Public Practice, Knowledge and Attitude on Managing Kitchen and Food Wastes in Bintulu, Sarawak, Malaysia

Nurul Husna Che Hamzah, Azira Sanusi, Nozieana Khairuddin, Nor Shafinaz Azman, and Azizul Hakim Lahuri

***Abstract*—Kitchen and food wastes discarded from the food related premises contributes to the high proportion of organic waste that end up in its landfill. The methane gas released during the dumping of food waste at the landfills is unsafe because the gas is flammable, and it is also a strong greenhouse gas. To tackle this problem, efforts are necessary to reduce the kitchen waste generated and to manage the disposal of waste sustainably. However, for this initiative to be successful, the owners and workers in food sector play an important role. The main objective of this study was to evaluate the practice, knowledge, and attitude of the food premises owners towards managing the kitchen and food waste in the district of Bintulu, Sarawak. Thus, a survey was conducted among 130 owners of randomly selected food premises. The collected data showed that food waste has the largest portion (46.7%) produced in Bintulu compared to other MSW such as plastic, paper, glass, metal, etc. Most respondents prefer to dump the food and kitchen wastes into garbage bins (79.2%) rather than composting (6.2%), donate, reuse, and recycle. This result proved the importance of building a biogas plant for kitchen and food waste since the respondents preferred to throw away the leftover food rather than composting the food. It will also help to propose appropriate treatment technologies to support the National Solid Waste Management (SWM) Policy and National Green Technology Policy for waste-to-wealth projects.**

***Index Terms*—Food and kitchen waste, public practice, knowledge level, solid waste management, waste recovery.**

I. Introduction

Food waste has the largest percentage of municipal solid waste (MSW) that is contributed by many sectors, including farmers, food distributors, food outlet or restaurant, households, and individuals. It was reported that the average food waste generated in 2010 was a massive 7600 metric tons per day, accounting for around 45 percent of overall MSW generated in 2016 [1]. The average household in Malaysia produces 0.5 kg to 0.8 kg of food waste per day [2]. Generally, MSW can be treated in 3 ways: thermal, biological, or landfill treatment as shown in Fig. 1. Biological treatment of MSW includes aerobic and anaerobic digestion, which can produce compost, fertilizer, and biogas. In anaerobic digestion, the waste is typically covered and the weight of the material that is deposited above is mechanically compressed. This method is time-consuming although it is the most low-cost way of waste treatment. Incineration is a thermal treatment process that involves the mass burning or combustion of moisture-free materials. However, this method has a major barrier due to the high moisture content of the waste materials, which highly reduces the calorific value [3].

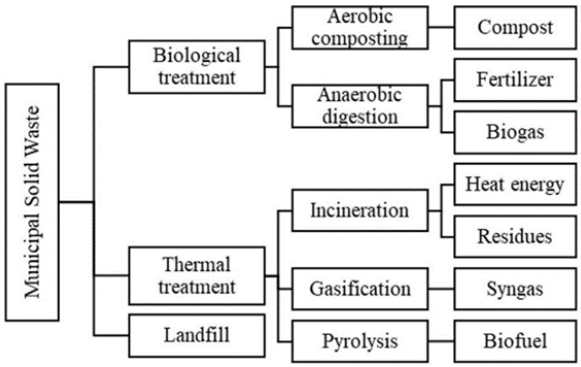

Fig. 1. Municipal solid waste (MSW) treatment.
Source: S. T. Tan, H. Hashim, J. S. Lim, W. S. Ho, C. T. Lee, and J. Yan, "Energy and emissions benefits of renewable energy derived from municipal solid waste: Analysis of a low carbon scenario in Malaysia," Appl. Energy, vol. 136, pp. 797–804, 2014, doi: 10.1016/j.apenergy.2014.06.003.

Biogas that is resulted from anaerobic organic waste digestion can be used to generate reasonably manageable and clean electricity [4]. Biogas or landfill gas are classified in biomass energy resource, and they can provide a win-win situation for the nation to strive for energy security while combating organic waste accumulation. The utilization of food waste can be seen as a sustainable full cycle of waste stream which facilitate the economy too. According to the U.S. Energy Information Administration (EIA) [5], municipal solid waste (MSW) should not be seen as garbage as it can be used at waste-to-energy plants and landfills to produce energy in the United States (US).

The decay of organic matter (OM) from waste in landfills generate biogas which has the gases such as methane (CH_4), carbon dioxide (CO_2) and small amounts of organic non-methane compounds. The biogas can be captured if the landfill is sealed and fitted with gas wells and pipes [6] which can be further used to generate electricity and steam. Methane is a hazardous greenhouse gas since it is 28 to 36

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times more effective than CO_2 at trapping heat in the atmosphere over 100 years [7]. The amount of global methane has increased drastically from 1980 to date (Fig. 2a). Based on the last update on October 5, 2020, the recent global monthly means in June 2020 was recorded at 1872.2 ppb compared to 1858.8 ppb in June 2019 (Fig. 2b).

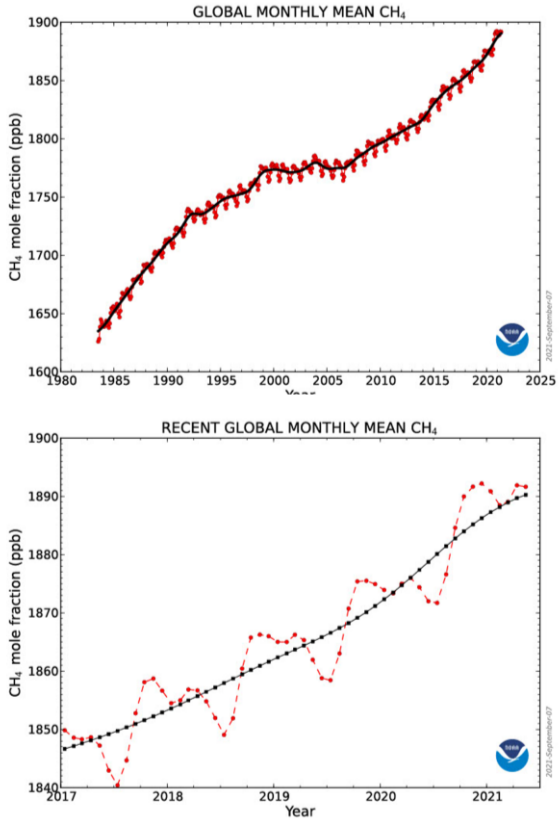

Fig. 2. a) Global monthly mean CH_4 and b) Recent global monthly mean CH_4 (adapted from [8]).

The predominant method for MSW treatment in Malaysia is the use of conventional open landfills [9], although this has caused bad health to nearby residents due to bad smell, disease-carrying rodents, and others [10]. Besides, land developments such as facilities building, and residential housing have also reduced the available land for landfills. The cost of managing domestic waste will also increase significantly [11]. There are several sanitary landfills with LFG (landfill gas) application, namely Air Hitam, Bukit Tagar, Jeram, and Seelong sanitary landfill which is in Johor is employed to capture and harness methane gas generated by biodegradable contents inside waste cells for electricity generation. The Bukit Tagar Sanitary Landfill (BTSL), which was built on a 700-hectare plot of land in Hulu, Selangor, has successfully captured and harvested methane gas from the first and second cells, which produce 1.45 million tonnes and 2 million tons of MSW, respectively [1], [12]. Neighboring countries such as Thailand have adapted MSW-based biogas technology for heat and electricity generation in many parts of the country [13]. The biogas collected provides free cooking fuel and lowers the electric bills of residents. Nevertheless, the deployment of kitchen and food waste in production of biogas at the landfill still not implemented.

In Sarawak, there are 51 operating landfills and 12 non-operating disposal sites [14]. However, Bintulu only has two landfills in Kidurong and Ulu Segan which need to accommodate over 433 tons of trash piled-up daily. Ulu Segan landfill in Bintulu is dedicated to receiving specific wastes whereas Kidurong landfill receive domestic wastes. The rising population may cause a shortage of landfill sites. This study was conducted in 2019 to investigate the awareness, knowledge, and attitude of food premises owners on managing kitchen and food wastes.

II. Materials and Methods

A. Study Area

This study was conducted in the Bintulu district which is a coastline town in the central region of Sarawak. It is situated 610 km northeast of Kuching, 216 km northeast of Sibu, and 200 km southwest of Miri, as depicted in Fig. 3. The location of solid waste management was also depicted in the figure. Data from the Sarawak government website stated that the population of Bintulu in 2020 is 266,200 and the land area is 1,991 km2. As one of the fast-emerging economy regions in the Sarawak state of Malaysia, Bintulu is facing fast urbanization and increasing population growth.

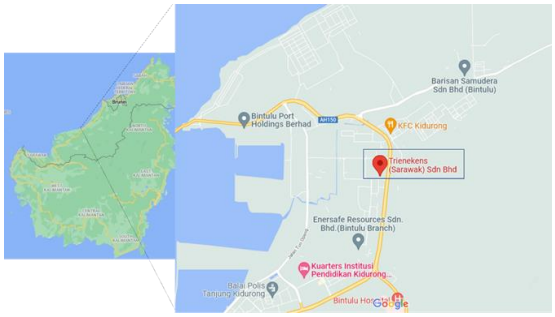

Fig. 3. Location of Kidurong landfill operated by Trienekens (Source: Google map, 2021).

B. Methods

The instrument used in this study is a structured questionnaire that was distributed randomly to the respondents. This study adopts a quantitative approach involving targeted respondents from the website of Bintulu Development Authority (BDA) [15] using the method similar with [16]. The information and details of food related licensees are listed on the website. The randomly selected premises were 130 from a total of 234 food-based premises. The Bintulu Development Agency (BDA) was established to serve as the government agency responsible for physical planning and development in Sarawak's Bintulu Division. The reliability and validation analysis were performed based on expert review. A website version of the questionnaire was developed using the Google Forms platform.

C. Questionnaire Design

A total of 130 sets of close-ended questionnaires were distributed to food premise owners at Bintulu, Sarawak. The questionnaire was designed to collect information on public awareness, knowledge, and attitude towards MSW management at their premises. The questionnaire was written in two languages, Malay, and English, and it was separated

into two sections: 1) Premise's information and 2) Solid waste management. Only fully completed questionnaires were admitted. Personal data were not collected within the questionnaire or on the Google Forms platform. Google Forms generated a spreadsheet with the answers of the questionnaires. The data collected within that spreadsheet were used, without any manipulation or statistical correction, to perform the statistical analyses. No questionnaires needed to be discarded. Five most common types of MSW (i.e., food, plastic, paper, glass, and metal) are included in this questionnaire. However, this study is focusing on the kitchen and food waste generation as the main objective.

D. Socio-Demographic Background of Respondents

The different groups of premises owners were randomly selected based on the list prepared by the BDA to answer the questionnaire survey. About 90 food premises owners were asked to answer the questions on paper, while another 40 owners were asked to fill in the online questionnaire forms. The types of premises investigated were fast-food restaurants, dining restaurants, food stalls, cafés, bakeries, catering, homes, homemade kitchens, and home catering. These food premises are known to dispose of MSW daily particularly food or kitchen wastes. The selected respondents represent all races and citizenship such as Bumiputera, non-Bumiputera and non-Malaysians.

III. Results

A. Distribution and Demographic Profile of the Respondents

The respondents for this survey are the food premises owners in the district of Bintulu. Table I shows the demographic profile of the respondents. From the table, it was seen that the female gender is more dominant in the food industry by 9.23% when compared to the male. This data was supported by [17] where they found the percentage of female business owner was higher than male (13.1%). It could be most of the workers in food premises are females. This might be due to the different food related businesses involved in the study such as fast-food restaurants, restaurants, food stalls, etc. Different gender might be interested in different types of food-related business.

TABLE I: Demographic Profile of the Respondents

Item	Group	Sample proportion (%)	Frequency
Gender	Male	45.4	59
	Female	56.4	71
Age	15-20	10	13
	21-30	46.2	60
	31-40	20	26
	41-50	17.7	23
	>50	6.1	8
Race	Bumiputera	80	104
	Non-Bumiputera	13.8	18
	Non-Malaysian		8
Education level	University/college/vocational	52.3	68
	Primary school	6.15	8
	Secondary school	39.2	51
	Malaysian Higher School Certificate	1.5	2
	-	0.85	1
Types of premises	Fast food restaurant	14.6	19
	Restaurant	67.7	90
	Food stall	13.1	16
	Bakery	0	0
	Catering	0.8	1
	Home	0.8	1
	Fast food and café	0.8	1
	Home catering	0.8	1
	Homemade kitchen	0.8	1

B. Awareness and Knowledge of MSW Management

Educational levels can improve public perceptions of climate change. For instance, the non-recycling group in Malaysia has been reported to be dominated by a low-income community with low levels of education [3]. From this survey, over half of the respondents (76.9%) understand about conventional MSW management (Fig. 4a).

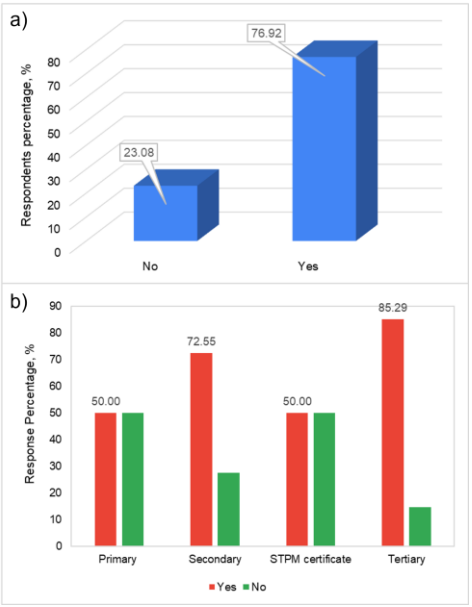

Fig. 4. Respondents' knowledge a) about solid waste management and b) based on educational level.

Most of the respondents know about how their waste is managed by the garbage collection authorities but the depth of knowing the system is unknown. Regardless of that, they are most probably only knowing to the extent of the waste will be collected by the truck but not until transition. Fig. 4b indicates that people with higher educational backgrounds know more about MSW (except for respondents holding Malaysian Higher School Certificate (STPM)). This study also indicates that those respondents who obtain higher education levels only efficiently instills environmental ethics and societal concern in the public.

Besides, the age of food premise owners is young mostly within 21 to 30 years by 46.2% (Table I). This was followed by age group 31–40, 41–50, 15–20 and lastly age group more than 50 with 20%, 17.7%, 10% and 6.2% respectively. The youngest age group is 15 – 20 years old. However, the age of latter respondents was among 18 years old and above. The highest group of food premise owners comprises graduates of universities, colleges, or vocational institutions. Higher educated people are more generally more concerned about environmental risks [18], [19]. The media in Malaysia has

also played a key role in delivering ideas and information on environmental issues. However, people nationwide are still unwilling to take steps to minimize their impact on the environment in terms of waste disposal [20]. The younger generation in recent years has been more exposed to current environmental issues through social media and school curricula compared to the past.

C. MSW Produced by Food Premises Owners

Each economic activity generates waste and different activities generate different quantities and types of waste. Besides, the waste composition is influenced by various factors, including the culture, location, weather conditions, economy and development levels of a given society [21]. Since the respondents of this study are food premises owners, the highest waste produced is food waste (79%). This data was supported by earlier studies which stated that about 45% of the MSW in Malaysia is food waste [22].

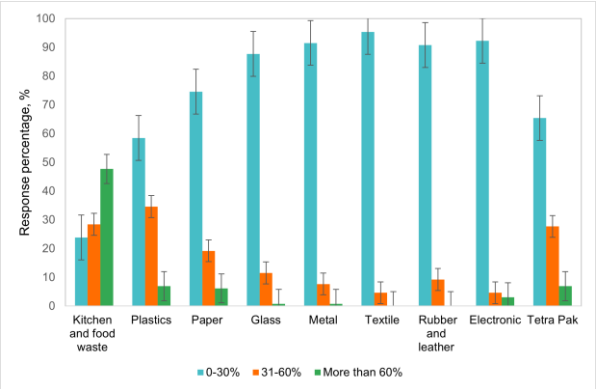

Fig. 5. Estimated daily production percentage amount of waste.

D. Food Waste As a Potential Feedstock for Biogas

The method of disposal varies according to public behavior and the facilities nearby. People living in a city have less free time to spend on gardening and composting. Hence, the simple way to easily dispose of garbage is by throwing it into the garbage container for collection by the local council. The most preferable disposable method of MSW was using a garbage lorry to transport the waste to the landfill sites. About 79% of the respondents chose to dispose of their food and kitchen wastes to the landfill sites using garbage lorry, compared to recycling (7.7%), composting (6.2%), and donating their belongings (6.2%) as shown by the red vertical bar in Fig. 6.

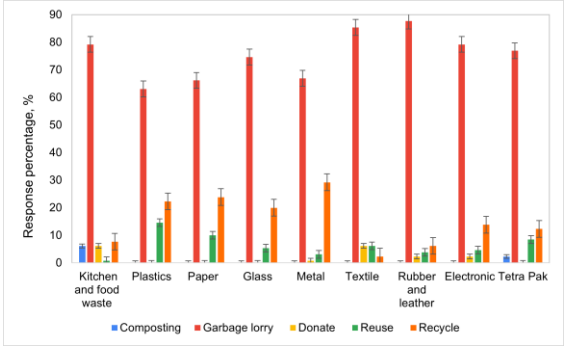

Fig. 6. Disposal methods of municipal solid waste.

This could be an insight understanding that the public awareness toward the sustainable full cycle of waste stream was below the expectation if implementing the biogas plant at the landfill sites. Hanum et al. (2019) reported that anaerobic digestion of food waste is a promising valorization technology in Malaysia due to a good C/N ratio that can enhance biogas production. Likewise, the composting of food waste is a time-consuming effort and the organic fertilizer produced has a high holding capacity for potentially toxic metal components [23].

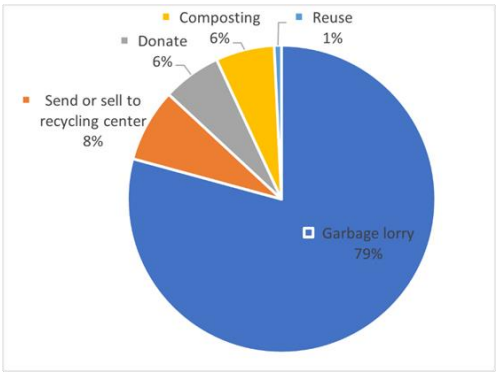

Fig. 7. Estimated percentage of disposal methods for kitchen and food waste.

In Fig. 8, it was shown that 87% of the total respondents agree to segregate the waste. However, the public attitude towards making it a habit is one of the most critical challenges in source separation [24]. To effectively treat and to maximize the energy potential from MSW and at the same time to save cost of constructing a facility to segregate MSW, both the government and local authorities need to educate and implement effective and practical household and commercial source segregation to separate organic waste and inorganic waste for WTE treatment processes. To effectively treat and to maximize the energy potential from MSW and at the same time to save cost of constructing a facility to segregate MSW, both the government and local authorities need to educate and implement effective and practical household and commercial source segregation to separate organic waste and inorganic waste for WTE treatment processes.

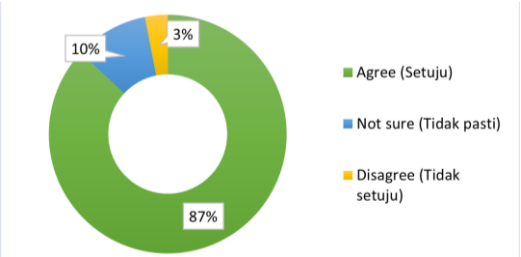

Fig. 8. Do you agree with the methodology "waste segregation at source"?

The appropriate segregation and collection of waste might be the core issue since the significant factor affecting biogas yield is the purity of the feedstock. The harvesting of biogas from MSW is highly reliant on the SWM policy as it involves effective waste segregation and collection for a secure supply of feedstock for biogas production [25]. The input to the anaerobic digester should only accept organic waste but can be biodegraded by microbes to produce biogas under anaerobic conditions. People tend to throw the MSW in the garbage containers daily without thinking about source

segregation since the garbage containers are emptied almost daily (Fig. 9).

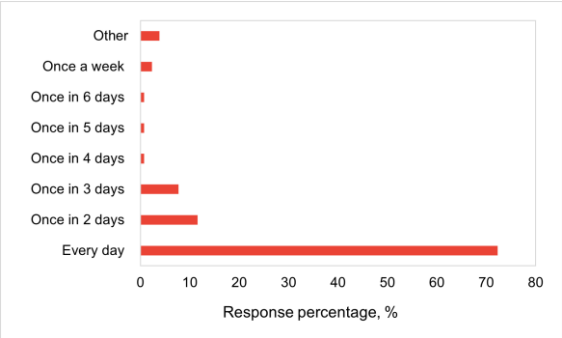

Fig. 9. Municipal solid waste (MSW) collection frequency.

To increase the efficiency of MSW management, groups and individuals should hold training, talks, and flyers for waste sorting could be done for future research work. Several respondents also recommend providing the recycling bin that can be used to hold recyclables before they are taken to recycling centers. Besides, they have suggested to start an awareness campaign about the importance of waste segregation, recycling, composting, etc. The environmental-related business owners should opt to convert the waste into biogas for electricity generation, since the garbage collection system is recognised as efficient. From the local kitchen and food waste data, it could estimate the generation of the waste for presuming the feasibility of the biogas plant for supplying electricity particularly to the families living in the suburban or rural areas in Bintulu.

IV. Conclusion

This paper investigated the practices, knowledge, and attitude awareness of local food premise owners towards the management of kitchen and food wastes. They are the highest contributors to food waste generation. From this study, a large quantity of kitchen and food wastes with an approximation of 79% was disposed through the conventional method (MSW management system). This large quantity of waste is a potentially valuable resource or feedstock for generating biogas (CH_4) through biogas technology since the high moisture content of food and kitchen wastes hinders incineration. The practice of local premises owners towards the effective management of kitchen and food waste is still low (79.23%) since most of the respondents choose to dispose their garbage to the landfill. Even though most of the food premise owners are from high educational background, their awareness towards good MSW is still low. This is due to minimal law enforcement. The results suggest that instead of throwing the food waste into the garbage container for collection by the local council, an initiative project for building a biogas plant should be considered since the biogas feedstock is easily available and free.

Conflict of Interest

Authors declare that no conflict of interest exists in this manuscript

Author Contributions

AS conducted the research, NHCH analyzed the data and wrote the paper; NSA helped in data collection, NK supervised and reviewed the paper, AHL editing and reviewing the paper. All authors had approved the final version.

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