

Chapter 2

Scholars' Comments and Criticisms on Construction and Municipal Solid Waste Management in Hong Kong and Singapore from 2000 to Present: A Review of Digital Information Online

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Abstract Waste is considered as an end of city product's life as well as a burden in modern society. The government of Hong Kong and Singapore are striving to improve construction and municipal solid waste management since 1960. At the same time, waste policies lead to social and economic controversies among citizen. How can we develop better sustainable waste management strategies? Will these methods lead to different level of environmental and economic problems? Whilst previous research in construction and municipal waste mainly sheds light on the methods of construction waste management on sites by interviews, surveys and case studies, few research has been conducted to study the digital information available in academic journal database and World Wide Web. This chapter tries to fill this gap by discussing (1) whether the government's waste management strategies are sustainable; (2) the efforts on construction and municipal solid waste made by the governments in Hong Kong and Singapore.

Keywords Municipal solid waste management • Hong Kong • Singapore • Landfill • Recycling • Sustainable development • Construction waste

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2.1 Introduction

The fast economic and population growth in Hong Kong and Singapore has led to a large amount of waste, especially construction and municipal solid waste (MSW). The increase in the amount of waste causes serious environmental burden such as natural habitat degradation, pollution of air, land, and water. Citizens, businesses, and the local government are now concern of the waste issues. In order to achieve a higher level of resource efficiency, strategic waste management on MSW and construction waste is indispensable (Tanaka 2007; Feng et al. 2009). In general, Lehmann et al. (2013) suggest that effective waste management strategies should include the following 5 major actions:

- (1) Eliminate waste consignment to landfill;
- (2) Advance the process of resource recovery and recycling;
- (3) Adopt suitable technology is used to increase the resources recovery and reduce the amount of waste disposal to landfills;
- (4) Improve waste sorting facilities' efficiency and effectiveness;
- (5) Improve materials' recovery according to the Environment Protection Policy so as to turn the waste to resources.

Nevertheless, different waste strategies result in different level of impacts on economy and environment. That is why the government of Hong Kong and Singapore has been committed to solve the problems of construction and municipal solid waste since 1960. To manage the waste problems, up-to-date information is needed. Digital information plays an important role in receiving and sharing the knowledge of various construction waste management strategies. Nevertheless, previous research on construction and municipal waste mainly rest on the methods and difficulties encountered by stakeholders via interviews, case studies and surveys. Few have done research on the digital information available in our internet. This chapter aims to fill this gap of research. It studies the information in academic journal databases and World Wide Web.

2.2 Sustainable Development

The concept of sustainable development is gaining popularity in recent years and there are many different definitions from different school of thought. The idea of sustainable development is synonymous with sustainability. It is derived from an older forestry term "sustained yield", which is a translation of a German term in 1713 (Donovan 2009). The concept of sustainability balances between reproduction and resource consumption already existed in the 12th century. However, the most widely quoted definition of sustainable development came from the Brundtland report in 1987 "sustainable development is development that meets the needs of the

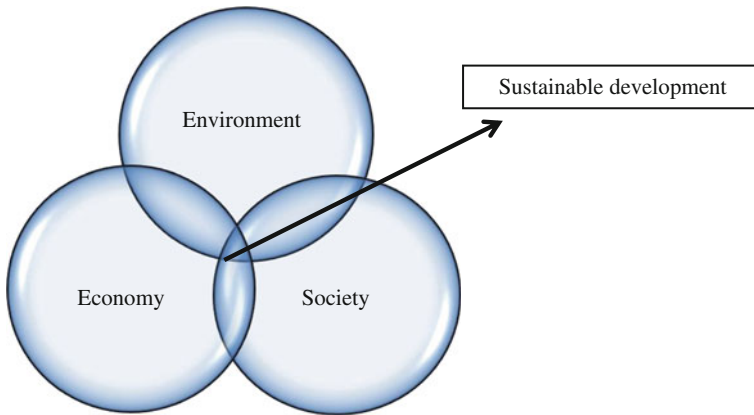


Fig. 2.1 Sustainable development: a co-development of economic, social and environment (Li 2011)

present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development 1987).

To achieve the goal of sustainable development according to the World Commission on Environment and Development (1987), an organization/individual must fulfil the following three major criteria:

1. Efficient: meeting our own needs and aspirations without doing damage to the prospects of future generations;
2. Clean: finding ways to increase prosperity and improve the quality of life while reducing overall pollution and waste;
3. Green: reducing the environmental burden we put on our neighbors and helping to preserve common resources (Sustainable Development Unit 2010; Sustainable Singapore 2013).

Another major view of sustainable development suggests that it embraces the co-development of social, environment and economics (Li 2010, 2014; Li and Ah Pak 2010). As it is used by the Hong Kong and Singapore government, our chapter will also adopt this version to discuss the issue of sustainability from this perspective (Fig. 2.1).

2.3 A Global Perspective on Waste and Its Management

In Canada, Ontario Regulation 102/94 mandatorily requires business or building owners to develop and implement waste reduction plans, update the audits and plans annually and conduct waste audits. Later, Ontario Regulation 103/04 revises

Ontario Regulation 102/94 (Yeheyis et al. 2013) and impose the 3Rs Regulations to ensure that municipalities, commercial and industrial sector to develop waste disposal reduction strategies which aim to reduce at least 50 % of the waste material (Yeheyis et al. 2013). It requires the owners of multi-unit residential (apartment) buildings with six or more units, owners which are listed in this regulation to implement source of waste separation programs for some of the specific wastes and to ensure that waste is recycled (Yeheyis et al. 2013).

In BRICS, various construction waste management strategies have been implemented. For example, in China, the Chinese Government has enforced regulations with regards to environment protection and waste management. For example, “measures for municipal solid waste management” provides rules on waste disposal charges (Hao et al. 2010). In India, Green Building Guidelines such as LEED India has led to a growing awareness in standardization of design, over-ordering minimization, workers’ environmental education, increase offsite construction materials’ production, just in time deliveries, waste auditing (Arif et al. 2012). In Delhi, there is over 120,000 *Kabari* (informal waste collectors) on the streets who collect aluminum cans, paper, plastic, glass and sell them to mini-scrap dealers as secondary raw materials market. This informal industry processes 59 % of Delhi’s waste and provides economic support to many families. In Curitiba, Brazil, the “Green Exchange Programme” offers slum dwellers fresh vegetables and free bus tickets when they collect garbage a to neighbourhood centres. Children are encouraged to exchange materials which can recycle toys (Lehmann 2011).

2.4 A Tale of Two Cities: Waste Management in Hong Kong and Singapore

This chapter studies the construction and municipal solid waste management in Singapore and Hong Kong and discusses possible solutions on how we can improve sustainable development. Although Singapore is an independent country and Hong Kong is only a small city in China, they share similar characteristics such as economic structure and situation, once ruled by the UK as British colonies and culture (both of them have a high proportion of Chinese).

Geographically speaking, Hong Kong and Singapore are small, densely populated coastal developing city-states located in Asia with limited natural resources. Their superb locations and excellent harbors caused the boom of trading in the early nineteenth century and population grew rapidly. According to the 2011 Population density report by the World Bank, both Hong Kong and Singapore rank the top-five of the most densely populated areas (World Bank 2014).

Likewise, they share similar economic development. For example, the 2014 annual report of economic freedom by Heritage Foundation, Hong Kong and Singapore are two out of the four places with the freest economy (The Heritage Foundation 2014). Besides, both of them share similar economic system and development. The World Bank shows that the 2012 GDP per capita at purchasing

power parity of Hong Kong and Singapore stood at USD 61,803 and USD 51,945 which were ranked as the 5th and 8th among the world highest GDP per capita (World Bank 2014).

2.5 Waste Statistics in Hong Kong and Singapore

With rapid economic development, Hong Kong and Singapore are now facing the problem of increasing waste. In 2011, there was about 6.3 million tonnes of waste in Hong Kong. Each person generated around 463.5 kg of waste per year. The major source of waste in landfills is municipal solid waste (66 %), which included food waste, metals, plastic, etc. The second main component is construction waste that is shown in Fig. 2.2. Besides, the total waste generated has increased by almost 50 % from 4.26 million tonnes in 1991 to 6.3 million tonnes in 2011. At the same time, the construction waste has a remarkable reduction at landfills that dropped from 5.98 million tonnes in 1991 to 1.21 million tonnes in 2011, approximate 80 % decrease. However, the quantity of MSW disposed of at landfills has raised 21 % since 1991 (Hong Kong Environmental Protection Department 2011) (Fig. 2.3).

In Singapore, there was about 6.9 million tonnes of waste generated in 2009 and i.e. each person generated around 1,330 kg of waste in a year. The total waste generated increased by 56 % from 4.6 million tonnes in 2000 to 7.3 million tonnes in 2012 (Fig. 2.4). Majority is MSW, contributing 70 % of all kinds of waste (Fig. 2.5) (Singapore National Government Agency 2013). The proportion of different type of the waste in Hong Kong and Singapore are similar.

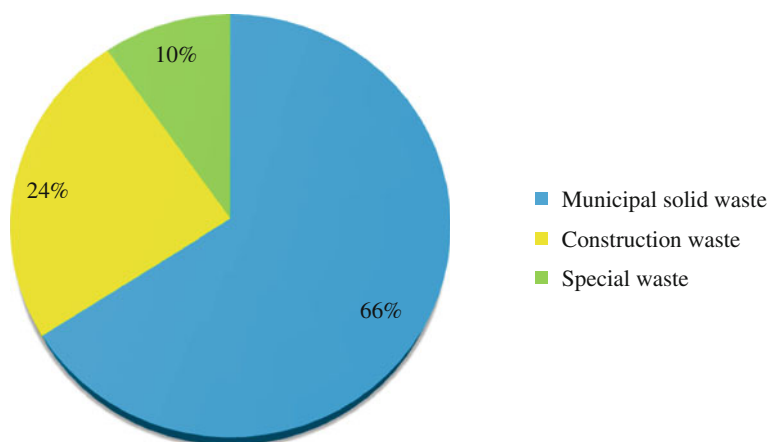


Fig. 2.2 Hong Kong disposal of solid waste at landfills in 2011 (Environmental Protection Department 2011)

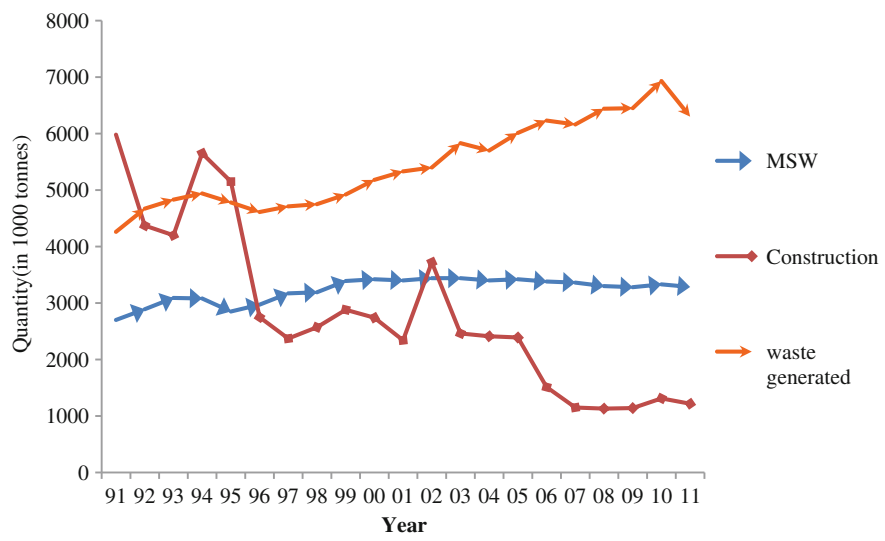


Fig. 2.3 Quantities of solid waste generated in 1991–2011 in Hong Kong (Environmental Protection Department 2011)

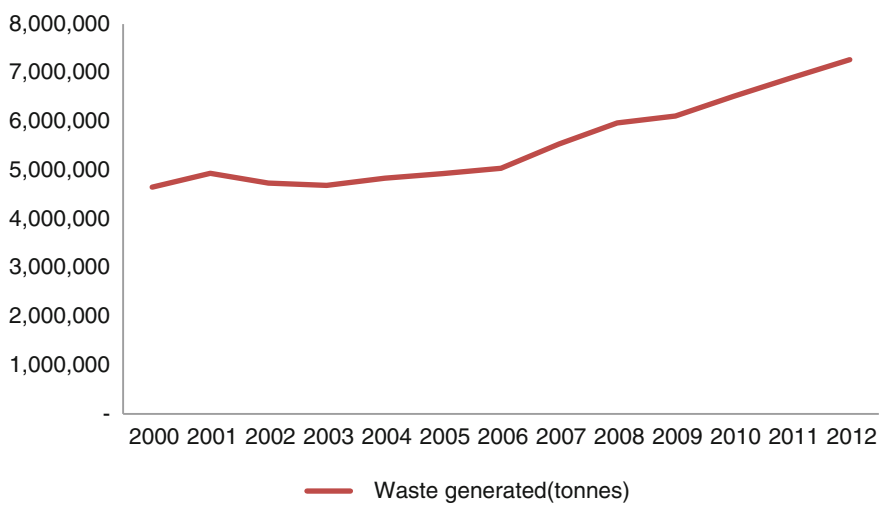


Fig. 2.4 Volume of waste in Singapore from 2000 to 2012 (National Environment Agency 2013)

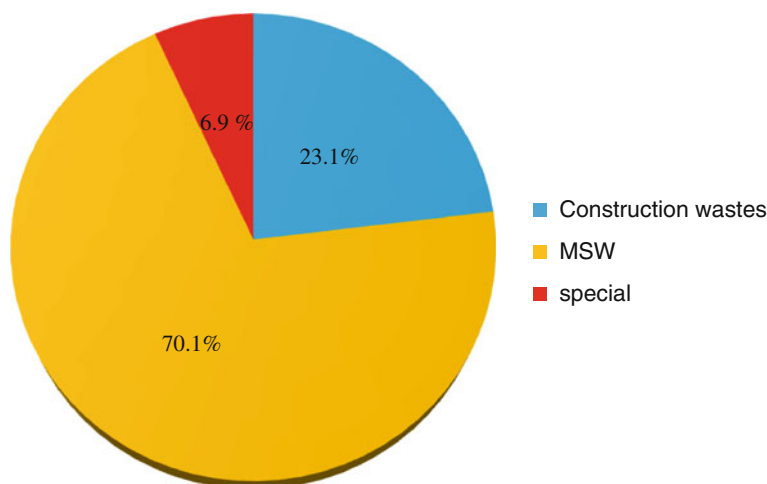


Fig. 2.5 Distribution of waste in Singapore in 2011 (National Environment Agency [2013](#))

2.6 Digital Information

Before the era of information digitization, a researcher who wanted to read an academic journal would have to travel down to a local library and access to the journal archive. The archive by the constraint of physical space available, maintains only a limited volumes of journals where some old issues may have been purged for making space for the new ones. The problems of latency in accessing paper journals in a physical premise, and incomplete information have been improved in the early 90s when a movement of digitizing journal information and founding online journals emerged. For instance, Mr. William Bowen, the president of Princeton College founded an online journal library called Journal Storage (JSTOR) that digitized academic journals from different disciplines into electronic copies, made available for online access. There are other popular and open-access digital journal archives such as, AGRIS, arXiv, CiteSeerX, ERIC, LexisNexis, NSDL.org, just to name a few.

To librarians, the digitization translates to savings on operation costs in managing hard-copies of the journals and freeing up precious physical storage space. To the users, it is the convenience in finding journal articles of many different publishers, from the online journal databases instead of physical journal shelves and rooms. There are some quality digital journal libraries providers, such as JSTOR that charges subscription fees for the license of use to colleagues, universities or commercial research institutes. The licensees are allowed to provide online access, usually via Intranet, to their students and staff in doing research usually at no charge. Some selected popular digital journal operators that charge subscription fees

include but not limited to, ACM digital library, Bowker, CINAHL, Econ Lit, IEEE Xplore and POIESIS etc. for accessing full text articles by subscription.

The advantage of digitized online academic journal over the free but uncontrolled materials from the Internet is the information quality, that includes accuracy and authority. Academic journals focus on specialized areas or categories of information, with meticulously checked contents. Usually in a reputable journal, peer review is conducted for maintaining the quality and substantial scientific credentials each paper carries before it gets published. The scientific journal papers usually contain credible data, described empirical research in full and formalized theories. The information from these scholarly journal papers are meant to be used by fellow researchers for on-going subsequent research. On the other hand, the information found on the Internet is usually unverified, and sometimes biased in views with either underlying political or commercial motives. Some are published for entertainment sake or with a propaganda purpose. Informative these online reports may be, yet mostly are gossips like and even full of advertisements.

In summary, researchers are offered the convenience of collecting relatively more reliable data from online digital journal archives than from websites on Internet. It takes only a computing device with Internet connection to do data collection rather than physically visiting a library. The other advantage lies on the ease and wide variety of available online databases for searching. The full-text article in each journal database can be effortlessly downloaded, stored on a mobile device and read at any time anywhere later as the research wishes. This can significantly reduce the hassles in academic information searches, leading to more focused research effort hence better results.

2.7 Research Method

In this chapter, we mainly discuss the most common and popular methods among these two places, i.e. landfill, recycle and incineration. Updated statistics about the operation of these three waste management methods is obtained from Environmental Protection Department (2011) in Hong Kong and National Environment Agency (2013) in Singapore.

Since this paper is a qualitative research on the comments and criticisms of the construction and municipal solid waste management. We adopt systematic content analysis as the research method. The scholarly literatures are searched and collected from the Google scholar, EBSCOhost research databases and ScienceDirect. The keywords use include 'Municipal solid waste management', 'Hong Kong', 'Singapore', 'landfill', 'recycling', 'sustainable waste management' from 2000 to present.

2.8 Similar Approaches of Construction Waste and MSW Management in Hong Kong and Singapore

Hong Kong and Singapore are densely populated cities in the world, waste has become one of the major problems that the government has to deal with. Both of them adopt similar method in handling waste, i.e. landfill and waste recycle.

2.8.1 Landfill

Landfill is the most popular method for waste disposal in the world, Hong Kong and Singapore are of no exception. In 1960, Hong Kong established the first landfill site in Kwai Tsing and the number of landfill increased to 16 by 1995. Nowadays, most of the landfills in Hong Kong were already closed and changed in use of land, only three landfill sites are still operating in the New Territories (Environmental Protection Department 2011). More than 90 % MSW and construction wastes are now disposed in three large landfills by waste collection vehicles every day.

Same as Hong Kong, there is an offshore landfill in the southern part of Singapore. The Semakau Landfill receives incineration ash which is delivered by tugboats at night. It also provides educational and interesting outings for local citizens, students and foreign visitors (National Environment Agency 2013). Even though Pulau Semakau operated a landfill, the western coast has become a scenic and green natural place with fresh air and provides a hub for rich biodiversity.

2.8.1.1 Scholars' Comments and Criticisms on Landfilling

Although landfill is the most widely use method to dispose MSW and construction waste, it is always considered as a costly, unsustainable way to our environment and economy. It is also not welcomed by the environmental groups. The European Union waste strategy consider landfill as the last resort of waste management (Depountis et al 2009). It is not environmentally sustainable owing to the potential hazard of organic materials (Bjarnadóttir et al. 2002). The landfill also gives rise to environment problems such as noise pollutions, emissions of dust and gases to atmosphere, contaminated surface water to watercourses (Depountis et al. 2009). However, the Semakau Landfill is operated in a more environmental friendly that very minimal gases existed in the landfill as organic wastes are not sent to landfill sites and there is a maximum 10 % of the total solid waste generated going to landfill under the National Environment Agency (NEA) scheme (Tan and Khoo 2006).

In Hong Kong, as the three landfills in Hong Kong has been used for about 20 years, the Environmental Protection Department (2011) estimated that all the existing landfills will be full by 2017 (Chung and Poon 1998). Landfill crisis has become a major challenge in Hong Kong owing to the limited land resources while

Table 2.1 Summary of scholars' comments on landfilling

Author (year)	Scholar comments	Place(s)
Fischer (1999)	Landfill is considered as the last resort in the waste management	Hong Kong and Singapore
Bjarnadottir et al. (2002)	It is not considered as environmentally sustainable owing to the potential release of hazard organic materials	Hong Kong and Singapore
Depountis et al. (2009)	Landfill would arise environment problems like emissions to atmosphere and water including noise, dust, gases, contaminated surface water runoff to watercourses	Hong Kong and Singapore
Tan and Khoo (2006)	The Semakau landfill is operated more environmental friendly with very minimal gases released at the landfill	Singapore
Tan and Khoo (2006)	Organic wastes should be disposed to the landfills	Singapore
Chung and Poon (1998)	Hong Kong is now facing an urgent problem of soon-to-be full landfill sites	Hong Kong
Yau (2010)	Landfill crisis has been seen as a major challenge in Hong Kong owing to the limited land resources. Creating new ones or extending the existing landfill sites is extremely costly	Hong Kong

opening new ones or extending the existing landfill sites is extremely costly (Yau 2010) (Table 2.1).

2.8.2 Recycling

In view of the urgent landfill crisis in Hong Kong and air pollution released from incineration plant in Singapore, recycling waste has been taken as an intermediary measure which creates less environmental damage and achieve environmental sustainability (Yau 2010). In Singapore, to support the construction waste recycle, the NEA provides lots of recycling facilities which turn the waste into non-structural concrete products for building construction (Zhang et al. 2009). According to the Singapore's NEA (2013), the recycle rate of construction waste increased from 85 % in 2001 to 99 % in 2012, reaching the target recycling rate set in Singapore Green Plan 2012 successfully. Besides, the recycling rate of MSW in 2012 is 58 %.

Owing to the rapid depletion in landfill sites, the Hong Kong government also set a number of Waste Reduction Task Forces to promote the idea of recycling in different sectors since 1997. At that moment, the recycle rate of domestic waste was around 8 % of the total waste disposed (Chan 1998). Hence, the government launched a 10 years implementation program in the Waste Reduction Framework Plan in 1998 (Environmental Protection Department 2011). The program includes provision of waste separation bins in public areas and encourages the developers to provide space for refuse storage and waste recovery (Environmental Protection Department 2011).

2.8.2.1 Scholars' Comments and Criticisms on Recycling

It is often of the view that recycle is a good way to achieve a sustainable development. It enhances the level of resource efficiency (Tanaka 2007), save energy, prolongs lifespans of landfills and reduces emissions to air, water from incinerators and landfills (Seik 1997; Ekins et al. 2003). Nevertheless, our stakeholders are fully aware of various economic concerns (Schultz et al. 1995). Yau (2010) comments that recycling can be a heavy long-term financial burden to the HKSAR Government if it offers monetary incentives to increase domestic waste recycle. Thus, the HKSAR Government should consider incorporating different economic incentives to encourage waste recycle such as setting up a reward scheme so that citizens can exchange recyclable materials for free public services. Besides, Hong Kong's recycle market is limited to recycling materials with a high scrap value and lacks of recycle facilities which may create hazardous substances (Tam and Tam 2006).

In Singapore, Zhang et al. (2009) believed that the Singapore Government endeavors to reduce waste reduction from disposing in the landfill by recycling. Hence, the lifespan of the Semakau Landfill increases from 20–30 years to 35–40 years. Even though Singapore successfully recycles waste, costs of recycling are high because of high waste collection and handling costs (Bai and Sutanto 2002) (Table 2.2).

Table 2.2 Summary of scholars' comments on waste recycle

Author (year)	Scholar comments	Place(s)
Tanaka (2007)	Waste recycle can achieve a high level of resource efficiency	Singapore and Hong Kong
Seik (1997), Ekins et al. (2003)	Recycle saves energy, prolongs life spans of landfills and reduces emissions to air, water from incinerators and landfills	Singapore and Hong Kong
Yau (2010)	Waste recycle would become a heavy long-term financial burden to the Hong Kong Government if it offers inducements continuously to boost domestic waste recycling. The Hong Kong Government should consider incorporating different economic incentives in its policies to encourage waste recycling like set up a reward scheme that citizens can exchange recyclable materials for free public services	Hong Kong
Tam and Tam (2006)	Hong Kong's recycling market is limited due to a high scrap value of the recycled materials and lacks of recycling facilities for waste which may create hazardous substances	Hong Kong
Zhang et al. (2009)	Singapore Government have helped tremendously to reduce waste from disposing in the landfill, as a result, the life span of the Semakau landfill increases from 20–30 years to 35–40 years	Singapore
Bai and Sutanto (2002)	The cost of recycling has been proven to be higher than original anticipation because of high waste collection and handling cost	Singapore

2.9 Different Approaches of Construction and MSW Management in Hong Kong and Singapore

2.9.1 Incineration

Solid waste incineration has been placed in a top priority over the past 30 years in Singapore. Incineration is a waste treatment process that converts the waste into ash, heat and flue gas and finally the ash would be disposed at the landfill. The incineration plants are known as waste-to-energy (WTE) plants because the steam generated during the combustion process would be used to produce electricity. The recovered energy is mainly used to operate the waste-to-energy plant, and the extra ones are then sold to the electricity institutions. As a result, the revenue from the sale of energy becomes a major income to the plants (Bai and Sutanto 2002). According to NEA (2013), there are five incineration plants in Singapore currently. They are Ulu Pandan (1,600 tons/day), Tuas (2,000 tons/day), Senoko (2,400 tons/day) and Tuas South (3,000 tons/day). At present, the solid waste disposed in Singapore is about 7 million tonnes and 37.6 % of the waste is going to waste-to-energy plants for energy recovery and incineration (National Environment Agency 2013).

2.9.1.1 Scholars' Comments and Criticisms on Incineration

Rapid industrialization and economic development causes tremendous increase of solid waste incineration in Singapore, even though it is much more expensive method than landfill (Bai and Sutanto 2002). Nevertheless, incineration has long been considered as non-sustainable waste management. According to Hellweg et al. (2001), wastes incineration generates nitrogen oxides, which could potentially contribute to environmental problems like acidification and ecotoxicity. Also, the ashes generated from incineration always show substantial levels of toxic substances (Qian et al. 2006). Therefore, Khoo et al. (2012) suggested NEA to find alternative uses for incineration ash instead of disposing at landfills. Therefore, Singapore tested the bottom ash to see whether it could be used as road pavement in order to reduce the amount of material sent to landfills (Tan and Khoo 2006). Although the incineration plant can produce electricity during waste burning, Tan and Khoo (2006) commented that the energy gained is outweighed by the environment damage caused by the incinerators (Table 2.3).

Table 2.3 Summary of scholars' comments on incineration

Author (year)	Scholar comments	Place(s)
Bai and Sutanto (2002)	Incineration is much more expensive method than landfilling	Singapore
Hellweg et al. (2001)	Incineration of wastes would generate emissions such as nitrogen oxides, which could potentially contribute to environmental problems like acidification and ecotoxicity	Singapore
Qian et al. (2006)	The ashes generated from incineration always show substantial levels of toxic substances	Singapore
Khoo et al. (2012)	The government should find alternative uses of incineration ash instead of disposing at landfills	Singapore
Tan and Khoo (2006)	Singapore tested the bottom ash to see whether it could be used as road pavement in order to reduce the amount of material sent to landfills	Singapore
Tan and Khoo (2006)	The energy gained is outweighed by the environment damage caused by the incinerators	Singapore

2.10 Summary

Sustainable construction and solid waste management requires full consideration in economic, social and environmental aspects. Even though landfill and incineration have long been considered as an unsustainable waste management, Singapore shows how waste disposal management can be operated in a more sustainable way. The Semakau landfill provides a good example to the world and change people's views on landfills. It not only provides space to store wastes, but also a comfortable place with educational value, fresh air and rich biodiversity to its citizens and visitors. At the same time, Singapore puts incineration in a top priority as a waste management strategies. During the process of waste combustion, the steam generated would be used to produce electricity that generates economic benefits.

On the other hand, Hong Kong still relies on the traditional, inefficient landfill as a final destination for construction and municipal solid waste. It is now facing a serious problem of landfill sites shortage. The expansion of landfill sites has led to a essential controversial discussion in the city and it is in no doubt a hard nut to crack issue for the Hong Kong government.

In view of the alarming landfill crisis and the environment damage from incineration, the Hong Kong and Singapore government promote waste recycle. Among all the suggested solutions for mountains of waste, recycle has been considered as one of the most viable solutions as evaluated by academic scholars as it achieves a high level of resource efficiency (Tanaka 2007) and reduces emissions of air and water pollutants from incinerators and landfills (Seik 1997; Ekins et al. 2003). However, if the government does not consider any other different economic incentives, recycle waste can impose heavy long-term financial burden. Hence, it is not a sustainable solution.

To achieve sustainable development, construction and municipal solid waste disposal may impose a major obstacle in city development. Therefore, in order to strike a balance between economic growth, social well-being and environmental protection, it is necessary and essential for the Singapore and Hong Kong government to promote recycle in an effective way and consider more sustainable waste management strategies.

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