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Improving Food Security Through Quantification of Food Waste: A Small Study at University's Cafeterias

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Abstract
Food loss and waste are mainly occur in developing and industrialised Asian countries due to spoilage in warm and humid climates. Service is one of the main food waste generator including restaurants and institutions. This study aimed to investigate and quantify the food waste generated from cafeterias in Universiti Sains Malaysia Health Campus (USMKK). Weighing of food waste were conducted daily and repeated for three cafeterias within five weeks using portable hanging weight scales. Questionnaire were distributed randomly to 369 respondents. This survey was conducted to investigate customers' opinions on food waste issues within university cafeterias. The number of customers was determined using a checklist. The results indicated that USMKK cafeterias generated average of 71.78 kg avoidable food waste and 275.93 kg unavoidable food waste. 26% of the customers claimed that they were regularly leave a quarter plate or bowl of uneaten food. Significant positive correlations ($p<0.001$) were found between number of customers and amount of food waste generated at the cafeterias. Factors that influence the generation of food waste at the cafeterias were include poor food quality, lack of freshness of the food, habits of consuming little amount of food and hours of operation of the cafeterias. The amount of avoidable and unavoidable food waste generated between the three cafeterias were significantly difference ($p=0.001$). Awareness campaign could increase the level of knowledge about food waste among customers. This would help the top management to plan suitable programme in minimising the production of food waste as to support sustainable environment.
Keywords: Food Waste, Food Waste Generation, Food Waste Quantification, Food Wasting Behaviour, Food Service Sector.

Introduction

Food loss and waste are very challenging to be managed due to the diversity in their generation patterns, physical and chemical properties and underlying difficulties and

disparities to quantify the increasing volume of the wastes. Population growth, industrialisation, urbanisation and globalisation contributed to the fast rising of food waste generation in Asian region. This trend might be influenced by the diversity of the dietary patterns and affordability of the nations to buy more products than necessary (Thyberg & Thonjes, 2016). The increasing rate of food waste production in Asia will continue to be a challenge as its management and investment are still not emphasised and prioritised (Zhang *et al*., 2014). Daily generation and volume rate of municipal solid waste (MSW) are accelerates due to economic growth, business activities and consumption rate. Total MSW generation in Malaysia is 38,142 tonnes/day in 2018 and it is expected to be 49,670 tonnes/day in 2020 (National Solid Waste Management Department (NSWMD), 2015; Mei, 2019). Food and green waste contributed 44% of global waste composition. Middle- and low-income countries generate 53% of food waste, with the fraction of organic waste increasing as economic development levels decrease (Kaza *et al*., 2019). According to Sulaiman and Ahmad (2018), the largest source for emission of greenhouse gases is the food waste disposed at the landfill sites. The treatment of generation of food waste at Malaysia is extremely limited. The innovative strategies are still very limited and under-developed for proper food waste management (NSWD, 2011). In Malaysia, there is no segregation of food waste at source nor separated from other solid waste at landfill sites before disposal. At present, only 15% of the 146 active landfills in Malaysia are environmental-friendly sanitary sites. Lower-income countries generally rely on open dumping. South Asia is one of the three regions that openly dump more than half of their waste (Sim, 2019). The possible solution to deal with the challenge of the overall waste management is a strategic plan primarily focuses on food waste management that emphasises the concepts of 3Rs (Reduce, Reuse and Recycle). The most encouraging way in separating the amount of food waste is through separate collection of food waste in food waste bins. It would increase perception about the participation which in turn may encourage the involvement in food waste separation (Azlina *et al.*, 2013). Graham-Rowe *et al.* (2014) suggested that food waste behaviour among some people was guided by a sense of what they felt was right. To keep food waste to a minimum, they should have a higher level of concern for the negative consequences of food waste. Motivation to minimise food waste due to the environmental concerns under such conditions might be less likely to be volunteered spontaneously among participants. Some participants did not concern the link between these behaviours and a reduced environmental impact (Doron, 2013).

Another major concern about food waste is its further consequences on food loss that may constrains food security by reducing the availability of nutritious food. Global food wastage is a threat to food security as tones of edible food waste are lost or wasted during harvesting and production. Further, a common behaviour among affluent households in urban areas is throwing away their edible food wastes. It is suggested that food waste could limit the opportunity to improve food security (Jereme *et al*., 2017). Schmidhuber and Tubiello (2007) defines food security based on three main pillars which are availability of good quality and nutritious food sources, physical and economic access to enough food for an active healthy life, and stability of food supplies and utilisation of food consumed. Loo (2011) reported that 10-30% of foods are wasted daily on average at restaurants in Malaysia. Besides, most consumers were not aware or even concern of the amount of food they wasted. The consumers did not even care for the fact that they cannot finish the meals because they were the one who paid for the food.

Food waste production is a complex issue in which many individuals need to play their part. Food waste is a waste composed of raw or cooked food materials. It includes food materials discarded at any time relating to food waste generated before, during or after food preparation such as vegetable peelings, meat trimmings, and spoiled or excess ingredients or prepared food (Quested et al., 2012). Sources of food waste vary including food industry, retail, restaurant, hotels, catering, canteen and households (Katajujuuri *et al.*, 2012). Waste produced in the food service industries such as restaurants, hotels and institutions (e.g. schools and hospitals) may be more complex to manage compared to household, as it is largely attributable to quality standards and over-serving which referred to as "plate waste" (Gooch *et al.*, 2012). On average, United State diners leave 17% of uneaten meals (Gunders, 2013). Most of the food in cafeteria is served in buffets. This might lead to overtaken of the food and high possibilities of not finishing the meals. A lack of effective feedback between students and staff and also the cafeteria staff will be some causes for food waste being generated in some cafeteria. The effective feedback from them has shown that food waste will be minimised and ensuring the cafeteria meals meets the demand (Cordingley et al., 2011).

The increase amount of food waste may also rely on the elements that influence customers to come to the cafeteria (number of customers) including the taste of food, competitive price, service response time, cleanliness of the cafeteria and its location, amenity, safety, employee courtesy, operating hours and availability of healthy menus (Min & Min, 2011; Tsai et al., 2007). Physical factors such as location, layout and lighting of the cafeteria can influence customer's behaviour, apart from situational factors (i.e. crowding, time factors) (Sun & Yazdanifard, 2015). For instances, busier customers tend to go to the closest cafeteria to save time and avoid traffic during peak-hours. Previous study by Chee and Yusoff (2012) have investigated the characterisation and composition of solid waste generated in the university. However, factors that influence the generation of food waste are not studied. Therefore, this study aimed to determine the amount of food waste generated in the university cafeterias, compare the amount of avoidable and unavoidable food wastes generated at each cafeteria, find the association between the number of customers and food waste generated, and explore factors that may influence the production of food waste.

Literature Review

One-third of all food produced for human consumption is lost or wasted globally amounting to as much as 1.3 billion metric tonnes annually. Food waste is an issue in all of the major economies in the world and it is a global problem of staggering proportions but the underlying reasons differ between countries. Due to spoilage in warm and humid climates resulting from the lack of modern transport and storage infrastructures, developing countries have high losses at the post-harvest and processing stages while food waste in industrialized countries is dominated by retail and consumer waste (Gustavsson *et al*., 2011). Kiran *et al* (2014) estimated about 278 and 80 million tonnes of food products are wasted in Asia and South East Asia, respectively. Food waste can be referred to organic wastes that originate from food processing plants, domestic and commercial kitchens, cafeterias and restaurants (Joshi & Visvanathan, 2019). Food waste can be categorized as either avoidable or unavoidable. However, food waste can be both edible and inedible. Edible food waste is considered avoidable, although Waste and Resources Action Programme (WRAP) (2007) describes some of this as "possibly avoidable", given certain foods that are not unanimously considered

edible. Avoidable food waste consists of products that could have been eaten such as leftovers, food left to go bad and food past its sell-by date. It means the food that is thrown away at some point prior to disposal or edible in the majority of situations (e.g. slices of bread, apples and meat). Whereas, possibly avoidable food waste is defined as food that can be eaten by some people and others do not (e.g. bread crusts) or food that is prepared in one way but not in another (e.g. potato skins). Unavoidable food waste consists of non-edible waste such as peels, bones, shells and coffee grounds as well as any fat or moisture lost in cooking.

Two of the four pillars of the 'Global Initiative on Food Loss and Waste Reduction' are awareness raising on the impact of, and solutions for food loss and waste, and policy, strategy and programme development for food loss and waste reduction. Throughout communication and media campaign, knowledge and changed behaviour of actors and consumers in the food chains can be increased. One of the initiative under food waste reduction strategy is field studies on food loss assessments (Food and Agriculture Organisation of the United Nations (FAO), 2017). Therefore, quantification of food waste is the crucial step to collect the baseline data of food losses in the food supply chain. Jereme *et al* (2017) suggested that any interruption in the food supply and access or interference on the food utilisation will lead to food insecurity and also the amount of food wasted every year by each waste generators including households, institutions, industries and commercial sectors. Global food insecurity is contributed largely by food wastes, nevertheless by practicing a sustainable life style, consumers can help to reduce the food waste.

In 1987, the Malaysia Government requested the Japan Government to assist in improving the entire waste management especially at the disposal sites. The upgrading and effective management of landfill sites are significantly contributed by transfers of knowledge from Japan to Malaysia for the past 25 years. The objective of Technology Development and Transfer project has been achieved. However due to various local constraints, there are still lacking in terms of "duplication" (Theng, 2004). Based on the Collaboration Project between the Ministry of Housing and Local Government (MHLG), Malaysia and Ministry of the Environment Japan (MOEJ), there are six strategies listed in the National Strategic Plan for food waste management. These include the establishment of databases on food waste management and regulation on food waste recycling (Strategy 1 and 2), food waste minimisation or reduction at source by food waste generator sectors (Strategy 3), enhancement of food waste treatment at source (Strategy 4), establishment of centralized or proper system for food waste treatment (Strategy 5) and recovery of methane gas from landfills (Strategy 6). Strategy 1 and 2 focus on data collections, set up regulations and provide incentives. Strategy 3 aims at minimizing at source which causes lesser food waste to be managed. Strategy 4 is turning the food waste into resources at the source by the waste generators to minimize costs for waste treatment and achieve the targets. Strategy 5 will establish more centralized facilities for food waste treatment as to provide alternatives. Last strategy is an appropriate final disposal with energy recovery as to minimize the impacts from the food waste (MHLG, 2011). The NSWMD continued and applied the 'Food Waste Management Development Plan (2016-2026)' which focusing on the industry, commercial and institution sector as an initiative to achieve efficient food waste management. One of the target is to reduce food waste by 20% from restaurants, food courts and hypermarkets, and by 25% from hotels and institutions by 2026 (NSWMD, 2016).

In Malaysia, the limited budget for food waste management causes the less efficiency in its management and also the policy for food waste treatment (Thi *et al*., 2015). Irregular and non-periodic analysis and documentation at national level from any local authorities restrict the information on food waste management and lead to inaccuracy in the database (Moh and Manaf, 2014). Furthermore, the strategy of food waste treatment is difficult to be sustained as there is no significant improvement in the waste management practice regardless of the introduction of National Solid Waste Management (2002-2020), National Recycling Programme (2000-2005) and Waste Minimisation Master Plan 2005 (MHLG, 2006). The management of food waste suitability is highly dependent on the costs of setting up and running the system. To set up highly advanced facility for recycling, recovery and safe disposal is normally the most expensive part of waste management. However, waste prevention and reuse are the least cost (Azlina *et al*., 2012). According to Azwan (2009), immediate action and improvement of garbage disposal management is needed for several issues in Malaysia.

Study on the motivations and barriers to minimise household food waste by Graham-Rowe, Jessop and Sparks (2014) found that some householders did not concern the link between food waste behaviours and a reduced environmental impact. There should be an educational program and continuous policies for enhancing sustainable pro-environmental attitudes as to minimise food waste. Concern on the potential environmental factor which act as a trigger of behaviour change is inconclusive. This is because consumers have so far failed to make any connection between food waste and environmental impact. There is a widespread belief that food waste has no environmental impact whatsoever because it is biodegradable and the consumers unreservedly believe that packaging waste is a greater environmental issue than food waste. The potential for an environmental message is unclear because consumers have yet to make any link between food waste and the environment even those who are environmentally conscious (Cox & Downing, 2007*).*

According to Refsgaard and Magnussen (2009), the formal rules and legislation will have impact on environmental or success of the system concerning who are responsible on sorting out the food waste. In addition, attitudes to recycling of food waste may be affected in a positive way if there are system of sorting out food waste and efforts of sorting are followed up by others. However, the incentives for recycling can change behaviour if the extra effort or cost of recycling match with these benefits. Separation at source depends on individual participation. Therefore, the success of recycling will be affected by the individual behaviour and attitudes. In Malaysia, the environmental awareness is low. Furthermore, due to the lack of awareness and knowledge among Malaysian community about solid waste management (SWM) issues and being ignorant about the effect of inappropriate SWM, it has definitely worsened the problem (Asmawati et al., 2012).

The amount of food waste generated is influenced by a variety of interlinked factors. Based on two comprehensive UK-based studies (WRAP, 2007), the food waste patterns also influenced by a routines which are actions and behaviours that tend to repeat over time. This set of habitual actions are pre-shopping, shopping and post-shopping routines (Malinchev, 2014). According to WRAP, individual with consistent pre-shopping routines such as checking before shopping, planning and making a written shopping list tend to waste less food. Besides that, unused food is often discarded due to consumers are incapable to determine the exact amount of food required for consumption. Creedon et al (2010) stated that food preparation

residues (e.g. vegetables peelings, meat trimmings), over-preparation of items in the kitchen (e.g. prepared food portions that cannot be reused/ frozen) and over-sizing of food portions are the reasons of food waste is produced. WRAP also identified that cooking too much at the preparation stage is the possible food that can be wasted. According to Glanz (2008), personal attitudes towards edibles, cooking and eating habits, shopping behaviour and storage of edibles have been identified as relevant factors for the arising food waste. The amount of food waste generated is influenced by consumption behaviour. In context of food consumption, preferences, taste, time constraints and prices are the decision criteria that influence the food consumption on an individual level (Reisch et al., 2013).

Cordingley et al (2011) studied the nature and types of food waste in schools, the reasons of food are wasted in schools and the impact of interventions developed to reduce the food waste. The reasons identified related to food being wasted were grouped into three categories which are operational, situational and behavioural. Operational reasons for food waste relates to catering policies on meals and the system. Situational not directly connected to food but to broader issues such as rushed lunch hours or the canteen environment while behavioural relating to individual choices and preferences. However, there may have been an increase in food waste due to nutritional value and food quality that could affect customer satisfaction (WRAP, 2007 & 2008). Food service in Malaysia universities have been providing day-to-day variety food options for their students and staff (Nadzirah et al., 2012). In addition, according to Lee (2004), many of the foodservice at universities and colleges provide many variety meals options and delivering fresh, healthy and tasty ingredients as customers' needs are concerned. Some of the university and college have different type of foodservice operations in which the concept representing a franchised restaurant brands or a self-branded restaurant concept.
Hwang (2010) studied the factors influencing customer satisfaction or dissatisfaction in the restaurant business and the findings indicated that customers most satisfied on good quality, tasty food, and restaurant cleanness. However, good value, tasty food and employees' knowledge of menu most affect customer dissatisfaction. It is important to pay a lot of attention to taste in relation to waste reduction. Therefore, some food services pay attention to improving the quality of the food they serve and to adapt it to the customer needs (European Federation of the Associations of Dietetians, 2012). According to WRAP (2007 & 2008), uneaten food was resulted from the food that are not the choice of meal option among customer. The food that being served are food that they have not chosen and they do not like. The level of customer satisfaction may be identified by various determinants from internal and external factors. Rahman, Kalam, Rahman and Abdullah (2012) reported that poor sanitation, poor food quality, insufficient facilities, poor food choice and service quality have effects on customer satisfaction. Shanka and Taylor (2005) indicated the most important determinants students would be considered in choosing a particular cafe on campus were significantly quality, price and service. These determinants of customer's satisfaction towards cafeteria could influence the generation of food waste.

Slow service in preparing and serving the food may affect lack of confidence among individual in the catering service to deliver additional or alternative food items at short notice. This may affect individual satisfaction and have a negative effect on the amount of food eaten (National Health Service (NHS), 2005). Aigbedo and Parameswaran (2004) stated that it is important for the management to provide goods or services in a way that pleases the customers.

Commitment from workers and support from the management is necessary in order to achieve a quality service organization. Foodservice managers must be knowledgeable of expectations and perceptions of service quality and satisfaction among the students. Hence, it is important for college and university foodservice providers to measure services provided that affect students satisfaction (Estepa et al., 2005). According to NHS, environmental reasons such as unpleasant smells, excessive or intrusive noise may reflect individual satisfaction and have a negative effect on the amount of food eaten. Andaleeb and Caskey (2007) had studied about satisfaction with food services to get insights from a college cafeteria. This study was carried out to determine college students' satisfaction with their food service establishments. Result shows that atmosphere, responsiveness and cleanliness are the significant variables that explain student satisfaction. Lee (2004) also deduced that college students' satisfaction levels were influenced by cafeteria environment, employee competency, price and nutritional information. On the whole, based on the existing evidence and previous findings discussed above, the quantification of food waste, determinant factors that influence customers' satisfaction towards the cafeteria's service, and environmental awareness towards food waste management are the essential elements that need to be further investigated either at macro or micro-level as part of the efforts in reducing food loss and waste to improve food security.

Methodology

This cross-sectional study investigated the food waste quantities that contributed by consumers and cafeteria staff in a randomly selected sample generated from three cafeterias in Universiti Sains Malaysia in Kota Bharu, Kelantan. The portable hanging weight scale with capacity of 5 kg and 50 kg were used for weighing the food wastes. The weighing activities were conducted over a period of five weeks from December 2013 to January 2014. The wastes from each cafeteria were daily collected simultaneously after cafeteria operation times and sorted into two groups: avoidable (e.g.: spoiled products and overproduction, edible) and unavoidable food waste (e.g.: vegetable peels and bones, non-edible) (American Society of Testing and Material standard (ASTM), 2003). Questionnaires were distributed to 369 study participants who were students, staff and university visitors. The sample size was determined by using Cochran's formula and referred to Krejcie and Morgan's sample size table. The questionnaire consisted of eight questions on demographic background such as gender and ethnic and attitude and behaviour towards generation of food waste at the cafeteria. The purpose of using questionnaire was to obtain further information and opinions from participants on food waste issues within cafeterias. The questionnaire was piloted among 12 customers at the same cafeteria to check the reliability and validity of the questionnaire prepared. The questionnaire was reliable and valid as the Cronbach alpha value obtained were 0.721 for likert-scale questions and 0.709 for multi-choice answer questions. A checklist was also used to determine the number of customers who came to each cafeteria. Semi-structured interview was conducted among six cafeteria staffs as to investigate their attitude and behaviour towards food waste reduction. Descriptive analyses were done for demographic data, quantity of food waste generated at each cafeteria and consumer's behaviour towards food waste generation. Spearman correlation test was used to find a relationship between factors of food waste generation and amount of food waste generated. Linear regression was used to find the association between number of customers and amount of food waste generated. Mann-Whitney Test was used to compare between avoidable and

unavoidable food wastes quantities generated. Data analyses were run using SPSS version 20.0.

Results and Discussion

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Sociodemographic Background

A total of 369 set of self-administered questionnaire were distributed to customers of USMKK cafeterias who were primarily USMKK's students and staff. As shown in Table 1, 37% of the respondents were male and 63% were female. Most of the respondents were Malay (81%). Majority of the respondents were students (81%), followed by USMKK's staff with 17%. Meanwhile, 2% were include visitors and contractors. Most of the customers were from School of Health Sciences (66%).

Table 1
Demographic Distribution of Respondents (n=369)

Demographic Variable	Frequency (n)	Percentage (%)
Gender		
Male	135	36.6
Female	234	63.4
Ethnic		
Malay	298	80.8
Chinese	50	13.6
Indian	16	4.3
Others	5	1.4
Profession		
Staff	62	16.8
Student	299	81.0
Others	8	2.2
Department/ School		
School of Health Sciences	244	66.1
School of Medical Sciences	53	14.4
School of Dental Science	22	6.0
Hospital Universiti Sains Malaysia	6	1.6
Administration Department	9	2.4
Development Department	4	1.1
Security Department	11	3.0
Others	20	5.4

Quantities of Food Waste Generated

The amount of food waste generated in the university cafeterias varied considerably from 29.5 to 678.0 kg per cafeteria. The average food waste generated were 41.96 kg per day (Caféteria A), 84.75 kg per day (Cafeteria B) and 3.69 kg per day (Cafeteria C). For weighing and sorting, the food waste was divided into two categories so that the edible waste was separated from inedible waste such as vegetable peels, scraps of raw food, coffee grounds and others. For weighing and sorting, the food waste comprised three sources in accordance to its origin which are kitchen waste, service waste and leftovers. As shown in Figure 1, in

Cafeteria A and B, unavoidable food waste was higher compared to avoidable food waste. For Cafeteria A, total unavoidable food waste recorded was 303.25 kg and 32.4 kg for avoidable food waste. In Cafeteria B, the largest constituents of unavoidable food waste analysed during the study was 518.9 kg while avoidable food waste was only 159.1 kg. The avoidable food waste (23.85 kg) was relatively high at Cafeteria C as compared to the unavoidable food waste (5.65 kg).

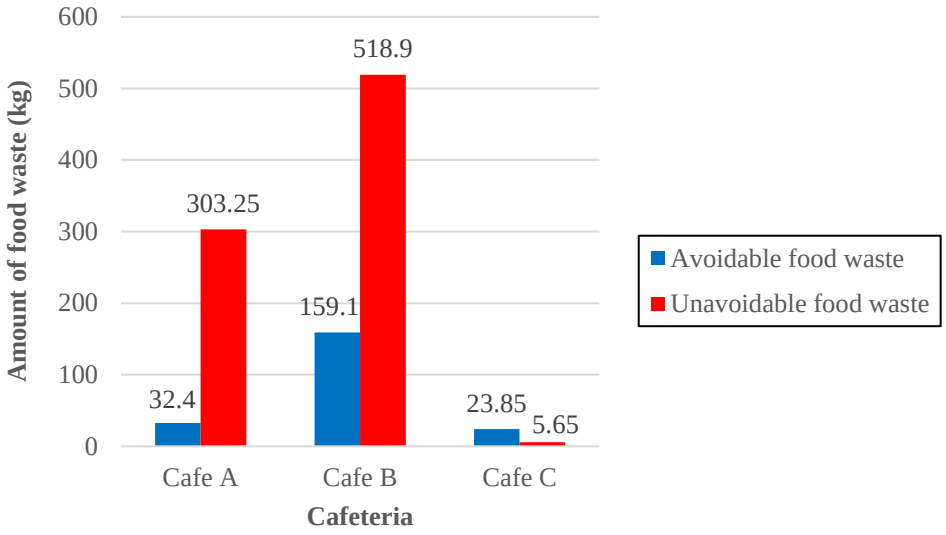

Figure 1 Quantity of Food Waste Generated in USMKK Cafeterias

Frequency of Visiting USMKK Cafeterias

Table 2 shows frequency of the respondents visiting USMKK cafeterias. Majority of the respondents eat at USMKK cafeterias every day (n=208, 56%). This is followed by 101 respondents (27%) who visit the cafeterias more than once a week.

Table 2
Frequency of Visiting USMKK Cafeterias

	Frequency (n)	Percentage (%)
Every day	208	56.4
Once a week	19	5.1
More than once a week	101	27.4
Once a month	7	1.9
2-3 times a month	12	3.3
Not sure	22	6.0

Determinants that Influence Customer's Satisfaction towards USMKK Cafeterias

Table 3 shows factors that influence customers to eat at the USMKK cafeterias. Most of the respondents (78%) agreed that the cafeteria that is located near to the office, campus or hostel will attract them to eat at that cafeteria. There were 50% of respondents agreed that they chose to eat at the USMKK cafeterias because of rushed hour. 39% of respondents prefer to eat at the USMKK cafeterias due to their cheap food price.

Table 3
Determinants that Influence Customer's Satisfaction towards USMKK Cafeterias

	Frequency (n)	Percentage (%)
Near the office or campus or hostel	289	78.3
Cheap	144	39.0
Rushed hour	185	50.1
Cafeteria environment	38	10.3
Food quality	61	16.5
Service	51	13.8
Hygiene	56	15.2
Cafeteria staff are friendly	50	13.6
None	6	1.6
Others	9	2.4

Amount of Uneaten Food

As shown in Figure 2, 71.5% were aware of the amount of waste they were leaving for disposal and 25.7% of respondents acknowledge to regularly leaved quarter of the plate or bowl of waste for disposal. 1.4% indicates approximately half of the plate or bowl of uneaten food left during an average meal followed by 1.1 percent with ¾ of the plate or bowl of uneaten food left.

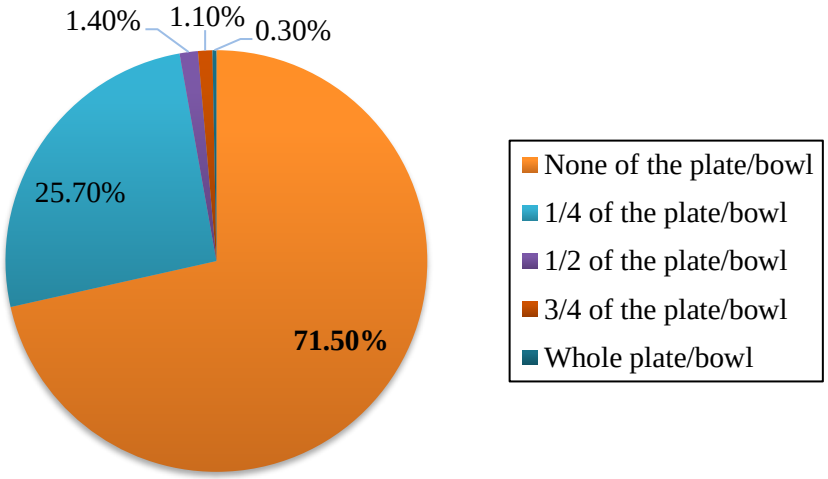

Figure 2 Percentage of Uneaten Food Left

Ways to Reduce Food Waste

Of the respondents surveyed, 85% felt that increasing food quality and taste would be a way to reduce the amount of food waste. The second most popular suggestion was increasing food freshness (69%) and having more food choice (66%). 61% of respondents agreed that food waste composting was also a good approach to reduce food waste (Table 4).

Table 4
Ways to Reduce the Amount of Food Waste Generated at USMKK Cafeterias

Suggestion	Frequency (n)	Percentage (%)
Increasing food taste or quality	314	85.1
Having more food choice	242	65.6
Increasing nutritional value	220	59.6
Improving cafeteria atmosphere (cleanliness)	220	59.6
Increasing food freshness	253	68.6
Improving service in food preparation and serving	181	49.1
Making a menu checklist	175	47.4
Composting the waste	224	60.7
Awareness campaign or educational programme	188	50.9

Factors that Influence the Generation of Food Waste

As shown in Table 5, number of customers had significant association with amount of food waste generated at Cafeteria A (R^2= 0.87, p=0.001) and Cafeteria B (R^2= 0.82, p=0.002). However, number of customers at Cafeteria C had no significant correlation with amount of food waste generated (p=0.274). Based on Table 6, the main factors that were significantly influenced the food waste generation were poor food taste or quality (r=-1.00, p<0.001), lack of freshness (r=-1.00, p<0.001), habits of consuming little amount of food among customer (r=1.00, p<0.001) and hours of operation (r=1.00, p<0.001).

Table 5
Association between number of customers and the amount of food waste generated at USMKK cafeterias

Number of Customers	Regression Coefficient	95% Confidence Interval	p value	R^2
Café A	0.035	0.021; 0.048	0.001	0.871
Café B	0.074	0.039; 0.109	0.002	0.816
Café C	0.024	-0.025; 0.072	0.274	0.195

Linear Regression, significant at p<0.05.

Table 6
Correlation between Amount of Food Waste and Factors Influence the Generation of Food Waste

Potential Factors	Amount of Food Waste	
	r	p value
Poor food taste/quality	-1.000**	<0.001
Poor food choice/variety	0.500	0.667
Lack of nutritional value	-0.500	0.667
Lack of freshness	-1.000**	<0.001
Too much food prepared by cafeteria	0.000	1.000
Take too much food	-0.500	0.667
Habits of consuming little amount of food among customer	1.000**	<0.001
Slow service in preparing and serving the food	0.500	0.667
Cafeteria atmosphere	0.500	0.667
Hours of operation	1.000**	<0.001

Spearman Correlation, **significant at p<0.05.

Comparison between avoidable and unavoidable food wastes quantities generated at the cafeterias

In Table 7, significant differences were found between avoidable and unavoidable food wastes quantities generated at the three cafeterias. The amount of unavoidable food waste was higher than avoidable food waste at Cafeteria A and B. However, Cafeteria C generated more avoidable wastes than the unavoidable wastes.

Table 7
Comparison between Avoidable and Unavoidable Food Waste Quantities Generated at the University Cafeterias

Cafeteria	Median (IQR), kg		Z statistics	p value*
	Avoidable food waste	Unavoidable food waste		
A	4.30 (1.53)	37.93 (3.38)	- 3.361	0.001
B	20.30 (2.49)	66.28 (5.21)	- 3.361	0.001
C	3.18 (1.76)	0.65 (0.25)	- 3.260	0.001

*Mann-Whitney test, significant at $p<0.05$.

Food Inventory Management Practices

Based on the interview feedback, the cafeteria staff reported that rice and side dishes were the type of food waste that has more leftover at all cafeterias. Others are traditional delicacies, fries and western food such as spaghetti. Most of the cafeterias have more leftover during evening meals. Most of the cafeteria staffs will do stock checking prior to groceries shopping. They would always making a list of the items that need to be purchased before going for food shopping. Majority of the cafeteria staffs stated that environmental conditions and attitude among customers were the factors that prevent the waste reduction. However, low level of awareness on food waste and customers' attitude discourage the action of reducing food waste. The cafeteria staff suggest to conduct awareness campaign on food waste among customers. Alternatively, some of the cafeteria distributed the unsold food to their staff to avoid food wastage.

Factors Contributed to Food Waste Generation at USMKK Cafeterias

Based on the survey conducted among 369 customers and six staffs of USMKK cafeterias, higher frequency of visiting the cafeterias may influence the food waste generation as cafeteria with many customers produced higher amount of food waste. The amount of food waste increases at Cafeteria B with the highest frequency (everyday) of coming to this cafeteria compared to other cafeteria. Besides, findings from the questionnaire found that there was a higher amount of uneaten food left at Cafeteria B (¼ of the plate or bowl). More food stalls were operated by different vendors at Cafeteria A and B. Therefore, these cafeterias have variety of food selection. Fatimah (2009) stated more food stalls operated by different individual has given students more options in terms of meal selections where students can choose whichever meals that suits their taste within the university cafeteria. A large amount of waste was unexpected because customers have the option to take unlimited portions of prepared food they are unsure they will enjoy. Hence, increase number of customers leads to increase in food consumption which also resulting to the increase amount of food waste generation at the cafeteria. This may be due to variety of food selection and type of food variation sold at Cafeteria A and B. Besides that, since there were variety of food

served and prepared, large amounts of ingredients needed for the food preparation. Therefore, the cafeteria generated of a large portion of unavoidable (inedible) food waste such as fruits rinds and kitchen waste (principally bones and organs that are not commonly eaten) in which were quite heavy. Cafeteria C have higher average amount of avoidable food wastes might be due to the cafeteria menu that mainly consisted of packed foods such as sandwiches, dessert and soups. A small amount of avoidable food waste was expected because the cafeterias' customers have the option to take limited portions of prepared food. This reduces the chance of selecting something they do like and will eat because it has the lowest amount of food selection and variation. According to Saphire (1998), different type of food service will generate different types of waste as it involves different types of food preparation.

Main factors that influence the customers to come to USMKK cafeterias were their location, rushed hour and cheap food. These findings were similar with Shanka and Taylor (2005) who showed that the location of the cafeteria, price and food quality were the most important determinants of university foodservice. According to Shanka and Taylor, the assessment found that the primary reasons of students to often considered in choosing a cafe on the campus grounds was its locational convenience as they preferred a cafe closer to their classes whereas some preferred a certain cafe for its price and food quality. However, Fatimah *et al* (2011) also identified that the food quality is to be one of the vital determinants that influences customers' satisfaction levels with the university foodservice. Furthermore, Andaleeb and Caskey (2007) also stated that the most important variable influencing student satisfaction was food quality. Therefore, quality of food give negative impacts to the generation of food waste.

The other factors that drive customer's satisfaction towards USMKK cafeterias were hygiene, service, cafeteria staff and cafeteria environment. These findings were supported by (Ruetzler, 2008; Bitner, 1992). In addition, a study on campus cafeterias in the US by Ruetzler showed that the main factor that influences students' satisfaction with university foodservice was quality service and hygiene. According to Bitner, food service environment is the overall atmosphere inside the foodservice facility which includes but is not limited to ambience, space, items inside the foodservice facility, layout, design, cleanliness, lighting, other customers's behaviour and staff appearance. Therefore, cleanliness, service, staff cafeteria and the cafeteria environment will indirectly affect the generation of food waste in the cafeteria.

Although most of the respondents suggested that increasing food quality and taste can reduce the amount of food waste, however this is an unrealistic solution as the food taste is very subjective. In addition, it can be suggested to cafeteria management to have a change in meal plan. The cafeteria management should prepare and serve the fresh menu in order to reduce the amount of food waste at their cafeteria. Some of the other suggestions included planned food menu that would lower consumers' susceptibility to overbuying and take a sufficient amount of food would result in a decrease in the amount of food waste generated at the cafeteria. Another suggestion that could reduce the amount of food waste was to increase communication between management and USMKK cafeterias' customers. Although the suggestion was of relatively low frequency, it is as a practical solution to decrease the amount of waste produced. Moreover, the findings from this study suggests that asking the

customer to finish up the meals that they have bought could decrease the food waste generation.

There was a relationship between number of customers and the amount of food waste generated at Cafeteria A and B. Number of customers at Cafeteria A and B was significant to the generation of food waste because the location of the cafeteria were nearest to the office, campus and hostel in which the research participants were primarily USMKK's students and staff and this may have contributed to the high amount of food waste produced. In addition, there are time constraints for the students and they are rushing to class. They are pressured to patronize the university's food service as an alternative source for their meals (Fatimah *et al.,* 2011).

Behaviour of Cafeteria Management towards Food Waste Reduction

The prevention measures taken by the cafeteria staff in reducing food waste generation includes checking the stocks before going for food shopping, buying only the necessary food and making a list. According to WRAP (2007), the pre-shopping preparation including menu planning, checking of what ingredients in stock and shopping list are the ways leading towards less food being wasted. The driving force behind the action of reducing the waste at the cafeteria were the environmental conditions, low level of awareness on food waste and the attitude of the customers. In addition, an important role for the arising of food waste is behavioural attitudes of individual. Customers have poor in planning meals and buy beyond their own needs (Priefer et al., 2013). According to Monier *et al* (2010), a lack of information on the level of impact of waste management is difficult for the food waste prevention initiatives. WRAP (2008) claimed that the cause of food waste production in the catering sector (such as in hotels, restaurants, and cafeteria) are due to the excessive size of food portions served which in part are left on the plate and usually involve preparation of a larger amount of food than is necessary. The finding in this study was contradicted with WRAP study due to the good behaviour of cafeteria management towards reduction of food waste. Most of the cafeterias were always checking the stocks before going for food shopping, buying only the necessary food and making a list before buying the food.

Most of the cafeteria staffs said that conducting awareness campaign is a good way that could increase the level of knowledge about food waste among customers. According to Silvennoinen *et al* (2012), awareness campaign is a good way of reducing waste that will influence the attitudes of the consumers and making people more aware of the importance of the food waste issue. The consumers could give feedback to let other people know that they value reducing waste and to show that they take this matter seriously.

Study Limitations

This study have investigated attitude and behaviour of customers toward generation of institutional food waste. Customers from different professions may have different perceptions and behaviour on food waste reduction. However, it was assumed that the respondents involved in this study were representative of higher institution's population. Therefore, the findings may serve as baseline data on the factors that may contribute to generation of food waste at institution level. Nonetheless, number of respondents in this study might become a limiting factor in assessing the overall and accurate perception towards generation of food waste at USMKK cafeterias. This was due to time and cost limitations to

conduct and complete the study. Time is limited since this research was done before student's semester break.

Another limitation was leachate that coming out during manual segregation of the waste. The leachate can triggered pest manifestations such as cockroaches, flies, insects and produced unpleasant odour around the sorting and weighing area. However the recommendation of cleaning the area had been taken. Another limitation was as described in the sampling methods section, the checklist was placed on the cashier table and at each stall at the cafeteria. It is more likely that the cafeteria customers will not tick on the form because they did not notice the checklist. Hence, some of the cafeteria customers were not accounted. However, it is possible for the USMKK cafeterias' customers to double tick at the checklist for different stalls.

Conclusion

In the present study, overall, the amount of unavoidable food waste generated at the university cafeteria was higher compared to avoidable food waste. Specific factors that could lead to food waste reduction have been highlighted. It may be beneficial to start food waste reduction initiatives by emphasising the point that reducing the food waste is the 'right' thing to do. In order to empower people to keep food waste to a minimum, they need to be trained in food management skills. However, there are potential barriers to food waste minimisation. Consumers' routines are also mediators of the relationship between moral attitudes and food waste. It means trying to change consumer's food waste behaviour either directly aim at changing consumers' routines or aim at changing their attitudes towards food waste. It can persuade them to make changes in their planning of food menu such as control their buying that would result in lower food waste generation. The awareness campaign at institutional level could contribute to the reduction of food waste and increase the level of knowledge about food waste among customers. In addition, it would help the top management to plan suitable programme in minimizing the production of food waste as to support sustainable environment.

The future research should investigate whether mediators of the relationships between food waste and consumer attitudes would be the factors of food to be wasted and where consumers are thus likely to be more aware of food waste as an environmental issue. In addition, further studies should be conducted to assess other areas and any related factors that may contribute to the generation of food waste at any other institutional cafeteria in Malaysia. Therefore, in the future study, larger sample from multiple institutions are recommended to get more valid and representative finding.

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