AUSTRALIAN JOURNAL OF BASIC AND APPLIED SCIENCES

ISSN:1991-8178 EISSN: 2309-8414
Journal home page: www.ajbasweb.com

Assessment of Solid Waste Generated in UNITEN, Putrajaya Campus.

[1]Mohd Hafiz Zawawi, [1]Nazirul Mubin Zahari, [2]Nor Azalina Rosli and [1]Ahmad Najmudin A. Hamid

[1]*Department of Civil Engineering, College of Engineering, Universiti Tenaga Nasional, Jalan IKRAM-UNITEN, 43000 Kajang, Selangor Malaysia*
[2]*Department of Civil Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia*

Address For Correspondence:
Nazirul Mubin Zahari, Department of Civil Engineering, College of Engineering, University Tenaga Nasional, Jalan IKRAM-UNITEN, 43000 Kajang.
TEL: +6 03 - 8921 2020 ext. 6305; E-mail: mubinzahari@gmail.com

ARTICLE INFO

Article history:
Received 18 July 2016
Accepted 21 August 2016
Published 3 September 2016

Keywords:
solid waste generation, solid waste composition, potential energy, potential profit, recycling, UNITEN Putrajaya Campus

ABSTRACT

The purpose of this study is to identify the solid waste generation and compositions that are generated from UNITEN Putrajaya Campus and also to calculate potential energy and profit that can be harvested from the solid waste. This study was conducted at UNITEN Putrajaya Campus where the samples of solid waste were collected from different types of source of generation namely residential colleges, faculty building, admin building and cafeteria. The solid wastes collected are weighed, mixed, quartered and the compositions of the samples are determined. From the analysis, the solid waste generation rate is 2,168.2kg/day during ongoing semester and 987.9kg/day during semester break which give 45.5% differences. The major composition of solid waste produced from this study area are food waste (56%), mixed plastic (9%), mixed paper (7%), mixed plastic bottle (6%), box and polystyrene (4%) and aluminum (3%). From observation, the amount of solid waste generated in UNITEN Putrajaya Campus is depending on the size of the area whereas the larger area has resulted in higher of solid waste generation. In terms of energy that could be recovered by incineration, the total estimation potential energy that generated by UNITEN is 7,750.6kJ/kg per day. The profits that can be achieved from the recycling activities are RM259.94 per day (during ongoing semester) and RM116.96 (during semester break). The analysis shows that solid waste generated in UNITEN has a good potential in recycling activities and give more benefit to UNITEN. With the data of the solid waste generated in this study, proper management strategies can be planned by top management of UNITEN and put it into action in the future. In long term, it will make UNITEN a green campus which eventually reduces the amount of solid waste generation.

INTRODUCTION

In the last two decades, municipal solid waste (MSW) management became a major concern and is presently one of the main public subjects under discussion. This is probably due to the considerable increase of MSW production in both absolute and per capita values. The amount of MSW produced increases with economic growth and the demand for efficient management solution (Magrinho *et al*., 2006 and Talyana *et al*., 2007). The Malaysian population has been increasing at a rate of 2.4 % per annum or about 600,000 per annum since 1994. With this population growth, the MSW generation also increases, which makes MSW management crucial (Manaf *et al*., 2009). Increasing of population growth in Malaysia has brought along with the increasing of the amount of waste generated. The national average of waste generated is range of 0.5 to 0.8kg/person/day, but in the cities the figures have escalated to 1.7 kg/person/day.

There are several factors that contribute to the volume solid waste in Malaysia such as population growth increasing, urbanization, income level and economic development (Zawawi *et al*., 2015). Those factors would

To Cite This Article: Mohd Hafiz Zawawi, Nazirul Mubin Zahari, Nor Azalina Rosli and Ahmad Najmudin A. Hamid., Assessment of Solid Waste Generated in UNITEN, Putrajaya Campus. ***Aust. J. Basic & Appl. Sci.,*** *10(14): 248-253, 2016*

affect the future of solid waste generation in developing countries (Agamuthu, 2001). Clearly, the way to limit the impact on the environment is by reducing the amount of waste that is generated. Failing this, waste must be either be recycled or reused (Messineo and Panno, 2008). Currently, the solid waste management method in Malaysia is very depending on land filling. Landfills have created various environmental problems such as flies production, bad odors and leachate that may cause negative effects such as the occurrence of diseases and groundwater pollution. Besides that, landfills are predicted to become the most expensive method because of the diminishing availability of space and stringent environmental standards. As available landfill space decreases, it might indirectly increase the cost of upgrading the new landfill.

This study will focuses mainly on the generation of solid waste in Universiti Tenaga Nasional (UNITEN) since there are no data regarding on the amount of waste being generated daily. An important point for the success of a waste management plan is the need for accurate and up to date the data on the quality and quantity of the waste that is generated in this area. With this data, proper management strategies can be planned by top management of UNITEN and put into action. This data could also be used to predict the future trends in the quantity and quality of the solid waste in UNITEN.

MATERIAL AND METHOD

There are several matters that are taken into consideration during the data collection of solid waste that is generated in UNITEN. Basically the study area for this research are residential college (Cendikiawan and Amanah), faculty building (College of Engineering), cafeteria (College of Engineering and UPTEN) and Admin Building in UNITEN. For each study area, the sample was collected for three (3) consecutive days per week on Monday, Wednesday and Friday to make sure the data collected was accurate and consistent. The data also can be classified into 2 categories i.e. during ongoing semester and during semester break.

The sampling method was used in this study is follow the Mexican Standard NMX –AA-015-1985 (SECOFI, 1985). All of the solid waste had been weighed then mixed thoroughly. The mixing to ensure that the composition of each type of waste is distributed before it is divided into selected categories. Only a quarter of the sample was chose for this study. Manual sorting was being used to classify the solid wastes collected for the compositional analysis of the solid waste. Figure 1 (a), Figure 1 (b) and Figure 1 (c) shows the process for obtaining the sample of solid wastes for this study. The results from the solid waste samples have been analyzed using the weight percentage for each subcategory. It has been calculated using the following equation:

$$\text{Sub-category percentage} = \frac{(\text{Amount of sub-category, in kg})}{(\text{Total weight, in kg})} \times 100\%$$

(a) (b) (c)

Fig. 1: (a) Waste Collection, (b) Waste Separation, (c) Weighing the Waste

RESULTS AND DISCUSSION

Solid Waste Generation:

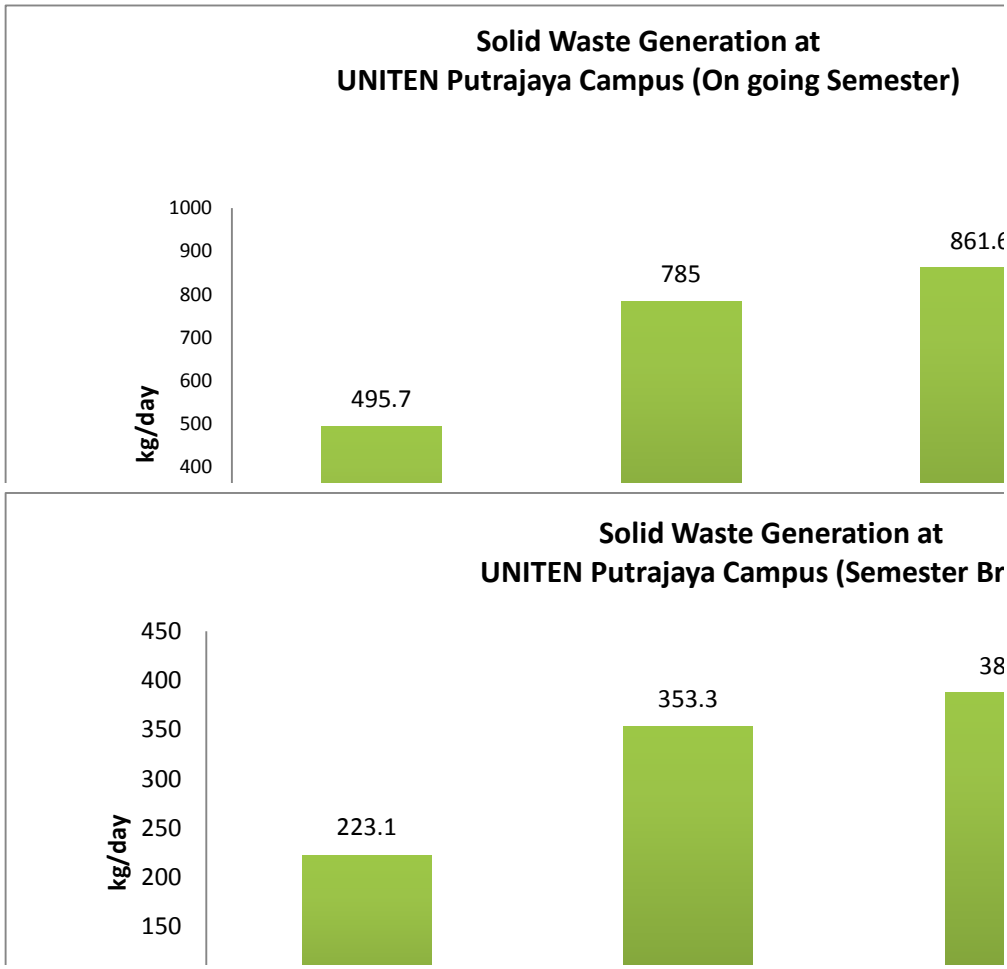

Fig. 2: Solid Waste Generation in UNITEN Campus Putrajaya (Ongoing Semester and Semester Break)

Figure 2 shows the solid waste generation during ongoing semester is 2,168.2 kg/day. The result shows the solid waste generation during ongoing semester for residential college, cafeteria, faculty and Admin building are 861.6 kg/day, 785 kg/day, 495.7 kg/day and 25.9 kg/day. The results indicated the residential college produced the highest amount of solid waste because residential college was the higher population in UNITEN during ongoing semester. Students were bought the food from stall to the residential college to have their meals and produced more solid waste on the residential area. This can be one of the reason of residential college are high. Also there were high number student stay in residential college. Meanwhile, the Admin building produces the least amount of solid waste volume compare to other study area. This could be due to the admin building just operated weekdays only from 8.00 am-6.00 pm. Other from this time, admin building was closed for public for security reason. Figure 2 shows the solid waste generation during the semester break is 987.9 kg/day. The result shows the solid waste generation during semester break for residential college, cafeteria, faculty and Admin building are 387.7 kg/day, 353.3 kg/day, 223.1 kg/day and 23.8 kg/day. The results shows the decreasing pattern because during the semester break, the population in UNITEN is less than ongoing semester. From observation, there are many factors that contribute to the solid waste generation at this study area. Many past researcher have described the several factors that contributed to the amount of solid waste generation include development density, management practice, population and community behavior (Kathirvale *et al*., 2003 ; Sivapalan *et al*., 2003). In another words, the large size would generate more solid waste. According to the Figure 2, increasing in population density and size of the area brings the similar factors that contributed to the amount of solid waste generated as the opinion stated by Kathirvale *et al*., (2003) and Sivapalan *et al*., (2003).

Solid Waste Composition:

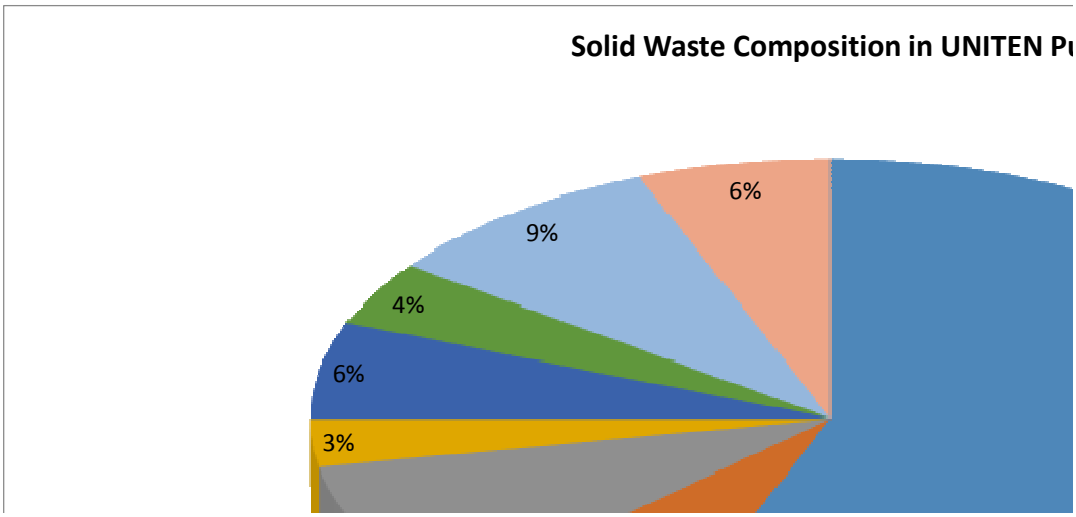

Fig. 3: Solid Waste Composition in UNITEN Campus Putrajaya

Figure 3 shows a solid waste composition in UNITEN Putrajaya Campus. There was little differences for ongoing semester and during semester break. Therefore, result in Figure 3 represent the overall percentage of solid waste composition in UNITEN Putrajaya Campus. The result indicated that most of the location selected was produced food waste. Food waste shows as the highest proportion of composition from other composition which is 56%. The percentage for mixed plastic, mixed paper, plastic bottle, box, polystyrene and aluminum are 9%, 7%, 6%, 4%, 6% and 3% respectively. From observation, it can be seen that the highest of food waste composition resulted from the food stall and cafeteria whereby foods can be easily bought in this area. The main material solid waste from food stall from plastic contribute second highest fraction of the solid waste generated. This is because many student bought the food with packaging from the plastic material. The lowest percentage of the solid waste composition is aluminum. UNITEN already provide the recycle bin for aluminum type. Tin can made from aluminum material has a highest profit for recycle materials.

Potential Profit from Recycling Activities:

Figure 4 shows the percentage of solid waste that can be recycled. Based on the result shows that 79% is non- recyclable materials and 21% is recyclable materials. Recyclable material are divided into the plastic bottle, aluminum (tin can), box (corrugated fiber board and cardboard). These recyclable materials can be sell for individual or group profit gain. The prices of recyclable materials are shows in Table 1. The price is taken from the three (3) local recycle center and make an average. Every year, the price is fluctuated based on the demand of each recyclable material.

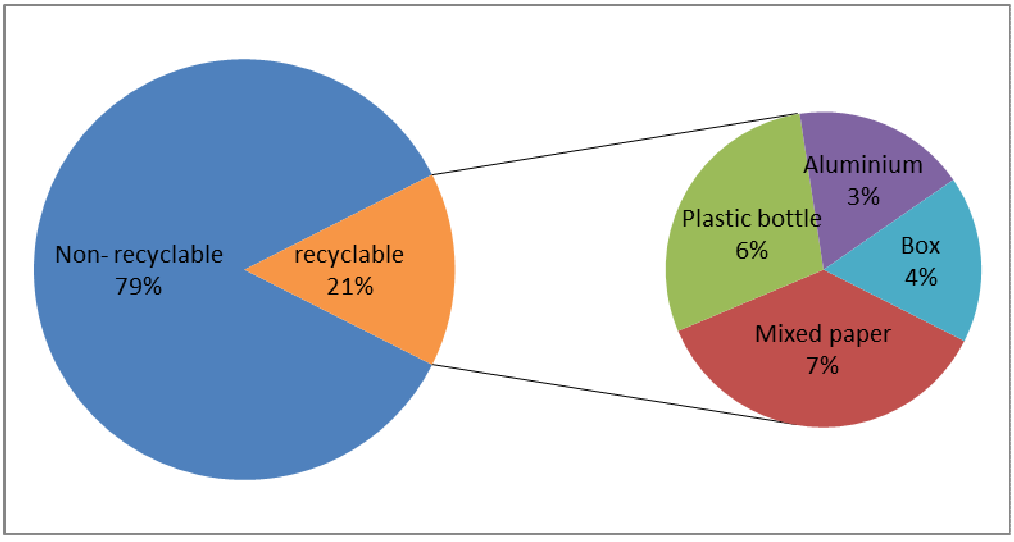

Fig. 4: Composition of Recyclable Material

Table 1: Price for Each Recyclable Materials

MATERIALS	PRICE (RM)
Plastic Bottle	0.50/kg
Mixed Plastic	0.40/kg
Aluminum Tin Can	3.00/kg
Mixed Paper	0.18/kg
Box	0.22/kg

Table 2: Profit from Recyclable Materials (During Ongoing Semester)

Types of Material	Residential College (RM/Day)	Cafeteria (RM/Day)	Faculty (RM/Day)	Admin Building (RM/Day)	Total profit (RM/Day)
Mixed Paper	15.12	3.11	1.97	1.16	21.36
Box	8.05	2.24	1.49	0.72	12.50
Plastic Bottle	28.80	4.80	12.93	1.14	47.67
Aluminum	111.60	32.40	32.07	2.34	178.41
Total	*163.57*	*42.55*	*48.46*	*5.36*	*259.94*

Table 3: Profit from Recyclable Materials (During Semester Break)

Type of Material	Residential College (RM/Day)	Cafeteria (RM/Day)	Faculty (RM/Day)	Admin Building (RM/Day)	Total Profit (RM/Day)
Mixed Paper	6.80	1.40	0.89	0.52	RM 9.61
Box	3.62	1.01	0.67	0.32	RM 5.62
Plastic Bottle	12.96	2.16	5.82	0.51	RM 21.45
Aluminum	50.22	14.58	14.43	1.05	RM 80.28
Total	*73.60*	*19.15*	*21.81*	*2.40*	*RM 116.96*

Table 2 and Table 3 shows the total income that can be gained from recyclable waste during ongoing semester and semester break. It can be seen that the total income UNITEN generated from recycling during ongoing semester is RM259.94. During semester break the profit that can be gained RM116.96. The differences between ongoing semester and semester break is 45%. The differences reflect to the population between ongoing semester and semester break. The result obtained from solid waste generated in UNITEN Campus Putrajaya has a good indicator of recyclable components in campus area. Thus, recycling is the good implementation to the human society because it can encourages toward green environment and save land from disposal to the landfill.

Potential Energy from Recycling Activities:

Table 4 and 5 shows the result potential energy of solid waste that can be produced from UNITEN Putrajaya Campus during ongoing semester and during semester break. The energy component per material was in constant value in unit kJ/Kg. The highest energy generated food waste are 5,619,525.0kJ and 2,528,763.00kJ during ongoing semester and semester break respectively. This due to the huge amount of the food waste that be generated by the daily activities. Food waste will generated the highest energy because natural of the biogas energy comes from the bacteria decompose activities. The purposed calculating the potential energy is to extend the knowledge on energy conversation in daily life. This result of potential energy also as a breakthrough for the extending research in campus regarding to the solid waste management.

Table 4: Potential Energy from Solid Waste (During Ongoing Semester)

COMPONENT	ENERGY(kJ/kg)	SOLID WEIGHT(kg)	ENERGY(kJ)
FOOD WASTE	4,650	1208.5	5,619,525.0
PAPER	16,750	118.68	1,987,890.0
BOX	16,300	56.83	926,329.0
PLASTICS	32,600	105.13	3,427,238.0
TIN CANS	700	59.47	41,629.0
TOTAL		*1,548.61*	*12,002,611.0*

Table 5: Potential Energy from Solid Waste (During Semester Break)

COMPONENT	ENERGY(kJ/kg)	SOLID WEIGHT(kg)	ENERGY(kJ)
FOOD WASTE	4,650	543.82	2,528,763.00
PAPER	16,750	53.41	894,617.50
BOX	16,300	25.57	416,791.0
PLASTICS	32,600	47.31	1,542,306.0
TIN CANS	700	26.76	18,732.0
TOTAL		*696.87*	*5,401,209.50*

Total potential energy that can be produced during ongoing semester and semester break are 7,750.6 kJ/kg respectively. The energy estimation was calculated by using the simple mathematical equation. The compositions of each solid waste class are multiply with their corresponding energy, which is kJ/kg.

Total Energy during Ongoing Semester = 12,002,611 kJ / 1548.61 kg = *7,750.6 kJ / kg*

Total Energy during Semester Break = 5,401,209.50 kJ / 696.87kg = *7,750.6 kJ / kg*

Conclusion:

As a conclusion, the solid waste generation rate are 2,168.2kg/ day during ongoing semester and 987.9 kg/day during semester break which have 45.5% differences. The major composition of solid waste produced from this study area are food waste (56%), mixed plastic (9%), mixed paper (7%), plastic bottle (6%), box (4%), polystyrene (6%) and aluminum (3%). From analysis and observation, the amount of solid waste generated in UNITEN Putrajaya Campus is depends on the size of the area whereas the larger area has resulted in higher of solid waste generation. The total potential energy can be recovered during ongoing semester and semester is 15,501.2 kg/day. Finally, the potential total profit that can be achieved from the recycle activities during ongoing semester and semester break is RM376.9. The result shows that solid waste generated in UNITEN Putrajaya Campus has a good potential for recycling activities and give more benefit to UNITEN and community. Local government also already start on waste segregation campaign in residential area and commercial area. Kuala Lumpur City Planning 2020 (KLCP2020) highlights 30% of total waste generated will be recycled in year 2015 to 40% of total waste generated will be recycled in year 2020. Thus, the community need to strikes for the future challenges on solid waste management program.

REFERENCES

Agamuthu, P., 2001. Solid Waste: Principles and Management with Malaysian Case Studies. Institute of Biological Sciences, University of Malaya.

SECOFI, 1985. Official Maxican Standard approved by the committee of Environment protection, Mexico.

Kathirvale, S., M.M.N. Yunus, K. Sopian, A.H. Samsuddin, 2003. *Energy Potential from Municipal Solid Waste in Malaysia*. Renewable Energy, 29: 559-567.

Sivapalan, K., N.M.Y. Muhd, K. Sopian, A.H. Samsuddin and R.A. Rahman, 2003. Modeling the heating value of Municipal Solid Waste.

Magrinhoa, A., D. Filipe, S. Viriato, 2006. Municipal solid waste disposal in Portugal. Waste Management., 26(12): 1477-1489.

Manaf, L.A., M.A.B. Samah and N.I. Zukki, 2009. Municipal solid waste management in Malaysia: Practices and challenges. Waste Management., 29(11): 2902-2906.

Messineo, A. and D. Panno, 2008. Municipal waste management in Sicily: Practices and challenges. Waste Management., 28(7): 1201-1208.

Talyana, T., R.P. Dahiyaa and T.R. Sreekrishnan, 2007. State of municipal solid waste management in Delhi, the capital of India. Waste Management., 28(7): 1276-1287.

Zawawi, M.H., N.A. Rosli, R.A. Bustami and N.H. Mispan, 2015. Potential of Utilizing Solid Waste Generated in UNIMAS West Campus. Applied Mechanics and Materials., 773-774: 1073-1078.