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Controlling Construction Waste by Implementing Governmental Ordinances in Hong Kong

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Abstract

Due to limited space, reducing the waste going to landfills has become a pressing issue in Hong Kong. As most of the solid waste was generated from construction activity, the Hong Kong government has instituted a number of measures aimed at reducing waste from this source. However, it appears that the application of these measures has been of limited effectiveness. This paper examines the effectiveness of implementing regulatory measures for reducing construction waste in Hong Kong. The data used for the analysis are from a survey to construction professionals in the local industry by means of questionnaire, interview discussions and case studies. The survey examined the commitments and responsibilities imposed on project participants for implementing waste management. The results of the investigation illustrate that legal commitments have been mainly allocated to contractors. Insufficient commitments and responsibilities are allocated to other project participants such as project clients, designers and consultants. The results demonstrate that there is need for a balanced allocation of responsibilities and commitments among all project stakeholders.

Keywords: Construction, waste management, regulatory measures, Hong Kong

1 Introduction

Construction waste is generally defined as the by-products generated from construction, renovation and demolition workplaces or sites of building and civil engineering works (Cheung, 1993). Previous studies suggest that construction industry is a major contributor to the generation of waste and pollution (EPD, 2003; Poon *et al.*, 2001). This is particularly true in those densely populated cities such as Hong Kong where construction related works are among the major economic activities. For example, in 2001, 38% of the disposed solid waste in Hong Kong was generated by construction and demolition (C&D) activities (see Figure 1). The report by Hong Kong Environmental Protection Department (EPD) (2003) also suggests that construction caused pollutions such as waste pollution, noise pollution, water pollution and air pollution are among the major pollution problems in Hong Kong.

<Figure 1>

There are five major sources of construction waste, including roadwork material, excavated material, demolition waste, site clearance and renovation waste (EPD, 1992; Poon *et al.*, 2001). In a typical classification, construction waste is listed as asphalt, brick, tiles, concrete, mortar, reinforced concrete, rock, rubble, sand, soil, bamboo, ferrous metal, non-ferrous metal, glass, junk, fixtures, plastic, slurry, mud, trees, wood and other organics and garbage (EPD, 1992; Poon *et al.*, 2001). In a typical landfill site in Hong Kong, the distribution of various construction waste components is given in Table 1. The Table1 illustrates that soil and slurry are the major construction waste.

<Table 1>

The factors that contribute to the generation of construction waste are various. A study by Graham and Smithers (1996) found that factors causing construction waste span the project life cycle, including design stage, procurement, materials delivering / handling, construction / renovation, and demolition. Whilst there are still other research works examining waste generation factors, the major waste generation factors across the project stages can be summarized as listed in Table 2.

<Table 2>

Hong Kong is running out of both reclamation and landfill sites. It was estimated that Hong Kong landfills would be filled up in 10 to 15 years, and approved reclamation projects would only provide outlets for landfill until 2004 (EPD, 2003). In recent years, mixed construction waste had accounted for more than 40% of the total waste intake at the three strategic landfills (EPD, 2003). It was also reported that of all the 17,910 tons per day of solid waste disposed at landfills in 2000, 42% was from construction waste (EPD, 2003). Waste generation doubled from 1990 to 1999, compared to an expected growth rate of 20% per annum (EPD, 2003). These facts demonstrate that minimizing construction wastes becomes a pressing issue in Hong Kong.

Various waste management methods have been developed by previous researchers. For example, promotion was launched for using environmentally friendly construction methods, such as using large panel systems, applying prefabrication components, and reducing the application of wet trades (Ho, 2001). A hierarchy of waste management methodology has been promoted to classify and prioritise in descending order the waste management options: (a) reducing waste; (b) reusing waste; (c) recycling waste; and (d) disposing of waste where the first three options are not possible (Faniran and Caban, 1998). The major benefits through applying this approach are considered as the avoidance of creating new and undesirable landfill sites, stemming potential environmental health risks associated with waste and its disposal and reducing the cost of construction (Lingard *et al.*, 2000).

Waste minimization involves a process or activity that either eliminates or reduces waste generation at the source or allows reuse or recycling of waste for benign purposes (EPD, 2003). Nevertheless, existing practice shows the limited effectiveness in controlling waste generation from construction activities. The study by Coffey (1999) suggests that waste management in general was not given a priority in the process of project implementation. More construction materials are usually required due to the lack of considerations given to waste reduction during the planning and design stage. The wastage of various construction materials is usually given little attention in construction practice. According to a survey by Shen and Tam (2002), waste management has been receiving less attention from senior management in construction business in comparison to construction cost and time management. The cost of implementing waste management is often thought to be higher than the benefits that the organisation may gain from such management. There is a lack of awareness of environmental management tenets among frontline staff. Although various methodologies for reducing construction waste have been introduced, the effectiveness of their application is ineffective (Lingard *et al.*, 2000; Shen and Tam, 2002). The reasons for limited effectiveness in implementation of these methods are varied, such as no specification of waste reduction methods, improper site layout planning, lack of equipment for waste sorting, lack of experience in waste recycling operations, lack of knowledge of secondary material markets, and poor knowledge of environmental and safety regulations (Shen *et al.*, 2003).

The construction industry will continue to be a major waste generator in the coming years due to the expected implementation of ambitious construction projects in Hong Kong. In the previous years, the Hong Kong government has been promoting waste mitigation by introducing various regulatory measures. For example, the White Paper issued in 1989 (EPD, 2005) set up a 10-year plan for controlling and reducing construction waste and it was planned to review the progress of implementing the policy at two-year intervals. Another typical regulatory measure is the policy circular (Ref: 15/2003) “Waste Management on Construction Sites” issued by the Environment, Transport and Works Bureau of Hong Kong Government (ETWB, 2004), aiming for facilitating sorting of C&D waste. This initiative requires that waste materials be sorted before they leave construction sites. For example, construction waste should be sorted into excavated materials, metals, cardboard and paper packaging, plastics, chemical waste and others. This is a typical regulatory measure for minimizing construction waste. Whilst these regulatory measures have been adopted, it seems that little work has been done to examine the effectiveness of their implementations. Thus, the major contention of this paper is to find out whether the regulatory measures for controlling construction wastes are effective in practice.

2 Regulatory Measures for Controlling Construction Waste

The Hong Kong government has been adopting various measures to reduce waste generation from construction activities. These regulatory measures can be classified as seven groups (EPD, 2003):

(1) Legislative Controls

To reduce waste generation and protect the environment by legal enforcement, the Hong Kong government has issued various laws and ordinances. These ordinances applicable to construction activities include Water Pollution Control Ordinance (1980), Noise Control Ordinance (1989), Waste Disposal Ordinance (1980), Air Pollution Control Ordinance (1985) and Environmental Impact Assessment (EIA) Ordinance (1998) (EPD, 2003).

The Waste Disposal Ordinance (WDO) is the major ordinance for controlling waste generation in construction activities. It provides 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. The WDO has specified the environmental conditions at waste treatment and disposal facilities. Concerned parties must comply with the WDO for the disposal of chemical waste, toxic, hazardous and difficult waste, and the management of sludge arising from water / sewage treatment systems. The WDO also controls the import and export of waste.

(2) Controlling Public Filling Facilities

Public filling facilities, including public filling areas, barging points and stockpiling areas, are managed by the Civil Engineering Department of the Government. Inert waste from various construction activities are regulated to reuse for land reclamation and site formation. These facilities will only accept the waste suitable for reclamation, composing mainly of granular materials such as concrete, brick, sand, rubble, rock and earth. The volume of inert waste generated from construction activities in the local construction industry is huge. According to statistics from EPD (2003), the inert construction material delivered to public filling areas in 1999 was 29,220 tons Thus, regulating the use of public filling facilities is very important.

(3) Controlling Landfill Areas

The non-inert substances from construction and demolition are called C&D waste, mainly including bamboo, timber, vegetation, packaging waste and other organic materials. C&D waste are not suitable for land reclamation and are usually disposed of at landfills. It appears that landfill is a common method for disposing C&D waste. For instance Construction activity approximately generates 20 to 30% of all waste deposited in Australian landfills (Craven *et al.*, 1994; Hendriks and Pietersen, 2000). More than 50% of the waste deposited in a typical landfill in UK is construction waste (Ferguson *et al.*, 1995). 29% of the solid-waste stream in the USA is construction waste (Rogoff and Williams, 1994). In line with the “Polluter Pays Principle”, the Hong Kong government has recently introduced charges for the disposal of waste at landfills (WDO, 2006).

(4) Providing On-Site Sorting Facilities

The Hong Kong government has built up a number of waste sorting facilities. Several on-site sorting facilities were set up in 1998 for recovering usable materials, including those from roads, filling, landscaping and aggregate, and for reducing the amount of materials landfilled (WDO, 2003). The Civil Engineering Department set up a temporary waste sorting facility in Tseung Kwan O, New Territories in early 2000. An additional waste sorting facility came into operation in 2004. According to the governmental plan, another new permanent sorting facility will be set up in the near future. These facilities will be capable of sorting out about 2,000 tons of construction waste materials daily.

(5) Implementation of an Environmental Management System

Environmental management systems (EMS) lay out a broad range of environmental management methodologies, including the basic management system, auditing, performance evaluation, labeling, life-cycle assessment and product standards. There are five major elements of an EMS, namely, environmental policy, planning, implementation and operation, checking and corrective actions, and management review and improvement. The Hong Kong Government has been promoting the application of EMS (EPD, 2005).

(6) Implementation of a Waste Reduction Framework Plan

The Hong Kong Government launched a Waste Reduction Framework Plan (WRFP) in 1998 (WDO, 2003). The plan aims to improve public awareness on waste reduction. The WRFP sets out programmes to avoid and minimise waste; promote recovery, recycling and reuse of waste materials; prolong the life of existing landfills and reduce the increasing costs of waste transportation, treatment and disposal. The WRFP also provides suggestions on how different economic sectors can incorporate various waste reduction measures into their business practices. The plan is expected to bring a change from the traditional attitude of collecting and transporting waste to the prevention and reuse of waste materials. WRFP specifies six objectives (WRFP, 1998): i) extending the useful life of the strategic landfills; ii) minimising the amount of waste to be disposed; iii) helping conserve the earth's non-renewable resources; iv) increasing the waste recycling rate; v) minimising the costs of collection, treatment and disposal of waste; and vi) improving institutional arrangements (WRFP, 1998). According to WRFP plan (WRFP, 1998), one of the specific targets is to reduce construction material wastage by the maximum level of 84%.

(7) Implementing Recycling Scheme

Whilst waste recycling has been adopted in Hong Kong, the practice is mainly promoted among commercial and industrial sectors. Recycling has not been effectively promoted among construction practitioners (EPD, 2001). To promote recycling in the private construction sector, a Demonstration Scheme (DEMOS) has been introduced to encourage the adoption of new technologies in waste minimisation and recycling. In order to further improve recycling awareness, the government intends to provide incentives for people to set up recycling plants. Intermediate sorting plants for construction waste are being provided as a means of ensuring that the minimum amount ends up in landfills and that the majority is recycled or reused for land reclamation sites.

3 Research Methodology

A survey on the current practice of applying regulatory measures for controlling construction waste in Hong Kong has been conducted recently. In conducting the survey, a structured questionnaire was sent to managers or representatives in charge of environmental and safety issues in 200 construction organisations. The names of the 200 firms were identified from the Hong Kong Construction Association List. The list includes all the contractors approved by the Hong Kong Government (HKCA, 2003). 75 effective responses were received.

In the survey, the respondents were requested to indicate the effectiveness of each type of governmental control measure by selecting one of five effectiveness grades, namely, ineffective, less effective, effective, very effective and mostly effective. For assisting analysis, these five grades are given numerical values of “1”, “2”, “3”, “4” and “5” respectively, representing the degree of effectiveness. The grade “ineffective” indicates that a respondent considers that the concerned measure contributes no benefits to controlling construction waste, and that “mostly effective” indicates the most effective measure. For each regulatory measure, an average effectiveness score was calculated through using the following model:

$$E_i = \frac{\sum_{j=1}^{5} n_j v_j}{75}$$

where E_i denotes the average effectiveness score of the regulatory measure i; v_j denotes the numerical value of the effectiveness grade j (j=1, 2, 3, 4, 5); and n_j denotes the number of respondents who consider that the effectiveness grade of the regulatory measure i is j. The computated results on the average effectiveness score of each regulatory measure are illustrated in Table 3.

<Table 3>

Furthermore, seven interviews were conducted to further corroborate the questionnaire results, including two large-sized main contractors, three medium-sized main contractors and two sub-contractors. In addition, eleven projects under the operation by these seven contractors have been visited for collecting further practical data to support the analysis.

4 Effectiveness of Regulatory Measures in Controlling Construction Waste

Reuse and recycling of waste materials are considered as the most effective approach for waste minimisation. Typical types of waste materials suitable for recycling are listed in Table 4 (EPD, 2003). These include aggregates, asphalt, excavated materials, pulverized fuel ash, metals, glass, plastic, rubber and expanded polystyrene. Nevertheless, it appears that the method of recycling waste materials has not been well received in the practice largely because the initial costs for waste recycling are considered very high. The discussions with the main contractors concerned in the survey suggest that there is need for genuine support from clients and developers to mitigate the financial burden in setting up environmental facilities and necessary equipment for waste recycling.

<Table 4>

In the interview discussions with main contactors, it was found that the current legislation in Hong Kong on waste management was considered difficult to implement on site. For instance, the legislation requires that chemical waste should be treated and separated before dumping. In the legislation, the equipment used for storing chemical material is also classified as chemical waste. However, construction firms often treat such storing equipment as general wastage, thus normally they do not separate the wasted storing equipments for chemicals and dump them as normal construction waste at landfills.

The success rate of applying the guidelines “Controlling Public Filling Areas” and “Controlling Landfill Areas” is relatively low, with significance index value of 2.17 and 1.97 respectively, in comparing with the maximum value 5. This indicates that the current practice of public filling areas and landfill areas is considered not effective in guiding construction firms to limit the quantities of waste generation.

According to the survey results, the guidelines “Providing On-Site Sorting Facilities” and “Implementing Recycling Scheme” gained the effectiveness scores of 2.04 and 2.39 respectively. The relatively low values reflect that the construction practitioners are not attuned to the significance of reducing the amount of waste going to landfill by adopting sorting processes. To promote waste sorting out, spaces should be allocated for sorting facilities on landfills areas or construction sites. And suitable skips/buckets should be provided for temporary storage of sorted materials such as metals, concrete, timber, plastics, glass, excavated spoils, bricks and tiles. Where construction sites have limited space for sorting waste materials, the minimum efforts should be devoted to separate the inert and non-inert portions.

The guidelines “Implementation of an Environmental Management Systems” and “Implementation of a Waste Reduction Framework Plan” were appreciated with the scores of 2.96 and 3.28 respectively. This indicates that the two guidelines are considered relatively more effective in controlling waste generation. As the implementation of waste reduction framework plan (WRFP) has been well promoted since 1998, most of the interviewed contractors have recognised the benefits of implementing the WRFP plan in reducing waste on site. Furthermore, implementation of environmental management systems (EMS) has also been well received as it helps improve environmental image of companies. According to one main contractor interviewed, many project directors consider “environmental performance” as an emerging project objective; and the effectiveness of practicing EMS will be better if support from clients and developers is obtained.

In general, contractors will not invest much on environmental management as this is considered an increase in their operating costs. Thus, the use of tax reduction and subsidies from government can be considered as motivators. In fact, these encouragement measures were considered very effective from the responses in the survey. Of course, careful control in the use of public money for implementing waste reduction measures is important so that there will be less dissatisfaction and outcry from the public. Furthermore, construction organisations usually only consider meeting the minimum requirements set in the mandatory control measures. If requirements are not mandatory, construction organisations will normally not implement them. Nevertheless, it is worth noting that the application of WRFP and EMS is increasing. More construction organizations in Hong Kong have started voluntary waste reduction schemes. It is suggested that the voluntary scheme should be extended to education to enhance environmental awareness. However, for the effective and efficient implementation of waste management in the current construction industry, both voluntary and mandatory schemes should be promoted collectively.

5 Regulatory Commitments for Controlling Construction Waste Among Major Construction Practitioners

The commitments and responsibilities for controlling construction waste among major construction practitioners are defined in various regulations (WDO, 2003). These major regulations include Waste Disposal Ordinance 1980 (Chapter 354), Waste Disposal (Chemical Waste) (General) Regulation 1992 (Chapter 354), Waste Disposal (Permits and Licenses) (Forms and Fees) Regulation 1992, and Dumping At Sea Ordinance 1995 (Chapter 466).

These regulations provide controlling measures to mitigate the environmental pollution from construction wastes through various procedures. These waste control procedures (WCP) can be broadly classified into (WCP-1) issuing activity permission; (WCP-2) ensuring the environment allowable for implementing the construction activities; (WCP-3) defining the liability and penalty for poor environmental performance; and (WCP-4) defining measures for mitigating the environmental pollution caused by construction activity. The implications of these environmental protection measures are summarized in Table 5.

<Table 5>

In the current construction practice in Hong Kong, major commitments and responsibilities for controlling construction wastes among major construction practitioners have been regulated. These major commitments and responsibilities, denoted by C-WaP, can be summarised as follows (WDO, 2003):

C-WaP1 A person shall not use, or permit to be used, any land or premises for the disposal of waste unless he has a license from the Director of Environmental Protection Department to use the land or premises for that purpose.

C-WaP2 Any person who without lawful authority or excuse deposits or causes or permits to be deposited any waste: (a) in a public place; (b) on any Government land; or (c) on any land other than Government land without the consent of the owner or occupier, commits an offence.

C-WaP3 Any person who commits an offence on the cleanliness of land is liable: (a) for the first offence, to a fine of $200,000 and to imprisonment for 6 months; (b) for a second or subsequent offence, to a fine of $500,000 and to imprisonment for 6 months; and

(c) in addition, if the offence is a continuing offence to a fine of $10,000 for each day during which it is proved to the satisfaction of the court that the offence has continued.

C-WaP4 Any person shall: (a) not be used for any purpose other than the storage of chemical waste; (b) be enclosed on at least 3 sides by a wall, partition fence or a similar device, which shall not be less than (i) 2 metres in height; or (ii) the height of the tallest container or where appropriate the height of the tallest stack of containers, whichever is less; (c) have adequate ventilation to prevent the formation of any dangerous or harmful concentration of vapour in the event of spillage or leakage; (d) not have any connection to any surface water drains or foul sewers; (e) have adequate space for the handling of the containers; (f) where the storage area is located inside a multi-storey building, be so located as not to obstruct or in any way prejudice the use of any means of escape or exit from the building; (g) where the storage area is not within a building, be provided with a roof or a similar covering; and (h) be kept clean and dry.

C-WaP5 Without prejudice to any other requirement relating to the storage of chemical waste, a waste producer shall ensure that any area in which containers of chemical waste in liquid form are stored: (a) has an impermeable floor or surface; (b) has a retention structure with the capacity to accommodate: (i) the contents of the largest container; or (ii) 20% by volume of the chemical waste, stored in that area, whichever is the greater; and (c) where such containers are stacked, is enclosed by walls or partitions constructed out of an impermeable material.

C-WaP6 A waste producer shall ensure that: (a) any container with chemical waste is not stored with other waste, whether chemical or otherwise, if it is likely that there will be dangerous consequences to the health or safety of any person in the event of its contact with such other waste; (b) any stacks of containers of chemical waste are made secure so as to prevent their falling down.

C-WaP7 The requirements relating to storage shall not apply where: (a) the chemical waste is stored in the working or processing area; (b) the quantity of chemical waste stored in a single working or processing area does not exceed 50 liters; (c) the chemical waste so stored is packed or stored in containers and labeled as required by this Regulation; (d) the containers are kept in a cupboard, cabinet or receptacle which is safe and suitable having regard to the nature of the chemical waste; and (e) in the case of different chemical waste which are likely in the event of contact with one another to produce consequences dangerous to the health or safety of any person are stored, that they are separated inside the cupboard, cabinet or receptacle, as the case may be, by an impermeable partition.

C-WaP8 Any person who: (a) places or throws any solid matter, mud or waste (except such as is contained in ordinary house sewage) in or into any public sewer or drain or any sewer, drain, inlet or other drainage work communicating with any public sewer or drain, or over any grate communicating with any public sewer and drain; (b) causes or knowingly permits any such matter, mud or waste to be placed or thrown, or to fall, or to be carried, in or into any public sewer or drain or over any such grate; (c) causes or knowingly permits any such matter, mud or waste to be placed in such a position as to be liable to fall or be carried as aforesaid; (d) discharges into any public sewer or drain or into any sewer or drain which, not being a public sewer or drain, communicates therewith, any chemicals, oils, petroleum or petroleum-spirit or any trade waste (not included as aforesaid) or any waste steam, or any heated liquid, which, either alone or in combination with other matter in any sewer or drain, causes or may cause nuisance or danger to persons entering or being in, or near to, any public sewer or drain or danger to any public sewer or drain itself; or (e) willfully, except with the permission in writing of the Authority, or negligently damages, alters, disconnects or otherwise interferes with any public sewer or drain or any connection therewith, shall be guilty of an offence.

C-WaP9 No person shall deposit or cause or permit to be deposited any litter or waste on or in: (a) any street or public place; (b) the common parts of any building; (c) any watercourse, stream, channel, ditch or reservoir; (d) any Government property except with the consent of a public officer; or (e) any land except with the consent of the owner of the land.

The above are the summarised regulatory commitments and responsibilities among construction participants. It can be seen that contractors assume more responsibilities (see Table 6). Other parties including client, designer and consultant have assumed less regulatory commitments. It raises the assumption that the currently ineffective implementation of environmental management in the local construction industry is largely due to the skewed allocation of regulatory responsibilities among project parties. To testify this assumption, a survey was conducted to eleven selected projects in order to understand whether regulatory measures are adopted effectively in the practice. The survey results are summarised in Table 7. The frequency of using the WCP among the surveyed projects is presented in Table 8.

<Table 7>

<Table 8>

From the results demonstrated in Table 8, it can be seen clearly that WCP-2 (ensuring the environment allowable for implementing the construction activities) has not been effectively received, which has been applied in less than 30 percent of the projects surveyed. This reflects that there is lack of proper planning for managing construction waste among the construction organisations. Since time and cost are traditionally considered as the most important criteria for judging the success of implementing construction works, other responsibilities such as environmental protection will be scarified.

6 Conclusion

As there are limited landfill spaces available in Hong Kong, implementing waste management has caused increasingly the attentions to construction stakeholders. This research examined the effectiveness of governmental functions in controlling construction waste in Hong Kong construction industry. The results indicate that the regulatory measures for controlling construction waste are of limited effectiveness in practice. The study has also found that existing waste control ordinances allow for skewed distribution of commitments and responsibilities of controlling construction waste among project stakeholders. This skewed commitment allocation is considered as one of the key reasons contributing to the limited effectiveness of implementing the regulatory measures in the practice. Revision and further development of legal measures are necessary to ensure that all project stakeholders play an active role and share commitments in waste control and reduction. This research provides references for studying construction waste management in other construction industries.

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Table 1: Typical composition of construction waste

Constituent	Percentage of weight
Asphalt	0.2
Brick/tiles	9.3
Concrete/mortar	17.1
Reinforced concrete	1.7
Rock/rubble	5.5
Sand	0.4
Soil	27.2
Bamboo	0.4
Ferrous metal	3.0
Non-ferrous metal	0.5
Glass	0.3
Junk/fixtures	0.4
Plastic	0.6
Slurry/mud	18.4
Trees	0.2
Wood	9.4
Other organics and garbage	5.4
Total	100.0

Table 2: Waste generation factors across construction project life cycle

Project life cycle process	Waste generation factors
Design	Design errors Poor buildability Design changes
Procurement	Shipping error Faults in taking off Ordering error
Materials handling	Damage due to improper storage Deterioration Improper handling (on-site or off-site)
Construction / renovation	Human error Damage due to improper operation on equipment Abandoned work due to poor workmanship Trades person Equipment error Others (e.g. catastrophe, accident and weather)
Demolition	Trip ticket arrangement

Table 3 Survey results about the effectiveness of regulatory measures

in controlling construction waste

Government controlling measures	Number of respondents					Average
	Ineffective	Less effective	Effective	Very effective	Strongly effective	
	“1”	“2”	“3”	“4”	“5”	
Legislative controls	9	41	21	4	0	2.27
Controlling public filling facilities	18	31	21	5	0	2.17
Controlling landfill areas	21	37	15	2	0	1.97
Providing on site sorting facilities	20	35	17	3	0	2.04
Implementing environmental management system	2	22	31	17	3	2.96
Implementing waste reduction framework plan	1	12	34	21	7	3.28
Implementing recycling scheme	12	34	18	10	1	2.39

Table 4 Recycled materials in construction industry (EPD, 2003)

Recycled materials	Uses	Local examples
Aggregates	Sub-base material for road construction, hardcore for foundation works, base / fill for drainage, aggregate for concrete manufacture and general bulk fill	Pilot studies carried out by works department
Asphalt	Aggregate fill and sub-base fill	Under investigation by Highways Department
Excavated materials	Filling materials	Housing Department's building projects
Public fill	Land reclamation	Land formation of public filling areas
Pulverized fuel ash	Manufacture of concrete products, uses in fill and reclamation, highway construction and reinforced soil structures	Construction of Chek Lap Kok Airport, use in structural concrete for foundation works in the Housing Department's building projects
Metals	Manufacture of new metals	Widely practiced in local construction industry
Glass	Substitute for sand and aggregates as pipe-bedding material, gravel backfill for walls, crushed stone surfacing, backfill and bedding	Nil
Plastic	Synthetic materials in form of plastic lumber for landscaping, horticulture and hydraulic engineering	Use at some public recreational facilities as garden furniture
Rubber	Manufacture of rubber slate tile use in roofing and sport / playground surface mat	Use at some public recreational facilities as playground surface mat
Expanded polystyrene	Manufacture of lightweight concrete for non-structural works	Use in manufacturing lightweight concrete in Housing Department's building projects

Table 5 Implications of waste control procedures (WCP)

WCP	**Implications**
(WCP-1), issuing activity permission, denoted by ▲	Any activity, which may have adverse impacts on the environment, must be approved by relevant authoritative departments. These activities, which have possible negative environment impact, should not be commenced before the official permit is granted
(WCP-2), ensuring the environment allowable for implementing the construction activities, denoted by ▼	Fulfillment of the requirements from regulations and ordinances in terms of quality, ensure the environment is suitable for on-site construction activities, including maintenance works, update these equipments requirements from time to time
(WCP-3), defining the liability and penalty for poor environmental performance, denoted by ◆	The prosecutions of the non-compliance of regulations and ordinances; continuous prosecutions will also arise highly penalty rate
(WCP-4), defining measures for mitigating the environmental pollution in implementing construction activity, denoted by ◢	The activities should be prepared with a qualified engineer or an authorised person in terms of principle, procedure, guideline, standard and limit and the availability of representatives to follow the particular projects. The activities should be prepared and maintain any measures for wastewater discharge in water pollution

Table 6 Interrelationship between commitments (C-WaP) and waste control procedure (WCP)

C-WaP	***WCP***	***Connected Parties***		
		Client	***Contractor***	***Architect***
C-WaP1	▲	√	√	
C-WaP2	▲		√	
C-WaP3	◆		√	
C-WaP4	▼◢		√	√
C-WaP5	▼◢		√	√
C-WaP6	▼◢		√	
C-WaP7	▼◢		√	
C-WaP8	▼◢		√	
C-WaP9	▼◢		√	

Table 7 Survey results about the application of environmental regulations in implementing construction project

Waste Pollution Control Measures	Surveyed construction projects										
	EIA-088/2002	EIA-085/2002	EIA-083/2002	EIA-082/2002	EIA-081/2002	EIA-079/2002	EIA-078/2002	EIA-077/2002	EIA-076/2002	EIA-075/2002	EIA-074/2002
WCP-1	Y	Y	N	Y	Y	N	Y	Y	N	Y	Y
WCP-2	Y	N	N	N	N	N	Y	Y	N	N	N
WCP-3	Y	Y	N	Y	Y	N	Y	Y	N	Y	Y
WCP-4	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y

Table 8 The frequency of using WCP among the surveyed projects

	C-WaP
WCP-1	8/11
WCP-2	3/11
WCP-3	8/11
WCP-4	9/11

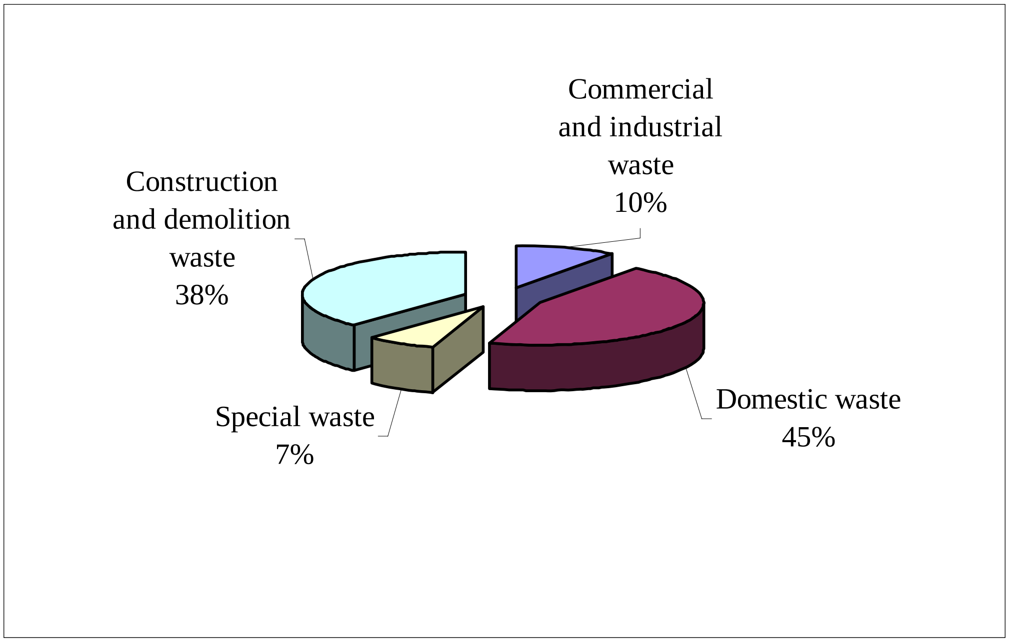

Figure 1: Solid Waste Disposal in 2001 (EPD, 2003)