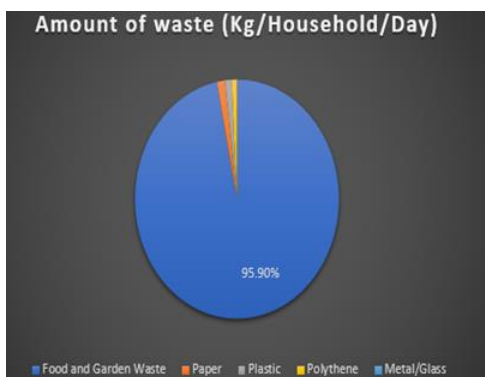

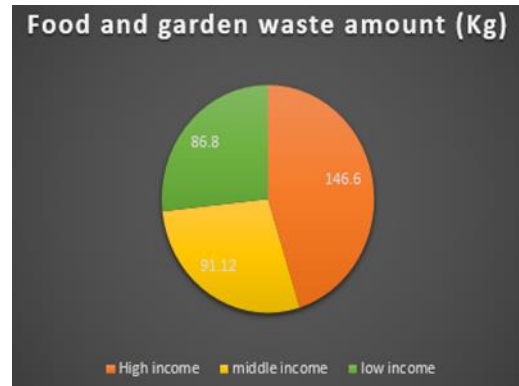Figure I: Amount of waste according to different waste types

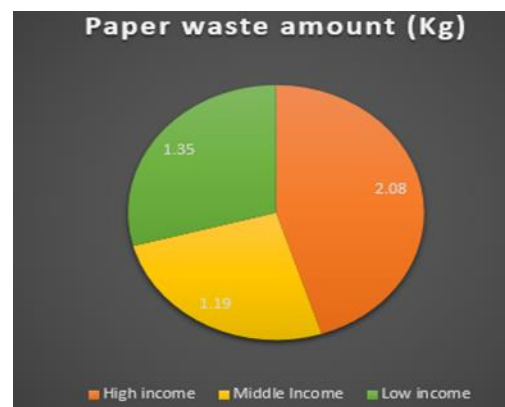Figure II: Amount of food and garden waste according to income levels

Figure III: Amount of paper waste according to income levels
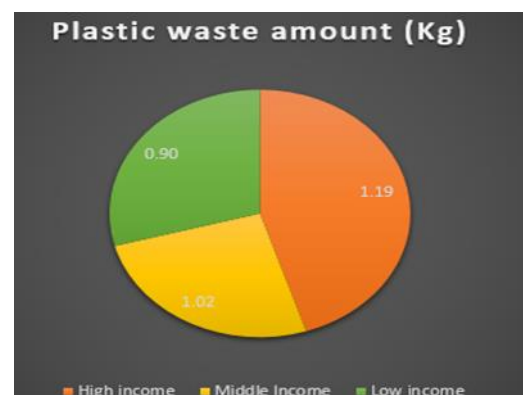

Figure IV: Amount of plastic waste according to income levels
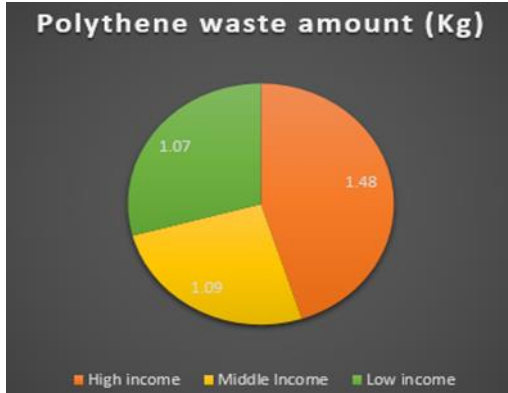
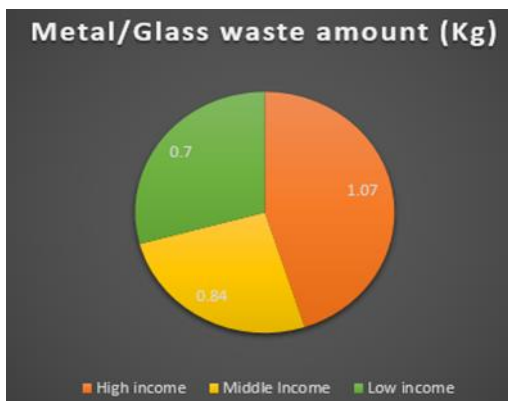Figure V: Amount of polythene waste according to income levels

Figure VI: Amount of metal/glass waste according to income levels

CONCLUSION

First selected the sample size. After selected the sample size, the income level was categorized through a questionnaire survey. Then the selected households were advised to measure their solid waste before disposal for one-week period by weekly basis. After one week each and every household was given three garbage containers to separate their waste into food, paper, metal, garden waste and polythene and advised them to measure the three containers weekly for one month and collect those data weekly. Then those collected data were analyzed and tabulated clearly. For that we can use Microsoft Excel. After analyzed the tabulated data, compared the waste generation and composition according to high, middle and low-income levels. Then used those data to improve future solid waste management plans and ongoing solid waste management and disposal practices. According to my research topic this research was performed to

assess the solid waste generation and composition in kurunegala area. Through my methodology I was suggested many improvements in solid waste management planning can be done and those data were very useful to plan implementation process to meet current and future needs for the solid waste management strategies in an efficient, cost effective, reliable and equitable manner with minimizing environmental pollution (water, air, soil) and to ensure the sustainability of eco system in the urban region. According to the analyzed data according to the income level the food and garden waste are the high amount of waste which generates highly from households. So, I recommend that by distributing compose preparing bins to households can reduce the food and garden waste generation through households. So, if the recommended methods are correctly implemented the problems associated with waste disposal in each can be resolved.

RECOMMENDATIONS

Motivation to reduce solid waste generation

In order to convince people to reduce solid waste generation[11] in household's awareness programs can be done, leaflets can be provided, presentations can be done for school children and the public based on reducing solid waste generation in households.

- Instruct the community on recyclable material processing and eco-conscious obtaining practices. By distributing the leaflets, by awareness programs the community can be instructed on recyclable material processing and eco-conscious obtaining practices.
- Removal of organic waste from landfill by generating composting opportunities. By doing presentations and workshops based on how to make compost within households using organic waste.
- Recycling and waste management in multi-family residences. By doing presentations and workshops based on how to recycle solid waste within households.
- Encouraging people to use recyclable materials by doing awareness programs.
- Food and garden waste can be used for compost preparation. But non-organic materials cannot be

recycled easily so we have to minimize usage of other non-organic materials.

- So, without using Disposable goods such as paper plate, paper bowl, Styrofoam cup, plastic spoon, roll of paper towels, paper napkin.
- We can use Durable goods such as ceramic/plastic plate, metal spoon, glass/plastic drinking cup, dish towel, cloth napkin.
- Instead of buying new containers from the market, use the ones that are in the house.
- And also, without throwing away the soft drink can or bottles we can cover them with homemade paper or paint them and use them as pencil stands or small vases.
- Also, we can use bags made of cloth which can be used over and over other than shopping bags.
- Can reduce the garbage collection cost by giving composting bins at a subsidized cost to households.

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