Synergy of the municipal solid waste (MSW) charging scheme with different strategies for food waste recycling in Hong Kong

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Abstract. Food waste minimization is an issue in any destinations. Most of the food waste from households, commerce and industries are disposed of in strategic landfills but the landfills are going to reach their capacity. A new policy, the municipal solid waste (MSW) charging scheme, will be implemented in 2023. It is anticipated reducing MSW production including food waste. This study conducts interviews with stakeholders and questionnaires with the residents in the region. Through the analysis of interviews and survey responses, the challenges and opportunities of the MSW charging scheme for handling food waste were determined. The interview results revealed that NGOs put effort into food waste reduction and recycling while the government tends to operate the MSW charging scheme by itself. In the meantime, the respondents from the survey believed in low effectiveness of the MSW charging scheme on food waste minimization. Education on food waste separation and cooperation with NGOs can coordinate with food waste recycling under MSW charging scheme. This research was fully supported by Research Grants Council of the HKSAR, China (UGC/IDS(R)25/20).

1 Introduction

Currently, most of the food waste in Hong Kong is discarded in landfills along with other municipal solid waste (MSW). In 2020, about 10, 809 tonnes of MSW disposal were transferred to landfills every day and 3,255 tonnes were food waste. Approximately 778 tonnes of food waste from industries and commerce were dumped daily. However, three strategic landfills in Hong Kong are nearly saturated. Waste reduction at the source and recycling are the focus of the government for dealing with waste issues. There is still a large amount of waste produced which is not a sustainable approach for food waste. Also, there has a negative impact on the environment because the organic wastes will decompose and bring out odors. Further treatment of leachate sewage and greenhouse gases is required [1]. In Hong Kong, municipal solid waste (MSW) charging scheme will be officially launched to the public in 2023. The MSW is charged by designated bags or labels, larger size of bags will

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be charged on higher prices while each oversized MSW such as furniture will be fixed a price with designated label. It is a producer responsibility scheme that attempts to reduce the generation of solid waste and raise public awareness of environmental protection. Food waste is the biggest portion of municipal solid waste (MSW), which accounts for 30% of them (118.8 million tonnes). Among the 30% of MSW, only 5.19% (6.16 million tonnes) of food waste can be recycled from MSW [2]. It represents a low food waste recycling rate in Hong Kong. This study is to determine the synergy of different strategies along with MSW charging in food waste management. Qualitative and quantitative data were collected to understand the challenges and opportunities of the MSW charging scheme on food waste recycling. Furthermore, solutions to achieve synergy between strategies are provided.

2 Literature review

2.1 Faultless charging scheme for food waste recycling

Germany, Austria and Korea are the top 3 countries of waste recycling which has implemented a similar policy of MSW charging scheme, Pay As You Throw (PAYT) [3]. In Europe, most countries have implemented the PAYT scheme including Germany and Austria. There are different charging options for households depending on their waste generation habits such as volume-based, sack-based, weight-based and frequency-based forms [4]. It is mandatory to sort the waste into specific categories in Germany and Austria. They have a well-established recycling system for waste sorting. Each city has its own waste management company. Industries, commerce and households should pay for the waste collection service. Food waste is segregated from the household MSW which is deemed as biowaste. A German Federal Ministry (BMUV) pointed out that separating food waste can reduce the volume of household MSW [5]. Also, the biowaste is collected separately from the mixed household MSW, therefore composts are less contaminated. In addition, landfill tax and incineration tax have a critical effect on decreasing the MSW generation in Austria. A rising tax of waste per tonne lower the percentage of MSW in landfill [6]. In Asia, South Korea is the earliest country to carry out a waste charging scheme (PAYT) where started to implement a mandatory food recycling program in 2013, stipulating that food waste should not count as general solid waste. Designated biodegradable bags should be used to collect food waste to reduce the difficulty of disposal and the odor emitted from the garbage. Also, these specific bags are charged that can balance 60% running cost of the scheme. Apart from forced recycling, food waste is weighted for charging. The charging scheme motivates the citizens to remove the water in the food waste by themselves before discarding it. It can assist the government to save US $8.4 million in collection fees [7]. The recycled food waste will be converted into fertilizer for planting. They all possess their waste separation and recycling methods along with MSW charging scheme.

2.2 Importance of food waste separation

Separation of food waste can increase its value and enhance the efficiency of recycling. There were several studies that demonstrated the valorization of specific food waste into useful materials. Zhang, Sun [8] proved that succinic acid, a food additive, can be reproduced from bakery waste while other food waste cannot. Brewery wastewater, dairy waste, used cooking oil and so on can be fermented with different microbial strains to produce bioplastic [9]. Furthermore, shrimp waste such as its shell acts as a raw material for chitosan production, which can be applied in food, pharmaceutical, textile or tanning industries [10]. Specific food

types cannot be sorted out if all types of food waste are mingled. Therefore, food waste without separation will lose the alternative way saving the resource of the earth.

2.3 Promotion of food waste recycling industry

The greatest obstacle to recycling business development is the lack of financial support from the government. A large investment is required for the labor force, transportation cost and building facilities. Mak, Iris [11] showed that administrative incentives and corporate support, logistics and management incentives, and economic incentives will affect food recycling behavior. Business support with economic incentives such as the capital cost, operation and maintenance cost of equipment may convince the high value of the food recycling industry and encourage to develop a food recycling enterprise. Meanwhile, sufficient administrative incentives and corporate support (e.g. staff education and rewarding scheme), as well as logistics and management incentives (e.g. enough area for food waste handling and storage) will influence individual attitudes and strengthen the effectiveness of food waste recycling between the food industry and recycling corporates [11].

3 Methodology

Qualitative and quantitative research methods were used for this study (Table 1). For the qualitative method, two stakeholders were interviewed including the consultant of a recycling center (NGO) and a staff member from the Environmental Protection Department (EPD) in Hong Kong. Each interview was held for half an hour. Chan Wing Lai, Eddie is a specialist in Energy Management and had experience in generating energy from food waste, who is the consultant of a recycling centre. Interview contents involve challenges of the local recycling industry and professional advice about food waste minimization. Kwok Koon Tai, Will is a Senior Environmental protection Inspector (Knowledge Management) from the EPD, which is a government organization. Interview contents involve the details of municipal solid waste (MSW) charging and the effectiveness of it. For the quantitative method, a designed survey was conducted. Citizens in Hong Kong were invited to fill in a questionnaire related to their understanding of the landfill situation in Hong Kong, their waste disposal habits, and their opinions of MSW charging. Through convenience and snowball sampling, a total of 150 surveys were intended for collection.

4 Results

4.1 Government strategies for food waste handling

The government published "A Food Waste and Yard Waste Plan for Hong Kong 2014-2022" in February 2014. There are 4 food waste management strategies including "Reduction at Source", "Food Donation", "Food Waste Collection" and "Recycling at Facilities" run by the government. The plan involves an important project establishing a network of 5 to 6 Organic Resource Recovery Centres to turn food waste into renewable energy with advanced technology. The first Phase 1 Organic Resource Recovery Centre is located at Siu Ho Wan in Lantau Island, which can cater for 200 tonnes of food waste per day and be operational on July 1, 2018. The second facility is located at Sha Ling, which will be operational in 2023 and capable to handle 300 tonnes of food waste per day. The third facility mapped out at Shek Kong is currently in the planning and researching stage. Besides, the EPD has been launching the Pilot Scheme on Food Waste Collection since July 2018 and a larger scale scheme was implemented in 2020.

4.2 Food waste classification

There are three levels of food waste classifications. The food waste never been eaten such as raw materials was classified as level 1. Food by-products from the food industry are level 2 while the cooked food from the table is level 3. Different recycling methods are used to deal with different levels of food waste classification. Food waste in level 1 is still edible with a certain quality which can be donated to people or organizations in need after inspection. However, all kinds of food waste are grouped in the recycling centre under the current policy in Hong Kong. Food waste in level 2 will be collected as quickly as possible to produce animal feed. Meanwhile, the food by-product of fruits and vegetables are collected for cleaning purposes as enzymes. Also, water content from food waste in level 3 is pressed out and discarded properly. The volume of food waste is reduced to about 80% and it will be transferred to the landfill subsequently.

4.2.1 Difficulties of food waste recycling

The government tends to handle food waste by itself and does not intend to provide any financial support to food or resource recycling centres. Only the extra time for registration of food waste collectors is offered by the government. Low profits can be obtained by the recycling industry which is difficult to run a business. Government can cooperate with NGOs for food waste recycling. The fees from MSW charging can be used to pay for the NGOs that assist the development of the recycling industry. It is not an effective way to collect and recycle through the government alone.

4.2.2 Opinions on municipal solid waste (MSW) charging

MSW charging will not be feasible in new decades. Everyone takes responsibility for food waste minimization. There will be a large decrease in food waste production if the government attaches importance to education. Education can lead to good habits with environmental awareness across generations. Thus, people are used to practicing environmental protection in daily life.

4.3 General public

The measurement scale includes nominal, ordinal, interval and ratio data. Results (Table 1) demonstrated that the majority of individuals are well educated with less than thirty thousand incomes. Meanwhile, most of them are less than 40 years old. Although they do not have a comprehensive understanding, they have a good sense of environmental protection, such as using fewer garbage bags in a month. Also, they have the habits of waste sorting which separate the waste into "recyclable and reusable" and "non-recyclable and reusable". Regarding municipal solid waste charging, the respondents believe that it can handle food waste but it is not effective for food waste minimization because it cannot reduce food waste at the source. Therefore, they are not highly motivated by it.

Table 1. Descriptive Statistic

	N	Mean	Median	SD	Skewness
Understanding on waste situation	101	1.703	1.75	0.53	0.046
Environmental consciousness	101	2.292	2.25	0.58	-0.361
Effectiveness of MSW charging	101	1.191	1.5	0.27	1.165
Acceptance of MSW charging	101	2.812	2.67	0.63	-0.634
Motivation of MSW charging	101	1.465	2.0	0.43	0.780
Age	101	3.386	4	0.86	1.372
Educational attainment	99	3.030	3	0.89	-0.240
Income	101	2.238	3.5	1.13	1.244

5 Discussions

Education can maintain the sustainability of the MSW charging scheme with remarkable success. The results of the questionnaire indicated that respondents had low confidence about the effectiveness of the MSW charging scheme because it does not tackle the problem at the root. Insufficient education is a source of food waste production. The effectiveness of the MSW charging scheme can be short-term. The government can cooperate with or subsidize NGOs for holding educational events. For example, "Food Angel" is an NGO in Hong Kong which conducts an annual environmental education programme. The students can be educated on food waste issues through study tours, incentive schemes and food waste regeneration workshops. Moreover, it provides various activities of Corporate Social Responsibility for different corporates such as food preparation, seminars and spontaneous fundraising activities to help people in need of food assistance. Coordinating with strict enforcement and price makeup of the designated garbage bag, promoting environmental consciousness is also required to sustain the effectiveness of the MSW charging scheme.

Collaboration with NGOs can enhance the efficiency of food waste recycling. The government consumes lots of time on planning and facility construction that drags on the implementation of policy. Also, the construction of facilities is slow progress. For example, the government planned to set up a network of 5 to 6 Organic Waste Treatment Facilities (OWTFs) between 2014 and 2024 [12]. Until 2022, only one Organic Resource Recovery Centre was established with operations. Although NGOs do not have the advanced technology for waste-to-energy conversion, they can assist in food recycling and food donation to decrease the overloaded food waste in landfills. For food recycling, some NGOs are dedicated to transforming food waste into another form of valuable item. For example, "FoodCycle+" in Hong Kong recycles the separated food waste into animal feed. Also, "Eco-Greenergy" in Hong Kong recycles coffee grounds into flowerpots and other products. For food donation, some NGOs handle raw food waste from wet markets or supermarkets and the food that is still safe to eat. Food banks in Hong Kong save the food from food production, manufacturing, distribution and retailers that are ready to be discarded but are still safe for consumption. Food after inspection or cooking is distributed to charities for free. The financial or technical support from the government is important to the food waste recycling industry. NGOs of food waste recycling in Hong Kong are self-operated or sponsored by

different organizations. Lacking investment in the food recycling business is a big obstruction to industrial development. In Thailand, their government collaborated with NGOs has a better performance of composting utilizing food waste [13]. Therefore, the execution ability and elasticity of policy can be increased if the government provides financial support and cooperate with different NGOs.

The value of domestic food waste can be maximized by food separation. Referring to the example of South Korea. Domestic food waste must be separate from other domestic solid wastes and charged. The food waste recycling rate increased from 2% in 1995 to 95% in 2019 [7]. Besides, food waste is classified into different levels. Food waste in level 1 has a wider range of usage than food waste in level 2 or 3 such as food donation. Single types of food waste can produce a more valuable resource rather than mixed food waste such as succinic acid from bakery waste and chitosan from shrimp shells. Based on the planned MSW charging, the charging scheme is applied for all types of municipal solid waste including food waste. In 2020, 76% of domestic food waste accounts for the total municipal food waste disposal, which is the majority of food waste. In recent years, the Coronavirus Disease 2019 has been raging worldwide. The consumption pattern and eating habits change because of the suspension of classes in schools and the arrangement of working from home. People are more prefer cooking and having meals at home to prevent exposure to public areas that may lead to infection. According to the statistic published by EPD, the amount of domestic food waste in 2020 had a 9% increase or 191 tonnes per day more than the amount of domestic food waste in 2019 [14]. Domestic food waste will be mixed with normal solid waste if there are no strategies and facilities for food waste separation. It hinders the utilization of domestic food waste into biogas. Food waste will be contaminated by other MSW and not able to be recycled. Woon and Lo [15] suggested an optic bag system to separate domestic food waste from general solid waste. Food waste is packed in an optic bag with a specific color while other MSW is packed in another designated bag. The waste from different households can be collected into one garbage bin and collected by refuse collection vehicles. When all the waste is transferred to the refuse transfer stations, the bags containing food waste will be sorted out by the optical sensor technology automatically [15]. Thus, charging optic bags and designated bags for MSW is feasible for domestic food waste reduction and recycling.

6 Conclusion

To summarize, MSW charging scheme will be effective for food waste minimization if it coordinates other strategies or recycling measures. The results indicated that there is no coordination of food waste between the government and NGOs. They put effort to reduce and recycle food waste according to their ways. Also, there is a lack of investment in the food waste recycling industry. Providing financial or technical support by the government can encourage industrial development. Moreover, strong coordination can assist the efficiency of food waste recycling. For instance, NGOs conduct more diverse educational activities than the government. On top of that, the government can share out the work of food waste recycling on the basis of MSW charging and cooperate with one another. Besides, a single type of food waste is more valuable than mixed food waste. Therefore, food waste separation along with MSW charging can maximize the utilization of food waste. In addition, food waste separation is not mandatory under current policies, but it can maximize the value of food waste. Therefore, it is highly recommended to put it into practice. To reduce the difficulty of execution in domestic food waste, an optic bag system is suggested to apply to it.

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