INVESTIGATING CURRENT CONSTRUCTION WASTE MANAGEMENT PRACTICES IN SOUTH AUSTRALIA: A PRELIMINARY STUDY

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ABSTRACT

The construction industry has been found to be a major generator of waste and the management of construction waste has become a pressing challenge. Due to persisting beliefs that construction waste generation is unavoidable and zero waste is not achievable, researchers have proposed different methods of waste management such as sustainable waste management, integrated waste management, holistic waste management and the waste management hierarchy during past decades. However, when it comes to the Australian context, construction and demolition waste contributes around 25.8% of overall landfill. Therefore, this research aims to identify current construction waste management practices in South Australia in order to find ways to improve them. Sixteen face to face semi-structured interviews were conducted covering major stakeholders in construction projects who had a minimum of ten years' experience in the construction industry and a minimum five years' experience in waste management. The findings reveal that while industry is going through a transition with regards to waste management, waste management practices vary from organisation to organisation. Site space was described as the main limiting factor to implementing onsite waste management practices and it was suggested that waste management should be an important part of project planning. Interviewees indicated that even though there are programmes like Green Star which aim to encourage recycling and waste minimisation; waste management was neglected in the design process. Findings also reveal the urgency of changing attitudes and behaviours towards waste and the importance of considering waste as a resource to encourage improvements in waste management practices. Issues associated with costs and financial management were highlighted as key in determining waste management practices. As such the findings of the study also point to the importance of considering systemic issues of political economy and how they impact on waste management practices.

Keywords: *Construction Projects; Solid Waste; South Australia; Waste Management.*

1. INTRODUCTION

The construction industry is one of the major consumers of energy and natural resources (Merino *et al*. 2010). The industry involves construction, renovation and demolition activities (Yuan *et al*. 2011) which generate a considerable amount of waste annually (Hao *et al*. 2008; Jaillon *et al*. 2009; Manowong, 2012). Yuan *et al*. (2012) also emphasised the non-environmentally friendly nature of the construction industry and its unacceptable level of waste generation. Adverse impacts of the construction industry include land depletion and deterioration, energy consumption, solid waste generation, dust and gas emission, noise pollution and natural resource consumption (Yuan, 2013). As dealing with environmental problems is seen as an increasingly pressing global issue (Hopwood *et al*., 2005), there is a growing focus on sustainability in construction. Due to the emerging trends of sustainability and sustainable development, construction waste management has gained special attention as it focuses on preserving health and the environment, minimising the burden to future generations and conserving resources (Tammemagi, 1999). It is emphasised that sustainable development cannot be achieved without a significant reduction in waste production, along with much increased resource efficiency (Phillips *et al*., 1999). Therefore, this research tried to identify current waste management practices in South Australia to find ways to improve them.

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2. LITERATURE REVIEW

The construction industry has been found to be a major generator of waste and how to manage construction waste in the most sustainable way is a pressing challenge (Manowong, 2012). Diesendorf (2000) considered sustainability as the goal or endpoint of the process of sustainable development. Chaharbaghi and Willis (1999) pointed out that there are different perspectives of sustainable development because industrialists see it as a constraint, environmentalists see it as avoiding catastrophe, politicians see it as a rhetorical device, the media sees it as a commercial opportunity, economists see it in terms of markets and economic development and technologists see sustainable development as a problem they can solve. Sustainable construction is widely considered to be best practice construction since it improves the durability of construction, encourages the use of recycled materials and reduces waste generation (Merino *et al*. 2010). However, as argued by Davidson (2008), there are tensions inherent in the concept sustainable development and the continuous pursuit of growth may not be possible on a planet with finite resources. Shen *et al*. (2004, p.473) defined construction waste as:

> Building debris, rubble, earth, concrete, steel, timber, and mixed site clearance materials, arising from various construction activities including land excavation or formation, civil and building construction, site clearance, demolition activities, roadwork, and building renovation.

Since construction waste can be generated in any stage of the construction project from inception to completion (Spivey 1974 cited in Kulatunga *et al*., 2006), it can be defined as an activity which generates direct or indirect costs, without adding any value or improvement to the product (Serpell and Alarcón, 1998). Construction wastes are comprised of a mixture of inert and non-inert materials (Hao *et al*. 2008; Jaillon *et al*. 2009; Wong and Yip 2004). Environment Protection Regulations (2009) define inert waste as solid waste that has no active chemical or biological properties and is not subject to biological or chemical breakdown. Inert waste includes sand, brick and concrete and non-inert waste includes bamboo, plastics, glass, wood, paper, vegetation and other organic materials (Hao *et al*., 2008). Spivey (1974) categorised construction wastes as demolition materials; packaging materials; wood; waste concrete and asphalt; garbage and sanitary waste; scrap-metal products; rubber, plastic and glass; and pesticides and pesticide containers. Jaillon *et al*. (2009) identified that formwork, packaging and protection, finish work, masonry work, scaffolding, concrete work, material handling and hoarding are key waste producing components in construction. When it comes to design waste, Coventry and Guthrie (1998, p.12) defined it as 'waste arising from construction sites both by acts and by omissions on the part of the designer, including opportunities to reduce waste lost by not using reclaimed materials'. The next subsection describes types of waste management practices and the need for waste management in construction projects.

2.1. TYPES OF CONSTRUCTION WASTE MANAGEMENT PRACTICES

Due to the persistent belief that construction waste generation is unavoidable and zero waste is not achievable, researchers have tried to introduce methods to minimise construction waste generation during past decades (Faniran and Caban, 1998; Kartam *et al*., 2004; Ling and Lim, 2002; Yuan and Shen, 2011). These include sustainable waste management, integrated waste management, holistic waste management and the waste management hierarchy (Chung and Lo, 2003). Chung and Lo (2003) explained that sustainable waste management is focused on environmental desirability, economic optimisation, social acceptability and equity as well as administrative diligence. Integrated waste management combines all solid waste streams, collection and a range of treatment methods, environmental benefits, economic optimisation and social acceptability into a practical and sustainable system (Chung and Lo, 2003, p.121). The waste management hierarchy is based on two pillars of sustainable construction: the minimisation of material usage and the minimisation of the impact on the environment. It includes waste reduction, reuse, recycling and disposal (Peng *et al*., 1997). The waste management hierarchy also includes avoidance of the production of waste along with the treatment of waste to reduce potentially degrading impacts. The 'Three Rs' principle is widely adopted in waste management and it includes reduction, reuse and recycling (Osmani *et al*., 2008) followed by incineration with energy recovery and safe disposal (Al-Sari *et al*., 2012). The Waste Wise Construction

Program Australia and Environment Australia (2000) describe the waste management hierarchy as shown in the Figure 1.

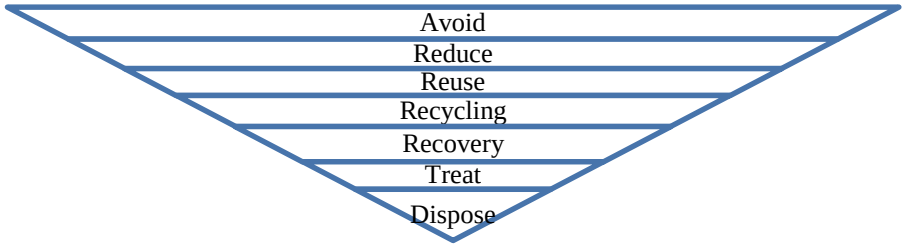

Figure 1: Waste Management Hierarchy
Source: Australian Government (2007)

According to the waste management hierarchy, the initial steps of waste management are to avoid waste generation. Secondly, it is necessary to reduce waste generation and then focus on the implementation of better methods to manage unavoidable waste (Teo and Loosemore, 2001). Researchers found that the most logical and economical way of reducing waste is to reduce waste from its source (Gavilan and Bernold, 1994). Supporting this view, Lingard *et al*. (1997) stressed that reducing waste at the source has the least detrimental impact on the environment, followed by reuse, recycling, composting, and incineration. Some researchers view reduction as the most effective and efficient waste management method since it reduces most of the waste disposal problems (Hao *et al*., 2007; Peng *et al*. 1997). Also reducing waste from its source saves money and landfill requirements (Tara 2011). In the Hong Kong context it was found that little consideration has been given to reducing construction waste at its source and that most of the time contractors adopt waste management plans onsite without integrating design and construction to minimise waste early in the design process (Jaillon *et al*., 2009).

There is a high potential in construction waste for reuse (Lingard *et al*., 1997). Wang *et al*. (2010) defined reuse as using the same material more than once in construction or use as a raw material for a new function. Lingard *et al*. (1997) understood reuse as the use of construction materials again without repossession. However, McDonough and Braungart (2009) pointed out that even though reusing waste may be seen as a really good thing for the environment in terms of waste reduction, some materials are not well designed for re-use and any toxins and contaminants they contain are simply being transferred to another place. Peng *et al*. (1997) stressed that recycling not only produces new materials out of waste but there should be an economic benefit. Reducing and recycling construction waste helps to reduce the usage of raw materials and has less impact on the environment (Craighill and Powell, 1997). Peng *et al*. (1997) highlighted ten factors for successful recycling: proper site selection, proper equipment, experience in recycling operations, trained supervisors and workers, knowledge about secondary material markets, financial capacity and knowledge of environmental and safety regulations. Better knowledge of equipment, waste separating techniques and quality controlling techniques will also help to improve the recycling of waste (Peng *et al*., 1997). Employees who are involved in the recycling of construction waste need to have proper training on the usage of recycling equipment, general operations of recycling, the values of different materials and how to work safely in a hazardous environment (Peng *et al*., 1997). According to Braungart *et al*. (2007), in many current process of recycling, materials lose their value as they circulate through industrial systems. McDonough and Braungart (2009) stressed that most of the time recycling is actually downcycling as recycling leads to diminishment in the quality of materials over time. McDonough and Braungart (2009) emphasised that downcycling can also increase contamination of the environment by realising toxins and dioxins during the process of recycling as most of the materials were not designed with recycling in mind. However, Hyder Consulting *et al*. (2011) cautioned that users of recycled materials need to be aware of differences between recycled materials and virgin materials. Furthermore, they noted that recycled materials may perform differently to virgin materials and sometimes perform better than virgin materials. Peng *et al*. (1997) argued that it is more cost beneficial to recycle and compost construction waste than to incinerate or landfill and the disposal of construction waste to landfill sites has a greater impact on the environment (Lingard *et al*., 1997). According to Hyder Consulting *et al*. (2011), resource recovery rates are higher in the regions where there is a strong market demand for recycled products with well-defined and well-exposed specifications to support recycled products.

The deficiency of legal land-filling sites, long transportation distances and high tipping fees, lack of enforcement measures and lack of knowledge of recycling options can encourage the illegal dumping of construction wastes (Katz and Baum 2011). Peng *et al*. (1997) identified that leachate, off-gassing, and potential groundwater contamination are typical problems associated with landfills. Peng *et al*. (1997) claim that incineration extracts energy from waste without producing toxic substances. Opposing this view, De Silva and Vithana (2008) stressed that incineration can be controversial due to the creation of toxic gas and ash, which can harm people and contaminate groundwater. McDonough and Braungart (2009) argued that even though incineration might be considered as preferable to landfilling as it produces energy out of waste, during the process of incineration dioxins and other types of toxins can be released as materials are not normally designed to be safely burned.

Compared to the construction stage, the design stage has been viewed as a stage which produces low waste (Australian Government, 2007). But most of the opportunities for waste generation can be minimised in the design stage by design for materials, standard sizes and flexibility, design for assembly and disassembly, design using prefabricated components, and design for ease of recycling (Australian Government 2007). On-site sorting of construction wastes is not yet popular due to lack of site space, skilled workers and necessary equipment (Hao *et al*., 2008). The most common approach of on-site sorting is sorting construction and demolition waste by hiring smaller bin hire operators to segregate waste manually, instead of using fixed equipment and automated sorting systems (Hyder Consulting *et al*., 2011). But with the trend towards increasing waste disposal charges, on site sorting should become popular (Hao *et al*. 2008). Effective implementation of waste management plans depends on the compatibility of these methods with the actual situation (Manowong, 2012). However, selection of the optimum method for waste management is difficult because wastes possess different physical and chemical characteristics depending on their origin. Furthermore, due to the presence of different waste management practices, natural and technical restrictions and conflicting objectives related to evaluation criteria for alternative management systems, this process becomes complicated (Kourmpanis *et al*., 2008). Therefore, this research aims to identify current construction waste management practices in South Australia in order to find ways to improve them. The next section describes the research method for this research.

3. RESEARCH METHOD

Interviews were conducted to gather data related to current waste management practices in South Australia. As described by Bennett (1991) interviews allow an in depth and in breadth examination of problems. Interviews can be unstructured and free-ranging, a general discussion, picking up points and issues as they emerge and pursuing them in some depth; or they can be structured around questions and issues determined in advance, based on theoretical principles, pre-conceived ideas or prior investigation (Bennett 1991, p.101). In this research semi-structured interviews were carried out and sixteen interviews were conducted with construction stakeholders including Architects, Clients, Construction Managers, Design Managers, Development and Technical Managers, Engineers, Facilities Managers, General Managers, Quality, Health, Safety, Environment Managers, Sustainable Advisors, Waste Contractors, and Waste Programme Coordinators. Initial contact with interviewees was made through the academic and industry networks of researchers who are involved in this research. Participants had a minimum of ten years' experience in the construction industry and at least five years' experience in waste management. Figure 2 presents the details of interviewees and interviewees were labelled using alphabetical letters from 'A' to 'P'.

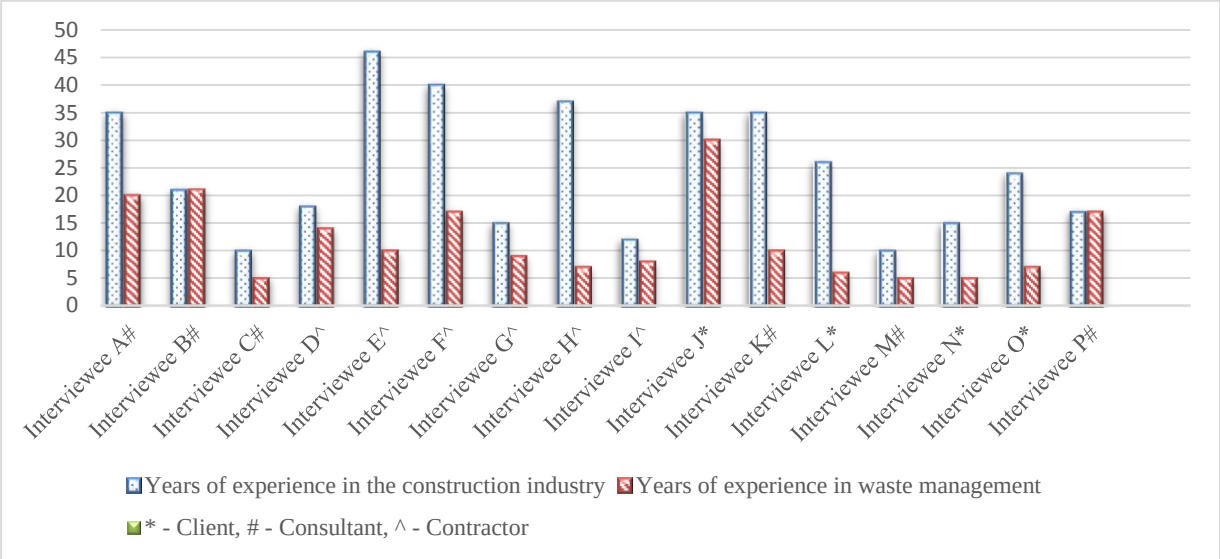

Figure 2: Details of Interviewees

As interviews were semi-structured, questions were varied according to the answers of respondents in order to get a holistic view on waste management practices. Interviews were tape recorded (with permission of the interviewee) to secure an accurate account of the conversations and avoid losing or misrepresenting data. After acquiring the free flowing texts from semi-structured interviews, data reduction and concept identification took place through code-based content analysis. Content analysis, a technique for gathering data, involves codifying qualitative information into pre-defined categories (codes) in order to derive patterns in the presentation and reporting of information (Guthrie *et al*., 2004). By using a qualitative content analysis programme (NVivo), the concepts arising from interview transcripts were coded. The data that was organised within the coding reports was mainly mapped using tables. The findings of this research are discussed in the next section.

4. RESEARCH FINDINGS

The following sub-sections describe findings of this research including different views of interviewees on waste management performance, current waste management practices, factors affecting waste management practices and factors which encourage the implementation of waste management practices in construction projects.

4.1. DIFFERENT VIEWS OF INTERVIEWEES ON PERFORMANCE OF CONSTRUCTION WASTE MANAGEMENT

Interviewees highlighted that there is no limit to the amount of waste that can be generated from construction projects because of the nature of construction projects. The following diagram shows different views of interviewees on construction waste management.

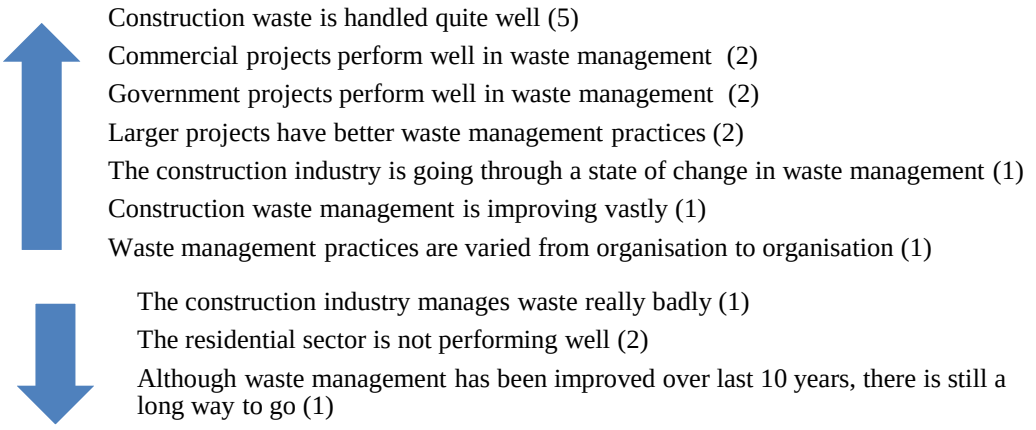

Figure 3: Different Views of Interviewees on Construction Waste Management Performance.
Key: Numbers at the end of each statement indicate the number of interviewees that agreed on that particular point.

As shown in Figure 3 interviewees had different views on the current level of performance of waste management in the South Australian construction industry. However, interviewees agreed that there is a fair amount of interest in waste reduction in the construction industry. In general it was perceived that commercial construction and public construction have better waste management practices than residential construction. Interviewee H stressed that especially in the commercial sector there is a tendency to reduce waste generation during construction delivery, manufacturing, ordering and even in post construction. He mentioned that in the past achieving an 85% recycling rate in construction projects was considered an unachievable target, but now some Green Star buildings end up with waste recycling rates of upwards of 90%. Interviewee B said that large projects employ sophisticated builders and tend to have better waste management practices than other projects. Interviewees stated that the industry is going through a transition and significant change in waste management has occurred in the last five years. Interviewee I also indicated that the overall performance of waste management in construction is improving vastly and now there are more facilities to cope with the waste streams. Interviewee H highlighted the influence of local governments, waste management operators, Zero Waste South Australia and waste management educators like KESAB Environmental Solutions, which promote waste management practices in the construction industry. Interviewee D pointed out that waste management practices vary from organisation to organisation and some organisations are better than others. However, according to Interviewee E, the construction industry is not good with waste management and still there is a long way to go, although it has been improved over the last 10 years. The following figure represents the different views of stakeholders on the implementation of waste management practices in construction projects.

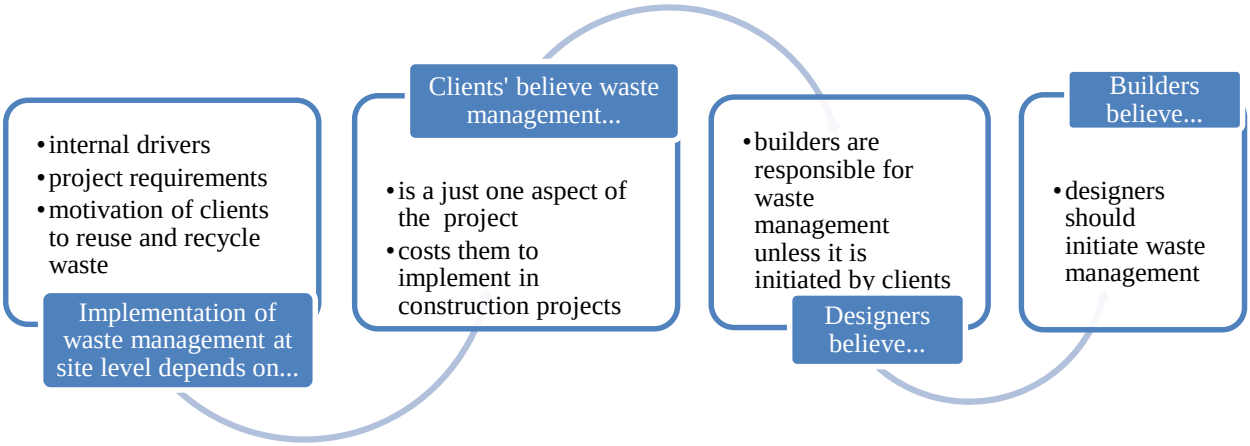

Figure 4: Different Views of Stakeholders about Implementation of Waste Management in Construction Projects

According to interviewees, most of the time drivers to implement waste management are internal. Interviewee I stressed that when it comes down to the individual site level, implementation of waste management practices totally depends on the project requirements and that decisions to reuse and recycle materials are solely based on clients' motivations and preferences. Interviewee L indicated that waste management is just one aspect of the overall management of the project and therefore, not a main consideration in construction projects. However, interviewees acknowledged that most of the time during the tendering stage, clients look at the contractor's overall waste management performance including what they are planning to do and what they have done in the past. Interviewee O pointed out that as there is a cost involvement in waste management, they have to decide whether it is worthwhile to make waste management a part of the contract or just leave it to the builder to manage construction waste. He highlighted that if there is no contract requirement in waste management, the amount of waste going to landfill is entirely up to the contractor and normally in higher value projects they have procedures to regulate waste management. Interviewee P also stated that in most construction projects, especially in commercial construction, contractors hire waste contractors to manage waste. However, the decision to implement waste management is driven by its financial returns. Interviewee A also mentioned that clients should initiate waste management in construction projects as it is very difficult to find time and money within their fee structures to act beyond the normal practice unless those changes are initiated by clients. Therefore, he stressed that in general, architects believe that builders are responsible for waste management and leave it with the builder. Interviewees G stated that initiation of waste management must come from designers. He pointed out that as builders they cannot change things as they are involved in the end of the process and they have to comply with the specifications. Accordingly, Interviewee P noted that in some specifications, consultants still highlight the need for virgin materials rather than recycled materials. He inferred that this is a barrier to the use of recycled materials. Therefore, it can be identified that all stakeholders have an important role in initiating waste management in construction projects and most of the time implementation of waste management depends on its cost and financial returns. The next sub-section describes current waste management practices in the South Australian construction industry.

4.2. CURRENT CONSTRUCTION WASTE MANAGEMENT PRACTICES AND FACTORS WHICH AFFECT CONSTRUCTION WASTE MANAGEMENT PRACTICES

Interviewees reported that most of the time, with the exception of office waste, all waste goes into a general waste bin to be sorted offsite by waste contractors. Normally at the end of each month waste contractors provide waste reports to the builders which allow builders to track different waste streams. However, as described by Interviewee D one of the main problems in waste management is separation of putrescible waste or organic waste from other waste as workers tend to put all waste in one bin. At the same time some waste contractors do not want waste to be separated onsite as they make money out of waste separation. For example Interviewee E mentioned that:

> "Very early in the phase when people start talking about waste minimisation; we did have an issue with one company where the people who collected the waste did not want the waste separated. We setup the site where… steel elements in one bin, plasterboards in another, concrete in another and a general waste bin for everything else. We couldn't find anybody to collect them separately… the waste collection people made their money out of separation. So they do not want us do on the sites. I think that attitudes changed a bit."

Interviewee P also pointed out that when waste is mixed, it increases the waste disposal rate per tonne. As such, it is really important to separate waste wherever you can. However, in congested sites there may not be enough space for onsite waste separation. In such cases, there may be only one bin and waste will be sorted off site. Figure 5 summarises general methods of waste separation in construction projects.

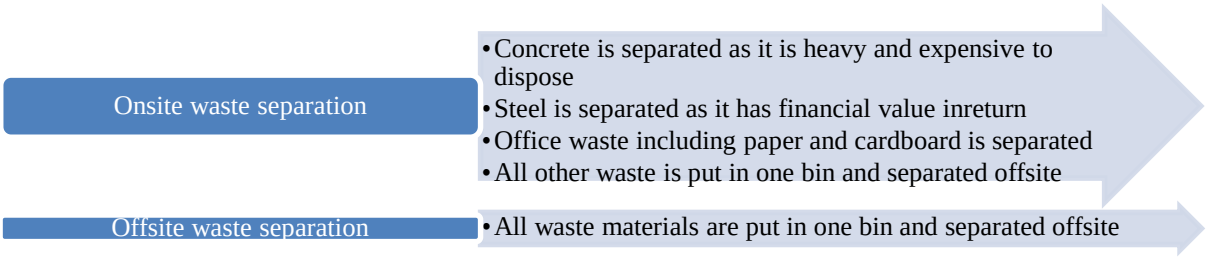

Figure 5: General Methods of Waste Separation in Construction Projects

Interviewee G also emphasised that site space is a key limiting factor in waste management and sometimes it is not practical to have separate bins for different waste streams. However, Interviewee I mentioned that waste can be better recovered when there is an onsite waste separation system. Therefore, the biggest challenges are to find enough space for onsite waste separation and to educate workers to use multiple bins. However, he said that when it comes to waste management the primary motivations of the industry are financial and a lot of work still needs to be done to change mind-sets as its comes down to dollars and cents. Accurate estimation of material requirements also plays an important role in waste management. However, Interviewee E asserted that there is a tendency to over order materials in construction projects and throwaway both excess materials and off cuts. Interviewee D said that to avoid this problem their company has contractual instruments and procedures for insuring accurate estimation of material requirements, which helps to minimise the amount of waste generation. For example, he noted

> "One general principal we have on the project is we don't allow the concreter to wash the concrete trucks on site. That's a good driver because it means that the concreter needs to measure required concrete quantity very carefully, because if he orders too much he needs to take it away again."

Interviewee D pointed out that in their projects they follow the waste management hierarchy and they have site oriented waste management plans. Also he mentioned that the waste management objectives and protocols are highlighted during weekly toolbox meetings and in subcontractor start up meetings to encourage workers to manage construction waste. However, company policies relating to waste management in construction projects vary according to project costs. For example, Interviewee O also stated that for higher value projects (projects costing more than $4million) they make waste management part of the contract and they do have procedures to regulate waste management practices. But for small projects which cost less than $4million, they only highlight the importance of waste management during the project meetings and the amount of waste going to landfill is entirely up to the contractor. Interviewee G stressed that as a Tier 2 builder they have an environmental management plan, which includes details about waste collection, recycling and minimisation of landfilling. He noted that as head contractors they control onsite waste management such as waste collection, separation and coordination, and disposal in coordination with the waste contractor. He said that they have a system to monitor waste generation and they receive a report at the end of each month for every single site, including how much waste is collected and recycled in each and every waste category. He claimed that his company achieve over an 85% recycling rate across their sites.

Interviewee H mentioned that there are problematic materials, including products like gypsum or plasterboard and asbestos that that do not have recycling options and can only be disposed of according to regulations. Interviewee E pointed out that excavated material is also a big issue in construction projects. He asserted that excavators have a tendency to tender based on the assumption that they can deliver excavated materials to somewhere else. Therefore, he revealed that most of the time the costs associated with excavation are not excavation costs per se, but transportation and dumping costs. He highlighted the importance of preplanning excavation activities during the design stage to minimise undue waste generation. Interviewee C stressed that for a long time, waste management was not considered a design exercise and it was left out from the design process. Interviewee I stated that as waste contractors their company supplies waste receptacles and the transportation facilities from sites to recycling facilities and provide consultancy services to select the best waste management practices for different projects. They also provide waste reports to construction sites and to the companies. He

said that a "lot of construction businesses now want their waste to be recycled or reused… we can offer the wide range of services. But it depends on what customer the wants." Interviewee O said that in their projects, contractors have to submit waste reports at the end of each month and then try to minimise the amount of waste that goes to landfill. However, he acknowledged that currently they do not systematically analyse this data and only use it to get some idea about their waste management performance.

Interviewee D highlighted problems with subcontractors in the waste management process. He pointed out that as a Tier 1 contractor they have to deal with a large number of subcontractors. He said that:

> "When we asked the subcontractors to also do the same, to provide us with their environmental management policies, more often they… are very generic. So it's done once and it's sat in folder somewhere no one looks at it. So when they come and work for us we say we want to see that information and then we ask them to make it specific to the project."

Packaging is also considered as a massive problem in waste management. However, from the interviews it can be identified that normally builders pass on their responsibility to subcontractors and subcontractors pass their responsibility to suppliers or manufacturers. For example Interviewee D further mentioned that they try to minimise the amount of packaging that comes to sites in the first place. He said that sometimes it is not possible when they have items like delicates which need padding for support. But in many other cases it is possible to have all the packaging removed from the items before they come to the site. Normally when the contractor collects materials from suppliers, contractors advise suppliers to remove the packaging, dispose it and then bring materials to site. However, Interviewee D said that "it doesn't always work but for large, bulky items it's been a very good practice." According to interviewees, the following are the most common types of materials that are reused and recycled in construction projects.

- Reinforcement and other metals
- Concrete
- Bricks and other masonry products
- Rubble
- Plastics
- Timber
- Decorative materials such as carpets and floor boards
- Paper
- Cardboard

As stressed by Interviewee I, in general, steel is the material with the highest recycling rates in construction projects. He further added that:

> "… we have different industries we take concrete, bitumen and make new products… For plastics, cardboard, steel… get recycled and back into the commodity exchange… timbers and those sort of thing depending on what type of timber it is… and how it gets recycled."

Interviewee I mentioned that there are always products that cannot be recycled because of their product qualities. Interviewee D observed that there has been an improvement in technology for reused and recycled materials in construction projects. For example, he remarked that all reinforcement in Australia is made out of recycled steel. Other products that they extensively recycle are hard materials like rubble for the construction of roads. Interviewee B also stressed that metals are often recycled and there is a major industry for recycled metal. Supporting these views Interviewee E said that "20 years ago everything got scrapped. But now everything has been improved and reusing aggregate out of concrete is a pretty common thing. Also reusing steel controls the import of virgin materials as well." Interviewee A stated that one thing that is around at the moment is recycled plastic which is used for decking. Interviewee H claimed that the market is only prepared to go for recycled products when price is low and the quality is good. Furthermore, Interviewee F asserted the difficulty to use recycled materials effectively due to some quality issues. For example he noted that "even though we use crushed concrete, most of the time we have to use fresh aggregate. We can only put very little amount of crushed concrete and high percentage needs to come from virgin materials." Therefore, it can be argued that even though the reuse and recycling of materials has been improved over the past decade, there are still some problems associated with their quality. Figure 6 represents the different factors that affect recycling of construction waste.

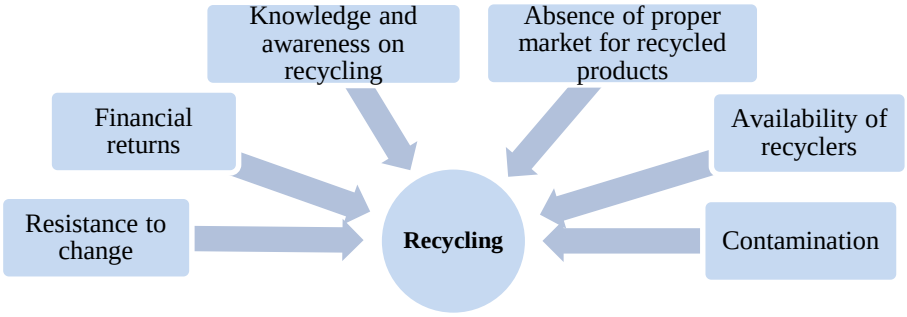

Figure 6: Factors Affecting Recycling of Construction Waste

As shown in Figure 6, different factors affect decisions related to recycling and the use of recycle materials in construction projects. Interviewee A noted that even though recycling is being embraced in the construction industry, there is always a level of resistance to change. At the same time he pointed out that as people always compare available options, in order to change consumer behaviours, it is necessary to show them that there is a cost and time saving by using recycled products. He further added that "unfortunately we are driven by our hip pocket… It is being like voting in elections. People take notice when it affects their pockets." Agreeing with this view Interviewee N stressed that as cost is one of the main considerations in construction projects, only materials that have financial returns get recycled in construction projects. He further added that:

> "I don't know whether contractors have a global view on recycling or whether it means better financial return for them… things such as steel or any metal product natural rock product, they tend to all get recycled."

He affirmed that designers are keen to recycle and the availability of recycling facilities also impacts on waste management as the easier it is for contractors to send their materials to recyclers, the more likely they will be to do so. Furthermore, Interviewee N confessed that even he does not know what all the products that can be recycled are and he is not sure whether all contractors know about them. Therefore, he recommended that efforts should be made by the relevant authorities to raise awareness of recycling in the construction industry. Interviewee O also highlighted that the ability to recycle also depends on the availability of recyclers. He mentioned that most of the time people do not know what is recyclable and what is not and whether there are enough facilities to recycle. However, Interviewee F criticised current waste management practices and pointed out the absence of proper markets for other recycled products. He further added that there is no proper manufacturing industry in Australia and most of the materials have to be imported from overseas. He questioned the possibility of recycling materials such as aluminium, glass and carpet as most of those materials are imported from overseas. He further added that most of the time recycling is expensive and not cost effective to implement. He highlighted the necessity of secondary markets for recycled products. He emphasised that recyclers need to demonstrate that their products are also as strong and of the same quality as virgin materials. Interviewee M indicated that even though there is a market for certain recycled products, most of the time people do not have confidence to use them because of issues like contamination. Agreeing with this, Interviewee C affirmed that when using recycled materials, it is necessary to check available standards in terms of provisions relating to the use of recycled materials. He stated that sometimes consultants do not want to specify recycled materials in construction projects as there can be impurities in those materials. He noted that most of the time even recyclers cannot guarantee the quality of their products and therefore, there are limitations in the use of recycled materials. The next sub-section discusses factors which encourage the implementation of waste management practices in construction projects.

4.3. FACTORS WHICH ENCOURAGE THE IMPLEMENTATION OF WASTE MANAGEMENT PRACTICES IN CONSTRUCTION PROJECTS

The following figure represents the factors which encourage implementation of waste management practices in construction projects.

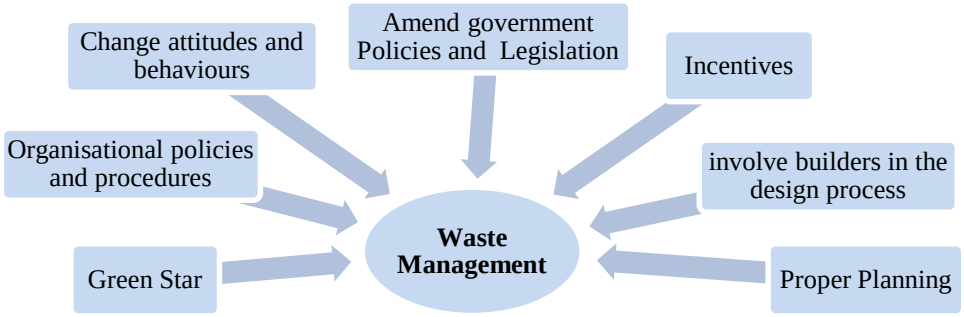

Figure 7: Factors which Encourage Implementation of Construction Waste Management

According to the interviewees, the Green Star rating system encourages the implementation of waste management in buildings. Interviewee O further stressed that in order to get higher ratings in Green Star, it is necessary to recycle and use recycled materials as much as possible in Green Star buildings. Interviewee C also pointed out that it is important to have standardised practices and incentives programmes such as Green Star which encourage recycling and the minimisation of waste generation. At the same time in some client organisations there are company policies and guidelines for ecologically sustainable development (ESD) planning and design delivery. Interviewee O added that "we do have lot of … statements within our policies and frameworks to encourage contractor and designer to deliver us with a minimal… landfill." Interviewee L said that when working on government projects government clients are very keen on meeting existing legislation and policy standards and they highlight these requirements in their tender documents. Interviewee K pointed out that waste management is an important part of project planning. He also noted that as the construction industry consumes a massive amount of resources, by minimising waste generation it is possible to reduce resource consumption in construction projects. Interviewee P revealed that it is necessary to change attitudes towards waste. He added that "it's not, we should call it waste, it is a resource… there are companies now that don't look from that material as being waste but as a resource… that's changing mind-set." Interviewee C also indicated the importance of changing mind sets of people around the use of recycled materials. He asserted that it is necessary to amend some of the Australian standards which might restrict the use of some recycled materials. Interviewee G highlighted that motivation to recycle is driven by incentives. He mentioned that there should be clear guidance, incentives and authorities to boost and encourage the usage of recycled products in the construction industry. Interviewee H noted that:

> "What we've got at the moment is the… legislated price but… if we go to the market trading type principle where there is incentive and there are certainly advantages for recycling or diversion to resource taxation wise or… just through whatever goes to landfill… some sort of mechanisms that encourages the developers and builders to make some money. So if you can show the developer… opportunities to make money or save money then that is the carrot approach that should be encouraged?"

Interviewee E also asserted the importance of reusing materials by modifying them instead of using new materials and of involving builders in the design process to minimise waste generation. Interviewee K stressed that waste is easily generated in the construction industry and it is necessary to use good planning to minimise waste generation. Interviewee D indicated the importance of having a good framework for waste management in construction projects. The conclusions drawn from this study are discussed next.

5. CONCLUSIONS

Interviewees highlighted that there is no limit to the amount of waste that can be generated from construction projects because of the nature of construction projects and that most of the time drivers to implement waste management are internal. Interviewees stressed that the construction industry is going through a transition with regards to waste management and that waste management practices vary from organisation to organisation. Site space was raised as the main limiting factor in the implementation of onsite waste management practices. Interviewees highlighted that generally it is believed that builders are responsible for waste management unless it is initiated by clients. Key factors which affect recycling in construction projects are resistance to change, financial returns, availability of recyclers, knowledge and awareness on recycling, contamination and absence of proper markets for recycled products. However, interviewees indicated that even though there are programmes like Green Star which encourage recycling and waste minimisation; waste management was not well integrated into the design process and has not been for a long time. The findings of this study have a number of important implications to improve waste management practices such as improvements in rating systems like Green Star, organisational policies and procedures, changing attitudes and behaviours, amending government policies and legislation, improving financial incentives and introducing ecological costing, involving builders in the design process, and practicing proper waste management planning on construction projects. As would be expected in a highly competitive and profit-driven industry, issues associated with costs and financial management were highlighted as key in determining waste management practices. As such, the study also points to the importance of addressing systemic issues of political economy, including the externalisation of environmental and ecological costs and the pursuit of endless growth on a planet with finite boundaries and resources.

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