

SUSTAINABLE CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT: COMPARISON OF CORPORATE AND PROJECT LEVEL DRIVERS

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The need for sustainable management of construction, demolition and excavation (CD&E) waste has for some years been considered a very important requirement in the construction industry. Construction industries in many countries have responded to the calls for waste management (WM) by instituting measures towards sustainably managing their designs, processes, materials and waste to reduce the negative burden of the industry on the environment. Today, almost all main contractor organizations in the UK have sustainability policies which cover the management of waste. These policies have led to the setting up of sustainable goals and requirements as part of the management of construction projects. Research on the drivers for sustainable WM in the construction industry suggest that, legislation and economic concerns are the key drivers for efforts by construction companies in this regard. Considering the project based nature of the industry, it is argued that drivers at the corporate level may not be the same as drivers at the project level. Through a multiple case study involving 4 construction companies and 8 construction projects in England, the different factors that drive WM in the construction industry at the corporate and project level are investigated. The results provide new evidence which suggest that the drivers for WM differ between the project level and the corporate level. Whereas economic consideration, company image, company sustainability agenda, client demands, government legislation, moral and social imperatives to manage waste, benchmarking and environmental concerns drive WM at the corporate level, at the project level, health and safety, the assurance of repeat jobs, charging schemes for sub-contractors and changing nature of the industry are extra factors that drive WM. This research concludes that, a better approach to sustainable CD&E WM should consider the project based factors together with the corporate or firm level factors in designing strategies towards sustainable WM.

Keywords: corporate level, drivers, sustainability, waste management strategy

INTRODUCTION

The need for sustainable management of construction, demolition and excavation (CD&E) waste has for some years been considered a very important requirement in the construction industry. The problem of construction waste is multiple folds and has social, environmental and economic implications. There is the environmental issue of

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pollution from waste (Esin and Cosgun, 2007), the social issues of misuse of natural raw materials (Lu and Yuan, 2011) and the running out of landfill space (Poon *et al.*, 2003), and the economic issue of increased cost of construction projects from the cost of materials wasted as well as the cost for disposal of waste at the landfill (Hao *et al.*, 2010). The quest for sustainability in construction has been fuelled by the realisation that the industry can improve its effects on the environment and also make economic gains at the same time. In this regard, efforts towards waste management (WM) have been increasing and the adoption of the waste hierarchy has been promoted as the best approach to CD&E WM. Research efforts towards WM have covered different areas including: attitudes of workers (Theo and Loosemore, 2001); practices to reduce waste; critical success factors (Osmani *et al.*, 2008); BIM and WM (Liu *et al.*, 201); and WM legislation (Osmani *et al.*, 2008; Adjei *et al.*, 2015). Lu and Tam (2013) report that the approaches towards construction WM take the form of hard technologies such as prefabrication, use of metal formwork and use of recycled aggregates, and soft managerial or economic approaches such as legislation. All these studies have made contributions to the quest for sustainable CD&E WM by influencing policies and measures adopted by construction companies.

Identifying Drivers for Sustainable Waste Management in the Construction Industry

Over the past two decades, considerable efforts have been devoted to understanding the factors that drive sustainable CD&E WM. Osmani *et al.*, (2008) report that government legislation is one of the most critical success factors for ensuring sustainable CD&E WM. Lu and Yuan (2010) conduct a study on the critical success factors for WM in construction projects and conclude that: WM legislation; WM system; awareness of C&D WM, low-waste building technologies, fewer design changes, research and development in WM, and vocational training in WM are the most critical in ensuring waste is sustainably managed. Osmani *et al.*, (2008) and Yuan (2008) also report that environmental protection is a key driver for managing CD&E waste. Through the use of Bayesian Belief Networks (BBN), Bakshan *et al.*, (2017) report that personal factors such as attitude have more impacts on WM than corporate factors such as training. Wu *et al.*, (2017) investigate the determinants of contractor's WM behaviour in china and conclude that economic viability and government policy both play important roles in improving contractor's behaviour towards WM.

Although these studies have made positive contributions to sustainable CD&E WM, the industry has a long way to go so far as sustainable waste management (SWM) is concerned. This calls for new approaches that have the potential to ensure better results are achieved from the measures adopted by construction firms. The motivation for this research is in line with the need to contribute new evidence towards the sustainable CD&E WM. Although the construction industry operates at two main levels: corporate level; and the project level (Vrijhoef and Koskela, 2005; Zhao *et al.*, 2012), research on sustainable CD&E WM has failed to acknowledge the two tier nature of the industry and the likely impact of this on efforts towards WM.

The Two Tier Nature of the Construction Industry

The construction industry can be said to work at two different levels: the corporate level, where overarching decisions are made; and the project or site level which is generally one of and project based. Unlike the manufacturing industries where policies and approaches developed at the corporate level can easily trickle down to the

manufacturing plant and assembly lines, the fragmented nature and organisation of the industry makes it different (Fernández-Solís, 2008; Nawi *et al.*, 2014). Vrijhoef and Koskela (2005) suggest that construction is dominated by project-based production with project teams constructed from relatively independent participants joining a constantly changing one-off coalitions of firms to deliver make-to-order or design-to-order projects (See also Winch, 2003). The nature of the industry and its projects create two different cultures: the corporate culture and the project culture (Vrijhoef and Koskela, 2005).

This research argues that, the difference in culture and operations between the corporate level and the project level are likely to influence the factors driving WM at the two different levels. It is likely that the measures adopted at the corporate level may not necessarily reach the project level (Keeble *et al.*, 2003; Zhao *et al.*, 2012). Although policy decisions are made at the corporate level, waste generation and management occurs at the project level. This makes the need to investigate the drivers of WM at both levels very important.

RESEARCH METHODOLOGY

For this research, multiple case studies with multiple embedded units of analysis was adopted. For the corporate level data collection, four construction companies who had previously won awards for their sustainability and best practices in WM were purposely selected. At the project level, 2 live projects from companies A C and D, and 3 from Company B (a total of 9 live projects) were purposefully selected. A summary of the case study companies and projects is shown in table 1.

Table 1 Summary of case study companies and projects

Company A		
Part of a British multinational facilities management and construction company		
Project A1		Project A2
School replacement project worth £22 Million, lasting 7.5 months. Educational (public sector client)		Redevelopment of a power station into apartments and shops worth £400 Million, lasting 39 months. (Client developer)
Company B		
Construction and property services company operating in England, Scotland and Wales		
Project B1		Project B2
New Build with part refurbishment school worth £12 Million Pounds lasting 8 months (Education Funding Agency)		New Build Leisure centre and retail Park worth £35 Million lasting 23 months (Developer)
Project B3		
New Build University Project worth £8 Million lasting 17 Months (Education Funding Agency for a university)		
Company C		
Leading property, residential and construction service group in the UK operating in Middle East, Far East and Caribbean		
Project C1		Project C2
New Build (Technology college on an existing site worth £12.5 Million design and build project lasting 12 months (Education Funding Agency)		New Build Hospital (Rapid Response Unit) worth £36.5 Million lasting 18 months (Health Trust)
Company D		
Property Solutions Management Company in the UK - specialist in retail distribution with major clients being major retail outlets and high-street shops		
Project D1		Project D2
New Build Retail park on a brownfield site with part demolition worth £20 Million lasting 8 months Investor (Contractor is the developer)		Retail Park fuel station and shopping mall with cinema on part green and part brownfield worth £45 Million lasting 27 months (Developer)

Data was collected via semi-structured interviews with 25 personnel from the corporate and project levels, analysis of sustainability, environmental and WM policies documents, site-waste training documents, and site observations. Participants

were sustainability managers, environmental advisors, projects managers, designers, site managers and sub-contractor personnel. QSR Nvivo, version 11 was used as a tool to help in the coding and retrieving of data. To ensure the analysis of data followed a well organised format, all data collected for the research was prepared through transcription and editing of audio recordings, and sorting of documentary evidence.

The coding process followed a cycle of what Saldana (2012) describes as encoding and decoding, where codes were used to represent extracts or passages from the interviews and documents. A total of 150 nodes/codes were generated from the data through micro analysis of (digging beneath) the data (open coding) to discover all meanings inherent in the data. The codes were further developed into categories (tree nodes). Through the process of description, analysis and interpretation, codes representing similar concepts were grouped further to develop themes and sub-themes. The results from the process were grouped under corporate level and project level drivers.

RESULTS AND DISCUSSION

This section of presents the results from the case studies and discusses the implications of the results in relation to achieving sustainable CD&E WM. The results from the corporate level are presented first, followed by the results from the project level. Discussion of the results and the implications for waste management are presented in the last section.

Drivers for Waste Management at the Corporate Level

From the analysis of the interviews with corporate level staff, and the review of company documents on sustainable waste management, the corporate level WM drivers were identified. The criticality of a driver for waste management was identified based on how much emphasis company policy and interviewees placed on a particular driver. The drivers (shown in figure 1) are divided into internal and external drivers. Whiles internal drivers solely dependent on the internal mechanisms within the company, external drivers are arise from factors outside the control of company.

Internal Drivers for Waste Management at the Corporate Level

In total there were 5 internal drivers for WM at the corporate level and these include: company sustainability agenda (vision), economic considerations, moral and social imperative to manage waste, company image, and environmental concerns. As shown in figure 1, economic considerations is one of the most important (and common) drivers for sustainable WM. Cost elements affecting WM were identified to be: cost of materials in the waste, the cost of man hours put into the process, the cost of permits, the cost of transportation, and charges for disposal of waste.

Interviewees suggested that the high cost of waste generation and disposal served as a driver to WM. It was identified that Company B spent about £2.4 million per year on waste generation and disposal and this influenced WM. For company D, about 0.5% of construction turnover is spent on waste and this high cost serves as a driver to put in place strategies to manage waste. Similar issues were identified for Company C. Martin and Scott (2003) previously reported that the Landfill Tax (cost of disposing waste) is an important driver for WM in the UK.

For companies A and B, the quest to achieve sustainability goals drives the overall WM agenda. The need to be sustainable is acknowledged by the Environmental

Policies of both companies A and B. For company A, the Waste Guidance Document and Waste Procedure Document make reference to the need to ensure sustainability is achieved throughout the WM process. Company image was also a common driver in all the companies and related to the need to demonstrate to clients that the company is a responsible contractor. Having a good image was identified to have an effect on a company's ability to win work and this influenced the pursuit of SWM.

Environmental concerns was identified to be the next driver for WM. According to the Sustainability Manager for company A, "It is an internal policy to do well for the environment" and this means ensuring all negative environmental impacts are reduced. Osmani *et al.*, (2008) and Yuan (2008) have all reported environmental concerns as a major driver for WM. Some companies also see the need to manage waste as a moral imperative.

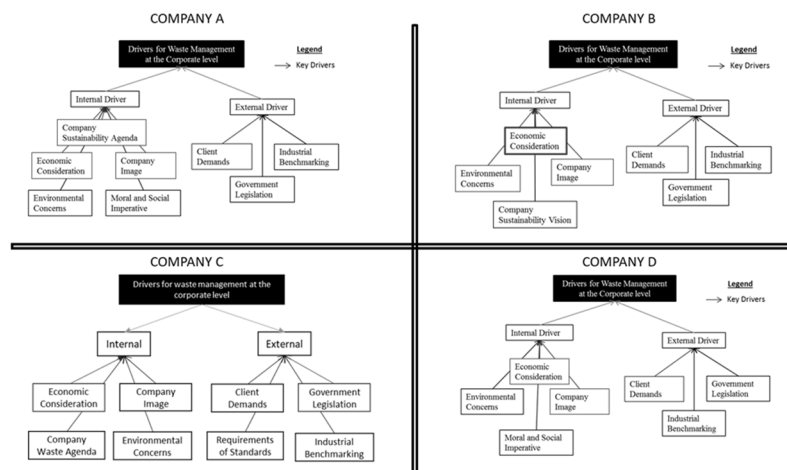


Figure 1 Drivers for sustainable WM at the corporate level

External Drivers for Waste Management at the Corporate Level

The key external driver for Sustainable CD&E WM in all four companies was identified to be client demands followed by government legislation. According to the interviewees, some clients are very interested in environmental performance and this drives WM. Some clients required high BREEAM rating (for example) and this served as a driver for WM. The need to meet client requests for WM influenced WM strategy of company C and B. As explained by the senior environment: "...a lot of clients are starting to have high targets for waste diversion from landfill or, in some cases, zero waste to landfill aspirations, so we need to demonstrate that we're working towards that too." Similar comments were made by interviewees from companies C and D. Though clients are generally reported in the literature to have less regard for the environmental burden of their projects, (Yuan and Shen 2011), this research suggests there are increasing numbers of clients who have genuine concerns for environmental and sustainability issues, including waste and these drive corporate level CD&E WM.

Within all four companies, the need to comply with government legislation also serves as a driver for WM. The threat of negative public image resulting from non-compliance with legislation served as an incentive to comply with legislative requirements. Ajayi *et al.*, (2015), Osmani (2012) and Yuan and Lu (2010) all report that government efforts towards WM are influenced by environmental concerns and economic considerations. The influence of legislation notwithstanding, results from this research suggests that government legislation is not the most critical driver for WM. Demands of clients for compliant firms served as a boost to comply with

legislation (See also Adjei *et al.*, 2015). Benchmarking performance against other contractors and the need to meet the requirements of standards such as ISO 140001, the Halving Waste to Landfill initiative of WRAP and the Considerate Constructors Scheme were all identified as drivers for WM. Research by Barthorpe (2010) and Glass and Simmonds (2007) also report that such standards help to raise the environmental awareness of constructions firms.

Drivers for Waste Management at the Project Level

From the analysis of observation reports, interviews with site teams and review of project level documentation, the drivers of sustainable CD&E WM at the project level were identified. A summary of project level drivers is presented in figure 2 below.

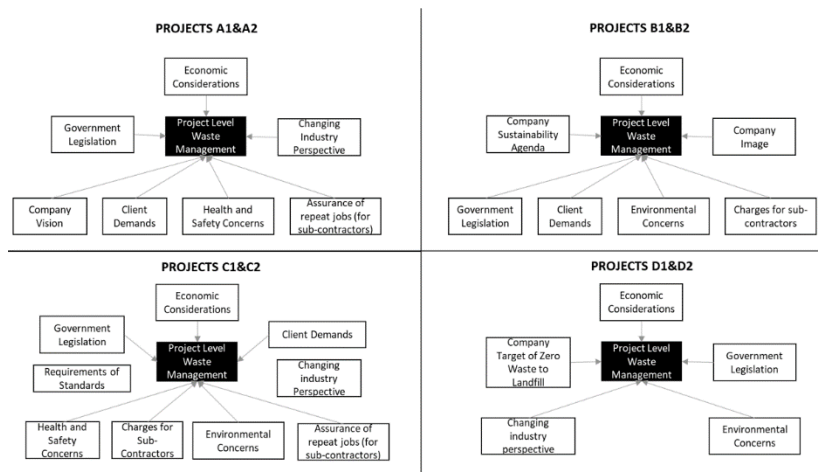


Figure 2 Drivers for Sustainable CD&E WM at the project level

As seen from figure two, although the influences differed, common factors such as economic considerations, client demands, and government legislation were identified to which drive WM. Although these factors are as a direct impact of corporate level action (WM drivers), the extent of influence of corporate level factors differed from one project to the other. Just as the corporate level, project teams were traditionally interested in cost savings and this to a large extent drove their WM efforts. In an interview with the Design Manager on Project B1, he hinted: “cost as a driver is currently an industrial thing where ways of saving money is a key driver for many activities in the industry and WM is definitely one of them. At the end of the day, everything comes back to cost. The cost of transporting waste out of site also drives practices where steel or timber when segregated can be taken away for free but mixing the waste means the need to pay for segregation.” The main cost elements of waste generation on projects were identified to be the cost of materials, the cost for transporting waste and the payment for landfilling of waste. Similar results have been reported in Shen and Tam (2002). Cost was also identified to be the easiest message to ‘sell’ to operatives who were involved in handling materials and work processes.

The next most important driver for WM on all nine projects was client demands where site teams were influenced by the specific demands a client may have for WM (sustainability inclined clients). It was identified that clients such as high street shops generally want high performance in terms of waste and sustainability. The extent of client demands driving WM on projects was to a large extent determined by the type of client. The South East Environmental Manager for Company B who served as an Environmental Manager on Projects B1 and B2 suggested: “the client has got the money and it depends upon what they feel. Some clients will go for the BREEAM

rating, which is highly coded, highly energised to wastage and control thereof, whereas clients that don't have would just be happy to get their building up and not consider that." The Project Manager on Project B2 also passed this comment: "the likes of Network Rail, ask questions like 'well, what are you doing about your waste, how are you managing it, how are you controlling it, what's your WM plan?' Such clients are interested in putting up sustainability reports and as such will require high performance on WM and these requirements drove WM on their projects. For sub-contractors who were involved with the day project, the main incentive for sustainable CD&E WM was the promise of repeat jobs from the main contractor. Sub-contractor personnel interviewed for this research explained that WM and sustainability performance was one of the basis for selecting sub-contractors by main contractors and this influenced their WM efforts. Another driver influencing the WM actions of sub-contractors was identified to be the charging schemes instituted by some project managers for poor WM where sub-contractors were charged for putting waste in the wrong skip.

Another very important factor driving waste at the project level was Health and safety concerns. Site teams suggested that the health hazards posed by waste generation and mismanagement on site served as a driver for WM. Another common driver on almost all projects was identified to be the changing perspective in the industry on the environment which is largely driven by realisation of the negative impacts of the industry on the environment. Legislative requirements such as the need to transfer waste to qualified persons, the need to seek clearance for the management of special waste and the need to use WM plans (which is no more a legal requirement), were identified to drive site level WM strategies. Interview with site teams also suggested that government legislation did not have a directed impact on site teams as this is mediated by company policies.

Comparing Corporate Level and Project Level Drivers for CD&E WM

Comparing figures 1 and 2, it is evident that drivers for WM at the project level do not always mirror the drivers at the corporate level based on the two tier nature of the industry. Where similar drivers are identified between corporate and project levels, the extent to which these drivers influenced WM also differed based on project characteristics and the project team in charge of WM. This difference can be attributed to the two tier nature of the construction industry. Whereas the corporate level determines the general direction of the activities of the company, the project level factors impact on the actual WM practices. Table 2 compares the corporate and project level drivers based on their criticality to WM.

Although previous studies have discussed drivers of WM such as economic incentives, government legislation, environmental concerns, client demands and benchmarking (See Wu *et al.*, 2017; Ajayi *et al.*, 2015; Osmani, 2012, Pit *et al.*, 2009;), which are all largely corporate level factors, the lack of attention to the two-tier nature of the industry remains a gap. Not considering drivers of WM at the two-tier level, means the potential to influence the extent of WM on site has not been fully utilised. Udawatta *et al.*, (2015) suggest that corporate level policies have a big impact on CD&W WM. Although this is true, the project level drivers bring another dimension to CD&E WM. As reported in Bakshan *et al.*, (2017) and Theo and Loosemore (2001), behavioural factors have an influence on WM at the project level. This implies that the drivers at project level could also be taken into consideration at the corporate level to influence corporate level waste policy.

Table 2 Comparison of corporate level and project level drivers for sustainable WM

Case study	Corporate level drivers	Project level drivers
A	Company sustainability agenda, economic considerations, company image, client demands, government legislation, environmental concerns, moral and social imperative, industrial benchmarking	Economic considerations, assurance of repeat jobs for sub-contractors, health and safety concerns, client demands, company vision, government legislation, changing industry perspective
B	Economic considerations, company image, client demands, government legislation, environmental concerns, industrial benchmarking	Economic considerations, charges for sub-contractors, client demands, company image and agenda, environmental concerns, government legislation
C	Economic considerations, company image, Company agenda, client demands, government legislation, environmental concerns, requirements of standards, industrial benchmarking	Economic considerations, assurance of repeat jobs for sub-contractors, health and safety concerns, client demands, charges for sub-contractors, government legislation, changing industry perspective, requirements of standards, environmental concerns
D	Economic considerations, company image, moral and social imperative, client demands, government legislation, environmental concerns, industrial benchmarking	Economic considerations, company target of zero waste to landfill, changing industry perspective, government legislation and environmental concerns

Although company agenda, economic considerations and client demands were the most critical factors at the corporate level, at the project level other factors such as health and safety concerns, charging schemes for sub-contractors and assurance of repeat jobs serve as very critical factors. Tam *et al.*, (2007) suggest there is direct link between sub-contracting arrangements and WM. This link occurs by way of sub-contractors' performance regarding WM. As shown in this research, the extent to which WM performance influences the likelihood of repeat projects drive project level WM. Although sub-contractors' performance occurs at the project level, taking this into consideration at the corporate level is likely to influence WM performance. Results from the project level suggests that project level WM depend to a large extent on the project teams. Theo and Loosemore (2001) and Bakshan *et al.*, (2017) report that attitude of project personnel impact on WM on site. For projects where corporate level staff were involved with site processes, results from this research indicates that corporate level drivers for WM have more impact. This suggests that conscious efforts should be made to enforce corporate level WM policies on site. For example, where H&S professionals were involved on site, H&S became a major driver. The results suggests that unless company waste management policies take project level factors into consideration, the WM goals of companies are not likely to be achieved.

CONCLUSIONS

From the implications of the results discussed above, it can be concluded that the current approach to sustainable WM will benefit from acknowledging the difference in factors driving WM at the corporate and project based levels due to the two tier nature of the construction industry. Considering the two tier nature of the construction industry, this research suggests a rethinking of corporate approaches towards WM taking project level WM drivers into consideration. In addition to the corporate level WM drivers such as company sustainability agenda, economic considerations, company image, client demands, government legislation, environmental concerns, moral and social imperative, industrial benchmarking, and requirements of standards, project level drivers such as: health and safety considerations, charges for sub-contractors, the assurance of repeat jobs for sub-contractors, and changing perspective of project teams are very important considerations for WM. The extent to which corporate strategy influences project level WM practices is to a large extent determined by the measures in place by the company to enforce corporate policy on project teams. Tying down WM strategies to the likelihood of repeat jobs and health and safety performance will have a key impact on sub-contractors and ultimately

influence WM performance as majority of projects are executed through sub-contracting. The design of government legislation on CD&E WM can also benefit from considering these drivers as they have a direct impact on waste generation and management on projects.

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