

Original Research

Analysis of Municipal Solid Waste Generation and Composition at Administrative Building Café in Universiti Putra Malaysia: A Case Study

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Abstract

Increasing solid waste is one of the most crucial environmental problems in Malaysia. Improper management of solid waste will cause many problems. Increasing solid waste, lack of segregation from the source, and lack of knowledge and awareness about recycling have only worsened the problem. Knowledge of solid waste generation and composition is necessary for accurate decision making in the management strategy of municipal solid waste. The objectives of this study were to measure solid waste generation and analyse and compare the composition of solid waste in two different cafés at Universiti Putra Malaysia. Solid waste samples were collected every day except for Saturdays and Sundays over a three-week period and were sorted and classified into several weighed compositions such as food waste, plastic, paper, aluminium cans, glass, metal, textiles, wood, and more. Results showed that total municipal solid waste generated during three weeks of sampling at Forestry café and Park View café were 325.75 kg, or an average of 21.72 kg/day, and 2979.70 kg, or 198.65 kg/day, respectively. There is significant difference in data collection between the two locations. From the result, it shows that organic waste was the main component in municipal solid waste composition for both cafés, where it is 81% for Forestry Café and 96% for Park View Café, followed by the other compositions. The high organic waste indicates the necessity for frequent collection and removal, as well as having a good prospect for organic waste recycling through composting. Based on this information, a proper waste management system can be introduced to treat the solid waste more efficiently.

Keywords: municipal solid waste, waste generation, waste composition, waste revenue

Introduction

Solid waste is one of the three major environmental problems in Malaysia apart from water pollution and air pollution [1]. Rapid urbanization and industrialization have

modified the generation of solid waste in Malaysia [2], which has increased drastically where it was expected to increase from about 9.0 million tonnes in 2000 to about 10.9 million tonnes in 2010, and finally to about 15.6 million tonnes in 2020 [3], while the national recycling rate is estimated to be only 10% [4].

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Table 1. Types of waste and their definitions.

Type of waste	Description
Commercial solid waste	Any solid waste generated from any commercial activity
Construction solid waste	Any solid waste generated from any construction or demolition activity, including improvement, preparatory, repair, or alteration works
Household solid waste	Any solid waste generated by a household, and of a kind that is ordinarily generated or produced by any premises when occupied as a dwelling house, and includes garden waste
Industrial solid waste	Any solid waste generated from industrial activity
Institutional solid waste	Any solid waste generated by: <ul style="list-style-type: none"> (a) any premises approved under any written law or by the state authority for use wholly or mainly for religious worship or for charitable purposes (b) any premises occupied by any federal or state government department, any local authority or any statutory body (c) any educational premises (d) any healthcare facilities including hospitals, clinics and health centres (e) any premises used as public zoos, public museums, public libraries, and orphanages
Imported solid waste	Any solid waste generated in other countries and imported to Malaysia for processing or disposal
Public solid waste	Any solid waste generated by public places under the supervision or control of any local authority
Solid waste which may be prescribed from time to time	Any solid waste generated at a specific time or occasion only

Solid waste as stated in the Solid Waste and Public Cleansing Management Act 2007 [5] can be defined as any scrap material or other unwanted surplus substance, or rejected products arising from the application of any process; or any substance required to be disposed of as being broken, worn out, contaminated, or otherwise spoiled; or any other material that according to this Act or any other written law is required by the authorities to be disposed of, but does not include scheduled wastes as prescribed under the Environmental Quality Act 1974 (Act 127) [6], sewage as defined in the Water Services Industry Act 2006 (Act 655) [7], or radioactive waste as defined in the Atomic Energy Licensing Act 1984 (Act 304) [8].

According to [5], the type of solid waste which also can be called controlled solid waste can be divided into eight categories: commercial solid waste, construction solid waste, household solid waste, industrial solid waste, institutional solid waste, imported solid waste, public solid waste, and solid waste that may be prescribed from time to time. Table 1 shows the types of waste and their definitions.

Solid Waste Management

Many cities in Southeast Asia are unable to practise good solid waste management due to lack of several matters, including institutional, financial, technical, regulatory, knowledge, and public participation [9]. Good municipal solid waste management should cover the generation of solid waste from other sources such as commercial, industrial, and institutional, as well as municipal services. In Malaysia, a method that is always used for the disposal

of municipal solid waste is through land filling, and most of the sites are open dumping areas [2]. Open dumping land-fill is preferable due to the cheaper cost and it is also the most common method to treat solid waste with a high percentage of organic materials [9]. Collection of waste almost covers all urban areas, but only about 66% of rural areas of Malaysia were covered [10]. Table 2 shows the percentage of waste treatment method applied in Malaysia.

Waste Management Hierarchy and Recycling

In waste management hierarchy, waste generation must be avoided or reduced from the source and waste disposal

Table 2. Waste treatment methods practiced in Malaysia.

Treatment Methods	Percentage (%)		
	2002	2006	Target 2020
Recycling	5.0	5.5	22.0
Composting	0.0	1.0	8.0
Incineration	0.0	0.0	16.8
Inert landfill	0.0	3.2	9.1
Sanitary landfill	5.0	30.9	44.1
Other disposal sites	90.0	59.4	0.0
Total	100.0	100.0	100.0

Source: [11]

Table 3. Solid waste generation in Peninsular Malaysia by states (in thousands of tonnes).

State	1996	1997	1998	1999	2000	2010*	Average growth rate (1998-2000, in %)
Kuala Lumpur	n.a.	n.a.	1,058	1,07	1,082	1,205	1.14
Selangor	n.a.	n.a.	1,169	1,204	1,24	1,617	3.04
Pahang	n.a.	n.a.	202	206	210	252	1.98
Kelantan	n.a.	n.a.	123	126	120	120	-1.22
Terengganu	n.a.	n.a.	119	122	125	157	2.52
N. Sembilan	245	250	267	278	291	427	4.69
Melaka	192	200	208	216	225	322	4.30
Johor	854	890	927	956	1,005	1,456	4.49
Perlis	26	27	28	28	29	34	1.79
Kedah	507	538	569	569	631	977	5.49
Pulau Pinang	570	591	611	611	648	844	3.03
Perak	672	696	719	719	763	996	3.06
Total	3,066	3,192	6,000	6,137	6,378	8,407	2.86

n.a. – not available

*estimate based on the average growth rate (1998-2000) for each state except Kelantan

Source: [12]

should be the last option to dump waste. Basically, the first option, i.e., source reduction and waste prevention, is generally designed to reduce the total amount of waste being discarded and to encourage the reuse of containers and similar products. Recycling, including techniques like composting, should become the second option of waste disposal. If waste cannot be recycled, the third option for waste disposal is incineration. Finally, sanitary landfilling is recommended as the final option due to the technological complexities and costs involved [13]. Fig. 1 shows the waste hierarchy.

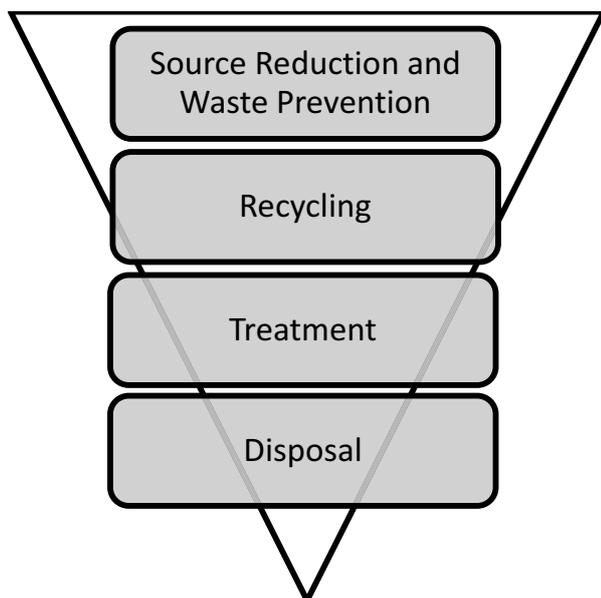


Fig. 1. The waste hierarchy.

Source: [13]

Table 4. Composition of solid waste in Malaysia in 2005.

Component	Percent (%)
Food Waste	45
Plastic	24
Paper	7
Steel	6
Glass	3
Other	15
Total	100

Source: [14]

Solid Waste Generation and Composition in Malaysia

The generation of solid waste in Malaysia has increased drastically where it was expected to increase from about 9.0 million tonnes in 2000 to about 10.9 million tonnes in 2010, and finally to about 15.6 million tonnes in 2020 [3]. Table 3 shows the solid waste generation in Peninsular Malaysia by states in thousands of tonnes. Waste composition is influenced by many factors, namely level of economic development, culture, geography, energy sources, and climate. As a country that is increasingly urban and where the population is becoming wealthier, consumption of inorganic materials (plastic, paper, aluminium) is increasing while use of organic materials is decreasing [15].

According to RMK-9, waste in Malaysia can be divided into six compositions: food waste, plastic, paper, glass, metal, and "other." Food waste shows the highest percentage, while glass shows the lowest percentage in solid waste composition [14]. Table 4 shows the composition of solid waste in Malaysia in 2005.

Technology Available for Waste Management

A number of technologies are available in Malaysia to provide efficient solid waste management systems that are technically feasible, reliable, economically viable, environmentally sound, and socially acceptable, but the Malaysian Government has been utilizing landfilling as one of the main disposal methods for MSW.

Landfilling can be divided into two broad categories, i.e., open dumping and engineered sanitary landfill. A sanitary landfill has features consisting of liners, leachate collection and treatment, gas harvesting, and daily and final covers. There are 296 landfill/dumpsites in Malaysia and 166 are still in operation, including nine sanitary landfills [16]. More sanitary landfills are planned for opening in the future either to replace or to upgrade the current dumpsites. Landfilling solid waste is an anaerobic process. It produces landfill gases that consist of CO₂, CH₄, H₂S, and NH₃, plus other traces of gases. It can be harvested, treated, and applied for electrical generation or direct heating if not flared. Methane is known to be one of the contributors to global warming. The generation is a function of the amount of waste being deposited. Besides producing biogas, landfilling requires huge land space and also releases an unpleasant odor, and leachate requires further treatment. The sanitary landfills in Malaysia include Bukit Tagar Sanitary Landfills in Selangor and Seelong Sanitary Landfill in Johor.

Another technology available for solid waste treatment is incineration. The ignition of solid waste allows a huge volume reduction for both solid waste and hazardous wastes. There are four incinerators owned by the government and one operated by a private company, named Recycle Energy Sdn. Bhd. at Semenyih, with a capacity for 1,000 metric tonnes per day. The other four incinerators are located in Pulau Pangkor, Pulau Langkawi, Pulau Tioman, and Cameron Highlands. Even though incineration does not produce greenhouse gases (GHG), it produces harmful gases, particles, and ash. Incinerators are equipped with scrubbers and other prevention technologies to remove those potential pollutants.

Composting of municipal solid waste is another approach used by some at community or individual levels. Some utilize earthworms to decompose the solid waste – especially food waste – in a method referred to as vermin-composting. Some private companies utilize anaerobic digesters to treat their organic waste on a small scale. According to Tarmudi [12], composting is a process that involves the biological decomposition of the organic matter under controlled operation to produce a humus-like stable product. It involves the aerobic digestion of the biodegradable fraction of MSW, such as paper and cardboard, and food and garden waste.

Recycling is also one of the approaches to manage solid waste. Recycling refers to the collection and separation of waste and its transformation and remanufacturing into usable and marketable materials [12]. In Malaysia, recycling programs were first launched in 1993. Unfortunately, only some people practice it, even though Malaysians' generally hold recycling in high regard. The recycling program was relaunched by the Ministry of Human Wellbeing, Housing and Local Government in December 2000, and the government declared 11 November as National Recycling Day [2]. According to Budhiarta [17], if compared before and after the recycling program was launched, the generation of waste produced every day does not show any reduction and is still the same.

Problem Statement

In Malaysia, solid waste is a major environmental problem. Increasing waste quantity can cause many problems because improper practices with respect to waste management leads to pollution, resource degradation, and health problems for humans and animals. Besides, no segregation from the source also has worsened the problem. Most of Malaysian waste is mixed waste, which means there is organic and inorganic waste. Organic waste can be used as composting materials while inorganic waste can be used and sent for recovery and recycling. Lack of awareness and knowledge to do recycling among the Malaysian community as well as being ignorant also causes the problem to become more severe. Many people are also unaware of the individual actions they can take to help curb the problem. This study will show about solid waste generation and composition at two different cafés at UPM. From waste generation and composition, a proper waste management system can be introduced to treat solid waste more efficiently.

Objectives of the study:

- To study waste generation at two different cafés at UPM (Park View Café and Forestry Café)
- To determine and statistically analyse solid waste composition at two different UPM cafés
- To estimate waste revenue at both cafés in UPM for a year

Methodology

Solid Waste Study

The study on solid waste generation and composition at two different cafés in UPM consisted of three main stages:

- 1) weighing the waste
- 2) recording the data
- 3) analysing the data

The data was obtained by direct methods, meaning direct weighing of the solid waste collected from the café where it was generated throughout the day. The data collection was conducted for 3 weeks, continuously except for Saturdays and Sundays. The weighing process was conducted every day after the café was closed. Garbage bags

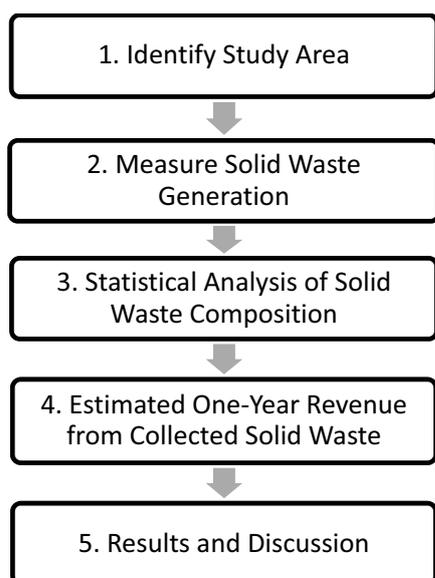


Fig. 2. Research methodology framework.

were provided to each café during the period of the sampling. The solid waste was separated into two categories, which were wet waste and dry waste by the café's owner. Wet waste composition contains mostly food waste and dry waste composition contains mostly plastic, paper, cans, and other materials. Then the solid waste is segregated by its type and the weighing process was conducted using a 50 kg scale. Fig. 2 shows the research methodology framework for this study and Appendix 1 and Appendix 2 shows the flow of sampling process.

Study Area

The study was carried out within Universiti Putra Malaysia (UPM). The study areas were Park View Café and Forestry Café – both chosen based on their locations near the staff and student centre. The Park View is located near the UPM main administration building and the Office of Development and Asset Management. It is open from 7:30 a.m. to 6:30 p.m., thus serving as an area where the staff, students, and public can go before continuing their business. The Forestry Café, is located in-between the Faculty of Forestry, the Lecture Hall, the Co-curriculum Centre, the Student Off-Campus Centre, and the Bus Centre. It is open 8 a.m. to 4:30 p.m., thus becoming a place where people can stop before continuing their work elsewhere. Fig. 3 shows the map of study area/sampling site.

Data Analysis

For data analysis, the data from solid waste generation and composition that had been collected and weighed was analysed using Excel. The data showed the relationship between quantities generated over time. The data from both sites (Park View and Forestry) was compared and analysed, also the waste revenue for both was estimated.

Table 5. Total daily waste generated (kg) at the Forestry Café.

Day	Total Waste Generated (kg)
1	14.55
2	17.60
3	14.00
4	23.00
5	17.60
6	26.70
7	23.40
8	29.15
9	20.40
10	18.00
11	29.15
12	23.90
13	20.30
14	23.90
15	24.10
Total	325.75

Results

Solid Waste Generation and Composition at Forestry Café

Forestry Café comprises two small buildings located not far from each other. One building is for the dining area and the other is where they sell food and drink. Most of the food sold is prepared at a different location before it is brought to the café. There is no cooking activity done there except for cooking simple dishes such as frying eggs. The Forestry does not practice waste separation or resource recovery. All solid waste is disposed of in one garbage bin.

Table 5 shows total solid waste generated at the Forestry during three weeks of sampling except for Saturdays and Sundays. The total of solid waste generated is 325.75 kg. Thus, average solid waste generated for a day is 21.72 kg. Based on Fig. 4, days 8 and 11 recorded the highest solid waste generated: 29.15 kg. Meanwhile, day 3 recorded the lowest solid waste generated at 14.00 kg.

Table 6 shows that organic waste dominates solid waste generation during three weeks of sampling except for Saturdays and Sundays by producing about 263.30 kg (or an average of 17.55 kg per day), while glass only produced about 2.05 kg (or an average of 0.14 kg per day). The highest value recorded is 25.30 kg for organic waste and the lowest is 0.10 kg for paper. There are some unrecorded values for glass, which indicates that there is no glass waste disposed on that day.

Table 6. Statistical analysis results of solid waste at the Forestry Café.

Parameters	Waste Composition (kg)					
	Organic Waste	Paper	Plastic	Metal	Glass	Others
Sum	263.30	7.90	25.20	16.30	2.05	11.00
Mean	17.55	0.53	1.68	1.09	0.14	0.73
SD	4.31	0.54	0.50	0.36	0.21	0.44
Variance	18.54	0.29	0.25	0.13	0.04	0.19
Minimum	10.20	0.10	0.80	0.70	0.00	0.30
Maximum	25.30	2.10	2.50	1.90	0.60	1.70

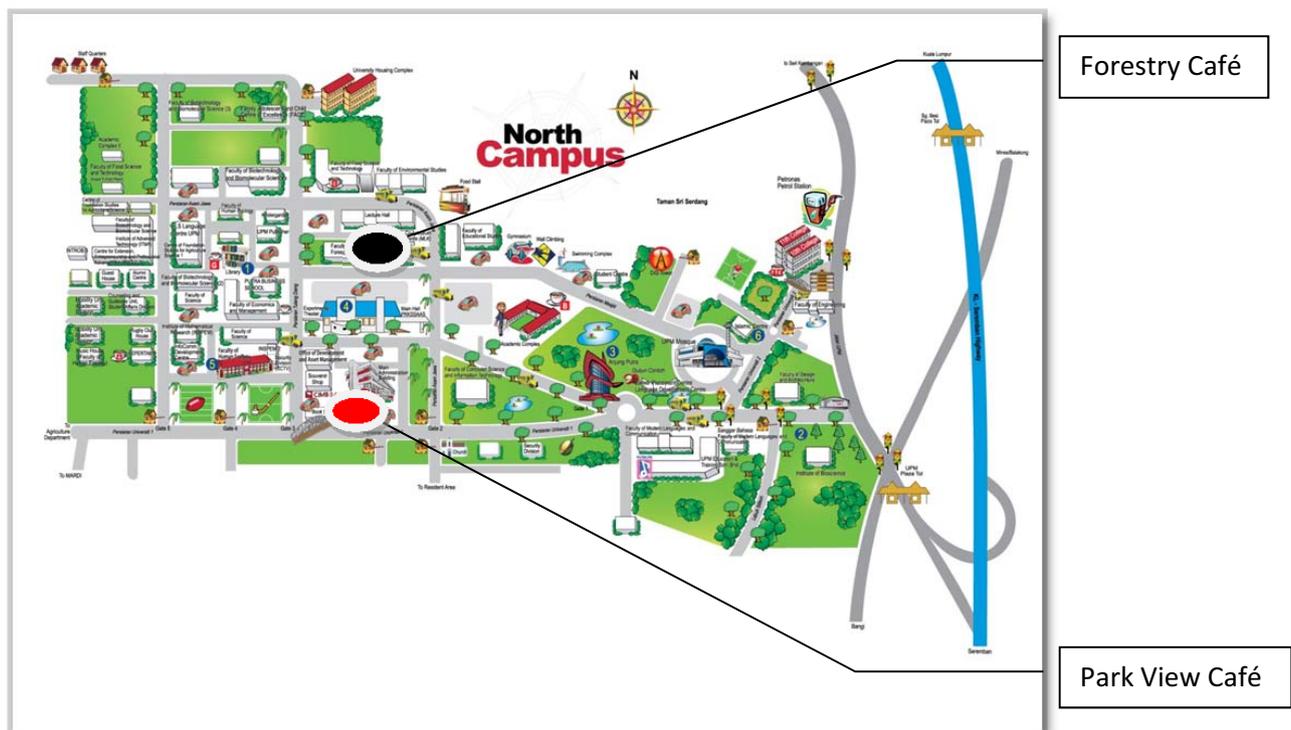


Fig. 3. Map of UPM North Campus.

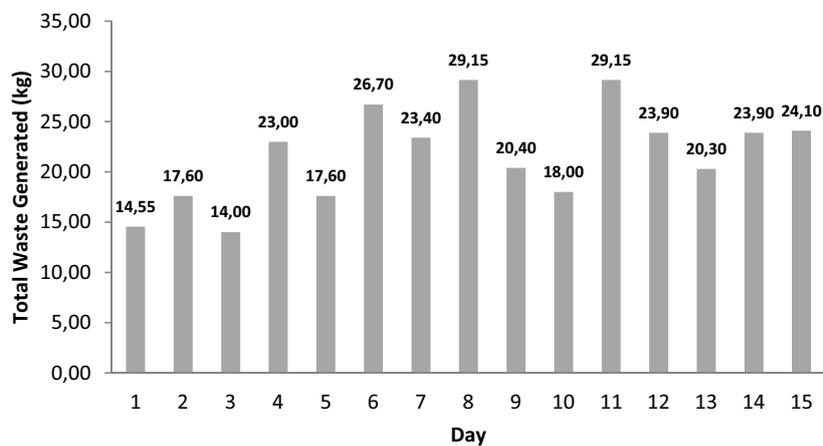


Fig. 4. Graph of waste generated vs. day at Forestry Café.

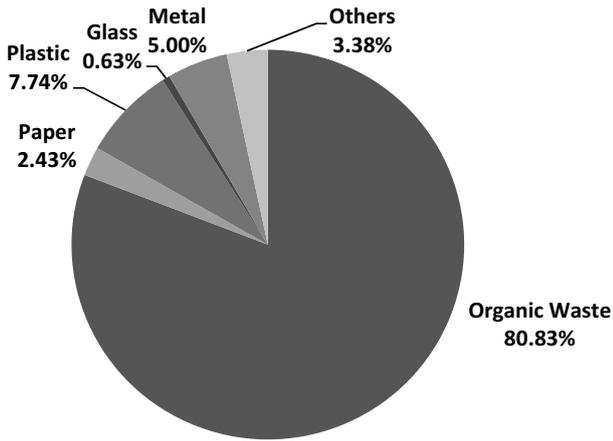


Fig. 5. Percentage of solid waste composition at Forestry Café.

Waste composition at Forestry Café consists of approximately 81% organic waste followed by 8% plastic, 5% metal, 3% others, 2% paper, and 1% glass. Fig. 5 illustrates the percentage of solid waste composition at Forestry Café. As for organic waste, the majority of the waste is food waste and banana leaves (used as nasi lemak wrapper). For plastic waste it consists of drinks packaging, drinking straws, fruit wrappers, bottles, and raffia ropes. Paper waste consists of egg cartons, mineral bottle boxes, and a few cigarette boxes and tissues. Glass is rarely disposed of, only once or twice a week. For metals, most of it is aluminium cans/tins. As for the “others,” the majority of these wastes are polystyrene but sometimes there is also wood. During peak times, because of insufficient plates, customers had to use polystyrene plates. This is why the composition of polystyrene disposal is high.

Solid Waste Generation and Composition at Park View Café

Park View Café consists of two parts: an indoor area and an outdoor area. All of the sales are conducted at the indoor area. The outdoor area is for dining purposes only.

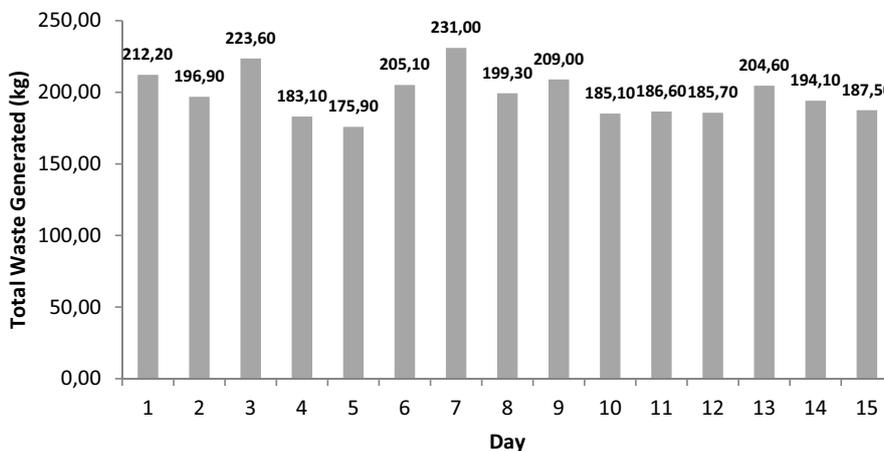


Fig. 6. Graph of waste generated vs. day at Park View Café.

Table 7. Total waste generated (kg) by day at Park View Café.

Day	Total Waste Generated (kg)
1	212.20
2	196.90
3	223.60
4	183.10
5	175.90
6	205.10
7	231.00
8	199.30
9	209.00
10	185.10
11	186.60
12	185.70
13	204.60
14	194.10
15	187.50
Total	2979.70

Observations during sampling showed that all customers who dine-in at the café must clean their own tables after they finish their meals. All the leftover food is required to be thrown in a bin labelled “food waste,” and the dishes must be placed in respective containers. For plastics, papers, and metals, the café practices resource recovery. All recyclable materials are collected and sold.

Table 7 shows total solid waste generated at Park View during three weeks of sampling, except for Saturdays and Sundays. The total of solid waste generated at Park View is 2979.70 kg. Thus, solid waste generated for each day is 198.65 kg. Based on Fig. 6, day 7 recorded the highest solid waste generated (231.00 kg), while day 5 recorded the lowest solid waste generated (175.90 kg).

Table 8. Statistical analysis results of waste generation at Park View Café.

Parameters	Waste Composition (kg)					
	Organic Waste	Paper	Plastic	Metal	Glass	Others
Sum	2,846.60	26.40	41.40	50.20	10.20	4.70
Mean	189.77	1.76	2.76	3.35	0.68	0.31
SD	15.17	0.43	0.64	0.36	0.09	0.19
Variance	230.17	0.18	0.41	0.13	0.01	0.04
Minimum	168.60	1.00	2.20	2.70	0.50	0.10
Maximum	221.50	2.90	4.20	4.10	0.80	0.70

Table 8 shows that organic waste dominates the solid waste generated during three weeks of sampling (except for Saturday and Sunday) by producing about 2846.60 kg, or 189.77 kg per day, while others only produced about 4.70 kg or 0.31 kg per day. The highest value recorded is 221.50 kg for organic waste and the lowest value recorded is 0.10 kg for “others.”

For the solid waste composition at Park View Café, organic waste shows the highest percentage, comprising 96%. Fig. 7 illustrates the percentage of solid waste composition at Park View Café. Organic waste at Park View Café consists mainly of processed kitchen waste such as meat and vegetable and food waste. All cooking activity is done at the café. So the raw materials such as meat and vegetables are processed there. Besides that, most of the customers will dine-in at the café because of the huge dining area. So the percentage of food waste is rather high. For paper and others, the composition is less than 1%. This is because the customers that dine-in at the Café use the plates provided by the Café. Therefore, there is less consumption of polystyrene.

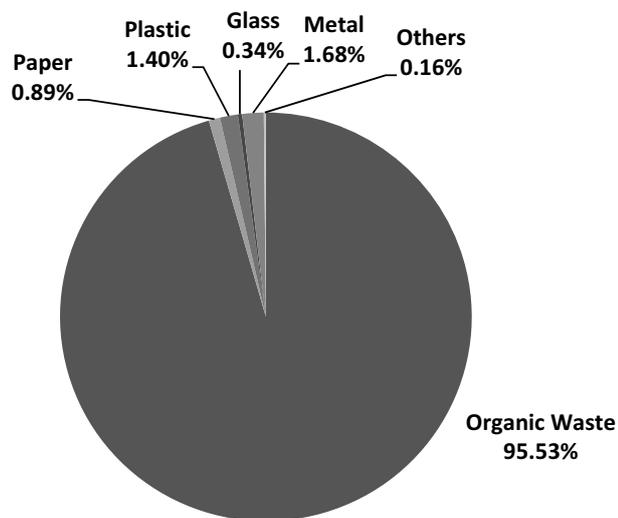


Fig. 7. Percentage of solid waste composition at Park View Café.

Table 9. One-sample Kolmogorov-Smirnov test.

	Forestry Café	Park View Café
N	15	15
Mean	21.72	198.65
SD	4.76	15.68
Asymp. Sig. (2-tailed)	0.93	0.83

Table 10. Statistical analysis results of solid waste generated (kg).

Parameters	Solid Waste Generated (kg)	
	Forestry Café	Park View Café
Sum	325.750	2979.700
Mean	21.717	198.647
SD	4.761	15.678
Variance	22.671	245.796
Minimum	14.000	175.900
Maximum	29.150	231.000

Statistical Analysis between Forestry Café and Park View Café

A one-sample Kolmogorov-Smirnov test was done to check the normality of the data collected. Large significant values (>0.05) indicate that the observed distribution corresponds to the theoretical distribution. Results (Table 9) show that the test distribution is normal. The p values for Forestry and Park View cafés are 0.93 and 0.83, respectively, which are more than 0.05.

Statistical analysis results for total solid waste generated (kg) for both cafés is summarised in Table 10. Using data from both cafés, one-sample t-test is done to know whether the differences in waste generated at both locations are significant. Based on the results (Table 11), there is significant

Table 11. T-test.

Location	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Forestry Café	17.67	14	0.00	21.72	19.18	24.35
Park View Café	49.07	14	0.00	198.65	189.96	207.33

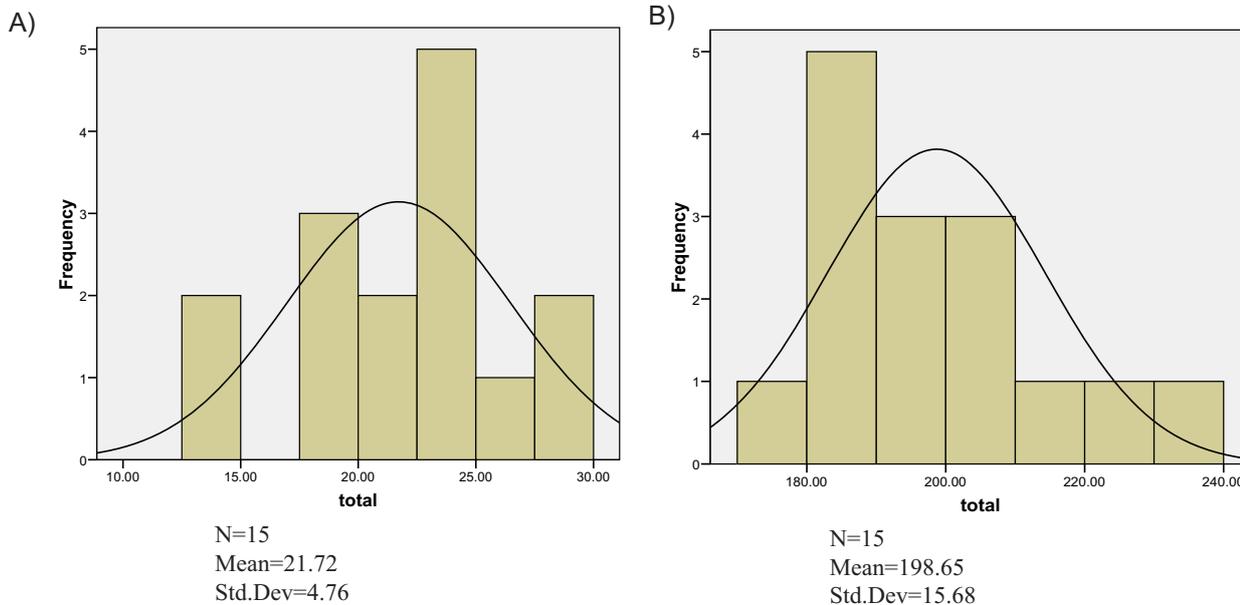


Fig. 8. Frequency distribution of total waste generated (kg) at (A) Forestry Café and (B) Park View Café.

difference between the two locations as $p=0.00$ at a significance level of $\alpha=0.05$. The mean of total solid waste generated at Forestry and Park View was 21.72 kg and 198.65, respectively. The significant difference is because more customers visit Park View compared to Forestry, which indicates why there is higher waste generated at Park View daily.

Fig. 8 shows a histogram with normal curve for total waste generation at Forestry and Park View. The histogram

clearly shows that the majority of the total waste generated was >21.72 kg at Forestry and <198.65 kg at Park View.

Based on the study area, Park View has a larger area compared to Forestry. Indirectly, Park View produces more solid waste since they operate at a larger scale. Fig. 9 shows higher value for organic waste, paper, plastic, glass, and metal except for “others,” where Forestry produced more than Park View. As mentioned before, Forestry produces a higher amount of polystyrene.

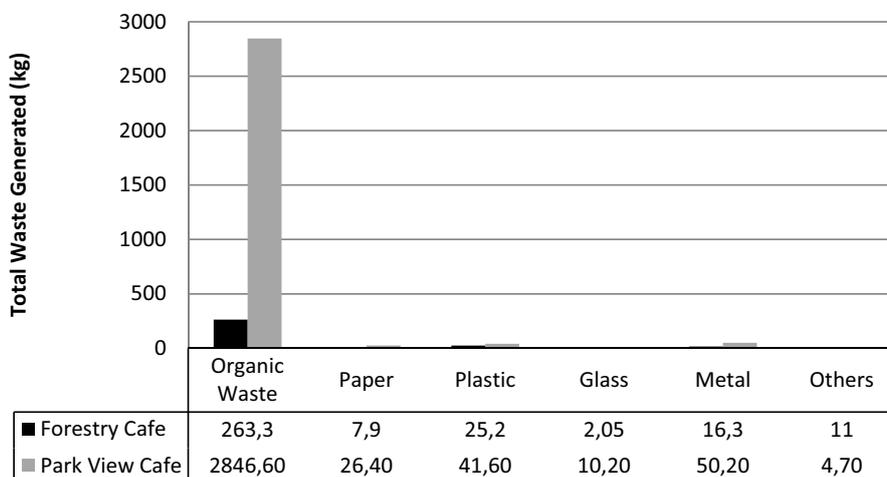


Fig. 9. Total waste generated (kg) by composition.

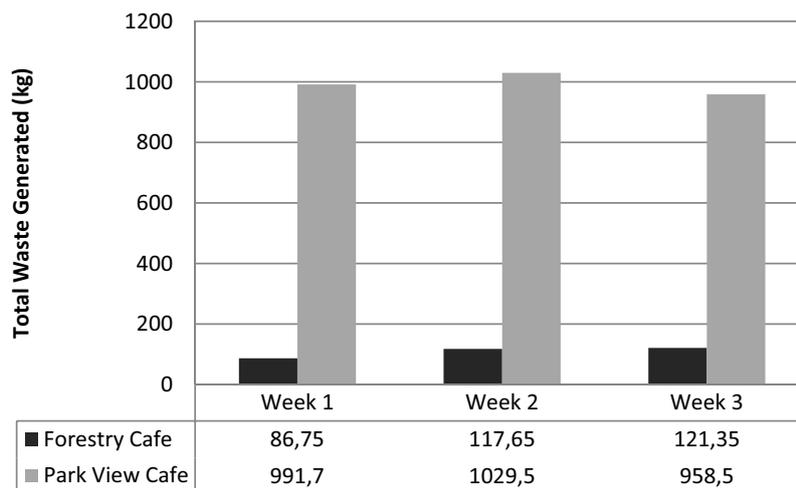


Fig. 10. Total waste generated by week.

During the three weeks of sampling, based on Fig. 10 Forestry showed an increasing amount of solid waste generated week by week, but Park View showed fluctuating results. For Park View, their amount of solid waste generated daily depends on the main menu of the day since they have different menus for each day. Both of the cafés generated higher waste during the second week because it was convocation week in Universiti Putra Malaysia, so there were more visitors at both cafés during the whole week.

Table 12. List price for recycled materials.

Material	Price (RM/kg)
Newspaper	0.24
Black and White Paper	0.36
Box	0.22
Magazine	0.22
Mixed Paper	0.18
Tetra Pack	0.50
Can/Metal	0.40
CD/VCD Casing	0.20
Aluminium can/Stainless Steel	3.00
Car's Battery	1.00
Plastic	0.40
Glass	-
Computer	4.00 per unit
Used cooking oil	0.80
CD/VCD	0.60

The price for recycled materials above are varies according to the current market price.

Source: [22]

Table 13. Estimated revenues received from collected recyclable materials for Forestry Café.

Type	Total Amount Collected (kg)	Unit Price (RM/kg)	Estimated Revenue (RM)
Paper (Box)	7.90	0.22	1.74
Plastic	25.20	0.40	10.08
Metal (Can)	16.30	0.40	6.52
Total			18.34

Waste Revenue

From the solid waste generated we can also estimate the waste revenue for each café. The list price for recycled materials varies according to the current market price. Table 12 shows the price for recycled materials in Malaysia provided by the Ministry of Human Wellbeing, Housing and Local Government's (KPKT) website.

From Table 13 the estimation of waste revenue for three weeks (15 days) of sampling at Forestry Café is RM18.34. So the average revenue they can get per day is RM1.22. In a month, Forestry Café can get approximately RM36.68. Thus, it can save about RM440.16 per year. Based on the revenue recorded, plastic gives the highest price (RM10.08) and paper gives the lowest price (RM1.74).

From Table 14, estimation for waste revenue for three weeks (15 days) of sampling at Park View Café is RM66.58. So the average revenue they can get per day is RM4.44. In a month, Park View Café can get approximately RM133.20. Thus, it can save about RM1598.40 per year. Based on the revenue recorded, aluminium gives the highest price (RM26.10) and mixed paper gives the lowest price (RM0.59).

Table 14. Estimated revenues received from collected recyclable materials for Park View Café.

Type	Total Amount Collected (kg)	Unit Price (RM/kg)	Estimated Revenue (RM)
Paper (Box)	17.50	0.22	3.85
Paper (Mixed paper)	3.30	0.18	0.59
Paper (Tetra pack)	5.60	0.50	2.80
Plastic	41.60	0.40	16.64
Metal (Can)	41.50	0.40	16.60
Metal (Aluminium)	8.70	3.00	26.10
Total			66.58

Discussion

Based on the results, food waste dominates solid waste stream at both cafés. As we know, food waste contains mainly organic matter. Burying organic waste in a landfill is a big problem because it breaks down and creates harmful greenhouse gases like methane, which damages the Earth's atmosphere if the waste is not treated properly. There are many benefits that we can get by recycling organic waste. Besides protecting the environment, we can also save money.

Responsible parties at both cafés must provide separate bins for waste disposal. One for organic waste like food waste and another for inorganic waste like paper, plastic, glass, metal, and other. Using the collected food waste, composting can be practiced. Food waste can be recycled in several ways, including in-vessel composting and anaerobic digestion. In-vessel composting involves mixing food waste with garden waste, shredding it, and then composting it in an enclosed system for around 2-4 weeks. Meanwhile, anaerobic digestion uses microorganisms to break down food waste, animal manure, slurries, and energy crops in the absence of oxygen, inside an enclosed system. For inorganic waste, it can be sent to recycle. Apart from waste minimisation, they also can gain money.

For Park View, they already segregate their waste. For food waste, they directly dispose of the waste in a garbage bin. For inorganic waste like paper, plastic, and metal, they send it for recycling. For Forestry they do not practice waste segregation. All their wastes are directly disposed of into one garbage bin. Then, after the café is closed, the waste is collected and disposed of at a larger garbage bin.

Much research has been conducted regarding waste generation and composition in Malaysia. Most of them show that organic waste dominates the waste stream in Malaysia, for example a municipal solid waste composition study at Universiti Kebangsaan Malaysia by Tiew [18] con-

cerning a particular type of municipal solid waste which is "tropical campus waste." The primary aim is to develop a representative estimation of the composition of the university's municipal solid waste stream. The study was conducted at the main campus. Twelve samples were taken over a four-week period. The daily waste was separated into organics (55%), plastics (30%), paper (11%), glass (1%), and metal (2%), plus rubber, leather, and wood (1%). Organic waste showed the highest percentage while glass, rubber, and leather and wood showed the lowest percentage.

Other research that has been done is household solid waste characteristics and management in a low-cost apartment in Petaling Jaya, Selangor by Yatim [19]. One of the objectives of the study was to characterise the generation of waste. Three-hundred and sixty samples were collected over a six-week period from 60 households. Organic waste (43.5%), plastic (25.2%), and paper (22.7%) showed the leading percentages.

The latest research that has been conducted is real data composition of municipal solid waste generated in Balakong, Selangor, Malaysia by Samah [20], whose aim was to study solid waste composition in Balakong, Selangor. The area covered eight residential areas, two industrial areas, and one hypermarket. The sampling was conducted for one month on a daily basis. Organic waste showed the highest percentage (48.07%), followed by paper (29.53%), plastic (16.69%), others (2.65%), glass (1.90%), and metal (1.16%).

Other research that has been done is household solid waste composition in Balakong City, Malaysia: trend and management by Samah et al. [21]. The paper focuses on the trend and management of the household solid waste composition generated. A survey was conducted at eight housing areas in a one-month period on a daily basis. Organic wastes (69.4%) record the highest percentage, followed by plastic (10.3%), paper (9.3%), other waste (5.4%), and glass (3.2%). Metal (2.4%) shows the lowest percentage.

Conclusion

This paper provides an opportunity to study solid waste generation and composition at Administrative Building Cafés, Universiti Putra Malaysia. Results clearly show that organic waste dominates the solid waste composition at Forestry Café and Park View Café at approximately 81% and 96%, respectively. The high organic waste indicates the necessity for frequent collection and removal, thus can be efficient for generating added-value products (e.g. compost/manure, biogas, etc.). So, UPM should develop a policy that makes it compulsory for cafés in UPM to separate their recyclable wastes. A proper way to dispose of food waste (organic waste) can be introduced. UPM should propose to buy its own composting machine to produce organic fertiliser. Other waste such as paper, plastic, metal, and other composition that has value can be sent to a recycling centre.

Appendix 1. Sampling method at Forestry Café.



(A) Solid waste generated in a day.



(D) Weighing process.



(B) Segregation by its composition based on Malaysian standards.



(E) Sampling process completed.



(C) Complete waste segregation.

Appendix 2. Sampling method at Park View Café.



(A) Sampling site.



(D) Segregation by its composition based on Malaysian standards.



(B) Waste generated in a day.



(E) Weighing process.



(C) Waste segregation.



(F) Sampling process complete.

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