THE EFFECT OF LEGISLATION ON THE CONTRACTOR'S ATTITUDES ON SOLID WASTE REDUCTION

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ABSTRACT

It has been a difficult task to reduce and handle solid wastes generated from construction and demolition (C&D) activities in a number of countries. In Hong Kong, the C&D solid wastes of which many of them are suitable for recycling land reclamation were typically disposed to landfills. Regarding this, in December 2005, a main piece of legislation regarding the C&D solid waste minimization namely the Construction Waste Disposal Charging Scheme (CWDCS) was enacted in Hong Kong. Since then disposal of C&D solid waste to public landfill sites has no longer been a 'free meal' for the contractors. While the government statistics indicate that the average quantity of C&D solid waste disposed to the public landfill has been tremendously decreased, disgraceful news about the illegal disposal of C&D waste by contractors have begun to mount. Some criticized that the illegal disposal was indeed driven by the legislation. It is because the legislation itself basically cannot solve the problems encountered by the contractors i.e. an effective solid waste reduction and management. As such, a behavioral change of solid waste disposal by the contractors has yet been noted. This study uses the enactment of the CWCS as a benchmark, and seeks to investigate [1] whether the Scheme has prompted the construction contractors to adopt C&D solid wastes reduction strategies in the construction projects; and [2] the effect of the strategy applied by the contractors on C&D solid waste reduction in their projects. A questionnaire survey was conducted. The analysed results based on the Pearson correlation analysis show that the enactment of the CWCS merely led the main contractors reorient their operational practices. Collaboration among project team members in C&D solid waste reduction remains inadequate. Recommendation in response to the research findings was suggested.

KEYWORDS

Solid waste reduction, Construction Waste Charging Scheme.

INTRODUCTION

Reducing and managing solid wastes generated from construction and demolition (C&D hereafter) activities have been problematic in many countries for years (Ferguson et al. 1995). In United Kingdom, C&D activities contribute to over 50% of the solid waste of the country (Ferguson et al. 1995). In Australia, solid wastes generated from the C&D activities engage 20 to 30% of the domestic landfill sites annually (Ekanayake and Ofori 2004). Similar situation is being faced by the government of the United States, 50 to 60% of the landfill sites are occupied by the C&D solid wastes (Kibert 2000). Likewise, in Hong Kong, a report from the Environmental Protection Department (EPD) of the government reveals that a huge amount of C&D materials being disposed at landfill sites are indeed recyclable (EPD 2010). If no action is taken for solid waste reduction, the capacity of the land reclamation and landfill areas will reach the threshold in early to mid-2010s. Civil Engineering and Development Department (CEDD) and the Environmental Protection Department (EPD) are the government bodies in Hong Kong who administer the policing issues related to the C&D solid waste management. In response to the problem, in December 2005, a main piece of legislation regarding the C&D solid waste reduction namely the 'Construction Waste Disposal Charging Scheme (CWDCS)' was enacted in Hong Kong. Since then, disposal of C&D solid waste to public landfill sites has no longer been a 'free meal' for the construction contractors. 'Main contractor who undertakes construction work under a contract with value of HK$1 million or above is required to open a billing account solely for the contract' (EPD 2010). A charge ranges from HK$27 to $125 per tonne applies for C&D materials being disposed to the government waste disposal facilities (ETWB 2004). Reckoned that the construction contractors can recover the charges from their customers,

it is expected that the levy would materially affect all construction practitioners, as well as the end-users of the buildings.

Government statistics indicate that the legislation may have led to the construction contractors' behavioural change in solid waste disposal. Just three years after the implementation of CWDCS, the amount of C&D solid wastes disposed to the public landfills tremendously decreased by nearly 60% from 6555 to 2659 tonnes per day (EPD 2006, 2007, 2008). Seemingly, the government won the first battle of C&D waste reduction for Hong Kong. Nevertheless, behind the battlefield, disgraceful news about the illegal C&D wastes disposal by the construction contractors was also reported. Some reckoned that such illegal disposal cases were driven by the enactment of the CWDCS. It is because the contractors on one hand do not wish to pay charges, but on the other hand may not easily recoup all the additional cost incurred from the client based on the contract terms. This study uses the enactment of the CWDCS as a benchmark, and seeks to investigate:

1. whether the Scheme has prompted the construction contractors to adopt C&D solid wastes reduction strategies in the construction projects; and
2. the effect of the adopted strategies in reducing C&D solid wastes in projects.

The findings of this research are anticipated to be helpful for the contractors to decide more effective C&D solid waste reduction and management strategies. Furthermore, the respective government officials can also base on this pilot study to consider or revise the policies in helping the construction contractors to reduce C&D solid wastes.

DEFINITIONS OF CONSTRUCTION AND DEMOLITION (C&D) SOLID WASTES

C&D solid waste management is a developing and emerging research topic in construction (Serpell and Alarcon 1998, Kulatanga et al. 2006, Tam and Tam 2006). Skoyles and Skoyles (1987) defined C&D solid waste as the difference between the purchased materials and those consumed in a construction project. A report from the Hong Kong Polytechnic (1993) extended Skoyles and Skoyles' (1987) work by defining C&D solid waste as the waste 'generated and removed from construction, renovation and demolition work places or sites of building and civil engineering structure'. Similar definition was used by Harvard Green Campus Initiative (2004) who defined C&D solid waste as those 'wastes generated from the construction, remodeling, renovation or repair operation'. Kulatanga et al. (2006) argued that 'waste' has been typically defined as the leftover from human and industrial activity that has no or minimal residual value. In this regard, C&D solid wastes, of which a large portion of them have residual values and can be recycled, should not fall under such definition (Kulatanga et al. 2006). Ekanayake and Ofori (2004) shared similar insight and defined C&D solid wastes as 'any material apart form earth materials, which needed to be transported elsewhere from the construction site or used on the site itself other than the intended specific purpose of the project due to damage, excess or non-use or which cannot be used due to non-compliance with specifications, or which is a by-product of the construction process'. Benefited from the wealth previous studies, EPD (2010) further defined C&D wastes as 'any substance, matter or thing that is generated from construction works and abandoned, whether or not include any sludge, screenings or matter removed in or generated from any de-sludging or de-silting or dredging works'. Having considered this study is carried out in Hong Kong and CWDCS is a piece of legislation drafted by the EPD; this study employs the definition of C&D wastes proposed by the EPD (2010).

THE CONSTRUCTION AND DEMOLITION WASTE REDUCTION STRATEGIES

In this study, methods that had been identified in international journal papers and/or government reports as effective for reducing C&D solid wastes are described as the C&D solid wastes reduction strategies. Construction by nature is a labour-intensive industry. In this connection, Kulatunga et al. (2006) emphasize the importance of nurturing the project team members and the front-line workforce with a positive attitude towards C&D solid wastes reduction. Based on a review of literature, they noted that senior management contributions to develop and implement waste reduction plans are often inadequate in construction projects. In this connection, senior management in a construction projects are suggested becoming **more devoted to develop waste management plan and implementation**. Furthermore, as contractors and sub-contractors are conventionally more concern about meeting the pre-determined time and cost targets, they may not fully address the importance of implementing the waste management plan. It is suggested that minimizing C&D waste in operations should be set as one of the project goals**.** In this connection, **waste reduction is recommended as one of the usual discussion issues in the regular meetings among consultants, main contractors and sub-contractors.** EDP (2009) introduced the Hong Kong Awards for Environmental Excellence to recognize those construction organizations who have 'demonstrated all-round and outstanding environmental performance' in their practices. Echoed with Kulatunga et al. (2006), EPD suggested 'developing waste management plan detailing waste

avoidance, treatment and disposal measures for any construction site' as one of the strategies for the contractors to reduce C&D wastes.

Based on a questionnaire survey conducted in Sri-Lanka, Kulatunga et al. (2006) also identified that the employees' understanding about the policy in waste reduction decreases from the top to the bottom of the organization hierarchy. It is therefore suggested that the **goal of reducing C&D waste in construction operations should be fully acknowledged by the front-line workers.** Furthermore, as benefits are not guaranteed by adopting the recommended waste management practice, front-line workers and the sub-contractors typically do not feel interest in reducing C&D wastes in their operations. In this regard**, introducing incentive scheme for encouraging best practice of waste reduction** is recommended (Kulatunga et al. 2006). Teo et al. (2000) reckoned that front-line workers' behaviors are the likely hindrance to C&D waste reduction as construction is a labour intensive activity. In this connection, cultivating the frontline workers to engage in reducing and managing waste is vital for the success of C&D waste reduction (Teo et al. 2001). Likewise, Tam and Tam (2006) suggested introducing an incentive scheme to encourage the construction contractors to reduce C&D solid wastes through avoiding recyclable construction materials from dumping to landfill sites.

Ekanayake and Ofori (2000) identified four major aspects that contribute to C&D solid wastes generation: Design, Operational, Material Handling and Procurement. In design aspect, the lack of consideration about wastage in construction designs and materials selection is pinpointed as one of the major causes of C&D waste generation. Furthermore, constrained by the time available for design development, architects and engineers often found a short of time to communicate with the contractors regarding the workability of the drawings and specifications. Consequently, the miscommunication may lead to design changes and reworks that generate undesirable C&D wastes. Another major source of C&D wastes is originated from the improper site and operational management during the construction process. With effective communication among the designers, main-contractors and the sub-contractors, operational errors that lead to rework and material wastage can be reduced. In material handling aspect, C&D wastes not only generate from the improper storage of building materials, but also from the unsystematic approach in sorting and segregating wastes. Ordering excessive materials or building materials that do not comply with the specification requirements are identified as the major procurement related sources of C&D wastes generation. Regarding the above, Ekanayake and Ofori (2004) further suggested a number C&D wastes reduction strategies. These include**: [1] maintaining effective communication among project team members to reduce design errors; [2] selecting/ proposing alternative construction materials with less wastage ; [3] clearing errors and discrepancies in drawings before commencing the work to reduce abortive work and rework; [4] reducing wastage caused by operational errors and mismanagement; [5] selecting/ proposing alternative construction methods that can reduce waste generation; [6] avoid ordering excessive materials and materials that do not comply with the specification requirements; [7] effectuating on-site sorting and segregation of wastes and recyclable materials ; [8] selecting a weatherproof and secured location for material storage; [9] improving in-house staff training and education.** Similar points of view can also be found in some construction industry review reports (Egan 1998, EDP 2009). Egan (1998) suggested that the more effective the communication among designers, main contractors and sub-contractors during construction period, the better the reduction of C&D wastes can be done. EDP (2009) suggested several criteria for assessing the contractors' contributions to C&D wastes reduction: [1] whether they purchase materials in a manner that minimises waste and avoid unnecessary costs; [2] whether they implement measures to minimize over-ordering and waste of materials; [3] whether they check consistency of drawings and specifications to avoid unnecessary hacking-off of concrete or unwanted work; [4] whether they use a designated area for temporary waste storage and subsequent segregation for ease of handling; [5] whether they instruct workers to adopt recycling and re-use of materials from demolition.

Summarizing from the above literature, 13 C&D solid waste reduction strategies are identified for this study. Their descriptions and references are presented in Table 1. The 13 strategies are identified through several case studies, reports and the survey results done in different countries including United States, United Kingdom, Sri Lanka and Hong Kong, China etc. The validity of these strategies in reflecting the practitioners' views is ensured.

Table 1 Construction and Demolition (C&D) waste reduction strategies

Strategies	Egan (1998)	Lawson and Douglas (2001)	Poon et al. (2001)	Ekanayake and Ofori(2004)	Saunders and Wynn (2004)	Kulatunga et al. (2006)	Tam and Tam (2006, 2008)	Esin and Cosgun (2007)	EDP (2009)
[1] Becoming more devoted to develop waste management plan and implementation					*	*			*
[2] Waste reduction becomes a usual discussion issue in the regular meetings among project team members					*	*		*	*
[3] Ensuring the goal of reducing C&D waste in construction operations is acknowledged by the front-line workers.						*	*		
[4] Introducing incentive scheme for encouraging best practice of waste reduction			*		*	*	*		
[5] Maintaining effective communication among project team members to reduce design errors	*			*					
[6] Selecting/ proposing alternative construction materials with less wastage				*					*
[7] Clearing errors and discrepancies in drawings before commencing the work to reduce abortive work and rework		*		*					*
[8] Reducing wastage caused by operational errors and mismanagement				*					*
[9] Selecting/ proposing alternative construction methods that can reduce waste generation				*					*
[10] Avoid ordering excessive materials and materials that do not comply with the specification requirements				*					*
[11] Effectuating on-site sorting and segregation of wastes and recyclable materials			*	*					*
[12] Selecting a weatherproof and secured location for material storage				*	*			*	*
[13] Improving in-house staff training and education				*				*	

DATA COLLECTION

This study uses the enactment of the CWDCS as a benchmark, and seeks to investigate the effectiveness of the C&D solid wastes reduction strategies being adopted by the construction contractors in projects. A questionnaire survey was conducted in order to collect data about [1] whether the CWDCS has prompted the construction contractors to adopt C&D solid wastes reduction strategies and [2] whether the respective strategies are contributive to reducing C&D solid wastes. The questionnaire consists of two parts. The first part includes questions designed to solicit the respondents' demographic information. Part 2 consists of two sections. Section 2(i) includes 13 questions which are designed for collecting the respondents' perceptive views on whether the CWDCS has prompted them to adopt the 13 C&D solid wastes reduction strategies as identified in Table 1. In Section 2(ii), respondents were asked to express their degree of agreement on whether the adopted strategies are whether the respective strategies are contributive to reducing C&D solid wastes in projects. In part 2, respondents were asked to respond to the questions on a seven point likert scale (from 1: strongly disagree to 7: strongly agree).

The questionnaires were then sent to the construction companies in Hong Kong. The list of target respondents were prepared by referring to the official webpage of The Hong Kong Construction Association (HKCA) and the updated Hong Kong Builders' Directory published by Far East Trade Press (2003). The target respondents include directors, project managers, professional grade staffs (including engineers and surveyors) and the operational grade staffs (including project coordinators and site safety managers) from the construction companies.

DATA ANALYSIS METHODS

Two types of data analysis methods were employed in order to achieve the research objectives: Descriptive Statistics and Pearson correlation. Descriptive statistics are used to describe the characteristics of samples. Furthermore, respondents' perceptive views on whether the CWDCS has prompted them to adopt the 13 C&D solid wastes reduction strategies and their evaluation about the contribution of the adopted strategies were examined by comparing the mean scores and standard deviations of the questions.

To examine the effect of the strategies on reducing the C&D wastes in projects, Pearson correlation analysis (PCA) was applied. PCA is a statistical method with a primary purpose to measure whether there is a significant relationship between two sets of ratings. The significance of relationship can be expressed by the ρ-value. As such, the relationship between two sets of ratings is considered as significant when ρ-value <0.05. Furthermore, the extent of the correlation between the two sets of ratings can be signified by the correlation coefficient value (the r-value), which can take on the values from -1.0 to 1.0, where 0 represents no correlation and 1.0 and -1.0 represent perfect positive and negative correlations respectively (Norušis 2002, Pallet 2001, Wong et al. 2004).

THE RESPONSE RATE

A total of 180 questionnaires were sent and 109 were completed and returned by the respondents. 9 replies were excluded due to the consistency of rating or the incompletion of responses. Therefore, a total of 100 valid responses were used for the analysis. The response rate of this study is 55.6%. Both the valid response rate and the sample size were considered reasonably well compared with the similar studies conducted in the Singapore (Ekanayake and Ofori 2004) and Hong Kong (Tam and Tam 2006). Among the valid responses, over 80% of the respondents have over 5 years working experience and all of them have experience in managing C&D solid waste on site (Tables 2 and 3 refers). These ensure the reliability of the data.

Table 2 Respondents' working experience

Respondents' working experience	Number of responses (%)
Less than 5 years	16 (16.0)
5 to 10 years	37 (16.0)
11 to 15 years	31 (16.0)
15 to 20 years	10 (16.0)
More than 20 years	6 (16.0)
Total	100 (100%)

Table 3 Respondents' experience in managing construction and demolition wastes on site

Question asked: Do you have any site experience in managing construction and demolition?	Number of responses (%)
Yes	100 (100%)
No	0 (0%)
Total	100 (100%)

FINDINGS AND DISCUSSIONS

Descriptive Statistics

The 13 strategies were ranked by the mean scores derived from all valid responses. If two or more strategies happened to have the same score, the one with the lower standard deviation will be assigned the higher ranking (Table 4 refers). From Table 4, it can be seen that the mean scale ratings for all questions are higher than the mid-point score of 3.5 in a 7-point scale. This can be interpreted that, as a whole, the respondents agreed that the CWDCS has prompted the adoption of the 13 C&D solid waste reduction strategies. Government statistics indicate that before the introduction of the CWDCS, contractors mainly disposed C&D solid wastes directly to the landfill sites. Based on the survey results, it seems that the CWDCS has successfully led the construction contractors to re-visit their construction waste reduction strategies. The general positive effect of their strategies reviews can be evidenced by the decreasing amount of C&D solid wastes being disposed to the landfill sites from 2006 to 2009.

Among the 13 strategies, 'Reducing wastage caused by operational errors and mismanagement' ranked first (mean scale rating 5.44). The next two on the list are 'Avoid ordering excessive materials and materials that do not comply with the specification requirements' (mean scale rating 5.37) and 'Effectuating on-site sorting and segregation of wastes and recyclable materials' (mean scale rating 5.30). The results indicate that contractors are

putting effort in reorienting their operational practices in response to the enactment of the CWDCS. Nevertheless, strategy that implies additional expenditure seems to be less popular. 'Introducing incentive scheme for encouraging best practice of waste reduction' ranked the lowest (mean scale rating 4.30). This may be due to the fact that tender price has been used as the sole criteria for contract award decisions. As a result of the tight budget and low profit margin, resources may be scarcely allocated to offer incentives to staff to reduce C&D solid wastes.

Furthermore, the mean scores of, 'Maintaining effective communication among project team members to reduce design errors' (mean scale rating 4.33), 'Clearing errors and discrepancies in drawings before commencing the work to reduce abortive work and rework' (mean scale rating 4.31) and 'Selecting/ proposing alternative construction methods that can reduce waste generation'(mean scale rating 4.30) are also comparatively low. The results indicate that contractors are less preferable to seek the inputs from the clients and their consultants when considering C&D waste reduction strategies.

Table 4 Means and rankings of adoption of waste reduction strategies

	Means Scale Rating	Standard Deviation	Rank
Reducing wastage caused by operational errors and mismanagement	5.44	1.28	1
Avoid ordering excessive materials and materials that do not comply with the specification requirements	5.37	1.26	2
Effectuating on-site sorting and segregation of wastes and recyclable materials	5.30	1.31	3
Selecting a weatherproof and secured location for material storage	5.27	1.43	4
Improving in-house staff training and education	5.21	1.39	5
Ensuring the goal of reducing C&D waste in construction operations is acknowledged by the front-line workers.	5.21	1.33	6
Becoming more devoted to develop waste management plan and implementation	4.78	1.22	7
Waste reduction becomes a usual discussion issue in the regular meetings among project team members	4.77	1.12	8
Selecting/ proposing alternative construction materials with less wastage	4.75	1.14	9
Maintaining effective communication among project team members to reduce design errors	4.73	1.21	10
Clearing errors and discrepancies in drawings before commencing the work to reduce abortive work and rework	4.31	1.23	11
Selecting/ proposing alternative construction methods that can reduce waste generation	4.30	1.06	12
Introducing incentive scheme for encouraging best practice of waste reduction	4.30	1.21	13

Respondents perceived that the strategies that their companies adopted are generally contributive to reducing C&D solid wastes in projects (Mean scores range from 4.00 to 5.39) (Table 5 refers). It is worth noting that despite being ranked as the least adopted strategy, respondents generally recognized the contribution of the incentive scheme in facilitating C&D waste reduction (Mean score 4.88). Nevertheless, among the strategies, 'Clearing errors and discrepancies in drawings before commencing the work to reduce abortive work and rework' (mean scale rating 4.00), 'Waste reduction becomes a usual discussion issue in the regular meetings among project team members' (mean scale rating 4.28) and 'Maintaining effective communication among project team members to reduce design errors' (mean scale rating 4.29) ranked the lowest three in terms of their contribution to the C&D waste reduction in projects. The results indicate that contractors are less preferable to reduce C&D waste by adopting those strategies which are dependent on the contribution of the clients' consultants. The results may be understandable in the sense that many construction projects in Hong Kong are procured under lump-sum contract arrangement. Contractors are typically paid for converting the clients' consultant design to reality. With such background, clients' consultants typically take the leading role in the project team meetings. Discussions are overwhelmed by topics related to the financial benefits of the clients. Waste reduction, which typically is viewed as an internal affair of the contractors, may receive less attention during the project meetings.

Table 5 Respondents' degree of agreement about the contribution of the adopted strategies to waste reduction

	Means Scale Rating	Standard Deviation	Rank
Reducing wastage caused by operational errors and mismanagement	5.39	1.26	1
Effectuating on-site sorting and segregation of wastes and recyclable materials	5.32	1.23	2
Avoid ordering excessive materials and materials that do not comply with the specification requirements	5.31	1.44	3
Selecting a weatherproof and secured location for material storage	5.18	1.38	4
Improving in-house staff training and education	4.93	1.09	5
Introducing incentive scheme for encouraging best practice of waste reduction	4.88	1.29	6
Selecting/ proposing alternative construction methods that can reduce waste generation	4.57	1.09	7
Ensuring the goal of reducing C&D waste in construction operations is acknowledged by the front-line workers.	4.49	1.23	8
Selecting/ proposing alternative construction materials with less wastage	4.39	1.16	9
Becoming more devoted to develop waste management plan and implementation	4.32	1.66	10
Maintaining effective communication among project team members to reduce design errors	4.29	0.95	11
Waste reduction becomes a usual discussion issue in the regular meetings among project team members	4.28	1.40	12
Clearing errors and discrepancies in drawings before commencing the work to reduce abortive work and rework	4.00	1.57	13

Correlation between strategies adoption and contribution to waste reduction

Pearson correlation analysis results are shown in Table 6. The adoption of 9 out of 13 strategies were found strongly correlated (with correlation coefficients ranged from 0.40 to 0.78) with their contribution to C&D waste reduction in projects at the significant level of $p<0.01$. This indicates that the greater the adoption of these strategies, the more contributive the adopted strategies in reducing C&D solid wastes in projects.

Some scholars argued that the cost incurred by proper waste management in projects may still be higher than the charges being imposed to the contractors (Poon et al. 2001). In this connection, it is dubious that CWDCS can be an effective tool to facilitate C&D waste reduction in Hong Kong (Poon et al. 2001). The results of this study indicate that the CWDCS to some extent serves its function as an economic disincentive to direct contractors' behavioral changes in C&D waste management.

4 strategies were found to have the positive correlation coefficients greater than 0.7: Reducing wastage caused by operational errors and mismanagement (Correlation coefficient = 0.78), Avoid ordering excessive materials and materials that do not comply with the specification requirements (Correlation coefficient = 0.75), Effectuating on-site sorting and segregation of wastes and recyclable materials (Correlation coefficient = 0.73) and Selecting a weatherproof and secured location for material storage (Correlation coefficient = 0.73). The results are generally in line with the observations of the EPD about the contractors' behavioural changes after the enactment of the CWDCS. Contractors are becoming more conscientious in exploring methods to reduce disposing C&D solid wastes to landfills. Wastes generated from C&D activities can be reduced by a number of strategies (Ekanayake and Ofori 2004). The results of this study indicate that contractors may be more effective in reducing C&D waste reduction through evaluating their own operational practice.

Significant positive correlations were not found in four strategies: Clearing errors and discrepancies in drawings before commencing the work to reduce abortive work and rework, Selecting/ proposing alternative construction materials with less wastage, Maintaining effective communication among project team members to reduce design errors, and Waste reduction becomes a usual discussion issue in the regular meetings among project team members. This indicates that even with a greater extent of adoption, the contribution of these strategies to the C&D waste reduction in the projects may not be enhanced significantly. These results are generally in line with many previous literatures claiming that the uncooperative manners among the project team members is one of the major barriers to the successful C&D waste reduction (Ekanayake and Ofori 2004, Kulatunga et al. 2006). Supporting by previous studies, the bid price driven environment and the conventional construction contract terms do not rewards contractors for reducing solid waste generation on site. Yet, contractors may be penalized

for not complying with the designers' instruction and completing the project on time and within budget. In this connection, it is not surprising that the contractors may have hesitation to initiate the move of C&D waste reduction in projects. Construction projects in Hong Kong are typically procured under the lump-sum basis. Designers who have the decisive role on design change and material use are typically employed by the developers. It is suggested that the architects and the engineers should align with the contractor and embrace C&D waste reduction as the common project goal. They are suggested to encourage feedback from the contracts regarding the possible methods to reduce construction waste. With effective communication between the designers and the contractors, materials wastage due to the incompatibility of design to the real site conditions can be prevented (Ekanayake and Ofori 2004)

Table 6: Correlation between strategies adoption and contribution to waste reduction

Strategies	Correlation between strategies adoption and contribution to waste reduction	
	Correlation coefficient	p-value
Reducing wastage caused by operational errors and mismanagement	.777*	.000
Avoid ordering excessive materials and materials that do not comply with the specification requirements	.753*	.000
Effectuating on-site sorting and segregation of wastes and recyclable materials	.734*	.000
Selecting a weatherproof and secured location for material storage	.734*	.000
Becoming more devoted to develop waste management plan and implementation	.501*	.000
Ensuring the goal of reducing C&D waste in construction operations is acknowledged by the front-line workers.	.449*	.000
Selecting/ proposing alternative construction methods that can reduce waste generation	.437*	.000
Introducing incentive scheme for encouraging best practice of waste reduction	.406*	.000
Improving in-house staff training and education	.403*	.000
Clearing errors and discrepancies in drawings before commencing the work to reduce abortive work and rework	.233	.020
Selecting/ proposing alternative construction materials with less wastage	.194	.053
Maintaining effective communication among project team members to reduce design errors	.100	.325
Waste reduction becomes a usual discussion issue in the regular meetings among project team members.	.082	.415

** correlation significant at p-value <0.01*

LIMITATIONS

Owing to the fact that this study is conducted in Hong Kong, the data collected, thus the findings should be read in the light of this geographical context. Secondly, the 95 valid responses used in this study are considered reasonable, although a larger number is preferred. Using greater sample size for analyses and collecting data from other countries can therefore be considered for further studies. Thirdly, respondents working in the contractor firms have been chosen for this study because the construction contractors are considered as the front-line workforce that converts construction project design into practical reality. Nevertheless, the results of this study reveal that the respondents' contractors firm are generally quite passive to discuss with the client's consultants regarding C&D waste reduction. Further studies are suggest to focus on exploring methods to facilitate collaboration among the construction designers and the contractors in reducing construction sold wastes in project.

CONCLUDING REMARKS

'Teamwork is the key ingredient in a successful project…. Environmental programmes will have high chance of success if they are co-designed with all involved parties whose participation are necessary for the programmes to succeed' (EPD 2010). The above statement found from the 'Hong Kong Awards for Environmental Excellence:

Guidebook for construction industry' can be used as a directive to improve the contractors' C&D waste reduction practice. Contractors in Hong Kong has been motivated by the CWDCS and taking the initiatives to reducing C&D wastes in their operations. Nevertheless, the results of this study indicate that the CWDCS may not direct collaboration among project team members in C&D waste reductions. Popular strategies being used by the contractors in reducing C&D solid wastes rarely focus on the responsibility and management inputs of the upstream construction supply chain integration.

Despite initiatives have been taken by the contractors to reduce waste in their operations, self-interest overwhelms the potential benefits of C&D solid waste reduction that can be generated through collaboration. Thus, developers and their consultants may become unwilling to share risks and benefits fairly with the contractors. It is suggested that project team members from the architects and engineers firms should hands to become more environmental friendly in terms of generating less construction waste in projects.

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