A Systematic Review of Construction and Demolition (C&D) Waste Management

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SYNOPSIS

Waste is present in all industrial production processes, including construction. Waste generated by the construction industry is collectively referred to as construction and demolition (C&D) waste. C&D waste is generated throughout the life of a structure, from construction to maintenance and renovation, and finally demolition. Due to the physical size, scopes and complexity of construction projects, waste generated in construction is often highly visible. Worldwide, C&D waste represents a significant amount of total waste generated (between 10% and 36% of all landfill waste).

C&D waste consists of many waste streams including timber, brick, concrete, plasterboard, insulation, paper, glass, and steel; much of which is avoidable. There are a number of factors that have significant effects on the generation of C&D waste. They can be broadly divided into 2 main categories: technical factors and human factors. In the technical category, such factors include:

1) inadequate/unrealistic considerations for planning and scheduling,
2) inadequate design
3) overstock/overestimates of materials
4) late/early deliveries of materials
5) poor handling of materials

Whereas, in the human category, such factors often include:

1) operatives’ attitudes towards C&D waste management
2) lack of waste management support from management
3) lack of waste management/minimisation considerations at the design stage

C&D waste can be reduced through having life-cycle considerations at design and reusing/recycling of materials during the construction. However, since each construction project is unique, benefits derived from waste management vary greatly from project to project. Despite this, good waste management practices could save up to 2% of the total construction cost. Recently, various approaches have been proposed to address C&D waste, with some being qualitative and some being quantitative. Despite these efforts, these models have shown varying degrees of success. This is due to the high costs, and the lack of incentives, to implement them. Overall, cost and financial considerations in managing waste are universal and remain undiminished in the psyche of people involved in construction worldwide.

Waste minimisation is a result of construction’s quest to manage C&D waste effectively. It is believed that minimising C&D waste can help construction become more efficient and sustainable over long term. It has been argued that regulations and economic incentives are effective tools to help minimise...
waste. But it has been shown that although regulations could help reduce C&D waste, the reduction is only sustainable if it is driven by the sector itself. Thus far, efforts to minimise C&D waste have been through the use of technologies. For example, McGrath (2001) offered a waste minimisation software called SMARTWaste; while Building Research Association of New Zealand (BRANZ) developed the REBRI guidance material. Huang et al (2002) used mechanical sorting techniques to recycle construction waste. Li et al (2005) developed mechanical sorting techniques to recycle construction waste. Osmani (2011) proposed using Building Information Modelling (BIM) to help minimise C&D waste. Despite their usefulness, one thing that has prevented the uptake of these tools is the sector’s reluctance to implement new ideas and systems. However, the continuous development of C&D waste minimisation methods over the last 15 years shows the maturity of construction worldwide in this area.

The final frontier of C&D waste management is zero waste. In theory, zero waste can be achieved through 100% recycling or reusing materials; but since this total efficiency is impossible to achieve, zero waste could be understood as a new standard for systems efficiency and integration. Although currently there is no single definition of zero waste, many programmes exist to promote zero waste at national level. At the industry level, however, there is a limited amount of studies on zero waste. In construction, although zero waste has not seemed to gain momentum, attention has been given to this recently. For instance, Alexander (2002) argued that systems integration across the whole sector can ensure successful implementation of zero waste. Rubinstein (2012) produced a practical guideline to help builders and contractors achieve zero C&D waste; while Kinuthia & Nidzam (2011) demonstrated that if appropriate effort and technologies are utilised, a construction zero waste objective is achievable in both economic and environmental terms. Overall, the body of knowledge concerning zero waste, particularly zero waste in construction, is very small worldwide. Of those available, most tend to describe zero waste rather than offering any real insights into the concept. As such, there is significant knowledge gap that needs to be filled.

Overall, future research into C&D waste management/minimisation is urgently needed to bridge the above-mentioned knowledge gaps. Given the limited research in this area, it is indeed a fertile ground for researchers. This study aims to make a contribution to this body of knowledge of C&D waste management/minimisation by:

1) providing insights into the current state-of-affair of C&D waste management/minimisation research; and consequently
2) proposing necessary future work/developments in order to promote and implement C&D management/minimisation

A comprehensive analysis of literature pertaining to C&D waste management and minimisation has been provided. Steps are undertaken include:

i. Classifying literature into 3 categories C&D waste management, C&D waste minimisation and zero waste in construction
ii. Using major search engine such as Google and Yahoo! to scan the internet for readily-available documents online
iii. Using major journal portals such as Elsevier or Taylor & Francis Online to scan and obtain industry-specific publications
iv. Restricting literature publication between 2000 to date to ensure they are all current and up-to-date
In particular, journal papers from the highly respected C&D waste management-focused Journals were chosen. These Journals include: Resources Conservation and Recycling, Waste Management, Waste Management and Research, Construction Management and Economics, Building and Environment, Journal of Construction Engineering and Management, Engineering, Construction and Architectural Management and Journal of Industrial Ecology.

In total, 71 papers have been reviewed. Of this, 51 papers discussed C&D waste management, comprising 72%; 18 focused on C&D waste minimisation, comprising 25%; and 2 papers mentioned zero waste in the construction sector, making up 3%. Although there is still much work in these 3 areas to successfully promote and implement C&D waste management in construction, the analysis has shown:

1) C&D waste management is a mature topic
2) C&D waste minimisation has been embraced by the construction industry, although there is a degree of uncertainty as to how it achieves this goal. This comes from the lack of understanding regarding the benefits of C&D waste minimisation as well as a lack of compelling arguments for implementation
3) Zero waste is the least developed area of C&D waste management research. Due to the limited amount of literature on this topic, meaningful discussions on zero waste in C&D are rare

Of all considerations relating to C&D waste management, economics is still the major considerations by construction in spite of suggestions that other considerations such as environmental and social aspects should be taken into account. Therefore, when considering waste management, waste minimisation and ultimately zero waste in construction, the economic aspects should be thoroughly demonstrated to convince the industry of its financial benefits. This is important because without economic imperatives, it is unlikely such a programme will take off. Therefore, this gap needs to be filled as soon as possible.