

Potential of Utilizing Solid Waste Generated in UNIMAS West Campus

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Abstract: The purpose of this study is to identify the solid waste generation and compositions that are generated from UNIMAS West Campus area and also to calculate potential energy and profit that can be harvested from the solid waste. This study was conducted at UNIMAS west campus where the samples of solid waste were collected from different types of source of generation namely residential colleges, faculties, Centre Teaching Facilities (CTF) 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 499 kg per day and the major composition of solid waste produced from this study area is food waste with the value of 54% followed by plastic bottle with 9%, mixed plastic with 8%, mixed paper with 7%, box and polystyrene are with 5% and the less percentage of solid waste composition is aluminium with 4%. For the total estimation potential energy that generated by UNIMAS West Campus is about 12819.9 kJ/kg per day and the profit can be achieved when the solid wastes are recycles is about RM 126.43 per day. The analysis shows that solid waste generated in UNIMAS West Campus has a good potential in recycling and give more benefit to UNIMAS. With the data of the solid waste generated in this study area, proper management strategies can be planned by top management of UNIMAS and put it into action in the future. In long term, it will make UNIMAS a green campus which eventually reduces the amount of solid waste generation.

Introduction

Nowadays, the contributing factors towards the increasing Municipal Solid Waste Generation in Malaysia are almost similar to other developing countries. The amount of solid waste generation has been increased corresponding to the several factors such as rapid population growth, urbanization, income level and economic development. Those factors would accelerate the future of solid waste generation in developing countries [1]. Currently, the waste management method in Malaysia is very depending on land filling. Approximately 5.5% of Municipal Solid Waste (MSW) is recycled and 1.0% is composted while the remaining 94.5% of MSW is disposed on land filling sites [2]. According to [3], landfill is the most common waste treatment method in Kuching city, whereby more than 70% of solid wastes generated were disposed of using the landfill method. However, due to the increasing amount of the solid waste, 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. The local authorities then had been struggling to find alternative way for the waste disposal challenge management. These 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.

This study will focus mainly on the generation of solid waste in institutional of UNIMAS as 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 UNIMAS 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 UNIMAS.

Materials and method

There are several matters that are taken into consideration during the data collection of solid waste that is generated in UNIMAS. Basically the sites areas for this study are residential college (Cempaka and Sakura), faculty building (Faculty of Science Social and Faculty of Cognitive Science and Human Development), cafeteria (Bunga Raya and Cempaka) and Center Teaching Facilities, CTF (CTF 1 and CTF 3). For each site, the sample was collected for 2 consecutive days per week on Monday and Friday to make sure the consistency of the data collected. The sampling method used for this study is spot sampling method. This spot sampling method was proposed by the Mexican Standard NMX –AA-015-1985 [4]. All of the solid waste had weighed and after that it had mixed thoroughly. This mixing had done to make sure that the composition of each type of waste is distributed before it is divided into four parts. Only a quarter of the sample was chose for this study. Hand sorting had used to classify the solid wastes collected for the compositional analysis of the solid waste. Figure 1 and Figure 2 shows the process for obtaining the sample of solid wastes for this study.



Figure 1: Sample of Solid Waste Collected



Figure 2: Quartering Method

The results from the solid waste samples have been analyzed. The weight percentage for each subcategory has been calculated using the following equation:

$$\text{Sub-category percentage} = \frac{\left(\frac{\text{Weight of subcategory}}{\text{Total weight of sample}} \right)}{\left(\frac{\text{Weight of subcategory}}{\text{Total weight of sample}} \right)} \times 100\%$$

Result and discussion

a) Solid Waste Generation

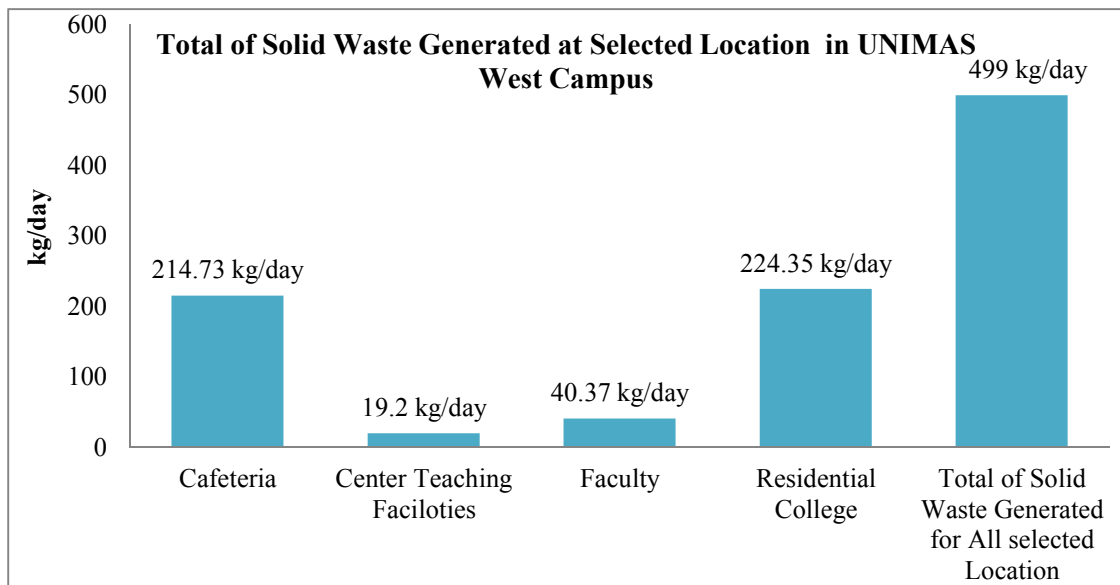


Figure 3: Total of Solid Waste Generated in UNIMAS West Campus.

Based on Figure 3, the result shows the total of solid waste generation in selected location in UNIMAS West Campus is approximately 499 kg/day. Apart from that, the result shows the total of solid waste generated for residential college is estimated at the rate of 224.35 kg/day, cafeteria generates 214.73kg/day, while faculty generates 40.37 kg/day and finally CTF generates 19.2 kg/day of solid waste. The results indicated that residential college produced the highest amount of solid waste because that place was located nearest to the shop and cafeteria. So, students are easily carried out their items that they bought into the college. Meanwhile, the CTF produces the least amount of solid waste volume compare to revenue in the residential college. This is because the CTF is the place of learning process and most of the CTF is intended for students as scheduled to start at 8.00 am to 9.00 pm. From observation, there are many factors that contribute to the solid waste generation at this study area. [5] and [6] have described the factors that contributed to the amount of solid waste generation include development density, management practice, population and community behavior. In another words, the large size would generate more solid waste. According to the Figure 3, the results bring the similar factors as the opinion stated by [5] and [6] which the factors that contributed to the amount of solid waste generation in UNIMAS area are increasing population density and size of the area.

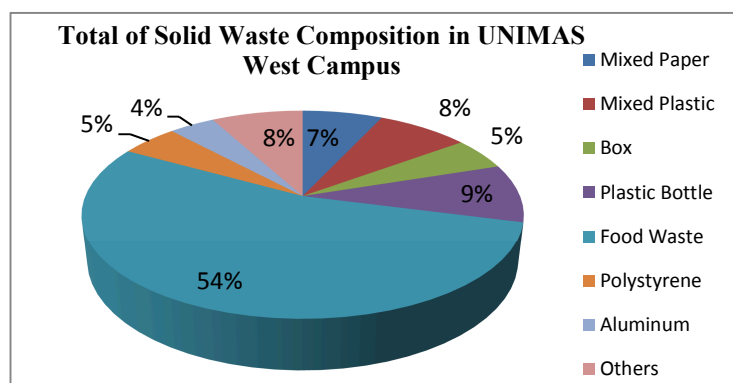


Figure 4: Total of Solid Waste Composition in UNIMAS West Campus

Solid Waste Composition. Figure 4 showing the total estimation of the solid waste composition in UNIMAS West Campus area. The result shows that most of the location had produced food waste as the highest proportion of composition from other composition. Food waste formed is the largest fraction of the solid waste with 54%, followed by plastic bottle with 9%, mixed plastic with 8%, mixed paper with 7%, box and polystyrene are with 5%, and the last percentage is 4% of solid waste composition is aluminum. From observation, it can be concluded that the highest of food waste composition resulted from the existing of food stall and cafeteria where foods can be easily bought in this area. Bottle plastic, mixed plastic and mixed paper formed the second highest fraction of the solid waste generated in this area because plastic waste is composed mainly of packaging item. The small percentage of the waste distribution is aluminum because sometimes the worker who collects the waste has already separate aluminum, box and mixed paper for recycle before throw all the waste to the disposal area. This material has a value of money where it can be recycled.

Solid Waste Treatment. Result obtained from solid waste generated in UNIMAS West Campus has a good potential of recycling and composting. Figure 5 shows the percentage of wastes that can be recycled. Based on the result approximately 75% of non- recyclable materials and 25% of recyclable materials were disposed off from UNIMAS West Campus. These recyclable materials can be sent for recycling programme, Buy Back Centre (BBC) which is conducted by Majlis Bandaraya Kuching Selatan (MBKS). In this program, the contributors bring their recyclable items to BBC and all the collected point can be used to redeem usable household items offered by MBKS. Besides, it also can be sent to recycling centre where the items will be sold and the contributors will get the money. As for this study, the recyclable amounts are summarized in Table 1.

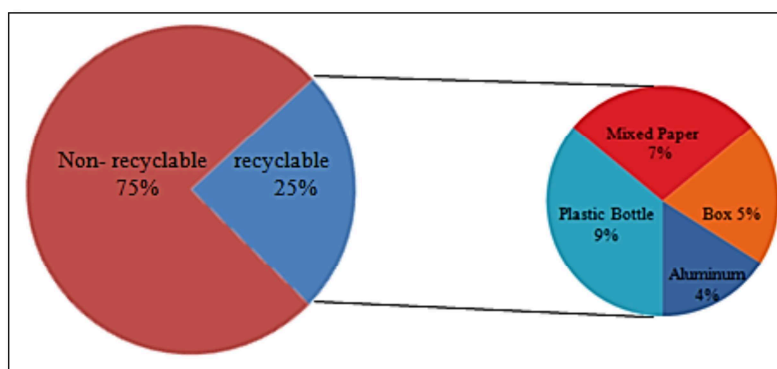


Figure 5: Recyclable Material in UNIMAS West Campus

Table 1: Recyclable of Solid Waste Materials in UNIMAS West Campus

| Types of Material | Cafeteria (kg/day) | CTF (kg/day) | Residential College (kg/day) | Faculty (kg/day) | Total of Recycle Material per day |
|-------------------|-----------------------|-----------------|---------------------------------|---------------------|--------------------------------------|
| Mixed Paper | RM 1.45 | RM 1.12 | RM 7.48 | RM 6.48 | RM 16.53 |
| Box | RM 3.18 | RM 0.80 | RM 7.6 | RM 2.96 | RM 14.54 |
| Plastic Bottle | RM 4.17 | RM 0.98 | RM 5.96 | RM 2.27 | RM 13.38 |
| Aluminum | RM 29.96 | RM 5.84 | RM 39.64 | RM 6.24 | RM 81.68 |
| Total | RM 38.76 | RM 8.74 | RM 60.98 | RM 17.95 | RM 126.43 |

Based on Table 1, the total amount of recyclable items per day in UNIMAS area is about RM126.43. Residential College is the highest produced amount of recyclable items followed by cafeteria, faculty and CTF area. The amount will be produced at Residential College when recycle happen per day is about RM 60.98. Besides that, the second highest amount of recyclable item was produced by Cafeteria with RM 38.76 per day. Both of this area has the highest amount of recyclable items among of other location because contributes more recyclable item. Result obtained from solid waste generated in UNIMAS West Campus has a good potential of recyclable components. Thus, recycling is the good method implemented because this method encourages toward greener environment without waste the reusable material.

Figure 6 shows the amount of solid waste from cafeteria that can be composted. Based on the results, 54% of wastes generated are categorized as organic wastes. However, from this 54%, only 39% of wastes can be composted because another 15% of organic wastes comprises of meat, fish and bones which could not be composted. The output from the composting can be used as a compost fertilizer which then can be used in gardening. Thus, composting can be a practical and economically benefitting method for reducing disposable waste. For solid waste that cannot be recycled or compost, it will be sent to the landfill. Overall, from this study the result show about 25% of the solid waste composition is recyclable material, while 39% compostable material and the rest 36% will be sent to the landfill due to reject or non-degradable waste.

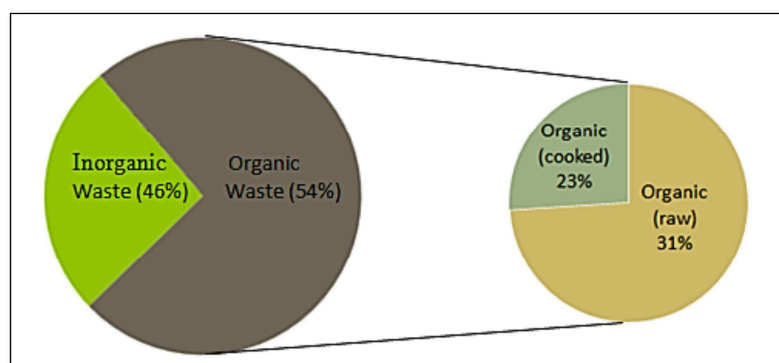


Figure 6: Organic Waste Composition at Cafeteri

Potential energy and profit that can be achieved. As indicated from Table 2, the result show the average total energy of solid waste in UNIMAS West Campus area is about 12819.9 kJ/kg per day and capable to generate about 3.46 KW electricity. Plastics waste is the main component to produce the higher of energy value with 3660654 kJ/kg per day compared to other component waste. Event though food waste is the highest amount of solid waste in this area but the potential energy of food waste is lower with the value of 1245316.5 kJ/kg per. This is because of plastics waste has a higher energy value because of complexity of the molecular structure of plastic making it harder to degrade.

Table 2: Potential Energy of Solid Waste in UNIMAS West Campus.

| Component | Energy (kJ/kg) | Solid Weight (kg) | Energy (kJ) |
|--------------|----------------|-------------------|------------------|
| Food Waste | 4650 | 267.81 | 1245316.5 |
| Paper | 16750 | 33.08 | 554090 |
| Box | 16300 | 24.24 | 395112 |
| Plastics | 32600 | 112.29 | 3660654 |
| Tin Cans | 700 | 20.42 | 14294 |
| Total | | 457.84 | 5869466.5 |

The energy estimation was done by using the formula below. The compositions of each solid waste class are multiply with their corresponding energy, which is kJ/kg.

$$\begin{aligned}\text{Total Energy} &= 5869466.5 \text{ kJ} / 457.84 \text{ kg} \\ &= 12819.9 \text{ kJ/kg}\end{aligned}$$

Conclusion

As a conclusion, the solid waste generation rate is 499 kg per day and the major composition of solid waste produced from this study area is food waste with the value of 54% followed by plastic bottle with 9%, mixed plastic with 8%, mixed paper with 7%, box and polystyrene are with 5% and the less percentage of solid waste composition is aluminum with 4%. From observation, the amount of solid waste generated in UNIMAS West 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 UNIMAS West Campus is about 12819.9 kJ/kg per day. Finally, the profit that can be achieved when the solid wastes are recycles is about RM126.43 per day. From the analysis, the result shows that solid waste generated in UNIMAS West Campus has a good potential in recycling and give more benefit to UNIMAS. Thus, the university has to implement a good waste management program and emphasis on 3R campaign which refers to reduce, recycle and reuse. In long term, it will make UNIMAS a green campus which eventually reduces the amount of solid waste generation.

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