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Implementing a Waste-Management-Plan Method in Construction

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Abstract
The increasing awareness of environmental impacts from construction waste has led to the development of waste management as an important function of construction project management. Various approaches for managing construction waste have been developed by many researchers around the world. The Hong Kong government started employing the implementation of a waste-management-plan method for all construction projects in 2003. During the trial period, the government received different version of feedback from the industry. The effectiveness of this approach gives less attention from the public. This paper investigates the effectiveness of the existing implementation of a waste-management-plan method in the Hong Kong construction industry. Questionnaire survey and structured interviews are conducted to explore attitudes and benefits in implementing waste management, and difficulties in implementing it. Although there are difficulties encountered in using the waste-management-plan method, effective measures in implementing it are then recommended. Furthermore, responsibilities for various project parties in effectively implementing waste management are outlined.

Keywords
Waste-management-plan, construction and demolition waste, effectiveness, construction, Hong Kong.

1 Introduction
Waste management in the construction industry has not been successfully controlled and much more work is required to achieve satisfactory standard. In the past, construction waste was commonly dumped to landfills. But as landfill areas are expected to run out in the next few years (Hong Kong Government - Environmental Protection Department, 2006), there is an urgent need to discover ways of waste management.

The Hong Kong government has been employed various waste controlling measures in the past few years, including a waste disposal ordinance, launched a green manager scheme, drafted a waste reduction framework plan, commissioned a pilot concrete recycling plant, stipulated the implementation of a Waste-Management-Plan (WMP) method, and promoted a public landfill charging scheme (Hong Kong Government, 2006). Among these measures, the newly employed scheme using the WMP method has received negative feedback from the industry. Construction organizations commented on detailed descriptions of waste management procedures in the WMP method which largely affect their productivity, showing the ineffectiveness of using the method in construction projects.

This paper focuses on examining waste generation in construction and the existing waste controlling measures employed by the Hong Kong government; exploring the effectiveness and difficulties of the existing Waste-Management-Plan (WMP) method; and proposing ways to improve the existing problems in implementing the WMP method.

2 Existing Waste Controlling Methods

There has been an overwhelming promotion of waste management tools and sustainable development activities in recent years. As a result, there is a growing awareness of waste management issues and the potential problems from negative impacts of the environment. Generally speaking, construction is not an environmentally friendly activity. Comprehensive reviews were encouraged to provide waste management measures in construction activities (Tam *et al.*, 2006, Tam *et al.*, 2005). Various factors are affecting the environment, which include land use and land deterioration, resource depletion, waste generation and various forms of pollution (Tam *et al.*, 2005, Tam *et al.*, 2006).

Debris from construction and demolition works constitutes a large proportion of solid waste. In the United Kingdom, more than 50% of landfill waste come from construction (Ferguson *et al.*, 1995); while 70 million tons of waste is from construction and demolition activities annually (Sealey *et al.*, 2001). In Australia, about 14 million tons of waste have been put into landfill annually, and 44% of the total waste is attributed to the construction industry (Craven *et al.*, 1994, McDonald, 1996). In the United States of America, around 29% of solid-waste is from construction (Hendriks and Pietersen, 2000). In Hong Kong, about 38% of solid waste come from the construction industry (Hong Kong Government - Environmental Protection Department, 2006).

Several measures have been implementing under government initiatives to help reducing waste generation, including: i) enacted the Waste Disposal Ordinance; ii) issued white paper for a comprehensive 10-year plan to reduce construction waste; iii) launched a green manager scheme; iv) issued a practical note on the use of recycled aggregate; v) commissioned a pilot recycling plant to supply recycled aggregate to public projects; and vi) issued a circular on waste management; and vii) issued charge for waste dumping.

The Hong Kong government has implemented various types of regulations and methods, which aims of minimizing waste production, thus improving the environment. Among them, the mandatory system in implementing the Waste-Management-Plan (WMP) method for all construction projects receives different versions of feedback during its trial period. Some argued that detailed descriptions of waste management procedures in the WMP method largely affect companies' productivity. Many construction organizations are lack of experience in drafting and using the WMP method. The companies also found difficulties in recycling construction materials on site.

3 Research Methodology

To examine the effectiveness of the existing requirements in implementing the WMP method for all construction projects, a questionnaire survey was conducted. The survey was sent to 250 parties including contractors, consultants, developers, governmental departments, and environmental professional associations. 78 had been received with a response rate of about 31.2%. However, two of the questionnaires were not properly completed and only 76 questionnaires were valid. The respondents can be classified into five categories, G1 to G5.

To determine the relative ranking of factors, the scores were transformed to important indices based on *Equation* (1) (Tam *et al.*, 2000):

$$RII = \frac{\sum w}{AN} \qquad (1)$$

where w is the weighting given to each factor by the respondent, ranging from 1 to 5 in which '1' is the least important and '5' the most important; A is the highest weight, in this study A=5; N the total number of samples; and RII the relative important index, $0 \le RII \le 1$.

After received the questionnaire responses, individual structured interviews were arranged with eight respondents, selected from different business sectors: one from government department, one from building developer, one from environmental consultant, two from registered building contractors, two from registered specialized contractors and one from member of environmental professional association. The interviews were intended for gathering further comments, elaboration and interpretation on the results obtained from the questionnaire and reduced the limitation of low response rates from G4 and G5.

4 Results

4.1 Benefits in implementing the WMP Method

The implementation of the WMP method has several benefits. Pollution prevention, better allocation of resources, better regulatory compliance, evaluation of risks and plans for preventing potential problems can be achieved through implementation of the method (Tibor, 1996). Previous studies have identified a number of benefits in implementing the method for construction (Jasch, 2000, Kuhre, 1998, Tam, et al., 2006). A list of benefits can be seen in Table 1 with the ranking by the relative important index.

Table 1: Relative Important Index for Benefits in Implementing a WMP Method

Benefits in Implementing a WMP Method	Σ w	Relative important index	Ranking
Propose methods for reducing waste	292	0.768	1
Propose methods for on-site reuse of materials	292	0.768	1
Propose methods for on-site waste separation	290	0.763	3
Propose disposal outlets	284	0.747	4
Identify different types of waste	276	0.726	5
Propose methods of dealing with packing materials	262	0.689	6
Develop an organization structure for waste management	256	0.674	7
Estimate quantities of waste requiring off-site disposal	254	0.668	8
Help implementing trip ticket system	248	0.653	9
Monitor and audit waste management programme	246	0.647	10
Propose methods of processing, storing and disposal of hazardous waste	246	0.647	10
Estimate quantities of identified waste	240	0.632	12
Propose areas for waste storage	222	0.584	13
Propose lists of materials to be reused or recycled	220	0.579	14

The survey results show that “Propose methods for on-site reuse of materials” and “Propose methods for reducing waste” are recognized as the most important benefits in implementing the WMP method, which requires a detailed procedure in showing how construction organizations reuse, recycle and reduce construction waste before starting their projects. A registered building contractor pointed out that he designed a detailed methodology in reusing, recycling and reducing major types of construction waste to implement the method, including concrete, tiles, steel, glass and plastic. He claimed that these reusing, recycling and reducing methods can be effectively used in planning the use of materials and reducing material consumption. Some local examples in material recycling are also recommended by the Hong Kong government (Hong Kong Government - Environmental Protection Department, 2006), for example, using recycled aggregate as sub-base material for road construction, using asphalt as aggregate fill and sub-base, and using glass as substitute for sand and aggregate as pipe-bedding material.

However, "Propose lists of materials to be reused or recycled" is not considered as the major benefit in the survey. An interviewed environmental consultant pointed out that the WMP method can provide a draft list of materials to be reused or recycled before a project starts; however, it sometimes shows different levels in the draft reusable, recyclable proposal and the practices of projects. A contractor claimed that most of construction organizations try to minimize their waste in other ways, including using prefabricated building components and reducing the use of wet trades, before reusing or recycling the construction waste. Therefore, the final waste generation can be greatly reduced.

4.2 Difficulties in implementing the WMP Method

Although there are many benefits can be gained in implementing the WMP method, there are still many construction organizations finding difficulties in the implementation. The major reason is high investment cost, such as resource input for training courses (Shen and Tam, 2002). Kuhre's study showed that the support of the implementation of the method from top management was crucial at the early stage of the process (Kuhre, 1998). Tron's study considered that the lack of relevant empirical experience on the method to support the development of a practical guideline was one of the main concerns for its implementation (Tron, 1995). Other major difficulties include lack of resources and expertise, lack of staff involvement and poor co-ordination between the government, industry and business (Chan and Li, 2001). Based on these previous works, nine major difficulties are identified and shown in Table 2 with the ranking by the relative important index.

Table 2: Relative important index for Difficulties in Implementing a WMP Method

Difficulties in implementing a WMP Method	Σw	Relative important index	Ranking
Low financial incentive	312	0.821	1
Increase in overhead cost	294	0.774	2
Complicated subcontracting system	282	0.742	3
Lack of promotion of waste minimization measures	280	0.737	4
Construction culture and behaviour	280	0.737	4
Lack of well-known effective waste management methods	276	0.726	6
Low disposal cost	264	0.695	7
Lack of proper training and education	258	0.679	8
Competitive market	252	0.663	9

"Low financial incentive" and "Increase in overhead cost" are considered as the major burdens in implementing the method. As facilities and equipment need to be provided on-site, the investment cost will be increased in the short-term. These difficulties can only be alleviated in the long-term when the waste generation reduces and cost savings can be improved.

Nevertheless, "Lack of proper training and education" is minimally affecting companies to implement the method. A registered specialized contractor explained that many academic professionals, for example, Green Council, Hong Kong Productivity Council and Centre of Environmental Technology, are actively organizing environmental related seminars and conferences. These training programmes can help enriching waste management knowledge and providing proper training for different levels of employees.

4.3 Effective Measures in Implementing a WMP Method

Previous studies have identified a number of ways to encourage the implementation of the method for construction activities. Applying environmentally friendly technology on site is one of the most effective measures to improve waste management (Tan *et al.*, 1999). McDonald's study emphasized the significance of establishing the WMP method during the construction phase (McDonald, 1998). Chen *et al.*'s study classified four groups of measures against construction pollution; namely, technological methods, managerial methods, planning methods, and building material methods (Chen *et al.*, 2000).

Based on the findings from previous researchers, fifteen tools in encouraging the adoption of the method are identified as shown in Table 3 with the ranking by the relative important index.

Table 3: Relative important index for Effective Measures in Implementing a WMP Method

Effective measures in implementing a WMP Method	Σ w	Relative important index	Ranking
Use of prefabricated building components	306	0.805	1
Purchase management	294	0.774	2
Education and training	294	0.774	2
Proper site layout planning	290	0.763	4
On-site waste recycling operation	288	0.758	5
Implementation of environmental management systems	280	0.737	6
High level management commitment	278	0.732	7
Install underground mechanical wheel washing machines	256	0.674	8
Identification of available recycling facilitate	254	0.668	9
On-site sorting of construction and demolition materials	252	0.663	10
Use of metal formwork	244	0.642	11
Central areas for cutting and storage	238	0.626	12
On-site waste conservation	228	0.600	13
Use of information technology on-site	224	0.589	14
Use of non-timber hoarding	222	0.584	15

By using the relative important index, “Use of prefabricated building components” is considered as the major effective measure to implement the method. Using prefabricated building components instead of wet trade construction can largely reduce waste generation. An interviewed building contractor clarified that reducing waste generation is the best option in implementing waste management, in which reusing and recycling are only the alternative methods in reducing waste on-site.

“Purchase management” and “Education and training” are considered as the second effective measures to implement the method. An interviewed building contractor explained that if the organization has senior management support in implementing waste management, environmental awareness for their projects can easily be enhanced, which can significantly reduce waste generation.

5 Conclusion

Waste management is a burning issue in the Hong Kong construction industry, the reason being the industry is one of the biggest pollution generation sectors. The waste-management-plan (WMP) method has been introduced to the Hong Kong industry in 2003 with initial negative feedback from the industry. This paper has examined the effectiveness in implementing the WMP method in construction industry. From the questionnaire surveys and structured interview discussions, it highlighted that the government is the most willingness project party in waste minimization; the major problem from the other parties is high investment cost. “Cost” is still considered as the major project scope while “Environment” as the least project scope. Although the cost in implementation of the method will be increased, benefits including “Propose methods for on-site reuse of materials” and “Propose methods for reducing waste” can be harvested. To effectively implement the WMP method, Use of prefabricated building components” was found as the most effective encourage method.

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