Waste Audit at Food and Beverage Outlet - A Case Study in Selangor, Malaysia.

Wai Loon FONG and Jenny ONG

***Abstract*—** Commercial sector in Malaysia contributed approximately 24% of total waste generated and 41% of them are food waste. Hotel, restaurant, and café (HORECA) is inevitably the highest food waste generator aside from food processing industries. This research was conducted to study the waste composition and recycling rate in a restaurant. During the one month study, a total of 663.32kg of waste was recorded. The waste composition was food waste (79%), cardboard (7%), glass (6%), plastic (5%), and others (3%). The restaurant's recycling rate is 17.4%, and this study shows that there is a potential to increase its recycling rate to 95.3%. Furthermore, to increase the recycling rate, it was suggested to carry out on-site and off-site waste treatment to reduce the amount of organic waste generated. This study can be used by the food and beverage outlets to carry out their waste minimization plan in the future.

***Keywords*—** waste minimization, hospitality, environment

I. Introduction

Solid waste generation rate in Malaysia has increased approximately 91% for the past 10 years due to high urbanization, industrialization and increased population rate [1]. Study done in Kuala Lumpur showed that commercial sector generate approximately 24% of total waste generated in year 2003. Moreover, 80% of these waste came from food wastes (41.48%), plastic based wastes (20.98%), and paper based waste (18.59%) [7], [14].

Generally, Malaysians generate up to 8 million kg or 8,000 tons of food waste a day, which can feed up to 6 millions of people and it takes around RM1.6 billion to manage these amount of waste [21]. In 2006, the recycling rate is 5.5% while the rate of composting is 1% [6]. However, Malaysia government planned to increase composting rate to 8% and recycling rate to 22% by year 2020. Compare to other countries in Asia, Singapore has increased their recycling rate from 44% in year 2002 to 48% in year 2004, while Korea had increased its recycling rate from 44% to 48% between the years of 2000-2008. Even though, the increased percentage is low, they are way ahead of Malaysia's in term of recycling rate.

In September 2015, Malaysia government had enforced the Solid Waste and Public Cleansing Act 2007 (Act 672) for Household Solid Waste Segregation Programme in six states, for instance, Johor, Malacca, Negeri Sembilan, Pahang, Perlis and Kedah, and the Federal Territory of Malaysia – Kuala Lumpur [23]. This regulation aims to control the solid waste generators and persons in possession of controlled solid waste, enforcement, as well as recovery and reduction of controlled solid waste. However, in Selangor, this regulation is yet to be implemented for both residential area and commercial sectors.

Waste handling and separation at source is a very important step in managing solid waste generated from the food and beverage outlets in commercial sector [16]. A study showed that food waste is averaging around 56% of the total waste generated from restaurant [18]. Various other studies also found that how much preparation food waste and plate waste are generated in the hospitality sectors [12]. Studies done in United Kingdom restaurants showed that 65% of organic waste came from preparation of food such as off cutting, peeling and ruined food while cooking; 30% of organic waste came from plate waste after customers consumed their foods; 5% of organic waste came from the spoiled, expired, or unusable food [15]. This shows the significant amount of food waste generated in a restaurant. Meanwhile, a research done by Environmental Protection Agency (EPA) showed that the commercial sectors in United State generated approximately 24.6 million tons of food soiled and scraps, unrecyclable paper and cardboard annually [22]. EPA also stated that 74% of the restaurant waste stream is made up of organic waste.

There are five common treatment methods that have been widely used for the treatment of organic waste in developing countries, which is *landfilling, incineration, composting or organic fertilizer, animal feeding, and anaerobic digestion* [21]. Landfilling is the most popular method [2]. However, landfilling is not considered as a feasible method for organic waste treatment due to the high emission of greenhouse gases (GHG) such as methane, which is at the rate of 8% [2].

Composting is a biological process where the biodegradable organics are metabolized by microbes into nutrient rich structural component of soil called humus. This process converts the organic waste into products which are useful for gardening, maintaining fertility of agricultural land, slope stabilization, landscaping, and even brownfield remediation [9].

Garbage enzyme is a solution produced from the fermentation of fruit waste, molasses or brown sugar, and water. It is a multipurpose solution that can be used for agriculture, household, or environment. For agriculture, garbage enzyme can be used as fertilizer and pesticide. For household, garbage enzyme can be used as detergent to remove oil and grease, and remove unpleasant odour and dirt. Garbage

Manuscript received March. 3, 2017.

Wai Loon FONG was with the Faculty of Engineering and the Built Environment, SEGi University, Malaysia (email: wallace_1359@hotmail.com)

Jenny ONG was with Institute of Biological Sciences, University Malaya, Malaysia. She is now with the Faculty of Engineering and the Built Environment, SEGi University, Malaysia (jennyong@segi.edu.my)

enzyme is a Do It Yourself (DIY) product that not only save cost and time, but also environmental friendly in the sense of reducing pollution [25].

This research aimed to study the waste composition, the recycling rate and the waste treatment in the restaurant.

II. Procedure and Methodology

This study was conducted in an Asian-French-Italian Fusion restaurant located in SetiaWalk, Puchong. It has been operating since December 2014, and it is the only branch in the country at present. There are several identified sources of waste generated in the restaurant i.e. kitchen, bakery, and bar. The data collection was done on daily basis for the period of one month, starting from 4/8/2015 (first Tuesday of August 2015) to 3/9/2015. Data of 4 Monday were not collected due to non-business day for the restaurant, therefore, only 27 days of data were collected.

Recyclables such as papers, cardboards non-contaminated plastics, cardboards, metals, glass, aluminum, and e-waste generated from bar and bakery were stored inside a steel bin, whereby a cardboard box was used for the recyclables generated from kitchen. Non-recyclables from kitchen such as the contaminated plastics disposed plastics (film plastic and torn plastic bags), and used napkins were separated and placed into a plastic bag. Organic waste generated from kitchen, bar and bakery were disposed into conventional garbage bin with plastic bags. Safety gloves and latex gloves were used during data collection. The conventional and digital weighing scale were used to obtain the weight measurement.

III. Results and Discussion

A. Waste generated in the restaurant

The restaurant generated a total amount of 663.32kg of waste during the 27 days study period. Total waste generated in the restaurant is shown in **Table 1**. In terms of proportion, organic waste contributed up to 79% from the total waste; cardboard 7%; and glass 6%. From this result, it is proven that the organic food waste has the major contribution on the waste generation in the restaurant. These organic waste can be recycled and transformed into useful product such as bio-enzyme, or waste compost. Overall, average amount of waste generated per day is 24.57kg.

TABLE I:
WASTE GENERATED IN THE RESTAURANT (KG)

	Week 1	Week 2	Week 3	Week 4	Week5	Total Weight	Average
Tuesday	23.81	29.34	27.59	23.26	24.61	128.61	25.72
Wednesday	24.7	19.85	32.09	17.76	25.38	119.78	23.96
Thursday	18	26.19	23.1	25.11	20.44	112.84	22.57
Friday	18.33	23.2	30.35	18.97	-	90.85	22.71
Saturday	29.48	30.89	25.29	22.09	-	107.75	26.94
Sunday	35.02	28.6	23.95	15.92	-	103.49	25.87

In addition, the kitchen area has generated 490.40kg of waste out of 663.32kg of total waste generated, which is approximately 74%; and of the waste generated at the kitchen, 76% is organic waste.

Generally, Saturday and Sunday recorded the highest number of customers in a week. **Fig. 1** shows that Saturday generated the highest amount of waste generated per day (average 26.94kg) as compare to other days, followed by Sunday. When there is more customers, it will eventually increases the process of food preparation and production, which is directly affecting the waste generation rate in the restaurant. Subsequently, Tuesday recorded the third highest amount of waste generated per day. Reason is Tuesday is the first day of business operation for the restaurant. When the restaurant started to prepare for the food which involved cutting of meats, sauces making, precooking, chopping vegetables, and other food preparation processes that may generate food residues. Sometimes, chilled or frozen foods might be found either spoilt or expired during stock checking.

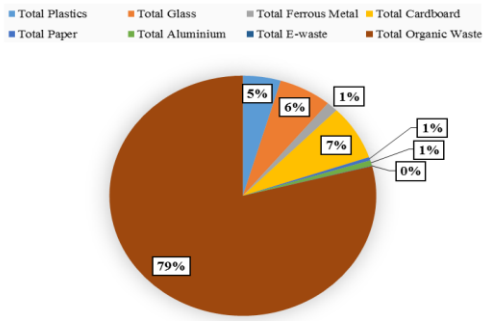

Fig. 1. Waste composition chart.

B. Correlation between total number of customer and total waste generated

The correlation study was done to identify whether the waste generated per day is affected by the number of customer visited the restaurant per day. Bases on **Fig. 2**, the R^2 shows a very low value of 0.0741, meaning that the daily waste generated and total daily customer visited the restaurant is not correlated. This outcome can be understood where the majority of waste are produced from the preparation, processing, cooking, or food wastage. Even when the number of customer is low in the day, preparation of cooking ingredients, which ultimately produce wastes, will still take place. Therefore, a low significant correlation is shown between the total daily customer and total daily waste generated. Despite on the low correlation, number of customer increase will still increase the possibility of waste generated from food production and plate waste. Therefore, the visited customer will still affect the waste generated on the same day.

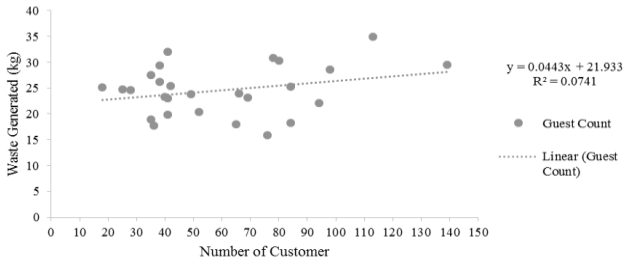

Fig. 2. Correlation graph between total customer and total waste generated.

C. Waste recycling rate and Effectiveness of waste minimization

Study was carried out based on two scenarios. First scenario which is the current practice, where waste segregation was carried out on common recyclable items such as papers, non-contaminated plastics, aluminum, glass, metals, and cardboard. While for second scenario, organic waste was treated instead of disposed. In the first scenario, organic waste was not segregated based on current practice. **Table 2** shows the difference in the recycling rate before and after when the organic waste is being recycled. For current practice, the highest recycling rate recorded was only 38.6% and as low as 2.8%, with an average of 17.4% recycling rate. If the organic waste are recycled, the potential recycling rate can be increased up to 97% and as low as 87.5% with 95.3% average recycling rate. If the organic waste is treated at site, the average recycling rate can be increased by 77.9% and the amount of waste for disposal can be minimized up to 416.98kg per month.

This study had indicated that the organic food waste are dominating the waste from the restaurant. These very good recycling materials can be potentially turned into multipurpose bio-enzyme, or organic compost fertilizers. The benefits of making food waste compost are to reduce the amount of waste significantly, to produce compost as fertilizer, and the restaurant are able to obtain additional income by selling the fertilizers. However, there's no buyer or collector for organic waste, and no composting facility for composting process was found nearby the study area. The garbage composter is comparably costly to be invested, and takes up space to install the machine. Garbage enzyme can be used as deodorant, insect repellent, oil remover and more. It require low initial cost as it only need fruit skins, water, and brown sugar to make it. However, the amount of organic waste used on producing the garbage enzyme would not significantly reduce the amount of waste generated. In fact, the fermentation process of garbage enzymes take up storage space in the restaurant and require at least 3 months before they are ready to be used.

TABLE II
COMPARISON ON CURRENT RECYCLING RATE AND POTENTIAL RECYCLING RATE

	Current Practice	Potential
Total Waste (Recycled) (kg)	115.42	632.4
Total Waste (Non-Recycled) (kg)	547.9	30.92
Total Waste (kg)	663.32	663.32
Highest Recycling Rate (%)	38.57	97.94
Lowest Recycling Rate (%)	2.8	87.55
Average Recycling Rate (%)	17.4	95.3

On the other hand, glass wastes such as glass bottles or jars are also one of the challenge in recycling. The restaurant had generated a total of 42.54kg of glass weight, around 6% of the total waste, which is the 3rd highest category of waste produced during the research period. Despite of its value, glasses were unable to be sold to majority the local buy-back center. Besides, only certain suppliers of beverage will buy back the used bottles. Therefore, glass wastes can only be sent to the drop–off center where there's no incentive given for recycling.

In terms of cost efficiency in the future view, recycler who collect from the restaurant provide the best service for the restaurant on the off-site waste treatment when compared to buy-back center and drop-off center. Drop-off center do not provide incentives, whereby buy-back center do not accept glass waste, which it is a major problem as the glass waste is the third highest contributor of the overall waste in the restaurant. In addition, the recycler also provide the service to collect recyclable such as glass waste and convert them into the credit points for shopping voucher.

IV. Conclusion and Recommendation

In total, the restaurant generated a total of 663.32kg of waste. More than 95% of these waste are recyclable items. Besides, the restaurant waste composition was dominated by organic food waste. 79% out of the total waste generated from the restaurant was organic waste, which is 523.80kg.

Waste generation rate has been determined throughout the analysis. The restaurant had an average waste generation of 24.57kg/day. The highest amount of waste generated fell on the Sunday of Week 1 at 9/8/2015, with 35.02kg of waste generated. Tuesdays of the month of data collection period recorded the highest total waste with 128.61kg. However, Saturdays has the highest average waste generated at 26.94kg/day.

On-site waste segregation is the fundamental waste management of all. The separation of waste into recyclables and non-recyclables ease the process of on-site waste treatment and improve the waste minimization efficiency. Segregation of recyclables into their respective categories can also ease the recycling processes. The current recycling practice of the restaurant had recycled only 115.42kg of waste out of 663.32kg, which is only 17.4%. If the restaurant recycled the organic waste, there's a potential of waste minimization up to 94%, and the recycling rate can also increase to 95.3%.

Further studies are recommended to be done with more restaurants in the same area, city, or even within the state to determine the waste generation patterns for restaurants.

As food waste is the major contribution of the waste from a restaurant, further study is required to measure the effectiveness of waste treatment for restaurant in the country. Similar study has been done in San Francisco Bay Area, United State of America, on the Economic, Ecological, and Social Cost and Benefits of doing on-site composting in restaurant [9]. These studies are able to provide more applicable solution for all the restaurant on their organic waste treatment within the country. These study can also further explain the importance of commercially available composting technologies to expand within the country in order to prolong the lifespan of the landfills available in the country to encounter the rapid growth of waste generation rate in the country.

Finally, further research is recommended to study on the chemical composition of organic food waste to identify the possibility of converting organic waste into renewable energy. The study of chemical composition of food waste can identify the potentiality of organic food waste to generate usable biogas methane. A similar research has been conducted in Singapore to study the energy conversion of organic waste by different biological and thermochemical technologies [27]. On the other

hand, there was a research to study on the composition of Organic Fraction of Municipal Solid Waste (OFMSW) and its effect on the biochemical hydrogen and methane gas production potential [28].

ACKNOWLEDGMENT

This project report could not be accomplished without the support from my lecturers, supervisor, and friends. I would like to express my sincere gratitude to my supervisor, Ms. Jenny Ong who had been providing genuine supports, guidance, and advises me throughout the project. I would also like to extend my highly gratefulness to my course advisor, Mr. John Chng who had also been providing me valuable suggestions and ideas on the project. Finally, I would also sincerely to my friends from the Bachelor of Environment Technology (Hons) who had inspired me throughout the project.

REFRENCES

[1] Abdullah, A. (1995). Environmental pollution in Malaysia: trends and prospects. *Trac Trends In Analytical Chemistry*, *14*(5), 191-198. http://dx.doi.org/10.1016/0165-9936(95)91369-4

[2] Adhikari, B., Barrington, S., & Martinez, J. (2006). Predicted growth of world urban food waste and methane production. Waste Management & Research, 24(5), 421-433. http://dx.doi.org/10.1177/0734242x06067767

[3] Campbell, B., Khachatryan, H., Behe, B., Hall, C., & Dennis, J. (2016). Crunch the can or throw the bottle? Effect of "bottle deposit laws" and municipal recycling programs. Resources, Conservation And Recycling, 106, 98-109. http://dx.doi.org/10.1016/j.resconrec.2015.11.006

[4] Elia, V., Gnoni, M., & Tornese, F. (2015). Designing Pay-As-You-Throw schemes in municipal waste management services: A holistic approach. Waste Management, 44, 188-195. http://dx.doi.org/10.1016/j.wasman.2015.07.040

[5] Enzyme?, W. (2015). What Is Garbage Enzyme?. Thediysecrets.com. Retrieved 27 December 2015, from http://www.thediysecrets.com/2009/11/what-is-garbage-enzyme/

[6] Fauziah, S. H., Simon, C., & Agamuthu, P. (2004). Municipal Solid Waste Management in Malaysia – Possibility of improvement? Malaysian Journal of Science, 23(2), 61-70.

[7] Kathirvale, S., Muhd Yunus, M., Sopian, K., & Samsuddin, A. (2004). Energy potential from municipal solid waste in Malaysia. Renewable Energy, 29(4), 559-567. http://dx.doi.org/10.1016/j.renene.2003.09.003

[8] Manaf, L., Samah, M., & Zukki, N. (2009). Municipal solid waste management in Malaysia: Practices and challenges. Waste Management, 29(11), 2902-2906. http://dx.doi.org/10.1016/j.wasman.2008.07.015

[9] Mitchell, M. (2001). On-site Composting of Restaurant Organic Waste: Economic, Ecological, and Social Costs and Benefits. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.194.9132&rep=rep1&type=pdf

[10] Moh, Y., & Abd Manaf, L. (2014). Overview of household solid waste recycling policy status and challenges in Malaysia. Resources, Conservation And Recycling, 82, 50-61. http://dx.doi.org/10.1016/j.resconrec.2013.11.004

[11] Periathamby, A., Hamid, F., & Khidzir, K. (2009). Evolution of solid waste management in Malaysia: impacts and implications of the solid waste bill, 2007. J Mater Cycles Waste Manag, 11(2), 96-103. http://dx.doi.org/10.1007/s10163-008-0231-3

[12] Pirani, S., & Arafat, H. (2014). Solid waste management in the hospitality industry: A review. Journal Of Environmental Management, 146, 320-336. http://dx.doi.org/10.1016/j.jenvman.2014.07.038

[13] Preliminary Count Report, Population and Housing Census Malaysia, 2010. (2010). Retrieved May 20, 2015, from Department of Statistics: http://www.statistics.gov.my/

[14] Saeed, M., Hassan, M., & Mujeebu, M. (2009). Assessment of municipal solid waste generation and recyclable materials potential in Kuala Lumpur, Malaysia. Waste Management, 29(7), 2209-2213. http://dx.doi.org/10.1016/j.wasman.2009.02.017

[15] Sustainable Restaurant Association. (2010). Too Good to Waste: Restaurant Food Waste Survey Report. Sustainable Restaurant Association, UK

[16] Tchobanoglous, G., Theisen, H., & Vigil, S. (1993). Handling and Seperation of Solid Waste at the source. In Integrated solid waste management (International Edition, pp.159-160) New York: McGraw-Hill.

[17] Tchobanoglous, G., Theisen, H., & Vigil, S. (1993). Waste Characterization. In Integrated solid waste management (International Edition, pp.150-151) New York: McGraw-Hill.

[18] The Hotel at Kirkwood Center. (2013). Retrieved May 20, 2015, from IOWA Waste Reduction Center (IWRC): http://iwrd.org/services/food-waste/case-studies/hotel-at-kirkwood

[19] Themalaymailonline.com,. (2015). Waste segregation: Start small, environmentalists urge the government. Retrieved 30 December 2015, from http://www.themalaymailonline.com/malaysia/article/waste-segregation-start-small-environmentalists-urge-the-government

[20] Thestar.com.my,. (2015). Recyclables must be set apart from organic items from September - Nation | The Star Online. Retrieved 30 December 2015, from http://www.thestar.com.my/news/nation/2015/04/20/waste-separation-in-six-states-recyclables-must-be-set-apart-from-organic-items-from-september/

[21] Thesundaily.my,. (2015). Malaysians waste 8,000 tonnes of food per day | theSundaily. Retrieved 30 December 2015, from http://www.thesundaily.my/news/1172736

[22] Thi, N., Kumar, G., & Lin, C. (2015). An overview of food waste management in developing countries: Current status and future perspective. Journal Of Environmental Management, 157, 220-229. http://dx.doi.org/10.1016/j.jenvman.2015.04.022

[23] United States Environmental Protection Agency. 1999. Organic materials management strategies. Solid Waste and Emergency Response (5306 W) EPA530-R-99-016. 54 pp.

[24] User, S. (2015). SWCorp - Definition. Ppsppa.gov.my. Retrieved 29 December 2015, from http://www.ppsppa.gov.my/index.php/en/definition

[25] Viscusi, W., Huber, J., & Bell, J. (2012). Alternative Policies to Increase Recycling of Plastic Water Bottles in the United States. Review Of Environmental Economics And Policy, 6(2), 190-211. http://dx.doi.org/10.1093/reep/res006

[26] o3enzyme.com. (2008-2014). Uses of Garbage Enzyme [Fact Sheet]. Accessed on 27th April 2015. Retrieved from: http://www.o3enzyme.com/enzymeusage.htm

[27] Pham, T., Kaushik, R., Parshetti, G., Mahmood, R., & Balasubramanian, R. (2015). Food waste-to-energy conversion technologies: Current status and future directions. Waste Management, 38, 399-408. http://dx.doi.org/10.1016/j.wasman.2014.12.004

[28] Alibardi, L. & Cossu, R. (2015). Composition variability of the organic fraction of municipal solid waste and effects on hydrogen and methane production potentials. Waste Management, 36, 147-155. http://dx.doi.org/10.1016/j.wasman.2014.11.019

W. L. Fong is borned in 27th March 1993, Selangor, Malaysia. He is a undergraduate in Bachelor of Environmental Technology, major in solid waste management and environmental sustainability in SEGi Universitry Kota Damansara, Selangor, Malaysia.

He is currently working in PWW Worldwide Enterprise (also known as Project Woodworks), a local brand that aims to empower sustainable lifestyle and responsible consumerism through exquisite wooden S (*Happiness*, *Environmental*, *Sustainability*) OFFICER. He is also working very closely with several NGO and governmental organizations such as Landskap Malaysia, Tropical Rainforest Conservation and Research Center, Malaysia Timber Industry Board, Malaysia Environmental NGO, and Ecoknights on environmental and social related projects.