ME1D01: Engineering and Environmental Management

with English Writing Requirements

(Subject Teacher Name: Mengying LI)

Third Draft Submission:

Sustainable Approach for Municipal Solid Waste Management: Lessons from Other Countries or Other Suggestions

Word count: 2452 words

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Date: **July 6**

Table of Contents

Introduction

The accelerated urbanization process leads to an increase in the amount of municipal solid waste, which has gradually become a major burden on urban development in Hong Kong. Sometimes in Hong Kong, municipal solid waste has not been effectively managed because the only disposal method has been strategic landfills. The landfill is a way for landfills to dispose of all kinds of waste. A large portion of Hong Kong's total waste ends up in strategic landfills and is processed there. Although landfills might be crucial for the appropriate disposal of waste, they could also have a lot of detrimental effects on the ecosystem in the future. For example, hazardous waste can end up in landfills and serve as a breeding ground for bacteria.

Municipal solid waste is defined by the Hong Kong government as "solid waste from household, commercial and industrial sources" (Environmental Protection Department, 2021). "The amount of municipal solid waste in Hong Kong in 2020 was 3.96 million tons" (Environmental Protection Department, 2021). "More than 10,000 tons of food waste is disposed of in Hong Kong's landfills every day" (2021). Currently, solid waste is disposed of primarily at “three strategic landfills in the New Territories” (2021). However, solid waste growth far exceeds the capabilities of current waste disposal infrastructure and regulations. It is difficult for Hong Kong to continue to build landfills to deal with our growing waste. We need to find more sustainable solutions to deal with our urban waste. “These three strategic landfills will be able to meet Hong Kong's waste disposal needs by the 2030s” (Environmental Protection Department, 2021). The current methods of waste management (landfilling) in Hong Kong are no longer appropriate "since the anaerobic digestion of organic wastes in landfills releases gases including methane (CH4), NOx, and SO2", as well as particles into the air during combustion (Ofori-Boateng et al., 2013).

The objective of this study is to find solutions to Hong Kong's waste disposal problems. Before the actual analysis, a brief review of professional journals and government publications from Hong Kong and other countries is conducted. This is followed by a comprehensive analysis from the standpoint of waste classification regulations, potential thermal energy production in food waste disposal, and landfill capacity. This is followed by recommendations for municipal solid waste management.

Literature review

One of the main reasons for inefficient municipal solid waste disposal is that food waste is not separated from producing biogas. The population and economic development have driven up the generation of municipal solid waste, with food waste accounting for most of the municipal solid waste in Hong Kong at 30% (Environment Bureau, 2013), which means more than 1 million tons of food waste would be utterly in limited use if food waste is not used in the waste disposal process. The remaining value, such as thermal energy produced by biogas in food waste, will be lost. Lo and Woon refers to food waste management systems in other countries, and propose a framework (Figure 1) for food waste separation, collection, and recycling to add value to food waste (2015).

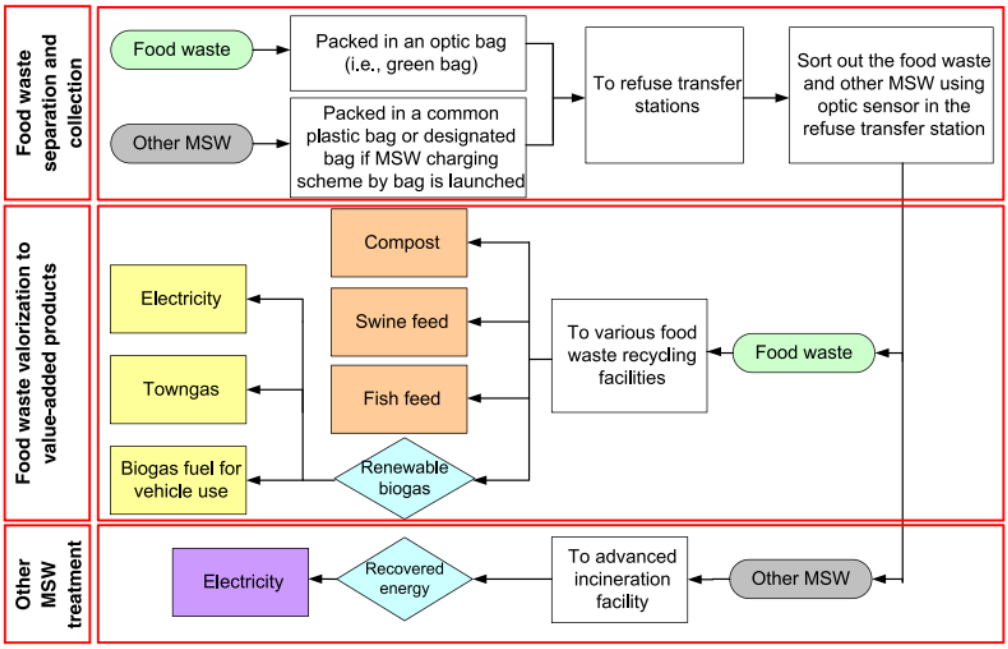

Figure 1 Proposed Framework for food waste separation (Woon & Lo, 2016)

Food waste can be contained in "green bags (optic bags)" while the remaining municipal solid waste could be contained in regular plastic bags (Woon & Lo, 2016). All waste is then sent to a waste transfer station, then food waste in the green bag will be "separated by the optical sensor and treat food waste and other solid waste differently" (2016). Not only food waste can be converted into profitable materials, but also be dealt with as the "raw material of biogas production" (2016). Although food waste can be separated by green bags and optical sensors, the government may consider issues with green bag distribution issues, and equipment purchasing problems. Also, most of the municipal solid waste is

treated by landfills, and no recycling facilities for food waste are in the waste treatment plant, Environment Protection Department needs to build a recycling plant for waste processing, and it needs a great deal of human and material resources.

In addition, a sub-problem from the processing food waste is firstly to improve the system of waste classification. The waste classification system is not properly implemented in Hong Kong. The government does not properly publicize and punish as the classification system is implemented. Waste classification has been implemented in Hong Kong since 2005 but no explicit regulation for waste classification. The main purpose is to raise environmental awareness and to meet the requirements of sustainable development. However, this road is still a long way to go, and it is still difficult to implement a nationwide promotion. Some citizens have little awareness of waste separation, which leads to extremely poor waste separation and disposal, and directly putting the waste into one bin will greatly increase the difficulty factor of waste disposal later. Waste classification in Hong Kong is only of limited benefit since the application framework lacks a punishment procedure, strong economic incentive, and has not yet penetrated public attitudes.

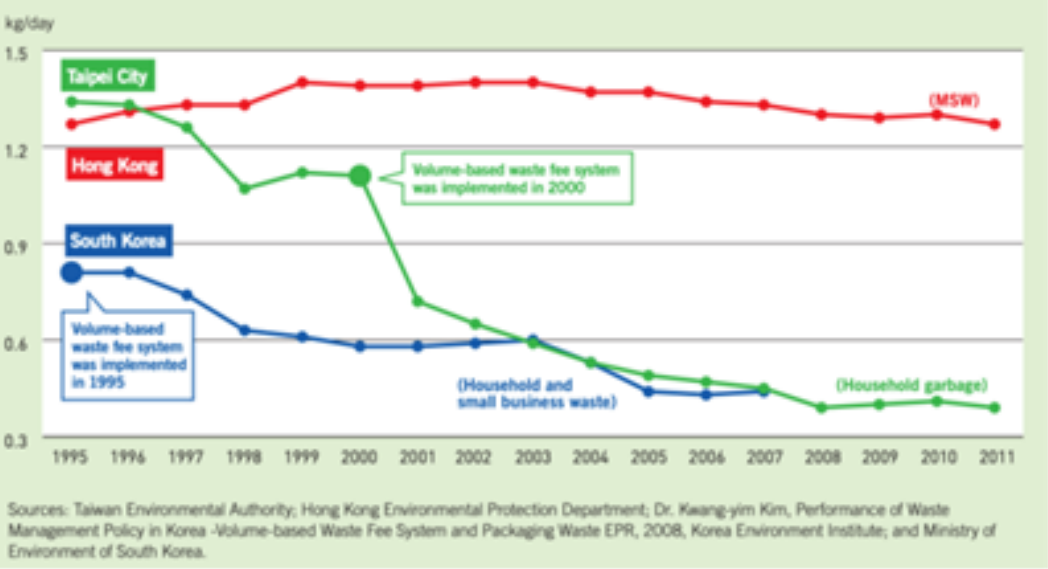

Figure 2 Comparison of waste management structure with other city or other countries (Environment Bureau, 2013)

Last but not least, landfill is the only way for municipal solid waste management in Hong Kong, and incineration is also a good waste management method for Environment Protection Department to consider. Figure 2 was hedging that compared to other countries, Hong Kong relies on landfills too

much (Environment Bureau, 2013). Other countries frequently use incineration to deal with solid waste, and a very small percentage relies on landfills.

The landfill is a traditional waste disposal method, but because waste is not well sorted and mixed waste collection is used, it often causes secondary pollution to water and soil resources when disposing of waste, resulting in high waste disposal costs. Most of the current municipal waste treatment methods in Hong Kong go directly to the final landfilling process without detailed classification and reduction, thus causing significant pollution to the ecological environment and serious waste of resources. In this process, not only recyclable resources cannot be effectively used, but also some harmful substances, such as soil and water pollution and subsequent treatment, may cause immeasurable harm to the human body. Hong Kong's over-reliance on landfills did not take full advantage of waste and insufficiently uses the energy from waste.

Countries with small land areas, such as Singapore, use the incineration method at 90%, while "the use of the landfill method is only 10%," which is mainly because the country is small, to save land (Ministry of Sustainability and the Environment, 2022). Also, the landfill waste that is left after incineration is disposed of in a landfill. "As there is no available land for the landfill on mainland Singapore", then Singapore set up regulations for incineration and very small amounts of solid waste are transported to landfills (2022). The statistics from the Singapore government also show that there will be "3% more electricity supply" with the excess heat energy from waste incineration (2022).

In Hong Kong, 100% of the waste is disposed of in landfills, and the amount of incineration is zero. This situation is extremely irrational, but in Hong Kong, landfill disposal advocates have frequently prevailed. Some knowledgeable people who are concerned about environmental health in Hong Kong are looking for ways to incinerate waste and want to dispose of municipal waste cleanly and efficiently, following the Japanese and Singaporean models. They started design studies four years ago and are preparing for incineration trials at cement plants. But the landfill advocates, under the banner of Greenpeace organization, vigorously promote the incineration of garbage that will produce dioxin poisoning. They put up propaganda advertisements in various MTR stations in Hong Kong and encourage residents who do not know the facts to demonstrate in front of the plant where the pilot garbage incineration plant is prepared, pulling banners against the slogan, so that the trial of incineration of garbage has been blocked so far, and the work cannot be carried out for several years.

Woon and Lo have raised that greenhouse gas released by incineration facilities depends on "the stack discharge system but offset by biogenic carbon storage" (Woon & Lo, 2013). The implementation of incineration facilities will be criticized by stakeholders such as Hong Kong's citizens. Also, the landfills system's greenhouse gas emission origins "from methane emission but offset by biogenic carbon storage" (2013). From the data collected by Woon and Lo, greenhouse gas emission from landfills is more than from the incineration system (2013). The aggravation or mitigation of greenhouse gases in the waste sector depends on the technology and efficiency of waste treatment facilities. People will create more waste with natural growth in the population and economic growth. Improving incineration technology can help preserve sustainable waste disposal to some extent. However, upgrading incineration technology in comparison to landfill technology must be based on current demand while improving incineration efficiency.

Recommendations

1. Use of waste incineration technology

According to the analysis, the first thing is developing incineration technology in Hong Kong refuse processing plant. The amount of municipal solid waste "in Hong Kong in 2020 was 3.96 million tons" (Environmental Protection Department, 2021). For land utilization rate, is something that must be well considered. From the cost of waste disposal, if the use of waste incineration heat to replace the heat of burning coal, because the Hong Kong region, the price of coal by foreign transport is very high. If government take into account the benefits obtained by replacing coal with garbage, the incineration method and landfill method of treatment costs are about the same. Considering the reduction of landfill waste, the incineration method reduces the volume by 85% to 90%. The landfill method does not reduce the capacity. For environmental impact, the landfill method causes sewage to be difficult to treat, or discharged into the river and sea to pollute the river and seawater, or seep into the ground to pollute groundwater, if government want to build a sewage treatment plant investment is even higher. Produce landfill gas both odor, but also easy to cause combustion or explosion. If landfill gas is used to generate electricity, there is also the problem of high investment. In addition, garbage is a breeding ground for mosquitoes and flies, snakes and rats, and is also the original birthplace of the plague. From the many aspects mentioned above, waste incineration disposal has more benefits than landfill disposal, but

Greenpeace advocates oppose the use of incineration methods simply because of the harmful and toxic gases that are produced. Emission standards can be met through gas treatment. Also, as the Environmental Protection Department to develop regulations to propose the boundaries for the emission of various substances into the atmosphere to ensure that public health is not affected.

2. Development of gas power generation technology

"Recent studies show that power generation technologies involving MSW gasification present promising routes to reduce the carbon footprints of energy conversion" (Indrawan et al., 2020). This review shows that gas turbines and micro gas turbines will be much more effective than other gas-power generation technology. Considering thermal efficiency, natural gas-fired power generation has high thermal efficiency. At present, the gas turbines just launched or being developed by major companies have an initial gas temperature of 1427℃, a simple cycle single-engine capacity of 280MW, and a combined cycle capacity of 520MW, with a thermal efficiency of over 60% (2020). In the sight of investment, the cost per unit of installed capacity for natural gas power generation is cheap, and the current investment cost per kilowatt is only 4,000-5,000 HKD / KW, or even lower, while the steam turbine power plant investment is currently as high as 8,000-11,000 HKD / KW (2020).

For a long time, the energy structure of Hong Kong is dominated by coal, which is expensive to buy from other countries. However, from the environmental protection point of view, the pollution emission problem of coal power is very serious and has not yet been effectively controlled. Therefore, in addition to the development of environmental protection devices for coal-fired power plants, it is necessary to adjust the energy mix of our country, i.e., to replace part of the coal-fired for power generation with high-quality clean fuels - such as natural gas (from municipal solids waste). Natural gas-fired gas turbines and their combined-cycle generating units are currently the technology of choice for improving the efficiency of the use of energy resources and solving the environmental pollution problem quite thoroughly.

3. Develop regulations about waste classification

In Hong Kong, if there will be a waste classification, then municipal solid waste will be separated into different categories, such as food waste, paper waste, waste with heavy metal, and so on. After the waste is collected after classification, the different types of waste are disposed of separately. It increases the rate at which waste resources have been used and minimizes the amount of rubbish disposed away.

Landfills are non-reproducible locations, which means they cannot be utilized again as living settlements in the future. Landfills take land resources only once. Additionally, some components of municipal solid waste are difficult to degrade, which severely erodes the ground although the landfills already use the most sustainable protection for soil. Waste may be reduced by more than 60% by classifying and eliminating recyclable and non-biodegradable materials.

The loss of such squandered resources to the entire ecosystem is not estimable, yet rubbish is produced because humans do not use the resources they have wisely and discard the ones they do not use as garbage. Part of waste may be made into treasure by classification and recycling; for example, recycling paper can conserve forest areas and prevent the waste of forest resources; biological waste, such fruit and vegetable peels, can be utilized as green fertilizer to turn land more nutritious. Sorting trash teaches individuals to use resources effectively and wisely, save resources, form healthy lifestyle behaviors, and eventually promote quality of life. A person will become more conscious of environmental protection concerns, comprehend how valuable resources are, and establish the behavior of preserving resources if they can develop effective garbage-sorting practices.

Conclusion

To find solutions to Hong Kong's municipal solid waste problems, we analyze why Hong Kong needs to improve the municipal solid waste management structure. The basic reason is that growth in population and economics have boosted municipal solid waste production, with food waste accounting for the bulk of municipal solid waste in Hong Kong. Another reason is the classification system of solid waste is not implemented well in Hong Kong. The final one is that existing landfill capacity will soon be exhausted as waste generation continues to increase. To address these barriers, in this report we discuss three strategies aimed at finding the best sustainable solid waste disposal option in Hong Kong.

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