Planning for SMEs’ Proactive Waste Management in Office Building Retrofit Projects

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Summary

Office building retrofit projects face many challenges for on-site waste management. While the projects themselves have the potential for a significant level of reuse and recycling from deconstruction and demolition, their unique characteristics often prohibit direct application of existing waste management systems, which are typically based on managing waste generated through new material application in new build projects. Moreover, current waste management plans include no stimuli to involve Small and Medium Enterprises (SMEs) for on-site waste management. As SMEs carry out the majority of on-site work as subcontractors, their active involvements will result in more proactive approaches to waste management and enhance project delivery.

This paper discusses the interim results of a continuing research aimed at engaging SMEs in the planning processes of waste management through the collaboration between subcontractors and main contractors of retrofitting projects. It introduces a conceptual model for SMEs to proactively plan and manage on-site waste generation for both deconstruction and construction stages, before traditional waste management plans by the main contractor come into place. The model also suggests a collaboration process between SMEs as subcontractors and large companies as the main contractor to improve the involvement and performance of SMEs in waste management of office building retrofit projects.

Keywords: waste management, SMEs, planning, office building retrofit

1. Introduction

The construction industry is facing major environmental challenges worldwide because of its significant impact to the environment [1]. To create good built environment and achieve sustainable construction along the process, waste is always a critical issue. In 2006-07, Australians generated approximately 43.8 million tons of solid waste, with 38% from the construction and demolition sector [2]. In the UK, the wastage rate in the construction industry was as high as 10-15% [3]. In Hong Kong, the annual generation of construction and demolition waste from 1993 to 2004 was more than doubled [4].

To maximize resources and reduce waste, retrofitting becomes more popular now than decades ago. It exerts less environmental impact [5], because the materials and components dismantled from the buildings usually presents high values of reuse or recycling [6]. As existing stocks of office buildings age and become deficient in performance, which is happening in many developed
countries\textsuperscript{7, 8}, they need to be refitted and upgraded, therefore stimulating the retrofit market. In UK in the year 2004, this sector accounts for almost half of the industry’s output \textsuperscript{8}. In Australia, with the average age of office building stock across CBDs ranging from 25 years in Brisbane to 31 years in Adelaide \textsuperscript{9}, there is an increasing need for retrofitting of a large stock of aging office buildings. Both owners and occupants are looking for more energy efficient and environmentally sustainable products in order to secure long term financial returns. This requires effective management of on-site waste from these retrofit projects.

Waste management plans (WMPs) or various formats of waste minimization strategy for construction projects is the policy widely accepted all over the world, including Australia, EU, UK, US, Spain, Hong Kong, etc. \textsuperscript{10-16}. The government obligates the project developer and contractor to design a waste management plan for the construction site. Four issues are typically included in such plans: waste type, waste quantity, waste collection and treatment, cost and financing. These issues are all based on post-generation stage of on-site waste and the plan is for “static” waste management. As retrofit process produces waste with project progress, the entire waste generation process cannot be effectively managed by the existing plans, as it follows a dynamic waste production schedule. When any changes or uncertain events take place during the project progress, waste generation in practice would be different from expectation. It will affect the efficacy of waste management measures and reduce the targeted reuse and recycling rates of the project. The waste generation process, which is closely related to the project implementation, has to be studied to form a new plan supporting dynamic management. Only through this way, more practical waste minimization target can be realized in retrofitting projects.

Most existing waste management plans require the main contractor which is usually a large company to conduct the planning task. In the UK for example, the Site Waste Management Plans Regulations 2008 formulates that the client and principal contractor will take all reasonable steps for waste management \textsuperscript{12}. Implementing a waste management program requires the investment of a large amount of money in the early stages of projects, including implementing site planning, using environmentally friendly materials, and installing waste management facilities and equipment, which are the main obstacles affecting company’s willingness to be involved \textsuperscript{13}, especially for Small and Medium Enterprises (SMEs) which are more cash flow focused \textsuperscript{17}. SMEs occupy overwhelming majority of market share in the construction industry. In Australia from 2007 to 2008, small and medium enterprises contribute 80-90\% of employment, profit and added-value of the whole construction industry \textsuperscript{18}. As the executers of almost 90\% of on-site construction work \textsuperscript{19}, SMEs have to deal with waste generation first hand therefore are most qualified to participate in waste management. Their active engagement and participation will improve the existing situation of deficient waste management and increase waste reuse and recycling. It puts forward the necessity to promote the current operation system of waste management plans by encapsulating the responsibility of SMEs in an appropriate way.

This paper intends to establish a conceptual model to engage SMEs in planning for on-site waste generation process of office building retrofit projects. The result will work towards improving the involvement and performance of SMEs in on-site waste management in retrofit projects. It may also lead to better practices of on-site waste management through the collaboration between main contractors and subcontractors.

2. Managing Waste in Office Building Retrofit Projects

Most retrofit projects involve changing both external and internal appearances of the building, so the waste materials produced from retrofit work are a large amount in a short time period \textsuperscript{20}. Previous research divided commercial building retrofit/refurbishment project into four phases including planning phase, strip-out phase, fit-out phase and occupation phase, to present features of good waste minimization practice \textsuperscript{21}. Several important issues for waste management were identified to consider and plan in each phase and the roles and responsibilities of project stakeholders were analysed to achieve waste minimization. It highlighted some important points such as the establishment of secondary markets for dismantled materials, maintaining a clear chain of responsibility for handling and sorting waste, recording of the quantity and destination of all waste leaving the site, “shallow estimating” of materials, group rather than individual packaging.
for items, and ongoing monitoring of waste generated against targets set at the beginning of the project \[21\].

Reuse and recycling are important objectives of managing materials and components dismantled by retrofit activities. Different office building components have different levels of reuse and recycling rate, on site or off site, due to the material composition and method of construction. Hardie et al. \[22\] divided the building in Australia into four categories including building fabric, fittings, finishes and service components. It was found that building fabric received a significant level of recycling and almost all of this recycling happened off site. Landfill was the principle destination reported for most fittings. The majority of all finishes ended up in landfill and no recycling on site was reported. High levels of recycling off site occurred with most services components but there was very little reuse reported.

Collecting data of on-site waste is a very important issue for waste plan and management, which can assist progress analysis of site performance, comparative study across a range of projects and lead to establishment of benchmarks of reuse and recycling practices. Hardie et al. \[23\] argued that a clear distinction has to be made between reuse and recycling to consider the exact way to treat waste. It was also believed that recording the destination of all waste after it leaves the site is necessary. This avoids the possibility of separated waste with no suitable end user being counted as recycled when it in fact ends up in landfill.

WMPs are widely used to prepare for on-site waste management. However, an overview of government regulations related to waste management plans in Australia indicated that there was no evidence of an industry consensus on the best system for monitoring and tracking waste on commercial refurbishment/retrofit projects. Very few companies adopted a standard method of measuring waste outcomes in order to make cross project comparisons \[24\]. There is no effective means of planning for waste minimization \[6\].

Existing research has mostly targeted post-generation stage of waste in office building retrofit projects. Reuse and recycling, which are the final results of waste generated during the project process, have been among popular topics of discussion, with the current state of play and ways for improvement covered extensively. But the waste generation process and the uncertain project nature \[25\] affecting waste production will determine the waste performance and affect the management quality. Some problems of practical issues have already been discovered by existing research. Attention now needs to be turned onto the internal process of waste generation on site, which happens along with the delivery of office retrofitting projects. To make waste management target more realistic, contractors are required to produce detailed waste generation schedule. However, current research has not worked out an effective way to incorporate such practices into the whole system of waste management.

3. Features of Office Building Retrofit Projects and Implications to Waste Generation and Management

Office building retrofit projects bring greater challenges to waste management compared to new build/demolition projects. Because of the continuous production of waste with the ongoing of project work, waste generation is influenced by project delivery according to some unique characteristics. The identified features of office building retrofit projects by previous research and their implications to on-site waste generation and management are shown in Table 1.
Table 1: Features of Office Building Retrofit Projects and Implications to Waste Generation and Management

<table>
<thead>
<tr>
<th>Source</th>
<th>Feature</th>
<th>Implication to waste generation and management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gn (1999); Perng, Hsia &amp; Lu (2007); Sanvido (1991)</td>
<td>Buildings are partially occupied Limited space</td>
<td>No interference with project delivery</td>
</tr>
<tr>
<td></td>
<td>Short schedule of site work</td>
<td></td>
</tr>
<tr>
<td>Douglas (2006); Yang &amp; Lim (2007)</td>
<td>CBD locations</td>
<td>More restrictions for on-site waste generation and handling</td>
</tr>
<tr>
<td>Dulung &amp; Pheng (2005); Holm (2000); Quah (1992)</td>
<td>Small subcontracts</td>
<td>SMEs’ participation as subcontractors and cooperation with large companies as main contractors</td>
</tr>
<tr>
<td>Egbu (1997); Gn (1999); Juan (2009)</td>
<td>Uncertainties during project delivery</td>
<td>Difficulties to control waste generation process</td>
</tr>
</tbody>
</table>

A recent survey confirmed that the complex process involving physical site constraints and new problems emerging from work progression is very common in office building retrofit projects. It could lead to changes of design and unexpected waste. This situation would change the initial waste management plan including managing activities and resource arrangement.

It is also discovered that the recycling rates quoted in WMPs of office building retrofit projects at the approval stage of a project may have little correlation with the actual rates achieved in practice. In fact, WMPs are based on estimated waste data, while the uncertain nature of office building retrofit projects makes such estimation unreliable. Besides, the management is only based on existing waste already generated on-site. It is not detailed enough to integrate waste generation with project delivery to provide a picture of the dynamic waste management process. It is also unable to establish effective and feasible waste minimization target. When unexpected events occur and affect waste generation, the existing WMPs cannot quickly react to waste generation change and adapt the committed to future project implementation and waste generation process. A detailed plan for managing on-site waste generation based on project delivery processes is needed to provide the realistic basis for organizing waste management activities. SMEs, with their ‘hands on’ approach to on-site waste, are ideally suited for such a responsibility.

4. SMEs’ Perceptions and Performance in Waste Management

Waste management is a critical issue on every part of the construction supply chain. It needs all project stakeholders to join forces and cooperate for waste avoidance and minimizations during the whole of project delivery. It is important to business and community sustainability that small businesses are actively engaged in reducing waste generation and implementing waste disposal practices. However, it was found that SMEs in general place considerably less emphasis on waste management within their site work process, compared with the main contractors.

According to some, waste management is often the job of large enterprises as main contractors, because they have to conform to building codes and regulations. Large companies usually have recognized and certified environmental management systems, which is perceived by labour-only subcontractors to be not cost-effective. A number of reasons may exist, such as:

- Small turnover without return on the costs of system establishment and certification
- Small sum of waste from small part of job not economical for management
- Lack of resources
- Lack of technical understanding and capability
Lack of motivation

SMEs are recognized as an indispensable part of the construction industry, concerning their active participation and great contributions\cite{18, 39, 40}. However, their performance in achieving sustainability in retrofitting projects has been lacklustre. It is argued that SMEs need to improve their capability in areas of acknowledgement, culture, management and technique to achieve performance promotion\cite{41}.

A survey conducted by the authors has confirmed that the lack of motivation and technical know-how among SMEs are common difficulties in office building retrofit projects. Effective method and techniques need to be established to promote active involvement of SMEs to waste management. Waste issue needs to be integrated with the whole project delivery. Waste should be managed as project resource and waste management needs to be planned based on project schedule and resource constraints. In this case, collaborations between SMEs and large companies are imperative to achieving such goals\cite{41}.

The result of the survey highlights that collaboration between SMEs as subcontractors and large companies as main contractors is an important factor for planning and managing waste during project work process. It is part of the organizational commitment, which is an important driver for SMEs to conduct effective on-site waste management. However, respondents of the survey indicate that there is not enough collaboration among contractors taking place in the current industry for proactive waste planning and management.

5. Proactive Planning Model for SMEs’ Waste Management

As integral parts of the construction supply chain, SMEs and large companies have lots of collaboration to do when working together as a unified team in the construction industry\cite{42, 43}. For waste management, the value of waste minimization and project sustainability is also controlled and realized by the cooperation of stakeholders\cite{44}. There is the prospect for SMEs to take up reasonable responsibility for on-site waste management to establish a way of collaboration with large companies.

SMEs, mostly as subcontractors, are the ones carrying out most of the on-site work\cite{19}, so they are most prone to problems and issues of on-site waste. It is possible for SMEs to proactively plan and manage waste generation process, before the traditional waste management plans by main contractors come into place. This approach will improve the performance of SMEs for on-site waste management and enhance effectiveness of waste management system for the construction industry.

Findings from the general literature study as well as specific issues unearthed from past research have suggested several key elements towards SMEs and Main Contractor collaboration, which include:

- Clear communication for existing building information
- Instant response to project variation
- Joint problem-solving for project complexity

The collaboration between SMEs as subcontractors and large companies as main contractors can be based on the appropriate distribution of responsibilities in on-site waste management plans according to the capabilities of the stakeholders and the specific characteristic of office building retrofit projects, as shown in Figure 1. SMEs are supposed to plan for on-site waste generation schedule before project starts, including waste types, quantities and time, which are related to their work methods and progression. Large companies as main contractors would outline the waste generation flow of the whole project based on the plans from each subcontractor. Therefore, they can have an overall strategy for on-site waste management and conduct detailed resource allocation and activity organization. In the case of unexpected event, differences of waste generation data in practice can be obtained and compared with the initial plans from SMEs. Large companies could modify waste management issues accordingly. In this way, the scale economy of waste handling and management can be achieved. Reuse and recycling rates can be set up more
practically thus easier to realize. More importantly, SMEs can engage and actively participate in on-site waste management in office building retrofit projects.

As part of an ongoing research, this planning model will form the basis for interviews and case study in the future for elaboration, modification and proof of the feasibility and applicability.

6. Conclusions

Effective waste management is a significant step towards the goal of sustainable construction. In office building retrofit projects, the issue of waste faces greater challenges due to the projects’ complex nature and the way wastes are generated. The performance of on-site waste management throughout the industry can vary significantly depending on the level of involvement of small to medium enterprises (SMEs), that carry out the majority of on-site works. A model is proposed for SMEs as subcontractors to plan and manage waste generation process in collaboration with large companies as main contractors. The model encourages SMEs to actively plan for managing on-site waste generation in line with work progression and large companies to identify waste flows and lead the forward planning process to manage the generation, minimisation and handling of the produced waste.

Continuing research in this space will help improve the engagement of SMEs in managing waste in office building retrofit projects within their grasp. It will also promote the practicality and deliverables of project on-site waste management plan, as well as optimize resource reuse and recycling for industry level sustainability. The next phase of the research will focus on the specific information and relevant tools that can be applied to the theoretical model and to integrate waste generation process with the whole implementation and delivery of office retrofitting projects.

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