A Paper to Waste Management

Impact of Construction Waste Disposal Charging Scheme on Work Practices at Construction Sites in Hong Kong

Ann T.W. Yu*[a], C.S. Poon[b], Agnes Wong[b], Robin Yip[b] and Lara Jaillon[b]

a Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong SAR, China
b Department of Civil and Structural Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong SAR, China

Abstract:

Waste management in the building industry in Hong Kong has become an important environmental issue. Particularly, an increasing amount of construction and demolition (C&D) waste is being disposed at landfill sites. In order to reduce waste generation and encourage reuse and recycling, the Hong Kong Government has implemented the Construction Waste Disposal Charging Scheme (CWDCS) to levy charges on C&D waste disposal to landfills. In order to provide information on the changes in reducinge waste generation practice among construction participants in various work trades, a study was conducted after three years of implementation of the CWDCS via a structured questionnaire survey in the building industry in Hong Kong. The study result has revealed changes with work flows of the major trades as well as differentiating the levels of waste reduced. Three building projects in the public and private sectors were selected as case studies to demonstrate the changes in work flows and the reduction of waste achieved. The research findings reveal that a significant reduction of construction waste was achieved at the first three years (2006 - 2008) of CWDCS implementation. However, the reduction cannot be sustained. The major trades have been influenced to a certain extent by the implementation of the CWDCS. Slight improvement in waste management practices was observed, but reduction of construction waste in the wet-finishing and dry-finishing trades has undergone little improvement. Implementation of the CWDCS has not yet motivated subcontractors to change their methods of construction so as to reduce C&D waste.

Keywords: Construction and demolition waste, Polluter-Pays-Principle, Recycling, Sorting, Waste Disposal Charging Scheme

1. Introduction

It is globally recognised that construction activities affect the environment. Construction work includes land used for development, land deterioration, resources depletion, waste generation and various forms of pollution (Ofori et al., 2000; Tam et al., 2005, 2006). In the United Kingdom, a total of 89.6 million tonnes of construction and demolition (C&D) waste was generated in 2005, of which 28 million tonnes were sent to landfills (DEFRA, 2011). In Australia, about 7 million tonnes of C&D waste was disposed at landfills in 2006-2007 and 42% of total waste was attributed to the construction industry (EPHC, 2009). In the United States of America, about 164 million tonnes of C&D debris were generated in 2003, of which 60% was disposed of at landfills. Hong Kong is no exception; it generates 15.4 million tonnes of solid waste from its construction industry and C&D waste accounted for about 23% of total waste disposed of at landfills in 2009 (Environmental Protection Department, 2010). Table 1 illustrates records of waste generation and recycling in developed countries and the result of construction activities. The consequence of generating large amounts of C&D waste is the shortage of landfill space for the accommodation of waste and the pollution of the environment including illegal dumping in many parts of the world such as China, Malaysia, Hong Kong and Israel.

Table 1

In Hong Kong, a huge quantity of construction and demolition (C&D) wastes is produced representing a large fraction of the total solid waste stream. The disposal of these wastes has become a severe social and environmental problem. Government sources have indicated that there are acute shortages of both public filling area (reclamation sites) and landfill space in Hong Kong. Hong Kong's three mega landfills are expected to be full within 5-6 years (Legislative Council Panel on Environmental Affairs of the HKSARG, 2006, EPD, 2010). For the past two decades, the Government of the HKSAR has implemented various measures attempting to reduce waste generation, including the amendment of the Waste Disposal Ordinance, issuance of a policy paper for a comprehensive 10-year plan to reduce construction waste, launching of a green manager scheme on construction sites, promulgation of a waste reduction framework plan, issuance of a practice note promoting the use of recycled aggregate, implementation of the policy of waste-management-plan (WMP) on construction sites, commissioning of a pilot concrete recycling plant, and introduction of a charging scheme for the disposal of construction waste. All of these actions are clear indications that the Government of the HKSAR is determined to tackle the increasing problem of waste generation by construction activities (Environmental Protection Department, 2007a-2007g).

The construction waste charging scheme which commenced in December 2005 is regarded as one of the most influential policies of the Government in suppressing the generation of construction waste. The “Construction Waste Disposal Charging Scheme” (CWDCS), encourages contractors to consider recycling and reusing C&D waste so as to reduce the disposal of construction waste to the limited landfill space in Hong Kong. According to Waste Disposal Ordinance CAP 354 (2005), disposal of construction waste is subject to a charge of HK$125/tonne of waste sent to landfills, HK$100/tonne sent to sorting facilities and HK$27/tonne sent to public fill reception facilities (1US$ = 7.8HK$). The Polluter-Pays-Principle (PPP) enacted under environmental law whereby polluters are responsible for the damage caused to the natural environment is widely adopted by many countries (Tam, 2008). In the construction industry, this ‘polluter pays’ principle provides economic pressure for contractor firms to initiate means of minimizing waste generation by sorting and recycling waste as part of the construction processes within construction sites. Referring to Figure 1 (a), the amount of construction waste requiring disposal at landfills was substantially reduced from 2005 to 2006 - 2008. However, the figure shows an increase after 2009 [refer to figure 1(b)]. According to the latest statistics of 2010, the construction waste disposed of at landfills was 3,584 tonnes per day which accounted for 26% of total waste (as compared to 3,185 tonnes per day in 2007, accounted for 14% of total waste). The data indicates that a significant reduction of the landfilled construction waste was achieved at the first few years after the implementation of CWDCS, but this reduction could not be sustained and therefore effectiveness of the CWDCS was questionable after three years of implementation.

Figure 1(a) and (b)

A major proportion of construction waste generation can be categorized in both design and operation activities (Gutherie and Mallett, 1995; Bossink and Brouwers, 1996; Poon et al., 2001, 2004a; Poon and Jaillon, 2002; Tam et al., 2005; Osmani et al., 2006, 2008; Poon, 2007; Jaillon and Poon, 2009). There are two main kinds of building construction waste: waste generated by superstructure construction (structure waste) and waste generated by work related to finishing (finishing waste). Concrete fragments, reinforcement bars, abandoned timber plates and pieces are structure waste. The sources of finishing waste range widely from surplus cement mortar arising from screeding works over the building floors, broken raw materials such as mosaic tiles, ceramics, stone fragments, plastering materials and paint primer. The packaging materials of household appliances, such as gas cookers, bathtubs, washtubs and window frames, are also part of finishing wastes (Poon et al., 2004b).

In Hong Kong, the fragmented nature of subcontracting systems is another source of waste generation (CIRC, 2010). A construction project is managed by the main contractor who appoints subcontractors of various trades to carry out the construction work. The main contractor usually supplies materials and organizes work sequences for all subcontractors to follow and the subcontractors merely carry out their work within their own scope according to the construction programme. The general practice in Hong Kong is for the main contractor to coordinate the work of subcontractors and to control the general progress of construction. In order to achieve smooth work flow between subcontractors, the main contractor endeavours to keep the site in a workable condition by deploying a team (usually a different subcontractor) to clean the working areas and remove construction debris from site. Pragmatically, subcontractors carry out their works by optimizing their own output, such that the waste of materials and damage to the work of others are not their primary concerns. Thus, materials wastage and damage to completed and semi-completed works are commonplace on construction sites. Controlling the waste management performance of subcontractors is crucial for the reduction of construction waste (Ng and Price, 2005).

The CWDCS encourages construction waste producers to reduce, reuse, sort and recycle construction waste before disposal. According to government records, the amount of construction waste disposed in the three landfills in Hong Kong decreased by 40% from 6,600 tonnes per day (tpd) in 2005 to around 4,000 tpd in 2006 (Environmental Protection Department, 2006). Also, the amount of construction waste disposed of at landfills in 2009 was about 3,121 tpd, demonstrating a reduction of 53% compared with 2005 data (Environmental Protection Department, 2010). It is obvious that implementation of the CWDCS has significantly reduced construction waste and prolonged the useful lives of the landfills. However, a negative approach that some companies have chosen to follow to circumvent the policy is that of illegal dumping, which has increased radically. The number of detected cases of waste materials fly-tipping increased by more than 400 percent from 365 cases in 2005, to 1,587 cases in 2006 (Chui, 2007). Although a construction waste fly-tipping spotting system has been implemented to encourage the public to report illegal dumping activities, it is difficult to obtain concrete proof of illegal dumping. A positive approach, on the other hand, in response to the CWDCS also exists, whereby construction industry stakeholders have implemented waste management plans mandatorily to deal with the cutting down of construction waste. The following flow charts are examples showing the extra effort extended by major work trades in suppressing waste generation. Figs. 2 (a), (b) and (c) illustrate the timber formwork, concreting and wet-finishing trades work flows, respectively, after implementation of the CWDCS.

Figure 2 (a), (b) and (c)

This study aimed at extracting the performance of the main trades in the implementation of the CWDCS. A comprehensive questionnaire survey was implemented and three in-depth case studies were made to investigate the impact of CWDCS after three years of implementation. The research findings and recommendations are relevant to the local and international practitioners in the building industry in their implementation of the proposals for C&D waste management.

2. Research Methodology

In accordance with the general practice of the construction industry of Hong Kong, this study grouped building construction into the six main trades generating the C&D waste. (see Table 2).

Table 2

Metal-related work trades such as "reinforcement fixing", "sheet metal works" and "steel and metal works" were not considered in this study and were not included as one of the above main trades. This is because the waste metal recycling industry is well established in Hong Kong. Scrap metal such as reinforcement bars, cut pieces of steel sections, aluminium extrusions and miscellaneous scrap metals are 100% recycled in Hong Kong. The implementation of the CWDCS has not affected the levels of waste in steel and metal works.

The study undertook a questionnaire survey in relation to three public and private building project case studies currently under construction. The questionnaire mainly addressed the changes of practice among building professionals of various trades since 2005 resulting from implementation of the CWDCS. The questionnaire aimed to capture the views and identify the behaviour of the respondents in respect of:

- Percentage reduction of C&D waste.
- Percentage change in the level of reuse/recycling of C&D waste generated.
- Percentage increase in sub-contract cost.

The questionnaire was distributed by mail and by hand to 319 targeted professionals who were working in the areas of construction project management, construction operation and project finance. The respondents can be broadly classified as follows:

- Project managers (representing the project management stream)
- Engineers (site agents are included in this group, representing site operation stream)
- Quantity surveyors (representing the project finance stream)

The survey was conducted in 2009 and 109 completed questionnaires were received. The response rate was 34% which is acceptable in the construction industry. Of the 109 returned questionnaires, 89 were valid responses. Forty-seven percent of the respondents identified themselves as project/construction managers, 25% were quantity surveyors, 20% were engineers and 11% fell under other categories involved with building projects.

In addition, regular visits at monthly intervals to three building construction sites were carried out for 18 months. The visits focused on observing those waste management steps taken by the main trades from the excavation of pile caps to the construction of superstructure and execution of finishing work. The flowcharts shown in Figs. 2 (a), (b) and (c) were used as references on these site visits. The working processes on site generally corresponded to that shown in the flowcharts. During superstructure construction, formwork fixing and striking, in-situ concreting and installation of precast elements (which applied in one case) were the main areas of attention. In the finishing work stage, brick and block laying, plastering, tiling, floor screeding and installation of sanitary ware and joinery work were the major areas of concern. Cleaning of the site and the methods used to handle construction waste were also studied on every site visit. Information obtained from site visits and interviews with frontline workers and supervisors of various trades was cross-referenced with the results of the questionnaire survey.

3. Results and Discussions

3.1. Results of Questionnaire Survey

The results of the survey indicate that the respondents had been working in the construction industry for relatively long periods. 67% of them possessed over 10 years of experience and only 14% had less than 6 years of experience. Half of the respondents were working in organizations of less than 400 employees and either participated in or were in charge of projects with contract sums of HK$100 million or more. Organizations of that size and projects in excess of HK$100 million are common in Hong Kong. The survey respondents could therefore be considered a valid sample accurately representing the general views of participants in the Hong Kong construction industry.

The questionnaire asked respondents to estimate the net percentage increase in sub-contract costs as a result of the implementation of the CWDCS. The survey result is summarized and illustrated in Fig. 3. The survey differentiated between changes in subcontract cost in the three scenarios of: a) no change, b) increase of subcontract amount by 2% or less, and c) increase of subcontract amount by more than 2%. The results indicate that the weightings attached to these three scenarios appeared to be evenly distributed among the major trades. No scenario was significantly more pronounced with any of the trades. Though the distribution of scenarios was roughly even, it is interesting to note that the selection of “2% or less increase” in subcontract cost was slightly less common than “no change” and the “over 2% increase” selections. It is reasonable to believe that stakeholders in the construction industry have taken three different approaches to dealing with the implementation of the CWDCS. Those who take a “no change” approach are reluctant performers with a laissez-faire attitude to reducing construction waste. The “over 2%” are aggressive performers in responding to the change and occupy leading positions in the construction industry of Hong Kong. The comparative minority who selected the “2% or less increase” are those who like to take moderate actions to test the situation. When change is imperative, they would follow the market leaders’ approach to perform their professional and social duties. In general, the implementation of the CWDCS seems to be a successful policy which has motivated about two-thirds of the stakeholders to take action to reduce construction waste. Another interesting result was that those who selected “over 2% increase” in subcontract costs were subcontractors specialising in earthwork, formwork installation and concreting work. By contrast, those who selected “no change” were those trades which do remove construction waste which they generate, although such removal is usually the responsibility of the main contractor. Examples are the wet-finishing and dry-finishing trades. As a result, a change in practice is underway, as more and more main contractors try to force subcontractors to clean up their own construction waste by adding terms and conditions in subcontracts or by penalizing the responsible subcontractor monetarily whenever the main contractor is in fact required to clean up the waste himself. This new expectation of the finishing trades gradually becoming accepted in the construction industry of Hong Kong. The relevant conditions in subcontract documents are often revised nowadays. As a result, subcontractors are more careful to avoid the generation of unnecessary waste. At the same time subcontractors are taking steps to increase their tender prices in order to absorb the extra work in cleaning and waste reduction. This is a clear indication that the main driver to reducing C&D waste is money.

Waste reduction can be actively achieved either by main trade subcontractors at source during the progress of their work and/or proactively by the main contractor in sorting and recycling that construction waste which has been generated. Implementation of the CWDCS has created positive results in the reduction of construction waste whichever case applies.

Figure 3

The questionnaire survey also revealed the changes in C&D waste generation by all main trades since the implementation of the CWDCS. Fig. 4 shows that most of the respondents had the impression that "no change" has taken place in the reduction of C&D waste of major subcontract works. It was clear that the respondents had the overwhelming view that the methods of construction by the main subcontract trades have not been changed by implementation of the CWDCS. It is not surprising, therefore, that there is "no change" in waste reduction by those main trades.

As mentioned above, the recycling facilities for scrap metal are well established in Hong Kong. Little change in waste generation in the steel and metal trade is therefore reasonable. Little change has also been experienced in the earthwork trade.

Figure 4

Due to the nature of excavation and backfilling, the amount of work involved in excavation and backfilling is not affected by implementation of the CWDCS. Nevertheless, incautious over-excavations have been reduced to a minimum because surplus excavated materials are now being subject to handling costs and disposal charges. A net reduction of 9.5% (12.5% - 3%) in the excavation work trade is reasonable. The percentage of increase and decrease is almost balanced for Wet-finishes trades (16.8% - 16.8% = 0), and Dry-finishes trades (16.7% - 12.0% = 4.7% decrease). The wet-finishing and dry-finishing trades are generally regarded by stakeholders as major contributors to construction waste and the findings of this survey support this perception. The results disappointingly show that very little waste in net reduction is occurring with these two trades after 3 years of implementation of the CWDCS. The "preliminaries" related trades in site cleaning, removal of packaging materials and the left-over materials for protection works have been directly impacted by the implementation of the CWDCS, but the findings show an unexpectedly low reduction of 5.4% (30.5% - 25.1%), which is an indication that frontline workers involved in preliminary work do not perform well or that the facilities provided for sorting are not sufficient. Comparably high reductions are found in Formwork Installation/stripping and Concrete Work, of 16.7% (36.1% - 19.4%) and 13.6% (32.5% - 18.9%) respectively. Many researchers have proved that construction waste generated from formwork installation/stripping and in-situ concreting can be greatly reduced by adopting precast concrete elements solutions. Precast construction is commonly adopted by stakeholders nowadays. This finding agrees with those of previous studies (Jaillon and Poon, 2009; Chan and Chan , 2002; Yip and Poon, 2008). Based on the survey result, in general, the level of decrease is higher than the level of increase for all main trades. It is believed that the decreases in waste are outcomes of waste management planning. Nevertheless, the increases are causing concern and stakeholders are therefore advised to put effort into addressing this aspect for every work trade.

To identify the percentage change in the reuse and recycling of construction waste before and after implementation of the CWDCS, investigation of the amount of sorting of C&D waste on site (or off site) is an effective approach. This study estimated the levels of reuse and recycling based on the survey results on the sorting of inert and non-inert wastes. As indicated in Figure 5, inert waste and non-inert waste are generated by different trades. Most of the inert wastes from excavation that are sorted on the spot are re-used as backfilling materials. Any surplus which is taken to other sites as filling material or is dumped as filling material in reclamation work. Demolished concrete from excavation work and building demolitions is collected and crushed as recycled aggregates for road sub-bases, paving blocks and recycled aggregate fresh concrete. Most of the excavation non-inert waste such as vegetation and topsoil are disposed of in landfills. The survey revealed that after implementation of the CWDCS, 29%, 30% and 16% of waste produced by the excavation, concreting and wet-finishing work trades respectively had been sorted, recycled and re-used for other construction purposes. Contractors began the trading of sorted excavation materials among themselves between different sites. Although the selling price of these sorted materials is not high, the amount of waste requiring disposal can be reduced. A win-win situation is created for both the waste seller and the sorted material buyer. Most importantly, a certain amount of waste is recycled and re-used for backfilling, road sub-bases and other purposes.

Timber is removed from non-inert waste, and the sorting workers examine the quality and size of plywood pieces to pick out those larger-sized pieces and the good quality stripped timber formwork. Such selected timber can be reused on smaller-scale construction works as miscellaneous formwork shuttering. However, the ultimate destiny of timber formwork is to be mixed with other non-inert waste and disposed of in landfills. The results show that the degree of participation in waste sorting is not high. Space limitations, little enthusiasm by the construction participants and possible obstructions to the progress of the normal work progress are believed to be the main causes behind the low percentages of waste sorting.

Figure 5

3.2. Findings of the Case Study

Three building projects were chosen as case studies covering the main trades involved in excavation of a pile cap to the construction of superstructure and the execution of finishing work. Regular visits to the three construction sites were carried out between June 2008 and December 2009. Table 3 summarizes the information recorded during the regular site visits and the unstructured interviews with frontline work supervisors and site management personnel.

Table 3

3.3. Discussions

The questionnaire survey shows that construction participants have taken the three approaches of “aggressive”, “moderate” and “reluctant” towards compliance with the implementation of the CWDCS. The case studies confirmed that result. The workers associated with cases 1, 2 and 3 acted aggressively, moderately and reluctantly in mitigating construction waste. Participants performed aggressively in earthwork, formwork installation and concreting work, in which the extra works and additional costs involved in reducing C&D waste, can be readily transferred from the main contractor to subcontractors. Reluctance existed in the cases of site cleaning work, wet-finishing and dry-finishing work, because the removal of construction waste they generate is carried out by the main contractor in general.

Earthwork, formwork and concrete trades showed more improvement than the wet and dry finishing trades. It is believed that because the former trades work in only one or two locations at a time, stringent control of waste is attainable, while the latter trades are carried out on all floors and scattered in various locations. The latter makes for more difficult monitoring of the production and management of wastes. The achievement of waste reduction by the wet and dry finishing trades is highly dependent on the mentality and self-discipline of individual subcontractors and workers together with effective commitment and management by the main contractor.

Both the questionnaire survey and case study revealed that participants on all main trades are reluctant to carry out on-site sorting in order to retrieve usable materials. Such work is hindered by the space for sorting activities made available and the tight construction schedule. Government and developers can impose stringent regulations and contractual terms to promote on-site sorting, but even then, the outcome depends on the available site space and the attitude of site management.

4. Conclusion

This study has explored the influences of the construction waste charging scheme on the main trades on the reduction of construction waste being achieved after three years of implementation in Hong Kong.

The literature review and questionnaire survey together with case studies on three project sites have verified the following:

a) According to the latest waste generation statistics, a significant reduction of construction waste was achieved at the first three years (2006 - 2008) of CWDCS implementation. However, the reduction cannot be sustained.
b) Implementation of the CWDCS has generated positive effects in waste reduction by all main trades as well as by main contractors for the first three years.
c) Financial benefit is the primary driver behind progress in the reduction of wastes on sites.
d) Wet-finishing and dry-finishing trades have undergone little improvement in terms of waste reduction.
e) Implementation of the CWDCS has not motivated subcontractors to change their methods of construction.
f) On-site waste sorting is only possible on large construction sites where space can be set aside.

Acknowledgements

This research was supported by the Hong Kong Polytechnic University and is gratefully acknowledged. Thanks are also due to the various parties in the construction industry in Hong Kong who provided information in facilitating the research study.

References

Bossink, B.A.G., Brouwers, H.J.H., 1996. Construction waste: Quantification and source evaluation. J. Constr. Eng. Manage., ASCE, 122(1), 55-60.

Chan, D.W.M., Chan, A.P.C., 2002. Public housing construction in Hong Kong: a review of its design and construction innovation. Archit. Sci. Rev., 45(4), 349-59.

Chui, T., 2007. Fly tipping of building materials on the rise. The Standard, 27 March.

CIRC, 2001. Construction Industry Review Committee, *Construct for Excellence – Report of the Construction Industry Review Committee*, Printing Department, Hong Kong Special Administrative Region Government.

DEFRA, 2011. Department for Environment, Food and Rural Affaires, UK government. <http://www.defra.gov.uk/evidence/statistics/environment/waste/kf/wrkf09.htm> (accessed on 18/01/2011).

Environmental Protection Department, 2006. Environmental report. EPD, Hong Kong SARG.

Environmental Protection Department, 2007a. A green manager scheme. EPD, Hong Kong SARG.

Environmental Protection Department, 2007b. Environmental protection. EPD, Hong Kong SARG.

Environmental Protection Department, 2007c. Landfill areas. EPD, Hong Kong SARG.

Environmental Protection Department, 2007d. Strategic environmental assessment. EPD, Hong Kong SARG.

Environmental Protection Department, 2007e. Waste disposal ordinance. EPD, Hong Kong SARG.

Environmental Protection Department, 2007f. Waste management in construction sites. EPD, Hong Kong SARG.

Environmental Protection Department, 2007g. Waste reduction framework plan. EPD, Hong Kong SARG.

Environmental Protection Department, 2010. Monitoring solid waste in Hong Kong, Waste statistics for 2009. EPD, Hong Kong SARG.

EPHC, 2009. Environmental Protection & Heritage Council, National Waste Overview, Nov. Available at: Franklin Associates. Characterization of building-related construction and demolition debris in the United States. U.S. Environmental Protection Agency, U.S.A., (accessed on 18/01/2011).

Gutherie, P., Mallett, H., 1995. Waste minimisation and recycling in construction – A review. CIRIA SP122, London.

Jaillon, L., Poon, C.S., 2009. Quantifying the waste reduction potential of using prefabrication in building construction in Hong Kong. Waste Manage., 29(1), 309-20.

Legislative Council Panel on Environmental Affairs of the HKSARG, 2006. Progress report on the management of construction and demolition materials, April.

McGrath, C., 2001. Waste minimization in practice. Resour. Conserv. Recycl, 32(3-4), 227-38.

Ng, K.W.A., Price, A.D.F., 2005. Assessing the impact of main contractor’s site co-ordination on subcontractors’ performance in Hong Kong, in: Khosrowshahi, F. (Eds.) Annual Conference, Association of Researcher in Construction Management. U.K.

Ofori, G., Briffet, C., Gang, G., 2000. Impact of ISO 14000 on construction enterprises in Singapore. Constr. Manage. Econom., 18(8), 935-47.

Ordinance and Regulations, 2005. Waste Disposal Ordinance (Cap. 354), Waste disposal charge for disposal of construction waste regulation. Hong Kong SARG.

Osmani, M., Glass, J., Price, A.D.F., 2006. Architect and contractor attitudes to waste minimisation. Waste Resour. Manage., 2(1), 65-72.

Osmani, M., Glass J, Price, A.D.F. 2008. Architects’ perspectives on construction waste reduction by design. Waste Manage., 28(7), 1147-58.

Poon, C.S., 2007. Reducing Construction Waste, Waste Manage., 27(12), 1715–6.

Poon, C.S., Jaillon, L., 2002. A guide for minimizing construction and demolition waste at the design stage. The Hong Kong Polytechnic University, Hong Kong.

Poon, C.S., Yu, A.T.W, Ng, L.H., 2001. On-site sorting of construction and demolition waste in Hong Kong, Resour, Conserv. Recycl., 32(2), 157-72.

Poon, C.S., Yu, A.T.W, Jaillon, L., 2004a. Reducing building waste at construction sites in Hong Kong. Constr. Manage. Econom., 22(5), 461–70.

Poon, C.S., Yu, A.T.W., Wong, S.W., Cheung, E., 2004b. Management of construction waste in public housing projects in Hong Kong. Constr. Manage. Econom., 22(7), 675–89.

Tam, C.M., Tam, W.Y.V, Chan, K.W.H., Ng, C.Y.W., 2005. Use of prefabrication to minimize construction waste – a case study approach. Int. J. Constr. Manage., 5(1), 91-101.

Tam, W.Y.V, Tam, C.M., Chan, W.W.J., Ng, C.Y.W., 2006. Cutting construction wastes by prefabrication. Int. J.Constr. Manage., 6(1), 15-25.

Tam, W.Y.V., 2008. The effectiveness of Hong Kong's construction waste disposal charging scheme. Waste Manage. Res., 26: 553-8.

Yip, R.C.P., Poon, C.S., 2008. Comparison of timber and metal formwork systems. Proceedings of the Institution of Civil Engineers, Waste Resour. Manage., 161(1), 29-36.