Waste Composition at UiTM Students' Centre

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***Abstract*— Municipal solid waste has become an issue to our environment due to its rapid generation following the vast development and change in lifestyle. The second highest waste generation is contributed by industrial, commercial and institute in Malaysia after residential sector. The objective of this paper is to evaluate the composition of waste at Universiti Teknologi MARA (UiTM) students' centre and also to determine the fraction of recyclables waste from there along with the potential benefits. Based on approximately 10,000 students at the time of study, the waste generation rate per student was estimated as 0.25 kg/day. The types of solid waste collected were paper, plastics, aluminium cans, food waste and miscellaneous (battery, cartridge ink, motherboard or any electrical circuit and wires, diapers, dead plants and others). The highest composition is food waste which accounted for 30% by weight. Meanwhile, the lowest composition is aluminium cans with the percentage of 2%. Based on this results, the students' centre can produce 8623.49 kg, 10760.93 kg, 533.63kg, 11159.51 kg and 5788.90 kg for paper, plastic, aluminium can, food waste and miscellaneous respectively per year. Therefore, it is estimated the revenue generated from the students' centre is RM 8492.31 per year. In conclusion, the waste composition study provides a better understanding of the waste generation trends which can help facilitate the provision of better waste management that emphasizes on the reduction and recycling of MSW.**

Keywords*— *Municipal solid waste, waste composition, recyclables, recycling potentials

I. INTRODUCTION

Solid waste management in Malaysia currently experiencing a lot of issues due to the rapid growth of population and hence waste disposal. Solid waste generation data is lacking in Malaysia because lack of data collection which has resulted in inaccurate and outdated databases. The Ministry if Housing and Local Government (MHLG) conducted the first nationwide compilation of waste generation and composition in 1987 and the result from the survey done concluded that in solid waste management, three major inadequacies were found. The factors are inefficient collection method, improper disposal manner, and collection system that only focus on certain areas. In 2011, there were 296 landfills all over the country but only about 166 were still operating then. The number of landfills has reduced with the introduction of the Solid Waste and Public Cleansing Management Act 2007 that provides the guidelines for proper waste management. However, 11 out of 166 are sanitary landfills which are capable of reducing environmental problems.

The waste generation is contributed predominantly by the residential sector followed by second industrial, commercial and institutional sectors. The typical waste composition varies between 30 – 40 % food waste, 10 – 18% paper, 20 – 30 % paper, 9 – 12% yard waste and smaller proportions for textiles and the inorganics.

Related to these issues, a comprehensive study was carried out to investigate the status of waste recycling and its future prospects in Malaysia. [10]The study revealed that although a huge amount of waste can be recycled, it is only less than 5% that can actually be separated and recycled. Of all the waste that can be recycled, the one with the highest potential is glass, paper, and plastics. Thus, proper education of waste management from primary to tertiary level is very much needed urgently before a successful recycling program can be in place as otherwise, recycling in Malaysia has a long way to go. This will not help to solve the major problems and obstacles of a sound solid waste management in the country.

1.1 Solid Waste Management in Institutional

Waste management programs in higher education institutions have begun more than 20 years ago and vary from voluntary and local efforts to institutionalized programs. The programs are more evident in developed countries, and the efforts have been caught up be the higher education institutions in developing countries. Following by rapid expansion of higher education institutions worldwide, the rapid increase in generation of waste presents the significance of sustainable waste management programs in higher education institutions. Some of the universities initiatives focused in recycling and waste reduction have been very successful. For instance, University of Southampton has achieved a recycling rate of 72% with cost saving of approximately £ 125k from 2004 to 2008 (Zhang, Williams, Kemp, & Smith, 2011). A study in Rhodes University, South Africa has identified areas to reduce the amounts of paper used and suggested alternatives to increase the rate of campus recycling (Amutenya, Shackleton, & Whittington-Jones, 2009).

In Malaysia, waste generation and composition studies were conducted and published. In University of Technology Petronas (UTP), solid waste generation from academic buildings of 8.8 and 2.4 kg/day in term-time and semester break respectively were reported in which 80% of produced materials at academic building are recyclable with predominant of paper percentage[9]. Furthermore, paper with 3494.2 cal/g as well as food provides energy recovery opportunities. Plastics with highest value of 12,403 cal/g however present low quantity in the whole campus waste of UTP [7] It is surprising though that although semester break means less students are available at the campus however waste generation is still apparent.

In comparison, the waste characterization from solid waste generation in UKM Faculty of Engineering and Built Environment [10] are as shown in Figures 1 and 2. Food waste seems to be very dominant in the solid waste category. This has prompted them to consider composting as a healthy activity to be conducted at the campus.

Table1: Waste composition during term time and semester break

	Percent by weight		Percent variation*	
Waste	Term Time	Semester Break	Decrease	Increase
Paper	40	33	2	
Food waste	30	20	50	
Cardboard	10	9	11	
Plastics	15	15		
Glass	1	5		80
Tin/Aliminium	4	5		20
Metals	0	31		100
Total	100	100		

***Based on semester break**

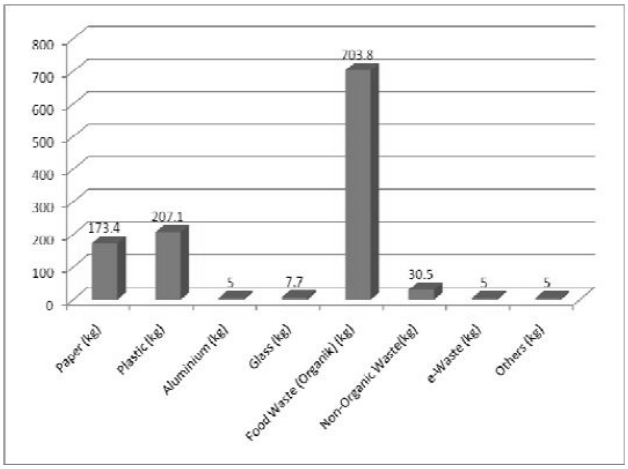

Figure 1 The composition of the solid waste in UKM engineering faculty

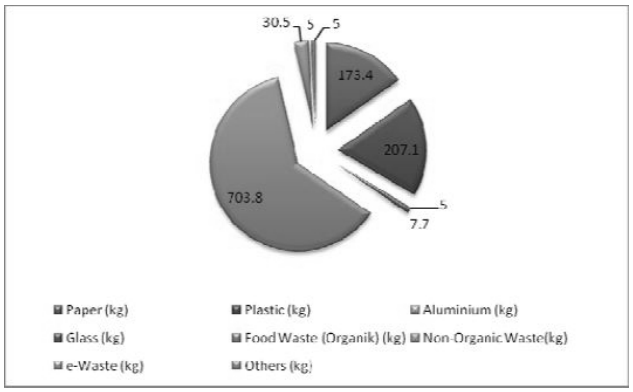

Figure 2 Solid waste composition in the UKM engineering faculty

1.2 Waste Characterization Study

UiTM engineering complex was built in 2003 and the largest building and structure in UiTM Shah Alam. The field samples taken were analyzed at whole building of engineering complex which also includes UiTM students' centre. This is because 25% out of about 40,000 of total population in UiTM Shah Alam, are registered as engineering students. Therefore, UiTM engineering complex is chosen as sample representative for waste composition study.

In this sample, it is observed that the solid waste in UiTM students' centre can be mainly categorized into four types, which are paper, plastic, food waste, and aluminium can. Other types of solid waste that was collected as sample such as battery, ink cartridge, motherboard, or any electrical circuit and wires, diapers, dead plant, and others are categorized as miscellaneous due to the variation in composition

II. METHODOLOGY

2 Sampling Procedure

A sample of solid waste is collected at UiTM students' centre for about 91 to 136 kg. Next, the sample is segregate manually by their categories which are paper, plastics, aluminium cans, food waste and miscellaneous (battery, cartridge ink, motherboard or any electrical circuit and wires, diapers, dead plants and others) to determine its composition. After that, a laboratory sample of each component is placed in sample bag to be analyzed. In the laboratory, the sample is cut to pieces before further reduce to fine particles using a grinder. Shredded sample is then placed in an oven at 105 °C for one hour to remove moisture. Finally, the sample is packed inside a sealed bag to prevent changes in its properties and send to the laboratory for elemental and proximate analysis. Time sample was taken is three times per day at morning (8-9am), afternoon (1-2) and evening (5-6) and it is taken weekly at 24/4/17 (Monday), 3/5/17(Wednesday), 8/5/17 (Monday), 15/5/17 (Monday) and 22/5/17 (Monday). The samples were taken three times per day so the sample of 100 kg could be taken since 8-9 am were the time of morning classes began, 1-2 pm the lunch break and 5-6 the classes ended. Each hours that had been picked indicates the hours of high peak in student hours and each sample collection is covered in one week cycle to identify the weekly trend of the waste composition and waste generation rate.

III. RESULTS AND DISCUSSION

3.1 Waste Composition

Table 2 Overall Composition of Waste Collected at UiTM Students' Centre

Date/Day Composition of Waste	24/4/17 Mon	3/5/17 Wed	8/5/17 Mon	15/5/17 Mon	22/5/17 Mon
Paper	15.20	20.91	26.50	30.26	25.26
Plastic	34.80	27.71	29.85	26.24	28.81
Aluminium Can	1.82	0.71	1.70	1.78	1.30
Food Waste	28.04	30.35	34.09	30.42	29.97
Misc. (battery, cartridge ink, motherboard or any electrical circuit and wires, diapers, dead plants and others)	14.10	15.23	19.18	16.80	13.99
Total	94.26	94.91	111.32	105.50	99.33

The percentage composition of each components was calculated by the formula:

$$\text{Percentage composition of waste fraction} = \frac{\text{Weight of separated waste}}{\text{The total of mixed waste sampled}} \times 100$$

The per capita generation was also determined as per the mixed or the total waste collected in a day and also separated fractions using this formula:

$$\text{Per capita waste generation} = \frac{\text{Weight of MSW generated}}{\text{Total number of person} \times \text{Total number of generation days}}$$

Table 3 Average Composition of Waste Collected at UiTM Students' Centre

Composition of Waste	Percentage Generated (%)	Kg Generated per Capita Day
Paper	23.45	0.0024
Plastic	29.09	0.0029
Aluminium Can	1.45	0.0001
Food Waste	30.31	0.0031
Misc. (battery, cartridge ink, motherboard or any electrical circuit and wires, diapers, dead plants and others)	15.72	0.0016

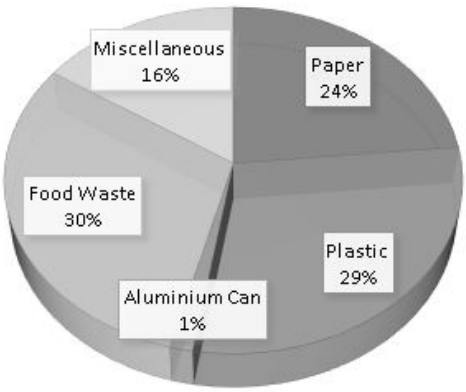

Figure 3 Waste Generation Composition at UiTM Students' Centre

3.2 Revenue from Recyclables

The waste composition data and the prices of the recyclables used for estimating revenues were the ones used by the Alam Flora Sdn. Bhd. 2016. The cost of labour, transport and other overhead are not considered in this study. Potential revenue of recyclable at UiTM students' centre are shown in Table 3.

Table 4 Economic Potentials Estimate of Recyclables in UiTM Students' Centre

Composition of Waste	Amount (kg/year)	Market Price (RM/kg)	Values (RM)
Paper	8624.95	0.30	2587.49
Plastics	10709.10	0.40	4283.64
Aluminium Cans	532.90	3.00	1598.70
Food Waste	11158.05	NA	NA
Misc. (battery, cartridge ink, motherboard or any electrical circuit and wires, diapers, dead plants and others)	5788.90	NA	NA
Total			8469.83

3.3 Reliability of Data

In order to get the best and accurate result for waste composition generated by the student, the sample preparation should be done in a bigger scale in term of waste samples, sources of the waste and place to conduct the sample preparation. To be properly conducted according to ASTM method, the samples should be taken from trucks that collected the waste from the place selected itself. Increasing the number of samples of solid waste can improve the precision of the result. However, this will increase the time required to collect the samples, preparation and its analysis.

IV. CONCLUSION

The composition of the waste is at UiTM engineering students' centre is determined. The composition of paper is 23%, plastic is 29%, food waste is 30%, aluminium can is 2% and miscellaneous (battery, cartridge ink, motherboard or any electrical circuit and wires, diapers, dead plants and others) is 16% by weight. The highest composition is food waste which accounted for 30% by weight. Meanwhile, the lowest composition is aluminium cans with the percentage of 2%. Based on this results, the students' centre can produce 8623.49 kg, 10760.93 kg, 533.63kg, 11159.51 kg and 5788.90 kg for paper, plastic, aluminium can, food waste and miscellaneous respectively per year. Therefore, it is estimated the revenue generated from the students' centre is RM 8492.31 per year. In conclusion, the waste composition study provides a better understanding of the waste generation trends which can help facilitate the provision of better waste management that emphasizes on the reduction and recycling of MSW. The fraction of recyclable also determined as RM 8492.31 is a potential revenue. Therefore, if they start recycling, there is wealth creation while helping to reduce the waste generation into the landfill.

ACKNOWLEDGMENT

The support received from Prof. Dr Sharifah Aishah Syed Abdul Kadir and the MARA University of Technology (UiTM) is highly recognized and appreciated.

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