

## Segregation of Municipal Solid Waste and Recycling Potential for Residential Hostel UiTM Sarawak

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### Abstract

Effective waste management through municipal solid waste (MSW) composition study is important for numerous reasons, including the need to estimate material recovery potential, to identify sources of component generation, to facilitate design of processing equipment, to estimate physical, chemical, and thermal properties of the waste and to maintain compliance with Malaysian Environmental Quality Act 1974. The scope of this study focuses on the segregation of municipal solid waste (MSW) in the residential hostel in Universiti Teknologi Mara Sarawak (UiTMS). The resultant demonstrates that plastics, organic, papers and polystyrene pack constitute the highest component in the hostel MSW. Among these components, plastics come on the first place, whereby it constitutes 35.35% of the total MSW, followed by organic or food waste at 27.8%, papers at 16.13% and polystyrene pack at 11.95%. This paper concludes that integrated solid waste management should be implemented for the effective solid waste management in UiTMS. Proper mix of alternatives and technologies such as waste combustion (incineration), land filling and recycling are being proposed due to main composition to be wastes from plastics, foods and papers.

**Keywords:** Municipal solid waste, Proximate analysis.;

### 1. Introduction

Municipal Solid Waste Management is a national critical issue in our country today. One of the issues is regarding the shortening life span of landfills in Malaysia due to intensifying solid waste generation by the rapid the growth of human population. Inefficient solid waste management draws the concern on how it would effects the environment as well as the public health. Flies production, bad odours and leachate may cause negative effects such as the occurrence of diseases. The MSW in Malaysia are mainly composed of organics, plastics and papers. The MSW composition varies depending on the waste sources like household, industrial sectors, commercial and institutional. The scope of this study focuses on the segregation of municipal solid waste (MSW) in the residential hostel in Universiti Teknologi Mara Samarahan (UiTMS) as there is 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 data on the quality and quantity of the waste that is generated in the area. With this data, proper management strategies can be planned by top management of UiTMS and put into action, notwithstanding the fact that this data could also be used to predict the future trends in the quantity and quality of the MSW of the residential hostel in UiTMS. This study is carried out to have a comprehensive characteristic of the waste that is generated and to determine MSW composition and generation rate. Hand sorting will be used for classifying the collected wastes into the following categories: plastics, paper, metals, aluminium, leather-wood-textiles-rubbers, organic wastes, non-combustibles and miscellaneous according to ASTM D 5231 - 92: Standard Test Method

for the Determination of the Composition of Unprocessed Municipal Solid Waste. The sorting procedure of Municipal Solid Waste (MSW) in this study is carried out according to the spot sampling method. Based on this method used by Kathirvale *et al.* (2003), about 30 to 50 kg of mixed wastes is to be taken which is then sorted. The MSW are sorted according to their categories such as plastics, polystyrene pack, organic or food waste, papers, glasses, ceramic, textiles, rubbers, metals and others are found in the MSW. Further analysis included proximate analysis for moisture content of combustible materials. The laboratory analysis is carried out on the MSW samples are based on recommendations from the American Society of Testing and Material (ASTM). Result from this study would provide data to categorise the MSW in UiTMS and the current trends is studied and by means of a prediction model for the future trend is predicted and proposed the appropriate method to treat it.

## 2. Literature Review

Solid wastes are defined, as wastes arising from human and animal activities which are normally solid and unwanted (Agamuthu, 2001). According to Corbitt (1999), solid waste generation can be subdivided into residential and nonresidential, depending on its source. MSW is defined as waste durable goods, nondurable goods, containers and packaging, food scraps, yard trimmings and miscellaneous inorganic waste from residential, commercial and industrial sources (Demirbas, 2004). MSW is mainly the household waste including commercial waste, institutional and some industrial waste (Tchobanoglous *et al.*, 2003). Generally, residential MSW contains more newspaper, yard waste, disposal diapers, textile, rubber and leather. Nonresidential MSW contains more corrugated cardboard, high-grade paper, wood, other plastics and other metal (Liu and Liptak, 2000).

Based on case study by Kathirvale *et al.* (2003), the main components of Malaysia MSW are found to be food, paper and plastics which make up approximately 80% of the waste by weight. Generally, approximately 76% of the total MSW generated in Malaysia is collected, while the remainder is deposited in illegal dumps, drains and rivers. An effective system for solid waste management must be both of environmentally and economically sustainable (Fauziah *et al.*, 2003).

About 1 - 2% is recycled, and the remainder is taken to disposal sites (Mohamad Said, 2003). Recycling also can help stretch landfill capacity and improved the efficiency and ash quality of incinerators and composting facilities by removing non combustible materials, such as metals and glass (Salvato, 2003). The awareness of recycling must be increased for example the Ministry of Housing and Local Government has launched and declared 11 November as the National Recycling Day. Recycling campaigns launched by certain local governments previously in 1990s failed due to poor public response, lack of collection centres and recycling facilities (Fauziah *et al.*, 2004). About 20% of MSW can be diverted from disposal sites if everyone in the community supports the recycling program (Manaf *et al.*, 2009).

The most important factor affecting the representativeness and validation of the data is sample collection. There are several methods for sample gathering such as using crane to grab the MSW from a pit waste processing plant, discharge from a waste vehicle and pick up from a waste collection station. Normally, one tonne of MSW is sampled which is reduced to 20 – 200 kg by dividing or quartering methods and sorted in one-quartered (Watanabe *et al.*, 2002)

## 3. Research Methodology

### 3.1 Sampling

The MSW are collected from the residential hostel, and thereafter being gathered at the on-site MSW storage in the hostel. The collections of samples are done at the on-site MSW storage during working days with moderate weather condition. The sorting procedure of MSW in this study is carried out according to the spot sampling method. Based on this method used by Kathirvale *et al.* (2003), about 30 to 50 kg of mixed wastes is to be taken which is then sorted. The data recorded in the sampling process are initiated by focusing on the weight of the total MSW samples prior to sorting, and thereafter the weight of the sorted samples according to its category. With the data obtained, the statistical value such as mean, standard deviation and range are calculated and recorded. The laboratory sample consists of four sub-samples: putrescibles (food waste), LWTR (leather, wood, textiles, and rubber), plastics (packaging materials, bottles, etc.) and papers (paper, cardboard except sanitary papers). The time interval between collection and analysis is 1–4 hours. At the laboratory, the determinations of the proximate analysis parameter such as total moisture content, volatile matter, fix carbon and ash will be carried out. These experiments are carried out as prescribed by the American Society for Testing and Materials (ASTM).

### 3.2 Density

The bulk density of MSW is determined based on the ASTM E1109-86.

### 3.3 Proximate Analysis

The proximate analysis determination is done in accordance with the American Society for Testing and Materials (ASTM) 2003. Moisture content, volatile matter, ash and fixed carbon of MSW are determined. Heating the MSW at 107°C for 1 hour and measuring the weight loss, according to the ASTM E790-87, the moisture content of the MSW is then calculated. The volatile matter content is determined according to the ASTM E897-88, by measuring the weight loss of the moisture free MSW sample inserted in an electric furnace at 950°C for 7 minutes. This is followed by tests based on the ASTM 830-87 to determine the ash content. The weight loss of the waste residue is measured after burning at 575°C for 1 hour in an electric furnace. The percentage of fixed carbon is determined by the difference after subtracting moisture content, volatile matter and ash of MSW.

## 4. Findings and Discussion

### 4.1 Composition of UiTMS Residential Hostel Municipal Solid Waste.

The compositions of the MSW are summarised in Table 1. Plastics, organics, papers and polystyrene are the major components constituting a total of 93.23% the municipal solid waste, representing about 37.35%, 27.8%, 16.13% and 11.95% respectively. Other minor components included metal (0.94%), glass (1.33%), ceramic (0.31%) and others (4.2%). According to Kathirvale *et al.* (2003), food, paper and plastics are the main components of the Malaysian MSW, which make up approximately 80% of the waste by weight. This is proven in this case of MSW of residential hostel, whereby plastics, food leftovers and papers are ranking top three among other MSW categories in residential hostel. This result is highly expected. Glasses, ceramics, metals and other constituents such as textiles, rubber and leather remain low in MSW percentage of residential hostel throughout the sampling. Metals like aluminium are recorded low in percentage as aluminium is a very precious recyclable item.

**Table 1.** Percentage of Components in UiTMS Residential Hostel MSW

COMPONENTS	Average Weight (kg)	(Percentage %)
POLYSTYRENE		
Food packaging	11.98	11.95
PLASTICS		
Plastic (Film)	23.13	23.09
Pet	6.43	6.42
Plastic (Rigid)	7.86	7.84
PAPERS		
Mixed Paper	8.35	8.34
Corrugated	7.80	7.79
GLASSES		
Clear & Colored	1.33	1.33
CERAMIC		
White ware Ceramics	0.31	0.31
METALS		
Aluminium	0.94	0.94
Fe (Metal/Tin)	0.00	0.00
ORGANICS		
Food	27.85	27.80
OTHERS		
Umbrella/hangers/textile	1.90	1.90
Rubber/leather	2.31	2.30
TOTAL	100.18	100.00

## 4.2 Proximate Analysis

Table 2 shows the research data on proximate analysis. The average moisture content for the MSW is about 67% which due to high percentage of organic components, making incineration a challenging task. Nonetheless the high percentages of combustible materials such as organics and paper may offset this concern. The result also shows that the percentage of volatile matter and ashes are 10.93% and 9.04% respectively.

**Table 2.** Proximate Analysis of Residential Hostel MSW

Proximate Analysis	Weight (%)
Moisture content	67.33
Volatile matter	10.93
Ash	9.04
Fixed carbon	12.7

## 5. Conclusions

A comprehensive study on the characterisation of UiTMS Residential Hostel MSW has indicated that it is highly heterogeneous material, which composed of plastics, polystyrene, papers, organic waste, glasses, metals, ceramics and other miscellaneous components. Overall, organics, papers and plastics are the main constituents by weight of MSW in Residential Hostel. The plastics waste composition is the highest which is about 37.35 %. The university has to implement a good waste management program and emphasis on 3R campaign which refers to reduce, recycle and reuse. The moisture content is 63% on average. These results indicated that the MSW is a low-grade fuel. Since the outcome has shown a high amount of non-biodegradable wastes, proper mix of alternatives and technologies such as waste combustion (incineration), land filling and recycling are well preferred for Residential Hostel MSW and the safest way to get rid of all the waste.

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