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d Abstract

Construction waste that emerges from construction site has become a major concern to the nation due to its negative footprints on the environment. Undeniably, huge amounts of construction waste will cause destructive effects on the environment if they are not managed properly. Therefore, the productions of construction waste need to be controlled and managed by the stakeholders in the construction industry. This paper conducts a review of existing waste control practices adopted by the responsible parties in Hong Kong and Malaysia in order to minimize the environmental impacts of construction activities. This paper also embraces the differences and similarities of waste control practices in both countries reviewed. In addition, the gap identified will form a basis of encyclopaedic research on construction waste control practices in the future. In turn, the research will lead to a better sustainable construction waste control framework, which complies with the Malaysian legislation and regulations. The study is very useful for construction stakeholders to promote a comprehensive efficacy of construction waste control practices and also furnish precious sources for other countries in controlling and managing wastes at construction sites in order to answer the challenge towards sustainable development.

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1. **Introduction**

Globally, waste volumes are increasing quickly, even faster than the rate of urbanization. Currently, the world cities are generating about 1.3 billion tonnes of solid waste per year. This volume is expected to increase to 2.2 billion tonnes by 2025. As countries urbanise, their economic wealth increases. As standards of living and disposable incomes increase, consumption of goods and services increases, which results in a corresponding increase in the amount of waste generated (Hoornweg & Bhada-Tata, 2012).

Local governments in Asia are currently spending about US$25 billion per year on urban solid waste management. This amount is used to collect more than 90 percent of the waste in high-income countries, between 50 to 80 percent in middle-income countries, and only 30 to 60 percent in low-income countries. In 2025, it is anticipated that the spending on solid waste management activities would increase by 200 per cent in 2015 (Hoornweg & Thomas, 1999).

Although solid waste is generated by different household and economic activities, the construction industry has always been considered as one of the major producers of waste (Al-Hajj & Hamani, 2011). Construction waste is not by nature an environmentally friendly activity; the sector has always been a major generator of construction waste (Lachimpadi, Pereira, Taha, & Mokhtar, 2012; Shen & Tam, 2002).

Realizing the negative impact of construction waste to the environment, governments at both national and international levels have introduced various policies and regulations to make construction activities more sustainable (Akadiri & Fadiya, 2013). This includes countries in the East Asia and Pacific (EAP) regions, Hong Kong and Malaysia (Hoornweg & Bhada-Tata, 2012). In 2013, with a total population approximately 7.2 million, Hong Kong had recorded a gross national income per capita of USD38,420 (World Bank, 2014a). Meanwhile, Malaysia having the population of approximately 29.7 million had recorded a gross national income per capita of USD10,430 (World Bank, 2014b). This puts Hong Kong as a high-income country, while Malaysia as the nation at upper middle-income country in the region (World Bank, 2014a; World Bank 2014b).

This paper reviews the existing waste control practices adopted in Hong Kong and Malaysia by comparing the construction waste control practices in terms of legal instrument, method of waste treatment and other practices between both countries.

2. **Construction and demolition (C&D) waste control practice in Hong Kong**

Like most modern cities, the need to attain sustainability is compelling in Hong Kong, which has suffered rapid environmental degradation in the course of achieving a spectacular economic boom since the early 1970s (Chung & Lo, 2003). In line with construction booming, in the year of 2012, Environmental Protection Department (EPD) in Hong Kong had reported that 13,844 tonnes per day of waste had been dumped at landfills.

Realizing the threat of C&D waste to the environment, the local industry has been promoting measures such as establishing waste management plans, reduction and recycling of construction and demolition wastes, providing in-house training on environmental management, and legal measures on environmental protection (Shen & Tam, 2002).

2.1. **C&D waste legal instrument**

The main authorities involve with construction waste in Hong Kong are the Environment Protection Department (‘EPD’) and the Civil Engineering and Development Department (‘CED’) (Ming-zhi & Gao, 2006). The Hong Kong government has issued various laws and ordinances to reduce waste generation and protect the environment by legal enforcement. These include Water Pollution Control Ordinance (1980), Noise Control Ordinance (1989), Waste Disposal Ordinance (WDO, 1980), Air Pollution Control Ordinance (1985) and Environmental Impact Assessment (EIA) Ordinance (1998) (W.Y Tam, Shen, Fung, & Wang, 2007) as shown in Table 1.
Table 1. Summaries of the legislation relating to waste control practices in Hong Kong.

<table>
<thead>
<tr>
<th>Ordinance</th>
<th>Explanation</th>
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</thead>
<tbody>
<tr>
<td>Water Pollution Control Ordinance (1980)</td>
<td>To safeguard public health, to protect the fabric of the sewage collection and disposal system and to contain the problem before the quality of the receiving waters deteriorate beyond natural recovery. Discharge of effluent from construction activities is classified under Discharge Subject to Control, thus discharger should apply for a license from EPD and comply with its terms and conditions (Environmental Protection Department, 1997).</td>
</tr>
<tr>
<td>Noise Control Ordinance (1989)</td>
<td>To provide statutory controls to restrict and reduce the nuisance caused by environmental noises including noise from construction activities such as piling works. Construction activities are grouped into two categories: general construction work and percussive piling; for example, piling by means of a hydraulic hammer or a drop hammer (Environmental Protection Department, 2006).</td>
</tr>
<tr>
<td>Waste Disposal Ordinance (WDO, 1980)</td>
<td>To provide a framework for managing waste from generation to final disposal. WDO prohibits any person from using any land or premises for the disposal of waste unless this has been authorised or a license from the waste disposal authority, the Director of Environmental Protection has been obtained. WDO has specified the environmental conditions at waste treatment and disposal facilities. Concerned parties must comply with WDO for the disposal of chemical waste, toxic, hazardous and difficult waste, and the management of sludge arising from water/sewage treatment systems. WDO also controls the imports and exports of waste (W.Y Tam et al., 2007).</td>
</tr>
<tr>
<td>Air Pollution Control Ordinance (1985)</td>
<td>To provide a statutory framework for establishing the Air Quality Objectives and stipulating the anti-pollution requirements for air pollution sources. It enables the making of subsidiary regulations to deal with specific air pollution problems, such as construction dust, etc. (Environmental Protection Department, 2010).</td>
</tr>
<tr>
<td>Environmental Impact Assessment (EIA) Ordinance (1998)</td>
<td>To avoid, minimise and control the adverse impact on the environment of designated projects through the application of the environmental impact assessment process and the environmental permit system (Environmental Protection Department, 2011).</td>
</tr>
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</table>

2.2. C&D waste management and treatment system

At present, Hong Kong relies solely on landfills for municipal solid waste disposal (MSW). Approximately 9000 tonnes of unrecoverable MSW are still discarded in the landfills every day. Currently, the government is experiencing a serious shortage of MSW disposal sites with an anticipation that the current three strategic landfills, namely, South East New Territories (SENT), North East New Territories (NENT), and West New Territories (WENT) will be exhausted in 2014, 2016, and 2018, respectively (Woon & Lo, 2013). In Hong Kong, C&D waste generators are responsible for its proper collection and disposal. Landfills and public filling areas are the major receiving bodies in Hong Kong (Chung & Lo, 2003; Poon, Yu, Wong, & Cheung, 2004).

The government is giving full encouragement and support at reusing, recycling and minimizing the amount of C&D materials disposal so that the life span of the landfills can be extended (Poon et al., 2004; W.Y. Tam & Tam, 2006). Before recycling stage takes place, the C&D waste generator needs to do waste sorting. C&D waste sorting is very crucial since it increases the efficiency of construction waste reuse and recycling (Lu & Yuan, 2012). At the early stage, on-site construction waste sorting for reusing, recycling and reducing C&D waste had not been popular in Hong Kong, and the common practice was contractors sent the construction waste directly to landfills or public
fill reception facilities for disposal. However, things changed when the Hong Kong government implemented a Waste Charging Scheme (WCS) in 2006 (Lu & Yuan, 2012).

“Construction Waste Disposal Charging Scheme” (CWDCS) was implemented based on the ‘polluter pays principal’. CWDCS encourages contractors to consider recycling and reusing of C&D waste so as to reduce the disposal of construction waste to the limited landfill space in Hong Kong (Yu, Poon, Wong, Yip, & Jaillon, 2013). A construction contractor will have a levy of HK$125 (USD1=HK$7.76) imposed for every tonne of construction waste containing not more than 50% by weight of inert substances for the dispose at landfills. He will be levied HK$100 per tonne if the generated construction waste containing more than 50% by weight of inert substances is accepted by off-site sorting facilities. Meanwhile, he will be charged only HK$27 per tonne if the construction waste consisting entirely of inert materials is accepted by public fill reception facilities (Yuan, Lu, & Jianli Hao, 2013). The price discriminations reflect the different environmental impacts caused by different forms of construction waste. It is also anticipated that the charge will be channelled back to the construction contractors to encourage more active construction waste management activities, such as reduction, reuse, and recycling. This particular scheme has been proven as an effective vehicle in stimulating on-site and off-site CWS (Lu & Yuan, 2012).

2.2.1. On-site waste sorting

Poon et al. (2004) stated that the best way to reduce the impact upon landfills is that - once waste reduction practices in design and construction have been adopted, the waste needs to be sorted on-site before disposal. The negative impact of construction activities on the environment has been significantly reduced through conducting on-site construction waste sorting (CWS) (Lu & Yuan, 2012). A direct contribution of the improvement CWS is that more construction materials on-site are separated at source, and thereby, the resource reuse and recycling efficiency have been greatly increased. Better on-site CWS has also resulted in less construction waste going to landfills (Yuan et al., 2013).

2.2.2. Off-site C&D waste sorting

The Hong Kong government has the duty to provide off-site sorting facilities to separate mixed materials. The inert material will then be used as public fill while the decomposable organic waste will be taken into the main waste disposal stream. The first construction waste recycling facility was set up at the South East New Territories (SENT) Landfill in 1998 to recover usable materials from mixed C&D waste (Ming-zhi & Gao, 2006). The government then launched the off-site CWS program and built two CWS facilities in Tuen Mun and Tuseng Kwan O areas, respectively, in 2006 for separating and sorting construction waste before its final disposal. Since its implementation, a significant amount of construction waste has been handled by these two waste sorting facilities, thereby reducing the use of existing landfills significantly (Lu & Yuan, 2012).

3. Waste control practice in Malaysia

The Borneo Post (2013) reported that in 2012, 33,000 tonnes of solid waste had been generated daily in Malaysia. Meanwhile, in 2010, the government of Malaysia spent RM1, 136.0 million for waste management. Of this total, expenditure on non-hazardous solid waste stood at RM920.5 million (81.0%), while scheduled waste at RM215.6 million (19.0%) (Department of Statistics Malaysia, 2011). Therefore, due to the negative footprint of the increasing of waste generation to the environment, the Malaysian government has initiated measures to address this problem with legal instruments and research on the best method to manage the C&D waste.

3.1. C&D legal instrument

The key stakeholders in managing solid waste generated by the industry in Malaysia are the Ministry of Housing and Local Governments, Department of Local Government, local governments, solid wastes contractors companies, as well as the industry and solid wastes recyclers (Mohamed, 2009). The government agencies, led by the Ministry
of Housing and Local Government, provide legislative and guidelines in managing industrial waste (Manaf, Samah, & Zukki, 2009; Mohamed, 2009).

Another government body involved in managing solid waste is the Ministry of Natural Resources and Environment (Nagapan, Abdul Rahman, & Asmi, 2012). The Ministry of Works also takes part in managing the waste at construction sites. The Ministry has established the Standard Specifications for Building works (SBW), which is governed by the Ministry of Works (Sin, Chen, Long, & Hwang, 2012). The other authority that concerns on construction waste is the Construction Industry Development Board (CIDB), in which the law under its supervision is Pembinaan Malaysia Act 1994 (Act 520).

In previous study, Sasitharan, Ismail, and Ade (2012) had listed out acts and regulations that relate to construction waste as shown in Table 2.

Table 2. Summaries of the legislation relating to waste control practices in Malaysia.

<table>
<thead>
<tr>
<th>Ordinance</th>
<th>Explanation</th>
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</thead>
<tbody>
<tr>
<td>Solid Waste and Public Cleansing Management Act 2007 (Act 672)</td>
<td>The act scopes are to improve and ensure high quality services in solid waste management. Waste management strategies, such as 3Rs, are a mandatory commitment on waste segregation and severe penalties for non-compliance with the regulations stipulated within the Act (Agamuthu &amp; Fauziah, 2011).</td>
</tr>
<tr>
<td>Environmental Quality Act 1974 (Act 127)</td>
<td>The act scopes are to prevent, reduce, control pollution and enhance the environment. The wastes appear in this act are more related to general environmental problems. The wastes are interpreted as liquid, solid, gasses and radioactive. The wastes are either normal waste or schedule waste (Sasitharan et al., 2012).</td>
</tr>
<tr>
<td>Pembinaan Malaysia Act 1994 (Act 520)</td>
<td>In this act, only Part I and Part IX can be related with construction waste issues. Part I describes construction works whilst Part IX is more towards enforcement and investigation. The act is to provide functions relating to construction works in the country. It gives power to investigation officers for entering construction site at any times to do inspection. This enforcement law gives the authority to act upon construction waste left on site through the term of site clearance (Sasitharan et al., 2012).</td>
</tr>
</tbody>
</table>

3.2. C&D waste management and treatment system

There are a few types of construction waste disposal treatment systems applied in Malaysia, namely, landfilling, incineration, and recycling (Lau, 2004). Landfilling is a main method used for the disposal of solid wastes in Malaysia (Jalil, 2010; Lau, 2004; Moh & Abd Manaf, 2014; Periathamby, Hamid, & Khidzir, 2009; Shari & Soebarto, 2014; Sin et al., 2012). Most of landfill sites are open dumping areas with overloaded capacity, which pose serious environmental and social threats (Moh & Abd Manaf, 2014).

Besides landfills, the incinerator is considered to be one of the disposal methods in Malaysia as the nation could not depend on landfills only. There are five existing small incinerators with the capacity of fewer than 100 tons in Malaysia, located at Pulau Pangkor in Perak, Pulau Langkawi in Kedah, Pulau Tioman and Cameron Highlands in Pahang, Lumut and Labuan. Three large-scale incinerators are going to be built in Taman Beringin, Kuala Lumpur; Bukit Payung, Johor; and Sungai Udang, Melaka (Moh & Abd Manaf, 2014). Currently, the incineration in Malaysia is mainly used to dispose clinical and hazardous wastes, where 100% of the wastes are incinerated (Dinie, Samsudin, & Don, 2013).

Similar to Hong Kong, to curb the excessive generation of waste, recycling programs were launched in 1993 in Malaysia. In December 2000, the Ministry of Housing and Local Government re-launched the recycling program and declared 11 November as the National Recycling Day (Manaf et al., 2009). However, most of the construction practitioners still do not implement the reuse, reduce and recycle 3R concept into their construction sites, or some of them are unaware of it. Besides, only a few systems are used, namely, the 3R concept, incineration and landfilling.
(Sin et al., 2012). Furthermore, the slow uptakes of utilizing reused and recycled materials or components in the Malaysian construction industry are due to factors, such as cost and perception of “low quality” (Shari & Soebarto, 2014).

Till now, disposing unseparated and reusable construction waste in landfills was certainly a common on-going practice in Malaysia (Shari & Soebarto, 2014). Despite the high potential and opportunities for solid waste recycling, wastes are still simply being dumped in an open area of ground without any attempt for recovery and recycling. In comparison to recycling rates of neighbouring countries, Malaysia is falling back at merely 5%, which proves how uncommon recycling practice is in Malaysia (Moh & Abd Manaf, 2014).

4. Comparison

As shown in Table 3, in Hong Kong, it is stated that two government bodies, namely, Civil Engineering and Development Department and Environmental Protection Department, are in-charge of environmental issues. However, the latter is the main government body responsible for environmental matters. As compared to Malaysia, there are three government bodies, namely, the Ministry of Housing and Local Government, the Ministry of Works and the Ministry of Natural Resources and Environment, which are in-charge of environmental regulation and enforcement. These departments are supported by a private agency, named the CIDB. This decentralization involving many agencies may have impacted the effectiveness in implementation of legislation and enforcement in terms of information dissemination, unclear or overlapping roles and responsibilities and red tapes. Nonetheless, this might be driven by the number of states and massive Malaysian land size. As opposed to the situation in the island of Hong Kong, centralized government departments are sufficient to implement the waste management efforts across all sectors. In order to increase efficiency in implementation, a single government body is to regulate all environmental issues and enforcement in the future.

Table 3. A comparison of existing C&D waste control practices in Hong Kong and Malaysia.

<table>
<thead>
<tr>
<th>Country</th>
<th>Hong Kong</th>
<th>Malaysia</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNP per capita 2013 (USD)</td>
<td>54,270</td>
<td>22,530</td>
</tr>
<tr>
<td>Waste generation in 2012</td>
<td>13,844 tonnes per day</td>
<td>33,000 tonnes per day</td>
</tr>
<tr>
<td>Agencies in-charge of environmental enforcement</td>
<td>Environmental Protection Department, Civil Engineering and Development Department</td>
<td>Ministry of Housing and Local Government, Ministry of Works, Ministry of Natural Resources and Environment and Construction Industry Development Board (CIDB).</td>
</tr>
<tr>
<td>Method of C&amp;D waste treatment</td>
<td>Recycling, Reusing, Landfilling, Public filling areas</td>
<td>Recycling, Incineration, Landfilling</td>
</tr>
</tbody>
</table>

In terms of legislation, environmental ordinances in Hong Kong are categorized into more specific waste categories. This provides a clear demarcation of each segment. It may provide better implementation as each
ordinance covers definite scope and distinct boundary. In Malaysia, the acts are drafted in a more general manner, thus bound to be similarities in its clauses across the act enacted by various government and private agencies.

For C&D waste treatment, there are similarities in the methods practised in Malaysia and Hong Kong, for instance activities such as recycling and landfill. Stakeholders in construction are very receptive to recycling programme in Hong Kong. This is driven by the enforcement of CWDCS. Malaysian recycling effort has not received much attention albeit the government’s effort to promote the benefits of recycling. Besides that, major critical steps undertaken by Hong Kong are on-site and off-site sortings. This is proven to be critical in the success of recycling and reuse of waste. On-site and off-site sortings in Malaysia have been in place to provide avenue for recycling; however, the implementation and effectiveness are still vague. Therefore, it is essential for Malaysia to inculcate on-site sorting and off-site C&D waste sorting to minimize waste management costs, hence extending the life span of landfills.

5. Conclusion

In conclusion, there are still many efforts that the Malaysian government can undertake by taking Hong Kong as a role model to tackle the C&D waste issue. In order for Malaysia to move towards a green or sustainable environment, the country has to benchmark itself to developed nations like Hong Kong in handling construction waste issues (Sasitharan et al., 2012). It is the aspiration of the nation to become a high-income country in the future. C&D waste management issue continues to linger if not getting worse in tandem with economic development. In readiness for the future, it is best to kick start the effort at this juncture.

We suggest that there is future research on creating awareness by means of providing effective trainings on proper waste management method. Facilities to support waste management particularly in recycling need upgrading and improvement. Replicating the success of CWSD to suit local environment and culture can be implemented and enforced accordingly. Enforcement by the government is essential to ensure that the requirements and standards are fulfilled. In Malaysia and any countries, in reaching sustainable development, the decisions related to solid waste management should be tabled out to the public from grass root level, which signifies the participation of all concerned (Behzad, Ahmad, Saied, Elmira, & Bin, 2011).

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