

# AN INVESTIGATION INTO THE IMPACT OF PROCUREMENT SYSTEMS ON WASTE GENERATION: THE CONTRACTORS' PERSPECTIVE

I.S.W. Gamage<sup>1</sup>, M. Osmani and J Glass

*Department of Civil and Building Engineering, Loughborough University, Loughborough, Leicestershire, LE11 3TU, UK*

While it is recognised that Construction Procurement Systems (CPS) and waste reduction have an effect on achieving sustainability, little research has been undertaken in the evaluation of the impact of CPS on construction waste generation. The research presented in this paper aims to investigate the impact of CPS on waste generation. A postal questionnaire survey was administered to the top 100 contractors in the UK targeting procurement managers and environmental/ sustainability managers to obtain their views to evaluate current practices of CPS and future trends; examine impact of CPS on waste generation; and identify potential CPS to integrate waste minimisation strategies. The findings revealed that the most popular CPS in practice is design and build. Contractors believe CPS do have an impact on waste generation in construction. Specifically, integrated – design and build and separated - cost reimbursable CPS have shown a significant impact on waste generation. Results also indicate that integrated CPS have major potential to integrate waste minimisation strategies than the management-oriented systems and separated systems. The content should be of interest to contractors, clients, and organisations dealing with procurement, waste and sustainability.

Keywords: contractor, procurement system, sustainability, UK, waste.

## INTRODUCTION

The joint industry and UK government strategy for Sustainable Construction 2008 states that construction procurement and waste minimisation are overarching target areas in achieving sustainable construction (BERR 2008). A seminal report of the UK construction industry 'Rethinking Construction' highlighted: 'there is plenty of scope for improving efficiency and quality simply by taking out waste of construction' (Egan 1998:15) as one of the areas which needs improvement. Recent figures published by WRAP (Waste and Resources Action Programme) show that construction, demolition, refurbishment and excavation produce around 120 million tonnes of waste in the UK each year (WRAP 2007). Similarly, the recently published waste strategy for England 2007 has identified the construction industry as a major generator of waste in England (DEFRA 2007). This situation has a detrimental effect on environment (Esin and Cosgun 2007); and on economic competitiveness due to extra costs for contractors such as overhead costs, delays and extra work on cleaning, lower productivity (Skoyles and Skoyles 1987), landfill tax; a wasteful company can be at a 10% disadvantage in tendering for new work (Guthrie and Mallett 1995). This is also a

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<sup>1</sup> W.G.Inoka-Shyamal@lboro.ac.uk

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burden to clients, as they have to bear the costs of waste eventually (Skoyles and Skoyles 1987). Therefore, it is necessary to tackle construction waste by minimising waste at source by identifying respective waste causes (Formoso *et al.* 2002; Osmani *et al.* 2008) before generating physical waste at the site.

Current and ongoing research in the field of construction waste management and minimisation mainly focuses on the design process (Keys *et al.* 2000; Osmani *et al.* 2008) and construction stage (McDonald and Smithers 1998; Chen *et al.* 2002). Only a few studies have suggested that the procurement process and Construction Procurement Systems (CPS) could have an influence on site material waste generation (Emmitt and Gorse 1998; McDonald and Smithers 1998; Ekanayake and Ofori 2000). Authors define CPS as an organisational structure that arranges specific relationships and authorities to the participants, which defines the relationship of key phases in a construction project and acts as a management framework to client for the management of the design, construction and eventually operation of the project. Accordingly, the selected CPS influences project phases as well as the outcome of a project; indeed it could have an influence on waste causes. Hence, this paper attempts to evaluate current practices of CPS and future trends; examine impact of CPS on waste generation; and identify potential CPS to integrate waste minimisation strategies based on contractors' perspectives.

## **WASTE GENERATION AND PROCUREMENT SYSTEMS IN CONSTRUCTION**

### **Construction waste: origins and waste minimisation approaches**

Construction and demolition activities accounts for approximately 32% of total waste generated (DEFRA 2006) which stands for one third of the total annual waste production in the UK. There are two principal ways in which construction waste can be minimised: through source reduction techniques and improvement of on-site waste management strategies (McDonald and Smithers 1998). Having said that many studies explored and classified sources and causes of construction waste in different ways. For instance some of the classifications are based on material types (Formoso *et al.* 2002); different project activities (Gavailan and Bernold 1994; Bossink and Brouwers 1996; Ekanayake and Ofori 2000); and project life cycle approach (Osmani *et al.* 2008). The latter indicated that although the construction waste (physical) is generated as a by-product of the construction process, the causes of waste are linked throughout the project stages. Keys *et al.* (2000) classified waste origins under the headings of manufacture, procurement, supplier, designer, logistics, client, contractor and site management which attempts to relate waste causes both project stakeholders and few project activities.

While approaches for reducing construction waste mainly focussed on-site waste management such as implementing waste management plans during construction phase, waste auditing and assessment and waste sorting methods, very few approaches were evident for pre contract stages; out of which number of studies focussed on waste minimisation through design (Gamage *et al.* 2007). However, studies into waste source and causes evaluation appeared to be focussed for all project stages (Gavailan and Bernold 1994; Bossink and Brouwers 1996; Ekanayake and Ofori 2000). Indeed, very few studies have highlighted that CPS could have an influence on waste generation/ minimisation. MacDonald and Smithers (1998) suggested there was a need to assess the ways in which different procurement methods affect the generation of waste on-site. Similarly, Ekanayake and Ofori (2000) pointed out it is necessary to

promote client CPS to avoid unnecessary material wastage. Moreover, Emmitt and Gorse (1998) recommended re assessment of building procurement to control construction waste focussing on individual responsibility and communication within 'temporary' procurement team. Hence, the impact of CPS on waste generation/ minimisation will be discussed further in the next section.

### **Relationship: construction procurement systems and waste generation**

One of the key decisions during a project (RIBA - Royal Institute of British Architects Work Stages B and C ) is identification of a suitable CPS for the management of design and construction processes. The RICS (Royal Institution of Chartered Surveyors) 'Contracts in Use' survey shows that level of use of separated systems (traditional systems -including variants) and management-oriented systems has declined from 1985 to 2004 (RICS 2006). At the same time the popularity of using integrated systems (design and build) and discretionary systems (Partnering) has increased. However, so far, the use of separated CPS is popular in the UK construction industry accounting for approximately 48% by value of contracts (RICS 2006). Further, the latter survey indicates the popularity of design and build is approximately 43% by value of contracts, which represents the largest percentage as single system in use. Having said that, the UK construction industry is being driven towards integrated CPS as it is recommended in government procurement policy (Egan 1998; OGC 2007).

Survey studies conducted by Jaques (2000) in New Zealand targeting contractor, architecture and quantity surveying practices and McDonald and Smithers (1996) in Australia on the majority of architectural practices revealed that alternative procurement routes held no advantages over the traditional route in terms of waste minimisation. However, McDonald and Smithers (1996) noted that this was more reflective of the experience and interests of the respondents, than that of waste control issue itself. This highlights a need for further investigation. Conversely, the survey study conducted by Johansen and Walter (2007) revealed that large amounts of waste are still inherent in the German construction industry owing to traditional contracting and certain planning methods. Similarly, Tam *et al.* (2007) who investigated the implementation of prefabrication in the context of different procurement methods used in Hong Kong revealed that design and build has 'high' importance in reducing construction waste, where as other CPS have a 'medium' importance level in reducing construction waste. Further, the latter confirmed that the involvement of the contractor at the early design stages of the project improves constructability which minimise waste production. Additionally, Jaques (1998) and McDonald and Smithers (1996) acknowledged that the design and build system offered more opportunities in waste reduction highlighting that creating a buildable design that allows for a logical sequence in construction, providing accurate and integrated project information, making waste efforts financially beneficial to the client, and the involvement of the contractor at the design stage, were all important in terms of waste reduction initiatives. However, Keys *et al.* (2000) noted that overlapping design and construction complicates the management of the design process and moves waste minimisation to the bottom of the priority list.

While there is a potential relationship between CPS and waste generation, an investigation into impact of CPS on waste generation is needed due to contradictory findings in literature. Moreover, the literature is based on different CPS which are grounded in different definitions, cultural and legislative structures. The next section

aims to present the survey findings within the UK context which examine current procurement practices and future trends; impact of CPS on waste generation and potential CPS to integrate waste minimisation strategies.

## **RESEARCH METHOD**

A cross-sectional, self administered postal questionnaire survey was adopted for data collection. The questionnaire was based on a comprehensive literature review on CPS and waste generation. The survey questionnaire was distributed among the UK top 100 contractor practices (Construction News – Top 100 September 2007) to gain broad insights on issues related to the relationship between CPS and waste generation. This paper focuses on selected key issues from the perspective of contractors. Construction procurement managers and environmental/sustainability managers were targeted within the sampling frame using a stratified sampling method. In the survey, 164 questionnaires (two questionnaires for each company targeting the procurement manager and environmental/sustainability manager) were distributed among eligible 82 contractor practices. Some companies were excluded from the list of UK top 100 contractors: e.g. Mechanical and Electrical, plant and equipment, of these 27 targeted respondents were ineligible due to refusals and incorrect contacts. In all, 46 questionnaires were received (from 36 contracting companies) during the survey administration period, giving a response rate of 34%.

SPSS (Statistical Package for Social Science) was used for the quantitative data analysis. The question data were based on a 5 point - Likert scale and findings were presented using descriptive statistics - proportion of responses. Respondents were given spaces to add additional comments regarding the issues forwarded in certain questions. Constant Comparison Method was used to analyse the responses for open ended questions as the method enables identification of emerging themes by constantly comparing each response and maintains a close connection between data and conceptualisation during the analysis (Bryman 2008).

## **SURVEY FINDINGS**

### **Current construction procurement practices and future trends**

Respondents were asked to rate from 1 (none) to 5 (used in all projects) the extent to which different CPS are being used in their current projects. Table 1 reveals that 'separated - lump sum' (50%) and 'integrated - design and build' (more than 52%) CPS are used by contractors in 'most' current projects. Interestingly, the results indicate that design and build is at least 'used in few projects' and is more popular than the separated – lump sum. Other CPS under consideration were not as commonly in use as either separated - lump sum or design and build. However, all CPS under consideration were 'used in some' current projects of contractor practices.

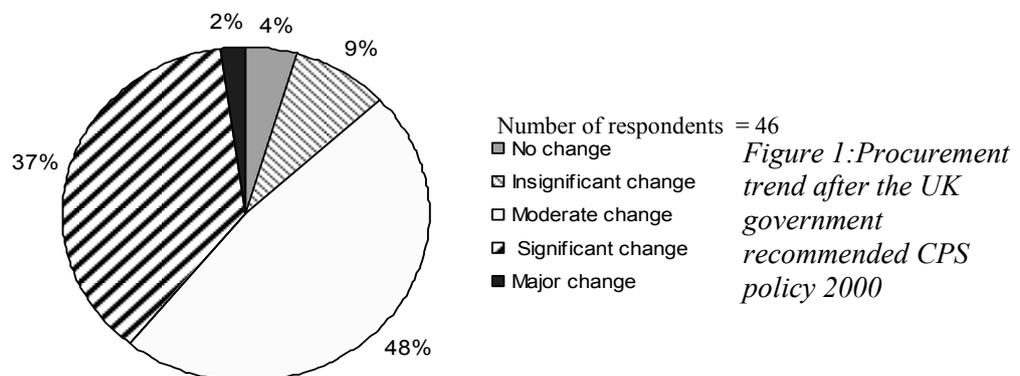
To assess any significant change that might have occurred in construction procurement trend in recent years, a procurement related government policy was used as a baseline (i.e. government is the major client, key regulatory and legislation body). Respondents were given UK government recommended procurement policy (since April 2000, projects to be procured by using one of the three integrated procurement routes as PFI, prime contracting or design and build (OGC 2007)) and asked their views to rate five choices (No change, insignificant change, moderate change,

Table 1: Use of CPS in current projects

Construction Procurement System (Number of respondents = 45)	Contractors' views (percentage)					Mean
	1	2	3	4	5	
Separated (Traditional)						
Lump sum	4.3	2.2	34.8	50.0	8.7	3.57
Re measurement	20.0	6.7	62.2	8.9	2.2	2.67
Cost reimbursable	24.5	44.4	26.7	4.4	-	2.11
Integrated						
Design and build	-	4.3	28.3	52.2	15.2	3.78
Develop and construct	22.2	11.1	37.8	26.7	2.2	2.76
Package deal	20.5	34.1	27.3	18.1	-	2.43
Private Finance Initiative (PFI)	31.1	26.7	28.9	8.9	4.4	2.29
Turn key	54.5	22.7	20.5	2.3	-	1.70
Management oriented						
Construction management	31.8	18.1	27.3	11.4	11.4	2.52
Design and manage	41.9	16.3	14.0	27.8	-	2.28
Management contracting	43.2	20.5	25.0	11.3	-	2.05

1. None; 2. Used in few projects; 3. Used in some projects; 4. Used in most projects; 5. Used in all projects.

significant change, major change). As shown in Figure 1, the majority (48%) of respondents stated that the government recommended policy has caused a 'moderate change' to the selection of CPS generally. However, 37% thought that the policy caused a 'significant change' to the selection of CPS. A minority of participants (13%) indicated 'no change/insignificant change'.



There were eight additional comments on this issue; out of which majority of respondents indicated that the policy has caused a change to the selection of CPS. For instance one respondent indicated that 'the policy has affected the procurement of contracts in a significant manner' and another mentioned that 'design and build has been the preferred route for risk-averse employers for many years'. Interestingly, few respondents mentioned that choice of CPS is driven by client's requirements which suggest that procurement selection is independent of implemented policy.

### Relationship between procurement systems and construction waste generation

Respondents were asked to rate from 1 (no impact) to 5 (high impact) the impact of different CPS on construction waste generation. As shown in Table 2, few respondents selected the 'none/insignificant' impact categories (less than 35%) in comparison with other impact categories (at least 65% of total respondents rated the impact of all CPS as 'moderate', 'significant' and 'high') which confirms that there is a relationship between CPS and waste generation.

Table 2: Impact of procurement systems on construction waste generation

Construction Procurement System (Number of respondents = 45)	Contractors' views (percentage)					Mean
	1	2	3	4	5	
Separated (Traditional)						
Cost reimbursable	7.7	17.9	23.1	41.0	10.3	3.28
Re measurement	7.3	19.5	48.8	17.1	7.3	2.98
Lump sum	7.0	25.6	48.8	11.6	7.0	2.86
Integrated						
Design and build	4.6	16.3	34.9	27.9	16.3	3.35
Develop and construct	5.6	16.7	44.4	22.2	11.1	3.17
Package deal	11.1	13.9	61.1	8.3	5.6	2.83
Private Finance Initiative (PFI)	11.8	20.6	55.9	2.9	8.8	2.76
Turn key	12.5	20.8	54.2	8.3	4.2	2.71
Management oriented						
Construction management	5.9	5.9	61.8	14.6	11.8	3.21
Design and manage	6.7	23.3	46.7	20.0	3.3	2.90
Management contracting	6.3	28.0	56.3	9.4	0.0	2.69

1. No impact; 2. Insignificant impact ; 3. Moderate impact; 4. Significant impact; 5. High impact.

Design and build recorded the highest impact (more than 44% 'significant/high' impact) on waste generation, not only under the integrated systems, but also among all other systems. Similarly, develop and construct system was seconded only to design and build under integrated systems, in terms of impact of waste generation. The other listed CPS under integrated have not shown any significant differences, yet the impact is not as significant as 'design and build' system. Cost reimbursable recorded the highest impact (more than 51% 'significant/high') on waste generation under the separated systems. More than 61% of respondents rated construction management as having 'moderate' impact on waste generation. From the results in Table 3, it is apparent that the impact of CPS on waste generation is 'moderate' for all CPS under consideration except integrated – design build and separated - cost reimbursable which both clearly show a 'significant/high' impact.

Nearly half of the (22 out of 46) respondents provided additional comments on this issue. While a few alternative ideas suggested different directions and contradictions on the impact of CPS and waste generation, the majority were in line with the quantitative results and literature findings.

A majority of the respondents indicated that there is a relationship between CPS and waste generation. For example one respondent indicated that 'a construction procurement system could have a significant effect on the waste generated'. Moreover, several respondents went further indicating what kind of relationship is

present between CPS and waste generation; they believed that integrated systems especially design and build produce less waste. One respondent stated that ‘design and build tends to promote innovative waste management to reduce cost’.

Some respondents highlighted that waste minimisation decisions or planning should be made in early stages of the project and contractor involved earlier. Some of the views to reflect latter were;

- ‘as a general rule the input from trade parties at design stage will improve wastage as it also impacts the contractors’ bottom line’,
- ‘integrated systems work best as they allow for design decisions to be made easily in the process which should provide for effectiveness’.

Thus, this further shows that design and build produces less waste, because as it allows contractors to involve and make effective planning during the design stage. Another respondent went further explaining the effectiveness of design and build on waste reduction by comparing with the traditional system;

- ‘traditional systems place emphasis on to the client and his team to manage waste generation - not always good at this. With design and build emphasis is with contractor. Therefore integrated systems can be effective to reduce waste generation rather separated CPS’.

Very few respondents (4) gave contradictory comments in which they indicated there is little relationship between CPS and waste generation. For instance one respondent indicated that ‘not convinced that procurement route has much to do with the production of waste’ and another stated ‘I think sometimes the relationship is weak between two’. However, these responses were very brief, showed uncertainty and importantly failed to give a detailed explanation.

### **Potential procurement systems to integrate waste minimisation strategies**

Respondents were asked to rate from 1 (no potential) to 5 (major potential) based on their experience how much potential each CPS has for integrating waste minimisation strategies.

*Table 3: Potential CPS to integrate waste minimisation strategies*

Construction Procurement System (Number of respondents = 46)	Contractors’ views (percentage)					Mean
	1	2	3	4	5	
Integrated	-	6.5	19.6	19.6	54.3	4.22
Separated (Traditional)	-	45.7	39.1	10.9	4.3	3.59
Management oriented	-	6.5	43.5	34.8	15.2	2.74

1. No potential; 2. Insignificant potential ; 3. Moderate potential; 4. Significant potential; 5. Major potential.

Table 3, indicates that respondents believed that all CPS have some potential to integrate waste minimisation strategies, as none of the CPS were rated as having ‘no potential’. However, more than 73% of responding contractors opined that integrated systems have a ‘significant/major’ potential to integrate waste minimisation strategies followed by management-oriented systems (50%). The worst potential systems in which to integrate waste minimisation strategies appeared to be separated (traditional) systems.

## DISCUSSION

The results of this paper are based on a survey that targeted the top 100 contractor firms. A larger sample may have provided slightly different results, but may have led to the inclusion of contractors inexperienced in use of different CPS.

The findings clearly indicate the popularity of design and build system in current projects. Additionally, the results reveal that the procurement trend is changing towards integrated CPS. Therefore, the results of this survey further substantiate the increasing popularity of design and build as a single CPS in the UK construction industry. Very little was found in the literature on the impact of CPS on waste generation. Having said that, more than 65% of the surveyed contractors reported that the selected CPS for a project has an impact on construction waste generation. More specifically, integrated – design and build, and separated - cost reimbursable which both clearly shown a significant impact on waste generation whereas other CPS shown a moderate impact. Interestingly, integrated systems were seen by contractors (more than 73%) as having the most potential to integrate waste minimisation strategies, which is supported by survey findings of Tam *et al.* (2007) and views of Jaques (1998) and McDonald and Smithers (1996). This research has confirmed that there is a perceived relationship between CPS and waste generation and contractors believed that integrated systems (especially design and build) produce less waste, because early contractor involvement leads to effective decisions on design, planning waste minimisation. However, the findings of this study contradict the results of Jaques (2000) and McDonald and Smithers (1996) as they concluded alternative procurement routes held no advantages over the traditional route in terms of waste minimisation.

## CONCLUSIONS

This paper has given an account of the emergent relationship between CPS and material waste in construction. The study set out to evaluate current practices of CPS and future trends, examine impact of CPS on waste generation and identify potential CPS to integrate waste minimisation strategies with in the largest UK contractor practices. The findings revealed that the most popular CPS in practice is design and build which also has shown an increasing trend in use. One of the more significant findings from this study is that contractors believe CPS do have an impact on waste generation in construction. Specifically, integrated – design and build, and separated - cost reimbursable CPS have shown a significant impact whereas other systems have a moderate impact on waste generation. Results also indicate that integrated CPS have major potential to integrate waste minimisation strategies than the management-oriented systems and separated systems.

This research contributes to a growing body of literature on CPS to enhance sustainable procurement practices that enable waste reduction. Although the current findings limited to contractors' perspective, it suggests that the focus should be placed on design and build and its relationship with construction waste as it has shown a major potential to integrate waste minimisation strategies and is becoming popular.

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