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Food Waste Pattern in Tertiary Education Institution in Penang: Quantitative Comparison of Food Waste Composition Between Semester Break and Start

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ABSTRACT

Food waste is the largest component of solid waste in Penang. Understanding the composition and sources of food waste is crucial to reduce and manage wasted food efficiently. As most of the studies were focused on commercial restaurants that mainly studied the waste pattern from the society, in this study, the focus is on a tertiary education institution and food waste was collected from five food premises from the campus of Universiti Sains Malaysia, Penang during the semester break and at the beginning of the semester. The waste was quantitatively investigated and compositionally analysed according to two categories: preparation and customer plate waste. Within each category, avoidable and non-avoidable waste was identified, segregated, and measured. The weight among the groups was compared statistically, and the carbon dioxide emission also calculated based on the Defra factor. In general, preparatory waste was significantly higher than the customer plate waste for both semester break and at the beginning of the semester. The avoidable waste generated from customer plate waste at the beginning of the semester was significantly greater compared to the one during the semester break, and this might indicate wastage of food by the undergraduate students. The current study suggests that food waste arises differently in the aforementioned categories from the tertiary education institution and future research might focus on the works that support the engagement of food premises to identify the reasons for food waste within their facilities and appropriate measures to address the issues.

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INTRODUCTION

The amount of food waste in Malaysia is estimated to increase to more than 6 million tons by 2020 (Alias, 2010). Wasted food in Malaysia is being managed as municipal solid waste (MSW) under the Malaysia Solid Waste and Public Cleansing Management Act 2007 (Act 672). The recyclable and avoidable trashed food was the dominant composition that had occupied almost 60% of the MSW (Hamid, 2015) and Penang state alone had generated more than 45% of food waste in MSW (Jabatan Pengurusan Sisa Pepejal Negara [JPSPN], 2017). These amount of trashed food had increased 7.6-fold from 2011 to 2014 (Lim et al., 2016) and the increment is expected to exceed 5 million tons per day by 2020. This large amount has brought significant impact on environment issues as they emitted greenhouse gases that caused climate changes during their decomposition at the landfill (Thi et al., 2015) and the waste might occupy landfill (Moh & Manaf, 2014).

Wasted food is generated on a daily basis via agricultural, industrial and domestic activities. In general, sources of food waste can be classified into three groups: (1) food losses, which mainly are the food materials lost during preparation, processing and production phases in the food supply chain; (2) unavoidable food waste, in which the inedible parts of food materials lost during consumption phase such as fruit peel and core; and (3) avoidable food waste, which are the edible food materials that were lost during consumption phase (Thi et al., 2015).

Despite the fact that several efforts had been introduced at the national level such as the National Solid Waste Management (2002–2020), National Recycling Program (2000–2005) and Waste Minimization Master Plan (2005) (Ministry of Housing and Local Government [MHLG], 2006), food waste management in Malaysia was considerably less sustainable due to inappropriate monitoring and administration practices. Lim et al. (2016) suggested that the food waste strategy in Malaysia as a developing country was ineffective compared to the other developed countries such as Korea, Japan, and Taiwan due to improper segregation of food waste from other solid wastes.

Malaysian authority had proposed and initiated the National Strategic Plan for Food Waste Management (NSPFWMM) in collaboration with the Ministry of the Environment of Japan in 2010 to encourage the public to practice good of food waste disposal habit such as food waste segregation. However, as mentioned by Hamid (2015), food waste strategy is relatively ineffective if the details of food waste such as the composition is not studied. Therefore, this study aims to act as a preliminary survey of the composition and quantity of food waste generated from food premises in Universiti Sains Malaysia, Penang during the semester break and at the beginning of the semester.

MATERIALS AND METHODS

Scope

As one of the preliminary food waste compositional analysis, it was agreed that the five engaging food premises were geographically within the same area for the most efficient use of time and resources. The five participant food premises named as Red House (RH), Bakti Permai Kak Ani (BPKA), Fajar Harapan AA Corner (FHAC), Fajar Harapan Pak Ku (FHPK), and Uptown (UT) were located as shown in Figure 1. The seating capacity across the five participant food premises ranged from 50-200 seats, and staff number varied from 6- 12. We aimed for a variety of type of food such as Malay, Indian, and Chinese food. The food types were standardized as economic rice (mixed rice) considered as casual dining (restaurants provide table service and serve moderately priced food) and about 75% of the food preparation was done onsite.

The waste collection was carried out on a weekly basis excluding the weekends during the semester break (May to July 2016) and at the beginning of the semester (September to November 2016) to ensure that the food premises had an average number of customers and the trend between the semester break and at the beginning of the semester can be compared. Preparation waste was collected in the morning (7 am to 10 am) during food preparation and customer plate waste was received after 4 pm to collect the waste generated from breakfast and lunch.

Food Waste Segregation

The method for classification and waste collection was modified from Sustainable Restaurant Association [SRA] (2010), which was the pilot study in food waste composition in London, United Kingdom. The definition of spoilage, preparation (prep) waste, and customer plate waste, avoidable and non-avoidable waste was detailed in Table 1.

The waste was prior categorized into prep and customer plate waste from the food premises and further segregated into avoidable and non-avoidable from the categories after collection and transferred to the laboratory (School of Biological Sciences, Universiti Sains Malaysia). Also, the amount of spoilage from the prep waste was measured and recorded. The waste was collected using a thick plastic bag (0.04 mm) in a 45-L dustbin container. The weight of waste was measured using an electrical balance (capacity 30 kg) before being transfered to the laboratory for composition segregation.

Two separate bins were made available for the kitchen staff to collect food waste from preparation and customer plates. The information was then documented with the help of pictures and notes. A summary of them are provided as follows:

- The weight (kg) of food waste relating to the preparation and customer plate waste (weighing carried out onsite).
- Preparation and customer plate waste were sorted and weighed in the laboratory according to

spoilage, avoidable, and non-avoidable (Table 1).
- The percentage of food waste from each of the classes
- The current waste management practices in place (observation).
- A summary of the auditor's comments on each day of collection.

Table 1

Definition of prep, customer plate, avoidable and non-avoidable waste

Type of waste	Definition
Prep waste	Food waste generated as part of the menu preparation and cooking process, including items that could be used but are thrown out, for example, peelings or off cuts for stock. This includes meals cooked for customers that don't get served (overcooked or ruined etc.). It is recognized that some prep waste could never be used for service (e.g., fruit stones)
Customer plate waste	Prepared food that comes back from the customer, including meals that have been untouched
Spoilage	Produce that has gone off or has been contaminated and is unusable. This includes front-of-house items from the dining room For example, mouldy bread
Avoidable	Avoidable food was defined as Wrap 2013 and SRS 2012 that Food thrown away that was, at some point prior to disposal, edible (e.g., slices of bread, apples, meat) and could have been eaten if it had been better portioned, managed, stored and/or prepared. "Avoidable" food waste also includes some otherwise acceptable food items that have not been eaten because of consumer preference, such as bread crusts and jacket potato skins.
Non-avoidable	Waste arising from food preparation that is not, and has not been, edible under normal circumstances (e.g., meat bones, egg shells, pineapple skin, tea bags).

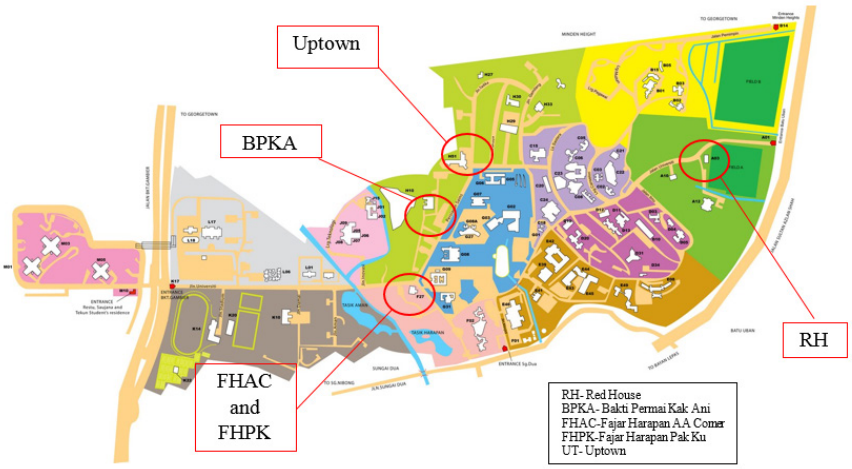

Figure 1. Location of participant food premises in Universiti Sains Malaysia, Penang

Statistical test

For both semester break and at the beginning of the semester, the weight of waste between 1) prep and customer waste, 2) avoidable and non-avoidable was compared using *t*-test by SPSS 21.0.

RESULTS AND DISCUSSION

Food waste is the largest component in municipal solid waste in Universiti Sains, Malaysia, Penang (Penang Island Municipal Council Experience [MBPP], 2007; Omran et al., 2009). However, until now there is not much studies conducted on the food waste composition. It is crucial to clarify that the data consist of pre-waste and unavoidable waste, and the result does not represent the food waste behaviour of the USM Penang community. A total of 74.3 kg and 106 kg of food waste had been generated during the 3 weeks' study during the semester break and at the beginning of the semester, respectively. Across the participant food premises, the mean of food waste generated from the two streams for both semester break and the beginning of the semester was: 61.23% of food waste from prep waste and 38.77% of food waste from customer plate waste. The comparison of prep and customer plate waste between semester break and the beginning of the semester is shown in Figure 2, and generally, the amount of prep waste was significantly greater than the customer plate waste ($p < 0.05$) from the five premises for both semesters break and at the beginning of the semester (Table 2 and Table 3). These results were paralleled with numerous food waste composition studies (SRA, 2010; WRAP, 2013), in which food waste analysis had been conducted in commercial restaurants and prep waste

Table 2

Food waste composition in food premises in Universiti Sains Malaysia Penang during semester break

	Pre-waste				Customer waste		
	Percentage (%)				Percentage (%)		
	Avoidable	Non-avoidable	Spoil	Total (gram)	Avoidable	Non-avoidable	Total (gram)
FHAC	28±8	58±4	13±1	7614±39	41±6	57±2	5072±44
FHPK	40±11	38±3	21±3	12520±102	33±10	66±4	6855±56
BPKA	41±16	37±5	21±2	8551±64	29±8	70±3	7891±82
UT	38±10	44±6	17±4	7818±85	32±9	67±5	5261±105
RH	14±9	80±5	5±2	9111±1001	19±12	80±6	3570±91

RH- Red House
BPKA- Bakti Permai Kak Ani
FHAC-Fajar Harapan AA Corner
FHPK-Fajar Harapan Pak Ku
UT- Uptown

Table 3

Food waste composition in food premises in Universiti Sains Malaysia Penang after semester start

	Pre-waste				Customer waste		
	Percentage (%)				Percentage (%)		
	Avoidable	Non-avoidable	Spoil	Total (gram)	Avoidable	Non-avoidable	Total (gram)
FHAC	38±10	52±6	10±2	12298±88	45±10	54±3	9129±87
FHPK	41±12	39±6	20±3	11425±64	39±4	60±6	7609±54
BPKA	40±17	41±7	19±2	13091±55	35±7	64±7	11083±73
UT	36±5	50±7	14±4	12071±69	42±6	56±4	8198±43
RH	16±6	80±8	4±2	15876±91	18±9	81±5	5210±68

RH- Red House
BPKA- Bakti Permai Kak Ani
FHAC-Fajar Harapan AA Corner
FHPK-Fajar Harapan Pak Ku
UT- Uptown

was occupied more than 45% of the total food waste. Tiew et al. (2010) and Hamid et al. (2015) demonstrated the dominance of organic waste in Universiti Kebangsaan Malaysia and Universiti Putra Malaysia, respectively, and suggested the food waste might mainly be generated from the kitchen (preparation waste).

Based on Defra greenhouse gas emission factors (Table 4), across the five participating restaurants, the average greenhouse gas emissions per restaurant, if the food waste was being sent to landfill, was 15.01 tons, 463.56 kg of food waste were sent for incineration combustion or anaerobic digestion, and only 132.46 kg

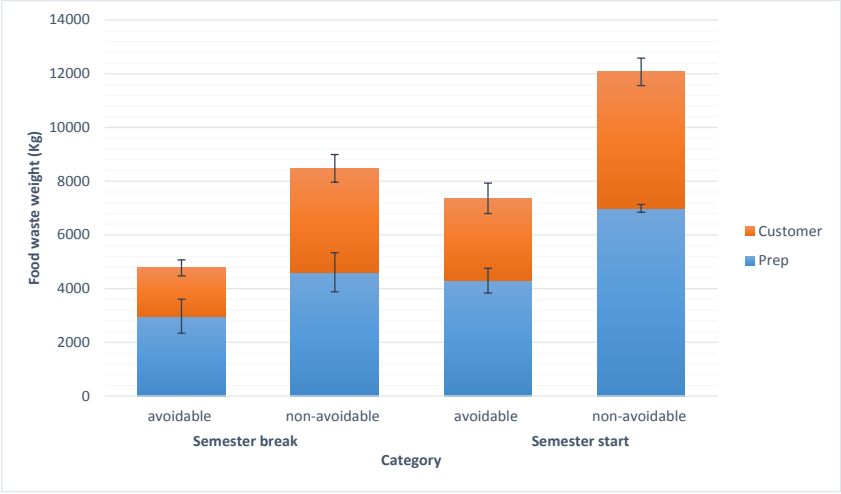

Figure 2. Food waste (avoidable and non-avoidable) in semester break and at the beginning of the semester

of the food waste sent for composting. Figure 3 shows the comparison of carbon dioxide emission when the food wastes from the participant premises are managed according to some standard methods in Malaysia. Nevertheless, the landfilling is the most frequent method for handling food waste worldwide including Malaysia due to it being relatively lower in terms of cost (Norkhadijah et al., 2013) although some places in Malaysia may practice incineration, but eventually were closed down due to the releasing of toxic gases from combustion (Lim et al., 2016; Thi et al., 2015). Therefore, it is suggested that the prep waste that cannot be avoided (non-avoidable waste) could be managed as compost that will be able to transform the organic food waste into useful fertilizer.

It is assumed that this is a pilot study in Malaysia for compositional analysis of food waste into avoidable and non-avoidable waste, as suggested by WRAP (2013). A researcher/practitioner will be able to

Table 4

UK Government GHG conversion factors for company reporting

Organic: food and drink waste	Carbon dioxide emission ($kgCO_2$ emitted / ton of waste)
Combustion (Energy is recovered from the waste through incineration and subsequent generating electricity)	21
Anaerobic digestion (Energy is recovered from waste through anaerobic digestion)	21
Composting	6
Landfill	680

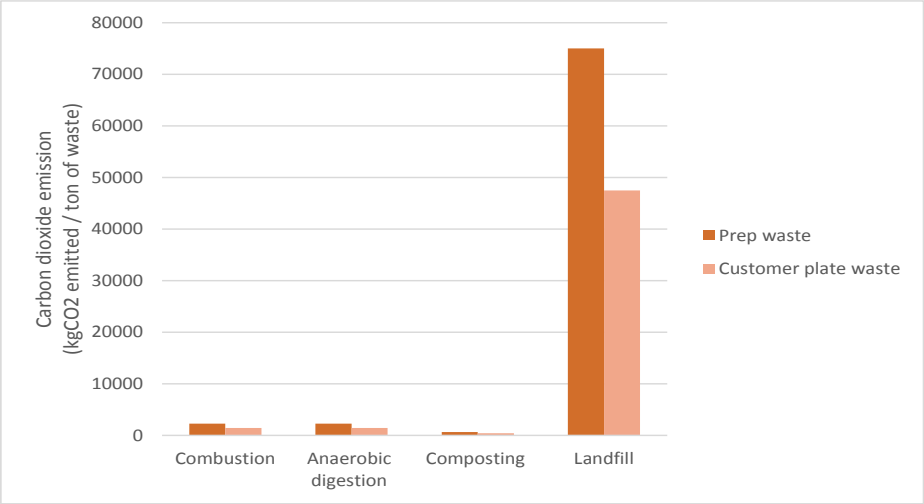

Figure 3. Carbon dioxide emission based on the food waste generated in this study

handle and manage waste more effectively by sorting them into these two streams. As can be seen in Figure 2, non-avoidable waste occupied the majority, in which 50.6% and 67.5% of prep and plate waste, respectively, during the semester break, and 54.0% and 61.6% of prep and plate waste, respectively in the beginning of the semester. During the semester break, food preparation from participant premises trashed an average of 2978 ± 633 g avoidable waste and this has no significant differences compared to the avoidable waste at the beginning of the semester ($\overline{x}$ = 4296 ± 462, n = 5, p = 0.05). However, for customer plate waste, the avoidable waste generated at the beginning of the semester ($\overline{x}$ = 3067 ± 567 g, n = 5) was significantly higher than the one during the semester break ($\overline{x}$ = 1798 ± 300g, n = 5); this may indicate the volume of food wasted by the retry and new intake students. This was understood that as the semester began, the number of students (retry and new intake undergraduate students) was estimated to increase; nevertheless, as the Pre-waste and customer plate waste showed a parallel increment of 41.98% and 43.91%, respectively, after the semester began, the significant higher avoidable waste component from customer plate waste was highly contributed by the new students. The wastage behaviour of students also showed by the estimation report of Chan (2011) that the total plate waste generated by all university students in Hong Kong might produce 45 tons daily and Ferreira et al. (2013) had measured the food waste index in a Portuguese university, and an average of almost 70% food was trashed by those students. Several solutions could be suggested to reduce the amount of plate waste such as advising students to carefully consider their portion sizes, and the food premises may offer varying portion sizes; institutions and food premises may offer take away boxes where appropriate; food premises should plan their menu to ensure the food will meet customers' expectations.

Observations of the study site showed that most of the participant food premises demonstrated less understanding of food waste prevention than the commercial kitchens (based on the input given by the operators of food premises). In many cases, food waste was not segregated into separate waste streams but disposed of in a general waste bin; however, the high level of preparation on the site leads to preparation waste representing the largest share in the food premises in Universiti Sains Malaysia. In addition, the bulk of the avoidable waste in preparation and customer plate waste consisted of Asian carbohydrate resources such as white rice and noodle due to them being unsold and unconsumed. Rice also formed the bulk of the component in most of the institutions in Asia such as Lo Wu Correctional Institution in Hong Kong, which thrashed around 500 bowls (100 kg) of rice every day (Environment Bureau, 2014).

Tertiary education students' food waste behaviours might be due to the food quality, food quantity, product mixes, and menu items (Kwon et al., 2010; Lee, 2015). In this study, some common reasons given

for prep food waste from kitchen (based on the input from food premise operators) were the food was unusable, for example, plant root, onion skin, and egg shell; over-estimation/portioning, for example, as the number of customers patronizing the premises were indeterminable and the orders were irregular; food was left too long on prep benches; miscooking or accidental dropping of the food during preparation. In contrast, the common reasons for customer plate waste are over-portioning; poor food cooking/quality, for example, unsuitable flavoring or over-seasoning.

There are some solutions offered by SRA (2010) to reduce prep waste and customer plate waste as detailed in Table 5. Some of the selected recommendations that are appropriate for Malaysian culture were discussed. In general, the food operators should have the right level of knowledge and commitment to further sustain the practices such as maximization of the use of any one food item through the implementation of "nose-to-tail" cooking. Lee (2015) also showed there are relationships among food waste, food quality, and menu options and the respondents indicated that skilled employees might produce a better quality of food and contribute to reducing food waste. A strategy such as "Less Rice, One Dollar Less" that was implemented in City University of Hong Kong (City University Hong Kong [CityU], 2017). For spoilage, 15.77% and 12.85% were generated from the total waste of prep in during the semester break and at the beginning of the semester, respectively. This amount is considered high when the standard suggested by SRA (2010) was at 5%, and those food premises would expect well-managed restaurants to lower this number.

Table 5

Recommendation for reducing and managing prep and customer plate waste (SRA, 2010)

Prep waste	• Careful ordering • Close attention to menu planning • Close attention to customer demands and trends • Keeping skins on vegetables, for example, skin-on potato chips and skin-on roast pumpkin • Re-using edible food items that often get thrown out e.g. orange skins from making orange juice are kept for making marmalade, parsley stalks retained for stocks and soup flavoring • Ordering fish and meat cuts to specification so the off cuts are kept with the producer. This should not 'shift' the food waste from one premises to an other – the butcher and fishmonger will have these off cuts on a larger scale and are more likely to be able to use these off cuts than throw them out. • Using nose-to-tail cooking methods
Customer plate waste	

Table 5 *(Continue)*

Customer plate waste	• Careful consideration of portion sizes, and offering varying portion sizes • Offering doggy boxes where appropriate. • Menu planning to ensure the food will meet with customer expectations during winter and summer weather. • Observation of customer eating, noticing any patterns of food that is consistently returned uneaten, such as some salad items or condiments

CONCLUSION

This study was intended to provide an overview of food waste generated from Universiti Sains Malaysia and indicated that food waste arose differently in the various categories. Preparation waste was significantly the majority component in food waste and the avoidable waste generated from the customer plate waste at the beginning of the semester was significantly greater compared to the ones during the semester break. Future study may focus on more tertiary education institutions and work that supports the engagement of food premises to identify the reasons for food waste within their premises and take appropriate actions to address the issues. Innovative food management is urged to be carried out for handling some common food waste (white rice and noodle) in Malaysia.

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REFERENCES

Alias, A. Y. (2010, Jan 27) Amal kitar semula [Recycling charity]. *Berita Harian*. Retrieved February 8, 2017, from https://www.bharian.com.my/

Chan, L. L. (2011). *Food waste*. CITY, Hong Kong: Joint Publishing (Hong Kong) Co., Ltd.

City University Hong Kong [CityU]. (2017). CityU green connections-food waste. Retrieved February 8, 2017, from http://www6.cityu.edu.hk/greenconnections/green_connection/sustainability/manage/food.aspx

Environment Bureau. (2014). A food waste & yard waste plan for Hong Kong 2014-2022. Retrieved January 20, 2017, from http://www.enb.gov.hk/en/files/FoodWastePolicyEng.pdf

Ferreira, M., Liz, M., & Margarida, R. A. (2013). Food waste as an index of foodservice quality. *British Food Journal, 115*(11), 1628–1637.

Hamid, A. A., Ahmad, A., Ibrahim, M. H., & Rahman, N. N. N. A. (2015). Food waste management in Malaysia-Current situation and future management options. *Journal of Industrial Research & Technology, 2*(1), 36–39.

Jabatan Pengurusan Sisa Pepejal Negara. (2017). Kementerian Perumahan dan Kerajaan Tempatan [Ministry of Housing and Local Governance].

Retrieved January 17, 2017, from http://jpspn.kpkt.gov.my/

Kwon, S., Bednar, C. M., Kwon, J., & Bush, R. M. (2010). An investigation of college and university foodservice administrators' perceptions of food waste reduction activities and food waste disposal methods. *Journal of Foodservice Management & Education*, *4*(1), 16–21.

Lee, S.S. (2015). *Food waste perceptions among college students in university food services*. Faculty Research Grant 2015 Final Report Parks, Recreation, and Hospitality, Arkansas University. Retrieved December 26, 2016, from https://www.atu.edu/research/facultyresearchgrants/14-15/Lee-FinalReport-Food%20Waste%20Management%20in%20University%20Dining%20Services.pdf

Lim, W. J., Chin, N. L., Yusof, A. Y., Yahya, A., & Tee, T. P. (2016). Food waste handling in Malaysia and comparison with other Asian countries. *International Food Research Journal, 23*, S1–S6.

Ministry of Housing and Local Government [MHLG]. (2006). *The study of national waste minimization in Malaysia.* Final report in cooperation with Japan International Cooperation Agency (JICA) July 2006. Retrieved May 6, 2016, from http://jpspn.kpkt.gov.my/resources/index/user_1/Sumber_Rujukan/kajian/PSP/Volume1_MainReport.pdf

Moh, Y. C., & Manaf, L. A. (2014). Overview of household solid waste recycling policy status and challenges in Malaysia. *Resources, Conversation and Recycling, 82*, 50-61.

Norkhadijah, S., Ismail, S., & Manaf, L. A. (2013). The challenge of future landfill: A case study of Malaysia. *Journal of Toxicology and Environmental Health Sciences, 5*(6), 86-96.

Omran, A., El-Amrouni A. O., Suliman, L. K., Pakir, A. H., Ramli, M. & Aziz, H. A. (2009). Solid waste management practices in Penang State: A review of current practices and the way forward. *Environmental Engineering and Management Journal,* (8), 97-106.

Penang Island Municipal Council Experience. (2007). *Sustainable solid waste policies and practice.* Penang, Malaysia: Gok, K. Y.

Sustainable Restaurant Association. (2010). *Too good to waste – Restaurant food waste survey report.* London, England: Sustainable Restaurant Association. (Version V001, 16/09/2010).

Thi, N. B. D., Kumar, G., & Lin, C. Y. (2015). An overview of food waste management in developing countries: Current status and future perspective. *Journal of Environmental Management, 157,* 220–229.

Tiew, K. G., Kruppa, S., Basri N. E. A., & Basri, H. (2010). Municipal solid waste composition study at Universiti Kebangsaan Malaysia Campus. *Australian Journal of Basic and Applied Sciences, 4*(12), 6380-6389.

WRAP. (2013). Where food waste arises within the UK hospitality and food service sector: Spoilage, preparation and plate waste. WRAP Retrieved January 18, 2017, from http://www.wrap.org.uk/sites/files/wrap/HaFS%20sector%20spoilage%20preparation%20and%20plate%20waste%20FINAL.pdf Accessed on 18 January 2017