ASSESSING THE RELATIONSHIP BETWEEN PROCUREMENT SYSTEMS AND WASTE GENERATION IN CONSTRUCTION

I.S.W.Gamage\textsuperscript{1,2,3}, M.Osmani\textsuperscript{2} and J.Glass\textsuperscript{3}

\textsuperscript{1,2,3} Department of Civil and Building Engineering, Loughborough University, Loughborough, Leicestershire, LE11 3TU, UK.

E-mail: W.G.Inoka-Shyamal@lboro.ac.uk

Abstract: The construction industry has a major impact on the environment, both in terms of resource consumption and raising waste production. The current research in the field of construction waste management and minimisation focuses mainly on onsite waste quantification and management; and stakeholders’ source identification. Although recent studies argue that a significant amount of construction waste originates throughout different stages of the construction procurement process, very few attempts have been made to examine the influence of procurement on construction waste generation. Hence, this research, part of a doctoral study, has been undertaken to explore the relationship between different construction procurement systems and construction waste generation. The paper covers: construction waste source evaluation; current procurement practices in the UK construction industry; and the relationship between waste and procurement systems. The conclusions capture knowledge on the relationship between procurement systems and construction waste generation; and pave the way for the development of a construction waste minimisation framework for procurement methods.

Keywords: construction procurement, UK, waste generation, waste minimisation.

1. INTRODUCTION

Construction and demolition activities generate a considerable amount of waste. Recent figures published by the UK Government reveal that construction and demolition activities produce 109 million tonnes of waste every year (DEFRA, 2007a). Furthermore, construction waste accounts for more than 50\% of all landfill waste in the UK (Ferguson et al., 1995). As such, the newly published waste strategy for England 2007 (DEFRA, 2007b) has identified the construction industry as a major source of waste in England. There is a consensus in the literature that reduction is the best and most efficient method for minimising the generation of waste and eliminating many of waste disposal problems (Formoso et al., 2002; Esin and Cosgun, 2007; Osmani et al., 2007).

The current and ongoing research in the field of construction waste management and minimisation focuses mainly on onsite waste quantification and source evaluation (Ekanayake and Ofori, 2000; Bossink and Brouwers, 1996; McDonald and Smithers, 1998). Several studies have focussed on waste minimisation from various angles such as implementing waste management plans during construction phase (McDonald and Smithers, 1998), waste minimisation through design (Keys et al., 2000; Osmani et al., 2007), waste source evaluation (Ekanayake and Ofori, 2000; Bossink and Brouwers, 1996) and onsite waste auditing and assessment (Chen et al., 2002). However, findings reveal that construction waste is accepted as a by-product of the construction
process, including procurement. Only a few studies point out that procurement system could have an influence on waste generation, but some argue that a significant amount of construction waste originates throughout different stages of the construction procurement process (McDonald and Smithers, 1998; Ekanayake and Ofori, 2000; Jaques, 1998), very few attempts have been made to examine the influence of procurement on construction waste generation. Hence, this research, part of a doctoral study, has been undertaken to explore the relationship between different construction procurement systems and construction waste generation. It reviews adopted definitions; examines construction waste origins; and, explores the relationship between waste and procurement systems in construction.

2. DEFINITIONS

2.1 Construction Waste

Various interpretations and definitions of waste can be found in the construction waste related literature. The definition of waste by the European Council Directive 91/156/EEC is “any substance or object which the holder discards or intends or is required to discard” (Directive 91/156/EEC [2], Article 1, Letter a). This definition applies to all waste irrespective of whether or not it is destined for disposal or recovery operations (Osmani et al., 2005). However, Ekanayake and Ofori (2000) defined construction waste as “any material, apart from earth materials, which needs to be transported elsewhere from the construction site or used within the construction site itself for the purpose of land filling, incineration, recycling, reusing or composting, other than the intended specific purpose of the project due to material damage, excess, non-use, or non compliance with the specifications or being a by-product of the construction process.” The adopted definition of construction waste for this research is a material which need to be transported elsewhere from purpose of project due to damage, excess, or non use or which cannot be used specific due to non compliance with the specifications, or which is a by product of the construction process (Skoyles and Skoyles, 1987).

2.2 Construction Procurement

CIB W92 (1997) [cited in Masterman, 2002] defined a procurement process as “a strategy to satisfy clients development and/or operational needs with respect to the provision of constructed facilities for a discrete life cycle.” This sought to emphasise that the procurement strategy must cover the whole lifespan of the project. However, the strategy, which is most appropriate method of procuring the project, is known as a procurement system (Masterman, 2002). Thus the term procurement system is defined as “the organisation structure adopted by the client for the management of the design and construction of a building project” (Masterman, 1992), and “the organisational structure adopted by the client for the implementation, and at times eventual operation, of a project” (Masterman, 2002). Similarly, Love et al. (1998) defined procurement system as “An organisational structure that arranges specific responsibilities and authorities to participants and defined the relationship of the various elements in the construction projects”, which expresses key attributes of the system and will be taken on for the purpose of this study.
2.3 Procurement Method or Contract Strategy?

The belief that a procurement system is defined by a simple contract strategy is misleading (Rowlinson and McDermott, 1999). However, Rowlinson and McDermott (1999) suggest a contract strategy is a key component of a procurement system and should be considered within the whole procurement system, encompassing the political, social and economic factors, which impinge upon any project. Further, they highlighted the acquisition of resources such as consultants, contractors, subcontractors, suppliers and client’s own resources are essential in order to realisation of construction project. Acquisition of resources or the process of combining necessary resources together is part of the procurement system and this could be termed as contract strategy. In order to clearly and adequately define contract strategy, the following variables should be considered: organisational form, payment method, overlap of project phases, selection process, source of project finance, contract documents, leadership and authority and responsibility (Rowlinson and McDermott, 1999).

3. CONSTRUCTION WASTE SOURCE EVALUATION AND MINIMISATION

3.1 Waste Origins and Causes

Gavilan and Bernold (1994) identified waste sources in construction as design, procurement, material handling, operation, residual and other. Bossink and Brouwers (1996) adopted a similar approach to extend the list of sources and respective causes. For the latter, it is important to note that ‘procurement’ represents ‘material procurement’ and not a ‘contract strategy’. Similarly Pinto (1989), Soibelman et al. (1994), and Pinto and Agopayan (1994) [cited in Bossink and Brouwers, 1996] related construction waste to material types such as steel, cement, concrete, sand, mortar, ceramic block, brick, timber, hydrated lime, wall ceramic lime, wall ceramic tile and floor ceramic tiles.

On the other hand, Keys et al. (2000) classified waste origins under the headings of manufacture, procurement, supplier, designer, logistics, client, contractor and site management. However, Ekanayake and Ofori (2000) categorised construction waste causes under four main categories as design, operational, material handling and procurement (material), whereas Osmani et al. (2007) adopted a life cycle approach to construction waste origins from inception to completion. These sources demonstrate that waste origins are attached to different elements of a procurement system such as: design related origins to design element, contractual origins attach to the contact strategy, procurement, transportation, on site management and planning, material handling and storage, and site operations attached to construction.
3.2 Waste Minimisation in Construction

There are two principal ways in which construction waste could be minimised: through source reduction techniques both on site and during the design and procurement phases of a building project, and through improvement of onsite waste management strategies (McDonald and Smithers, 1998). Economic, social and political pressures are likely to continue to drive up the costs of waste disposal over the next few years, which will increase importance of waste minimisation strategies in the UK (Turner and Powell, 1991). Indeed, the increase in the Landfill Tax in the UK from £24 a tonne in 2007 to £32 a tonne in 2008, will act an economic incentive to reduce waste at source and increase the recycling of construction waste. Osmani et al. (2006) went further to categorise construction waste minimisation drivers as: environmental, economic, industry concerns, and government policies, and regulations. Thus, it is apparent that there is an emerging requirement for waste minimisation in construction. However, literature revealed that many studies attempt to cater for this emerging need in different ways. In 2007, Osmani et al. revealed the current and ongoing research in the field of construction waste management and minimisation in eleven clusters (such as Construction waste quantification and source evaluation and On-site construction waste sorting methods and techniques) and so broadened waste minimisation research studies by exploring waste minimisation through design.

However, there appears to be little research related to assessing the impact of procurement systems on construction waste generation/minimisation. An attempt to explore the relationship between waste generation and procurement systems in construction is discussed in the next section.

4. RELATIONSHIP BETWEEN WASTE AND PROCUREMENT SYSTEMS IN CONSTRUCTION

4.1 Procurement Systems and Trends in the UK Construction Industry

Procurement systems have different organisational structures and arrangements that can affect not only the design and construction stages of a project but also cultural, managerial, environmental and political issues (Masterman, 2002). Sharif and Morledge (1994) [cited in Rowlinson and McDermott, 1999] who have drawn attention to the inadequacy of the common classification criteria for procurement systems in enabling useful global comparisons. In a review of procurement and contractual agreements in the UK, Latham (1994:5) [cited in Rowlinson and McDermott, 1999] noted the difficulty of drawing conclusions from existing studies, and stated that “some international comparisons reflect differences of culture or of legislative structures which cannot easily be transplanted to the UK.” Furthermore, Masterman (2002) reported that it is difficult to quantify accurately the past or present level of use of all, or any of available procurement systems, due to lack of truly comparative figures for the individual methods over a set period of time from a sufficiently wide range of reliable sources. However, he mentioned that the RICS (Royal Institution of Charted Surveyors) surveys come nearest to achieving accurate
and truly comparative figures as a reliable source. Masterman (2002) adopted a four fold categorisation of procurement methods in the UK: ‘Separated’ (the conventional system), ‘Integrated’ (Design and Build, variants of Design and Build), ‘Management Oriented’ (Management Contracting, Construction Management, Design and Manage) and ‘Discretionary’ (British Property Federation system, Partnering). This categorisation was based on the way in which the interaction between the design and construction, and sometimes the funding and operation, of the project is managed.

4.2 Assessing the Relationship between Waste and Procurement Systems in Construction

There is a small but growing body of literature that attempted to explore the affect of procurement methods on construction waste generation and minimisation. As such, McDonald and Smithers (1998) emphasised the need of minimising the amount of waste generated during the design and procurement phase of a building contract and suggested that the future work should involve assessing the ways in which differing procurement methods affect the generation of waste on site as a result of the different interrelationships involved in alternative procurement processes. Additionally, Ekanayaka and Ofori (2000) stated it is necessary to ‘promote appropriate clients procurement systems’ where contractors’ experience in methods and sequence of construction can help in the decision-making process during the design stage to avoid unnecessary extra work during construction which cause time delay and material wastage. Begum et al. (2007) argued that waste minimisation should be integrated into the construction process, and planned at the design and tender stages.

Jaques (2000) enquired, whether alternative methods of procurement offer improved opportunities for waste minimisation strategies to be adopted. In response 20% of architects and 15% quantity surveyors thought that alternative procurement methods would improve waste strategies. However, 43% of architects and 50% of quantity surveyors were agreeing that is sometimes true. Further, quantity surveyors stated ‘there has to be a cost incentive to reduce waste. The only incentive at the present - the more waste the less margin on all procurement methods other than cost reimbursable contracts. The more competitive the procurement method the least margin, therefore minimal waste/more profit. Fixed sum procurement strategy is generally the more competitive method for this purpose’. The same study concluded that alternative procurement routes did not have any significant advantages over the traditional route in terms of waste minimisation. However, the fixed sum form of procurement was suggested as an alternative method of procurement to offer improved opportunities for waste management strategies. This is contrary to a study carried out by McDonald and Smithers (1996), where respondents thought that fixed sum offered few opportunities in terms of waste minimisation and there was no clear relationship between different procurement methods and waste minimisation. In summary, the literature presents no clear evaluation of the impact of procurement methods on construction waste generation.
4.3 Relationship between Waste Generation and Procurement Systems

Separated systems or more common term conventional methods of procurement have been criticised for their sequential approach to project delivery, as they have contributed to the so called ‘procurement gap’ where by design and construction process are separated from one another (Love et al., 1998). This leads to a lengthy design and construction process, poor communication, undermined relationships and finally resulted in problems of buildability. Ngowi (1998) reported a number of apparent problems related to traditional procurement system such as: difficulties in phasing and sequencing of functions; lack of coordination between participants and trades; adversarial contract conditions; and unsatisfactory competitive tendering. Hence, the method does not sufficiently make use of the contribution that organisational and individual team members’ knowledge can make to a project’s design, waste and under utilisation of resources are inherent within the different stages of design and construction. Additionally, tenders are obtained on the basis of an incomplete design and facilitate to respond to late demands for changes, known as variations, which result in rework leading to inevitable waste production (Masterman, 2002). However, when a design is fully developed and uncertainties eliminated before tenders are invited, tendering costs are minimised and proper competition is ensured. This allows contractors to provide competitive bid value (by eliminating unnecessary costs) and can be a preset driver for minimising the costs associated with waste production.

In an integrated procurement system, design and construction responsibility lies with contractor, hence this could result a buildable design (since contractor’s experience absorbed to the design) and improved constructability. The absence of a bill of quantities makes the valuation of variations extremely difficult and restricts the freedom of clients to make changes to the design of the project during the post contract period (Masterman, 2002). However, Keys et al. (2000) reported that overlapping of design and construction complicates the management of the design process and moves waste minimisation to the bottom of the priority list.

A ‘management oriented’ system is carried out by an organisation working with the designer and other consultants to produce the design and manage the physical operations that are carried out by workers, or packages, contractors (Masterman, 2002). As result of employing separate management organisation early start and shorter duration by acceleration of the project is possible. Early stage advice, obtained from the contractor to improve design, buildability, programming and materials and material availability together with general construction expertise (Masterman, 2002), provides an effective opportunity to minimise waste generation. The system offers a good opportunity to adopt value management in the early stages and employ specialised trade contractors in the latter stages of the project providing an incentive to minimise waste. Involvement of the client is highly encouraged by the ‘Management Oriented’ system, however, this could result in both positive (able to force construction team to adopt waste minimisation strategy) and negative (last minute decisions and changes) impacts on waste generation.
Discretionary is an administrative and cultural framework in which any procurement system(s) can be incorporated, thus allowing the client to carry out the project by imposing a very specific management style or company culture, while at enabling the use of the most suitable procurement methods (Masterman, 2002). The RICS survey (2004) reported that ‘Partnering’, which is an innovative, multi-party, two-stage contract where client, consultants, contractors, and specialists sign it at an early stage and then work towards an agreed maximum price and a commencement of agreement, has been identified as the emerging arrangement in recent years. Literature indicates that the use of ‘Partnering’ arrangement enhances the communication between parties, efficient working, greater productivity, allowed innovative thinking, research and development, shorten construction period and quality of final product. Effective utilisation of personal resources is key feature of Partnering, which enhances flexibility and responsiveness in terms of added skills and resources available from other parties (Bower, 2003) providing good incentive to minimise waste. Furthermore Partnering allows contractor’s involvement with design team in early stage and continue relationship for future projects developments as well, so that it optimise design team time, enhances buildable design, improved opportunities for adaptation of new methods leading to waste minimisation strategies. Bower (2003) stated that manufactures and suppliers stand to gain through partnering include approval of their product recommendation, a voice in the design intent, involvement in the coordination with other projects trades and the possibly of report business. Thus, this could prevent many waste causes related to material procurement, handling and onsite waste origins.

Literature reveals common waste driving variables of procurement systems. Further, each procurement systems could have different relation to those waste driving variables due to unique characters of those systems. Similarly, procurement systems with different relationship with waste driving variables influence on waste origins and respective causes in different capacities. This results a varying amount of waste generation in construction according to the use of different procurement systems. In conclusion, the common waste driving variables of procurement systems in construction are:

- Arrangement of organisation structure (organisational form)
- Management (including leadership, authority and responsibility)
- Communication
- Process duration
- Relationships between parties
- Client involvement
- Tendering process
- Payment method
- Innovative thinking opportunities (i.e. value management, advanced construction technologies)
- Contract type and documents

Identification of waste origins and causes with respect to different phases of procurement process is vital in terms of waste minimisation. The use of different procurement systems may affect only certain phases in the procurement process. For instance, Osmani et al. (2007), through a survey with architects, investigated design waste generation and found that the majority of responding architects believed that
waste is predominantly produced during onsite activities and rarely generated during design stages.

5. CONCLUSIONS

This paper has given an account of and the reasons for the need of assessing the relationship of construction waste and procurement systems in construction by considering past literature, waste origins and waste minimisation. One of the most significant findings emerge from this study is that very limited number of studies were conducted within the area of procurement systems and construction waste. Additionally, literature emphasised the need of research in this field. Further, the paper attempted to identify the possible waste generation drivers from different procurement systems and relationship between different procurement systems and waste origins. Hence, very few attempts have been made to examine the influence of procurement on construction waste generation. As a result, the forthcoming research will set out to develop a construction waste minimisation framework for procurement methods. The next stages of this study will focus on identifying waste production driving variables by generating procurement systems versus waste production scenarios; attempts will be made to identify the common waste driving variables of procurement systems in practice other than the theory, to identify the extent of influence of waste-driving variables specific to the different procurement systems, to assess the extent of impact of waste driving variable of procurement systems towards waste origins and waste causes and identify relevant waste causes and origins in to respective phases of different procurement systems.

6. REFERENCES


