

GREEN CONSTRUCTION AND CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT IN AUSTRALIA

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Abstract

The construction industry has faced issues regarding the proper management of Construction and Demolition (C&D) waste in Australia. As enshrined in many Australian waste strategy documents, waste is everyone's responsibility. Therefore, initiatives promoting the concept of shared responsibility are being paid attention in more recent waste managed system and policies. Green Construction (GC) is one of these concepts that, alongside other focus areas, advocate effective C&D waste in construction projects. GC for C&D waste is mainly implemented through the Green Star (GS) scheme (Green Building Council of Australia) and the Infrastructure Sustainability (IS) scheme (Infrastructure Sustainability Council of Australia). This study sought to better understand how these two rating systems are being implemented and could benefit the construction and resource recovery industries. In this study, the review of relevant literature including industry and organisational reports, guidelines and academic papers could provide insight into the position of GS in Australian jurisdictions. In total 7 case study reports were found to show positive results achieved by the application of IS and GS. The limited number of case reports, however, presents a limitation as to reaching a definitive conclusion on the benefits of GC programs. Hence, it is highly recommended that future research is undertaken to demonstrate GC programs' capacity in the effective management of C&D waste in a diverse range of construction projects. The results may inform policy development and encourage construction and waste recovery industries to adopt best management practices enshrined in these schemes.

Keywords

Waste strategy, Shared responsibility, Green star scheme, Infrastructure sustainability, Jurisdictions

Introduction

Rapid growth in construction activities in Australia in recent years has led to increased generation of construction and demolition (C&D). According to the latest statistics (NWR 2018), about 20.4 Mt of C&D waste was generated across Australia, which is equal to 30.5% of total waste generated, from which 33% is being disposed in landfill. With the existing rate of migration and population growth (Australian Bureau of Statistics 2018), it is expected that C&D waste generation will continue to grow steadily in the coming years. Failure in delivering effective management of C&D waste generated will have unintended economic, social, political and environmental repercussions (Park & Tucker 2017).

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Therefore, it is of particular importance to properly manage this growing issue at the national level. Effective management of C&D waste, however, is not straightforward and requires a contribution from various stakeholders in the construction and recycling industries. Several issues in the C&D waste management system have been found and strategies to overcome them have already been proposed in Australia (Park & Tucker 2017; Tam, Le, Wang & Illankoon 2018; Udawatta, Zuo, Chiveralls, Yuan, George & Elmualim 2018) and elsewhere (Menegaki & Damigos 2018; Wang, Li & Tam 2014). Among the many stakeholders, it seems that construction companies have an instrumental impact on C&D waste generation, re-using and recycling.

One way to encourage construction companies to contribute to further recycling, re-using and recovery of C&D waste is to design and implement environmental sustainability programs that award stars or rates to construction companies (Siew, Balatbat & Carmichael 2013). These rated awards are granted based on informed decisions and cautious activities that take place in construction projects that meet the awarding organisation's requirements. The award or rate can increase the construction company's reputation in the market, which is eventually translated to economic profit. Such profit is achieved through construction companies advertising campaigns to promote their environmental-friendly vision, design and product. This can increase the selling value of their buildings and add value to the property. For instance, a CEO of a property investment management company in the UK stated that, '*greening our portfolio over the next two years is not only environmentally the right thing to do, it also makes sound business sense*' (Lewry, Fisher & Holden 2018, p. 1). A review of case studies in the UK showed the increase in rentable value for such properties is between 5–10 per cent (Lewry et al. 2018). Another incentive for construction companies originates in the benefit gained from the demonstration of their commitment to the set requirements making them eligible or advantaged in public projects. Governments have started to include environmentally responsible construction practices in the evaluation criteria of tenderers in public construction projects.

The Green Construction (GC) concept, otherwise known as green building, sustainable building and high-performance building, refers to the combination of efforts towards reducing in part the impact of construction activities on the environment and society. GC in the context of C&D waste is referred to as a notion that intends to employ low waste building technologies and promote utilisation of C&D waste or recycled materials. There are about 40 green programs across the world (Siew et al. 2013; Thaickavil & Thomas 2019) that share similar principles. The seminal ones include 'Environmental Assessment Method' (BREEAM), the first and foremost green building rating system in the UK that is implemented in 76 countries worldwide (BREEAM 2019); Leadership in 'Energy and Environmental Design' (LEED), developed by the US Green Building Council that was launched in 1998 and is the most widely used green rating system with certifications in over 165 countries and territories; 'Comprehensive Assessment System for Built Environment Efficiency' (CASBEE), the green building rating system developed in Japan in 2001; 'Building Environmental Assessment Method' (BEAM) plus, the green building assessment system developed by the 'Hong Kong Green Building Council Limited; and the 'Green Rating for Integrated Habitat Assessment' (GRIHA) rating system 'developed by The Energy Research Institute (TERI), New Delhi, and Ministry of New and Renewable Energy, Government of India.

Australia is considered to be a leading country in the development and application of GC schemes to reduce the environmental impact of construction activities. However, there is limited research undertaken to study the extent to which application of GC programs could effectively achieve the benefits stated under the main Australian GC schemes. Therefore, this review study attempts to shed light on the green rating tools being implemented in Australia to better understand how they contribute to the management of C&D waste. The review informs a larger research project entitled 'A National Economic Approach to Improved Management of Construction and Demolition Waste', which is being conducted at RMIT University and supported by the Australia Built Environment National Research Centre. This project endeavours to foster a holistic national approach to address C&D waste issues. Its objectives include the development of a consistent approach to define and measure C&D waste, identification of influential economic factors that govern disposal/reduce/reuse/recycle of C&D waste, conducting a feasibility study on the creation of a marketplace for trading C&D waste, and

identification of opportunities to integrate supply chains model in the management of C&D waste. The objectives are in relation to several strategies mapped out in the National Waste Policy 2018 (National Waste Policy 2018) and can provide a solution to tackle the issues raised in light of new changes in Chinese regulations that ban waste trade imports.

Methodology

Data collection, processing, and analysis

This review study is based on the secondary data that is publicly available. The document analysis technique was conducted to explore activities that aim to further reduce, reuse and recycle C&D waste through GC programs in Australia. The sources reviewed include policies and other relevant studies that focus on the relationship between a GC scheme and C&D waste management. In total, 10 academic papers and industry-based reports were analysed that provided information about GC and C&D waste in Australia. Microsoft Excel V. 2016 is used to analyse the data and visualise results.

Context of study and C&D waste regulation in Australia

Australia is a large country with a population of 25 million that is mostly settled in capital cities. The state and territory governments attempt to regulate C&D waste management by enforcing relevant legislation and voluntary schemes. C&D waste legislation mostly takes place at the state and territory level. Australia has 6 states: Victoria (Vic), New South Wales (NSW), Queensland (Qld), South Australia (SA), Western Australia (WA) Tasmania (Tas) and 2 territories: Northern Territory (NT) and Australia Capital Territory (ACT). The majority of regulations and policies that govern C&D waste are produced and administrated by state Environmental Protection Authorities (EPA). The history of C&D waste legislation dates back to the 1970s when the first EPA act (Environmental Protection Act 1970) came into effect in Victoria. A review on the C&D waste-related regulations in different Australian jurisdictions has previously been provided in Shooshtarian, Maqsood, Khalfan, Wong and Yang (2019).

Results

The concept of green construction was introduced in Australia in two main forms, the Green Star (GS) Program and the Infrastructure Sustainable (IS) rating system, by two authorities, the Green Building Council of Australia (GCBA) and the Infrastructure Sustainability Council of Australia (ISCA), respectively. The following sections deal with these two rating systems and explore how they consider C&D waste in their requirements.

The green star rating tool

Since its establishment (2002) as the nation's authority (non-for profit) on sustainable buildings, communities and cities, GCBA has developed sustainability programs to certify, educate and advocate green built environment projects in Australia. A year after the establishment of GCBA, it started

providing the Green Star (GS) scheme, which is Australia's only national and voluntary rating system for buildings and communities. Currently, there are four internationally recognised rating tools under the GS Program, namely 'Communities', 'Design & As-Built', 'Interiors' and 'Performance'. These voluntary tools promote the efficient use of management practices of construction and fit-out materials and target C&D through 'Construction and Demolition Waste' credits. The C&D waste credit aims to encourage and reward management practices that minimise the quantity of C&D waste going to landfill from base building and/or interior fit-out works. The credits operate to engage verified waste contractors and processing facilities that comply with minimum standards of GCBA reporting that were developed in 2013. GCBA claims that green projects (buildings) recycled 96% of their C&D waste.

Generally, there are three areas of improvements in GS for C&D waste-related credits:

- Recycling of construction and demolition waste from the building
- Design of the storage for waste to encourage good recycling practices
- Use of recycled materials

According to the criteria, credit points are awarded when a project can prove that less than 4.5 kg/m² of fit-out area have been sent to landfill. In particular, the following items can win credits for construction projects:

- **Reduction:** Reduction of C&D waste: 1 credit
- **Reuse:** Façade reuse (retained by 50%: 1 credit; retained by 80%: 2 credits), Structure reuse (retained by 30%: 1 credit, retained by 60%: 2 credits)
- **Aggregate:** Coarse aggregate is crushed slag aggregate or other alternative materials—at least 40% (0.5 credit), Fine aggregate is manufactured sand or other alternative materials—at least 25% by mass; in Australia, both of these two categories are sourced from C&D waste
- **Recycled content products:** 3% product (1 credit), 6% (2 credits), 9% (3 credits).

The following table presents the categories of GS rates and corresponding scores.

Table 1. Categories of Green Star (GS) rates

Score	Rating	Category
10-19	One Star	Minimum Practice
20-29	Two Star	Average Practice
30-44	Three Star	Good Practice
45-59	Four Star	Best Practice
60-65	Five Star	Australian Excellence
75+	Six Star	World Leadership

The evaluation of performance and effectiveness of GS in Australia has been the focus of several investigations in recent years (Table 2). A study in Australia (Park & Tucker 2017) has recommended the GS's C&D Waste credit to be mandatory; it also suggests that the additional costs that a client must incur to get a GS certificate should be reduced in future. A report (Green Building Council of Australia 2014) on the benefits of a decade's application of GS in Australia revealed that GS certified buildings are recycling 96% of their C&D waste. This report found that, in total, 37,600 truckloads of C&D waste have been diverted from landfill due to good waste management practices. Specifically, in one outfit project, the construction company could achieve a surprising rate of 0.35 kg/m² of C&D waste going to landfill. Another study in 2015 (Udawatta, Zuo, Chiveralls & Zillante 2015) reported decisions in construction projects are constrained by financial gains unless a special requirement to comply with GS or any similar schemes is in force. One of the interviewees in this study indicated that

designers do not tend to consider opportunities for waste minimisation unless they are required to fulfil building rating tools such as GS. Overall, the authors of this research concluded that GBCA could improve its GS program to address the impacts of three main deterrents towards waste management practices: lack of economic interest, professional roles and less accountability of construction stakeholders.

Table 2. Summary of investigations on the impact of green construction on C&D waste management in Australia

Tool	Study	Project	Summary of waste management results
Green star	GBCA (2010)	SA Water	Diverted 98% of construction waste away from landfill, reducing waste processing costs and the strain on local waste facilities.
	Green Building Council of Australia (2014)	Report of Frasers Property Australia's office fit-out)	GS certified buildings are recycling 96% of their C&D waste. In total, 37,600 truckloads of C&D waste have been diverted from landfill due to good waste management practices This project only sent 0.35 kg/m ² of C&D waste to landfill
	Green Building Council of Australia (2018)	Westfield Sydney	This project that applied GS principles could recycle 90% of the waste produced during demolition and construction activities
Infrastructure Sustainability	Bauer (2011)	Whitsunday's STP upgrades	Application of IS scheme requirements resulted in fewer construction materials (4,4000t fewer materials), application of green concrete in roads, 40% fly ash blend in asphalt and 100% reuse of excavated materials
	Bauer (2011)	Gold Coast Light Rail	Following IS principles, the project could cut down the need to excavate and relocate 68,200 tonnes of waste material, reduce reduction concrete and steel required by 40%, reduce embodied carbon emissions of 3,200 t CO ₂ ^e , recycle sand from excavation, reduce costs for transport and recycling, and improve local beaches. The report also showed that the project owners could save 44,000 tonnes of materials, leading to a 55% reduction in embodied carbon emissions. It also resulted in the recycling of 156,000t of inert and non-hazardous construction waste. They also recycled 100% of spoil.
	MMRA (2016)	Melbourne Metro Tunnel	Adhering to ISCA and GC schemes guidelines this project sourced at least 95% of all timber from re-used timber and post-consumer recycled timber. The project managers ensured that greater than 95% by volume of reusable topsoil and spoil (general fill), greater than 90% by volume of inert and nonhazardous waste, and greater than 60% by volume of office waste is diverted from landfill.

The main stakeholders have questioned the practicality of achieving the GS scheme requirements. However, GCBA invites stakeholders to comment on the main issues and publishes their feedback through discussion papers periodically. The criticisms mostly refer to potential additional costs, the realism of targets, and the complexity of audit processes (Green Building Council of Australia 2013).

The sustainable infrastructure rating tool

In addition to GBCA, the ISCA (a non-for-profit industry council) developed a voluntary rating system called Infrastructure Sustainability (IS) for environmental assessment of infrastructures (nonbuilding projects) in terms of sustainability in 2007 (Diaz-Sarachaga, Jato-Espino, Alsulami & Castro-Fresno 2016). This scheme seeks to foster resource efficiency and reduction of waste and associated costs in infrastructure projects (ISCA 2019). Its equivalent programs in other countries include Envision (USA) and the Civil Engineering Environmental Quality (CEEQUAL) assessment (UK). Under the resource efficiency category of its environment component, this program aims to take a circular economy approach to resource management and thinks about resources holistically from reusing resources on-site to finding new and innovative used for ‘waste’ products (Newman, Hargroves, Desha, Kumar, Wilson, Farr, Whistler & Matan 2014). This tool credits infrastructure projects according to five credit categories: ‘Management and governance’, ‘Using resources’, ‘Emissions, pollutions and waste’, ‘Ecology’, ‘People and place’ and ‘Innovation’; and in three phases, ‘Design’, ‘Build’ and ‘Operation’. Following the planning and design phases, requirements for sustainability and performance during construction are appraised. The ‘Build’ rating is awarded at the conclusion of project construction and replaces the ‘Design’ rating. The point-based award categories consist of Commended (25-50 points), Excellent (50-75 points) and Leading (75-105 points).

ISCA has demonstrated the impact of IS scheme implication on the C&D waste management in two Australian projects (Bauer 2011). In the first project, an upgrade of two treatment plants at Proserpine and Cannonvale (Qld), the project owners could benefit from reusing recycled materials, clean fill and reduction in raw materials and embodied carbon emission (Table 2). The second case was a transport project in Qld, where adhering to IS requirements produced several economic benefits including cost saving in transport, excavation and use of raw materials, recycling fees and embodied carbon emissions. This report echoed the project success story of 90% recycling of inert and non-hazardous C&D waste produced during construction (Table 2).

Discussion

Impact of green construction programs on C&D waste management

Green construction programs are assumed to effectively improve C&D waste management in the Australian construction industry (Newman et al. 2014). In Australia, the results of a few studies have shown that, if properly managed, GC programs facilitate a substantial reduction in the construction waste generation, increase in reuse of recycled and salvaged C&D waste materials (Table 2). However, there is an emerging need to further demonstrate this capacity within various construction projects varying in size, purpose, build budget, etc. This demonstration should aim to encourage the main actors in the construction industry to further reduce C&D waste and increase the in waste-driven materials uptake during construction and demolition activities.

Barriers to the application of green construction schemes to reduce C&D waste

Despite the proven evidence for the economic benefits of GC programs all around the world (Kats 2003; Zhang, Shen & Wu 2011), several research studies have identified key barriers decreasing the

willingness to follow GC principles (Samari, Godrati, Esmaeilifar, Olfat & Shafiei 2013). These barriers are wide-ranging and emerge from different sources. For instance, in Malaysia, it was found that the lack of credit resources to cover the upfront cost, risk of investment, lack of demand and greater final costs are the main barriers to GC implementation (Samari et al. 2013), issues that can be also traced in the Australian construction industry (Udawatta et al. 2015). In Australia, a case study in SA identified the main barriers in C&D waste management as the lack of economic interest, professional roles and less accountability of construction stakeholders (Udawatta et al. 2015). In removing these barriers, the authors believed that GS scheme could be of help, provided that GBCA improves its rating tool given these issues. Another study on the barriers to implementation of GC in Australia found that the initial enthusiasm for separating the C&D waste materials dissipated as the projects progressed (Wilson & Tagaza 2006). For instance, it was reported that recycling skips were found to contain a mix of materials, which can be related to ignorance, laziness or time pressures to complete a project and clean-up expediently. To tackle these issues, the appointment of an officer tasked to check practices or random on-site visits by project managers can be helpful. Furthermore, involving union representatives in site meetings to reinforce the benefits to workers of sustainable practices is another solution (Wilson & Tagaza 2006).

The role of government to promote green construction

Governments play a key role in promoting GC programs (Samari et al. 2013). Through adjusting legislation and providing financial incentives, a government can further encourage the construction industry to move towards the GC concept. However, these strategies should be designed in such a way that assures these companies that no additional on the base build costs will occur. For instance, governments can incentivise major stakeholders by aligning regulations governing C&D waste with GC program requirements. Relaxing regulations to provide the levy exemption for clean fill and providing discounted levy fees for C&D waste residuals in recycling facilities (Environment and Communications References Committee 2018) will provide a competitive advantage for those who intend to use recycled materials in their construction projects. Another example is to develop and promote sustainable procurement policies (Berry & McCarthy 2011). Currently, the Australian federal government, ACT, SA, NSW, Qld, and WA have their procurement policies in place.

Conclusion

This review study aimed to review the activities for the management of C&D waste in light of the requirements of GC programs in Australia. Currently, there are two rating voluntary systems (i.e. green star (GS) scheme and infrastructure sustainable (IS) tool) that are implemented in different Australian jurisdictions. Despite the limited number of case studies in Australia, the research could provide evidence on the positive impact of these two programs on the management of C&D waste in various construction projects. The limitation identified, however, may impede the efforts towards the promotion of these programs among public organisations and the industry. This limitation makes it difficult to arrive at a decisive, justifiable and transferable conclusion. Therefore, it is highly recommended that further studies be conducted to provide more information on how GC programs can contribute to reducing C&D waste generation, increasing uptake of recycled materials and reusing C&D waste in the construction industry as a whole. Particularly, future research should be directed towards the economic aspects of these programs in which the industry's interest lies. If properly communicated, this can encourage more construction companies to join and implement such programs.

Acknowledgments

The authors would like to acknowledge the support of the Australia Sustainable Built Environment National Research Centre (SBEnc), Project 1.65. However, the views expressed in this conference paper are those of the authors and do not necessarily represent the views of SBEnc.

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