

PAPER • OPEN ACCESS

## The impact of regulations on construction and demolition waste market creation and stimulation: Australian stakeholders' perception

To cite this article: S Shooshtarian *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1101** 062012

View the [article online](#) for updates and enhancements.

You may also like

- [Overview of recycled concrete research through development years \(2004-2018\)](#)  
J Xiao, A D Singh, Z Duan et al.

- [Comparison of the energy consumption in the production of natural and recycled concrete aggregate: A case study in Kerala, India](#)  
Alan V Ittyeipe, Anu V Thomas and K P Ramaswamy

- [Study on Partial Replacement of Natural Aggregate Concrete \(NAC\) With Recycled Aggregate Concrete \(RAC\)](#)  
Monisha Ramasamy, Dhanusuya Jaganathan, Kaasurajan Soundararajan et al.



The Electrochemical Society  
Advancing solid state & electrochemical science & technology

243rd ECS Meeting with SOFC-XVIII

Boston, MA • May 28 – June 2, 2023

**Abstract Submission Extended  
Deadline: December 16**

[Learn more and submit!](#)

# The impact of regulations on construction and demolition waste market creation and stimulation: Australian stakeholders' perception

S Shooshtarian<sup>1</sup>, T Maqsood<sup>1</sup>, S Caldera<sup>2</sup> and T Ryley<sup>3</sup>

<sup>1</sup>School of Property, Construction and Project Management, RMIT University, City 3000, Melbourne, Australia

<sup>2</sup>Cities Research Institute, Griffith University, Brisbane 4111, Australia

<sup>3</sup>School of Engineering and Built Environment, Griffith University, Brisbane 4111, Australia

salman.shooshtarian@rmit.edu.au

**Abstract.** The use of recycled products largely depends on the existence of viable end markets. In Australia, state regulations have a pivotal role in creating and stimulating the market for recycled construction and demolition (C&D) waste products. Hence, this study aims to identify regulatory barriers and enablers affecting C&D waste end markets. This study employed a qualitative research approach to understand the effectiveness of the current C&D waste regulations. The data collection concerned a series of interviews with C&D waste experts across five Australian states (i.e., Victoria, New South Wales, Western Australia, Queensland and South Australia). Overall, 27 interviewees were recruited from various stakeholder groups (e.g., recycling, government, construction, consultation & manufacturing). The findings provide an insight into the primary factors affecting market development for recycled C&D waste materials. A series of reforms are proposed to improve the current regulatory framework. They aim to address issues around recycled C&D waste uptake in construction projects. The research contributes to the body of knowledge in the field of built environment and design by providing first-hand information about regulatory mechanisms involved in utilising recycled products. Policymakers and authorities can use the results to devise advanced regulations that provide a level playing field for all parties involved in C&D waste management in Australia and other countries with similar contextual conditions.

## 1. Introduction

The issue of construction and demolition (C&D) has become a central focus of Australian environmental protection initiatives across federal, state and local levels [1]. In 2018-19, the architecture, engineering and construction (AEC) industry produced 27 million tonnes of C&D waste in Australia, of which only 14 million tonnes were recovered [2]. A waste import ban from some Asian countries has increased the pressure on the Australian waste recovery sector that exports waste overseas [3]. To this end, various education, enforcement, and encouragement strategies are being explored in the Australian context [4]. Whilst not a silver bullet to solving C&D waste issues, market development for recycled products is perceived as a sustainable solution to mitigate some of its negative impacts [5, 6]. In Udawatta, Zuo (7) study, 31% of surveyed participants reported that the unavailability of the market for recyclers hinders sustainable C&D waste management practices. The findings of a survey administrated by Shooshtarian, Khalfan (8) suggest that 92.5% of participants agree to the increased implementation of market



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](#). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

incentives; the surveyed experts also rated the five top enablers of market development as an investment in technology and infrastructure (16.7%), sustainable procurement (14.6%), landfill levy (13.2%), adequate supply chain system (11.1%) and a national approach (7.6%). Another study reports that New South Wales (NSW) experts rated the technical aspects as the most critical barrier category [9]. The results of the survey and focus group discussions from this study also reveal the most significant barriers to developing a market for the C&D waste stream. These include the high cost of onsite waste sorting, lack of consistent waste data reporting system; unsustainable demand and supply; inadequate communications and incentives across the supply chain; and complicated web-based exchange systems.

The waste market business model has shifted towards online marketplaces leveraging digital technologies. Web-based waste marketplace examples, otherwise known as waste exchange systems, are technically live databases to connect organisations seeking to dispose of materials with organisations looking to reuse or recycle the same materials [10]. Using the Advisory System for Processing, Innovation and Resource Exchange (ASPIRE) as a case study, King, Lusher (11) investigate online waste marketplaces in Australia. The survey findings in this study suggest that facilitator contact with companies, pre-existing personal relationships and companies interested in the future use of recycled materials primarily drive online waste marketplace development. Another study finds that the lack of active user-friendly web-based marketplaces dramatically hinders the effectiveness of waste exchange in the C&D waste stream [9]. Regulations significantly impact how the domestic markets for C&D waste are established or performed in the AEC industry. The following section provides a brief review of the literature on C&D waste regulation in Australia.

### *1.1. Contextual background: Waste regulation in Australia*

In the Australian context, C&D waste is regulated through three tiers of government: federal, state or territory, and local. However, the federal government is not directly involved in regulating C&D waste unless the regulations set by the other two tiers conflict with international treaties that Australia is a party to (e.g. Agenda 21, Basel Conventions, and Stockholm Conventions) or they impose threats to the environment that are of national concern [12]. Technically, local governments and municipalities provide waste collection and recycling services, manage and operate or administrate landfill sites, deliver education and awareness programs, and provide and maintain recycling infrastructure. Therefore, most legislation occurs at the state and territorial government levels. In most states and territories, the Environmental Protection Authority (EPA) organisation is responsible for implementing and monitoring waste regulations. In collaboration with some government organisations, this organisation also engaged in waste policy development. The waste policy at the federal level is the National Waste Policy (4), which recommends the main pathways and strategies to improve waste management in Australia. Various research has found that unsupportive and inconsistent regulations and policies hinder Australia's C&D waste management [7, 10, 13]. Shooshtarian, Maqsood (14) analysis of the Australian state waste strategy documents explored the main barriers and opportunities stipulated in these documents. The issues with the Australian waste regulatory landscape are multifold. They mainly include disparities between state and territory regulations, lack of or inadequate definition of C&D waste [15], lack of support for waste recovery and use of recycled products, and double standards when dealing with raw and recycled materials. Despite limited research investigating C&D waste regulations and their impact on the Australian waste management system [16], studying the effect of those regulations that directly impact C&D waste market creation and stimulation is a new area of investigation in Australia.

### *1.2. Research scope and aim*

This research aims to identify the main issues with the current waste regulations and standards that hinder the creation and stimulation of domestic end markets for C&D waste materials. This research seeks to understand how inadequate waste regulation influence circular economy principles in the built environment sector in Australia. The research participants representing various organisations and businesses in four states of Australia (i.e., New South Wales - (NSW)- Queensland - (QLD) -, Victoria

- (VIC) - and South Australia – (SA)-) were inquired on their views on current regulations. These four states were selected as they exhibit the greatest C&D waste generation, recovery and exchange rates.

## 2. Research methodology

This paper adopts a qualitative research approach, and the primary data were collected through semi-structured interviews with experts who had relevant experience in managing C&D waste in Australia. The following sections describe the research approach used in this study.

### 2.1. Data collection

A purposive sampling strategy was the most time-effective sampling approach available. It was employed to recruit a wide range of participants across the C&D waste supply chain. Recruitment was executed according to the Australian National Statement on Ethical Conduct in Human Research and RMIT University Human Ethics Committee instructions and requirements. The project industry partners, the Australian Sustainable Built Environment National Research Centre (SBEEnrc) and the Waste Management and Resource Recovery Association of Australia (WMRR), assisted with the recruitment process by providing their network contact details. WMRR's members consist of businesses and experts engaged in recycling and waste management activities. SBEEnrc members include experts from government, industry and academia involved in built environment issues, most notably C&D waste management. WMRR is the primary industry stakeholder for this work, while SBEEnrc funded the research project. In 2020, the RMIT and Griffith University research teams received approval from the relevant university research ethics committees.

Since the study required experts in the field, one of the main selection criteria was the adequate experience in dealing with waste management in Australia. Email communication was the method of recruitment. In the first round, an email with the project information sheet was sent to a list of participants compiled by the research team. This covered 60 individuals with relevant experience in waste management and the resource recovery sector in only four states of Australia: NSW, QLD, VIC and SA. The list consisted of the two organisation members and other experts identified by researchers. A reminder email was also sent to those who did not respond in the first round. Interview participation was voluntary. Attending the interview confirmed informed consent. The investigators maintained the privacy and confidentiality of all interview information as per the human ethics requirements. The interviewees were conducted online, using the Microsoft Teams application. Each interview took, on average, 45 minutes, including a brief description of the study objectives and the interview structure. The interview consisted of questions covering the main issues and opportunities regarding the development of the market for recycled C&D waste materials. The questions sought participants' experience, their opinion on the impact of COVID-19 on C&D waste recovery activities, issues around the development of the market for recycled C&D waste materials and other information provided by participants. However, this paper only presents the findings on the following interview question: 'How do you think of the current legislation about C&D waste end-of-life management in your jurisdiction?'

### 2.2. Data analysis

The audio data (1,000 minutes of data) were carefully transcribed word-for-word by a professional transcriber. The research team further verified the quality of text data. The analysis of transcripts was performed using NVivo Pro 12 application [17]. This application facilitates codifying text-based qualitative data and conducting thematic analysis of participants' qualitative responses [18].

## 3. Findings and discussion

Research findings are presented in two sections. Firstly, the profile of the participants, including their position, experience and organisations, are outlined. Secondly, participant perceptions of current waste regulations and market development and stimulation in the four study states are analysed.

### 3.1. Participants' profile

Overall, 27 interviewees were recruited from various stakeholder groups (i.e., recycling, government, construction, consultation, and manufacturing). The primary stakeholders who have a crucial role in utilising recycled products (e.g., government, recyclers and construction professionals) are well represented in the sample size. As shown in Table 1, most of the participants were government officials (9), followed by recyclers (8), professionals working in the construction industry (5), experts employed in the construction materials manufacturing sector (3) and consultants with relevant experience (2). A summary of participants' profiles, including the primary location of their business and the focus of the operation, and their position and length of experience, is provided in Table 2. The interviewees were based in WA (n=11), QLD (n=7), VIC (n=4), NSW (n=3), and SA (n=1). In terms of gender, five interviewees were female, and the rest were male, echoing the industry gender imbalance.

**Table 1.** Summary of profiles of interviewees and their organisations.

P	State	SG	Position	Exp (Y)	P	State	SG	Position	Exp (Y)
P1	NSW	M	State Manager	4	P14	VIC	R	Sales Manager	8
P2	NSW	R	Director	30	P15	VIC	R	Managing Director	25
P3	NSW	M	Strategy Business Development Manager	4	P16	VIC	CN	Quality & Environment Manager	18
P4	QLD	G	Sustainability Manager	20	P17	WA	CT	Principal Engineer Pavements & Drainage	13
P5	QLD	G	Sustainability Manager	11	P18	WA	R	General Manager	12
P6	QLD	CN	Sustainability Operations Manager	20	P19	WA	G	Sustainability Manager	5
P7	QLD	CN	Senior Waste & Resource Consultant	13	P20	WA	G	Senior Development Manager	14
P8	QLD	G	Environmental Coordinator for transport & Infrastructure	14	P21	WA	R	Resource Development Manager	10
P9	QLD	G	Executive Director of Resource Recovery	16	P22	WA	R	Director-operations	5
P10	QLD	CT	Managing Consultant	10	P23	WA	M	Technical Manager	15
P11	SA	R	CEO	10	P24	WA	G	Manager – Policy	16
P12	VIC	R	CEO	18	P25	WA	CN	Residential Sustainability Manager	4
P13	VIC	G	Environmental Project Advisor	4	P26	WA	G	Manager of Material Engineering	19

CN: Construction, CT: Consultation, G: Government, M: Manufacturing, R: Recycling, SG: Stakeholder Group, Exp: Experience (years)

It is noteworthy to mention that not all research participants responded to the paper's main research question (N=22/27) due to various reasons ranging from lack of knowledge to time constraints during interviews.

### 3.2. Participant perceptions of waste regulations in four states

There were 18 interviewees who indicated that current waste regulations are insufficient to support the creation and stimulation of end markets for C&D waste materials, and improvements are required. The following sections provide participant perceptions of current regulations and policies.

#### 3.2.1. Waste regulations and policies in NSW

The responses to the question related to current regulations and policies revealed a variety of aspects. All participants expressed positive and negative perceptions of relevant regulations (Table 2). Specifically, P1 described opportunities for overall improvement of existing legislation while pointing out the current challenges related to inconsistencies, stating:

*"We see that there's a huge opportunity in continuing the path of what we've done in New South Wales from a national perspective. The hesitation for us comes from the points we've just made around inconsistencies of legislation, inconsistencies of materials in those markets, uncertainty around legislation and the approval processes".*

These strict regulations lead to uncertainty to invest, discouraging many players in the market to engage in recycled products business. For example:

*"The one thing that does concern us greatly, is the risk of change to the legislation, particularly in the orders and exemptions. The EPA fought rightly or wrongly to make changes to a number of orders and exemptions recently in the end-use space that effectively destroyed that market. " [P1].*

**Table 2.** Summary of participants' opinions on current legislation with respect to market development.

P	Comments
P1	<p>This participant stated that it is not an attractive sector because it is so highly regulated, and there are high contamination risks. To address these risks, it is critical to follow appropriate tests and all those processes.</p> <p>While this participant acknowledged that legislation has the right intent, he argued that there are some issues with the current EPA, particularly around changes made to the POEO Act with asbestos waste reforms. In terms of testing for asbestos, before it arrives at a recycling site, it is the developer's choice as to whether or not they do the asbestos clearance certificates.</p> <p>There are inconsistencies in the interpretation and legislation of asbestos contamination that need to be resolved. Within this context, dealing with local approvals is a very cumbersome process; for example, it may include approvals from different local and state-level authorities. Getting them all to agree and come together to permit a businesses' intentions in creating those end-markets can be difficult.</p>
P2	<p>The limited representation of scientists and engineers in the New South Wales Environment Protection Agency was highlighted as a challenge for data communication. This participant viewed this government body as an emotional or philosophically-based regulator rather than a science-based one. This leads to an uncertain external environment for C&amp;D recycling in the Sydney region. It was anticipated that if the existing regulation is enforced, most businesses will exit the recycling business because of the significant risk.</p>

This participant highlighted the significant need for policy reform to allow some level of recycling material trials and waste recovery, explaining:

*"The resource recovery orders and exemptions for their intention work well but need reform. And that's just about being clear around how the resource recovery exemptions operate and being flexible enough that as the markets start to move—and we're looking at different ideas and uses for recycled materials" [P1].*

### 3.2.2. Waste regulations and policies in QLD

The responses to the question related to current regulations and policies revealed a variety of aspects. Most participants shared their insights on relevant regulations with some comparison with other states. Overall, there were concerns around strict regulations, restrictive specifications, and the critical need for approaches beyond compliance drive and demonstration projects led by the government. P10 described the restrictive nature of the specifications in Queensland, explaining: *"Particularly in Queensland it's tough because the specifications are quite restrictive, have held things back somewhat in terms of the ability to use a lot of recycled content [RC] materials"*. Another participant from the construction sector pointed out that the regulations should give more confidence to the businesses. For example: *"At the moment, the regulatory regime in place is unable to give us confidence around managing out the risk of asbestos fines. " [P6]*.

The current legislation is more compliance-driven. For example: *"It'll be compliance-driven; legislation always is. I don't think it's going to achieve new outcomes, better outcomes. It's not going to*

*challenge people to do better; it's not the right incentive at the stick" [P5].* Going forward, there should be reformed legislation urging people to go beyond the compliance approach and achieve more advanced outcomes. A government sector participant acknowledged that the regulations are influencing more positive behaviour, especially with targeted guidelines for road infrastructure projects. "*I think they're currently quite good. Again, those Transport and Main Roads guidelines helped us. The waste levy coming in[provides] industry impetus to minimising waste.*" [P8].

Furthermore, there is a critical need for local government authorities to demonstrate best practices of using recycled C&D material in their large infrastructure projects and encourage increased uptake of recycled materials in any infrastructure project. Table 3 summarises the participant responses to the question on waste regulation in QLD.

**Table 3.** Summary of participants' opinions on legislation concerning market development in QLD.

P	Comments
P4	The participant indicated the government had taken actions to ensure disposal costs are more expensive than the recycling and reusing industry. Hence, those environmental and social externalities values need to be factored into a short-term economic aspect (e.g. waste levy) to support the industry. It is critical to show the wider economic benefits to make disposal at the landfill a last resort and thereby stimulating the market.
P5	This participant indicated that the challenge with the regulations is that it requires the bare minimum (do no harm) and limits the attempts to do better through better aspirations. Furthermore, she emphasised that it is compliance-driven, and it cannot challenge people to do better; therefore, it is not the right incentive.
P6	This participant expressed that the regulatory regime in place cannot give them confidence in managing the risk of asbestos fines. While they can use RC for fly ash, glass, and other materials, demolition waste is problematic. This is mainly due to the sampling rates and the extent to which that is set up across the country and differences in each jurisdiction. This participant also pointed out that incentivisation in some regions is much better than in others.
P7	This participant shared her previous local council experiences related to the challenges of obtaining approval to use recycled C&D material in new infrastructure projects. It was also argued that the regulation had been a barrier for the industrial practitioners who are keen to move things forward.
P8	This participant was generally positive about the current regulations and emphasised that the Transport and Main Roads guidelines and the waste levies gave the industry the impetus to minimise waste. It has provided more guidance on direction, which is always suitable for any aspect.
P9	This participant stated that the current regulations address more because of a broader question around the waste. There is a lack of specific targeting of C&D waste management, and there are more opportunities to create more comprehensive planning strategies and the development assessment and approval procedures.
P10	This participant described the challenges related to the restrictive nature of regulations (i.e., products specifications have limited the ability to use many RC). This participant also pointed out that there has been more progress in other states such as Vic and, to some extent, NSW.

### 3.2.3. Waste regulations and policies in VIC

The responses to the question revealed different aspects. While one participant [P14] could not provide a comment on current legislation, the other participants had various opinions ranging from positive to negative perceptions of regulations and specifications, respectively [P15], to making overall improvements [P16] and ensuring the guidelines and policies materialise in action [P13]. Table 4 summarises the participant responses to the question on waste regulation in VIC.

**Table 4.** Summary of participants' opinions on legislation concerning market development in VIC.

P	Comments
P13	It is not clear how the new EPA act released in July 2021 will impact the market development. Referring to one recycling company in Victoria, P13 implied the current regulations are

unsupportive. Sustainability Victoria has developed policies that assist stakeholders in developing markets through incentives such as financial support for infrastructure development and/or sustainable procurement. The Victoria Recycling Policy encourages the increased use of recycled products to drive the market. Other organisations such as Major Projects Victoria have also developed guidelines. The participant indicated that a clear roadmap showing how to put these guidelines into action is still lacking.

- P15 While the participant found the current legislation is adequate, he stated that the new specifications would negatively impact the use of recycled products across Victoria. He did not support mandating minimum RC in regulations but instead recommended informing and helping stakeholders to identify opportunities to use RC.
- P16 Improvements are needed, and one example of this is to accredit companies using RC or provide monetary incentives through government leadership.

### *3.2.4. Waste regulations and policies in WA*

The responses to the question related to current regulations and policies revealed that not everyone is familiar with the current regulatory framework and relevant efforts to reform them. The majority of responses indicate the need for improving the current regulations. Only a few interviewees (P19, P20, P26 & P27) acknowledged the recent reforms at the state level to enhance the effectiveness of state waste regulations. Notably, the interviewees with that knowledge were the ones that represent the public organisations that are involved in waste regulation and policy development. This trend represents the fact that current waste policies are not effectively communicated to stakeholders. The responses also highlighted some of the reform priorities in current legislation. These include an emphasis on reusing waste materials and lack of extended producer responsibility policy (P17); waste end-of-life management (P18); proper distribution of landfill levy revenue (P19); encouragement of using recycled materials (P20); focusing on non-hazardous materials (P22); pushing and improving the current regulations during the construction industry's busy periods (P23); clarity on definitions and requirements relating to handling waste materials as opposed to resources (P26); and legislation stimulating market development (P27). Table 5 summarises responses to the question on waste regulation in WA.

**Table 5.** Summary of participants' opinions on legislation affecting the C&D waste market in WA.

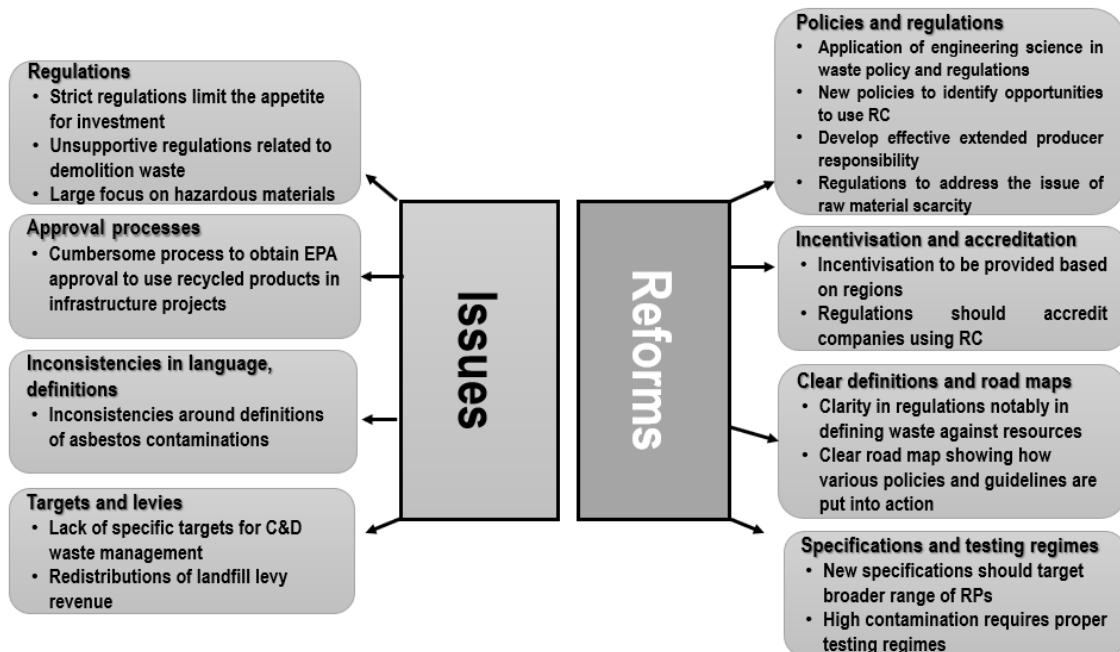
P	Comments
P17	The legislation is not strong enough, and current regulations are not directed towards reducing waste. Furthermore, state waste regulations do not emphasise reuse and recycling as they should. Notably, reusing is ignored in regulations, and there is no compulsion against landfilling the resources that could be reused. The lack of extended producer responsibility is another issue that is not regulated under the current legislative framework. Currently, the decision on recycling C&D waste is primarily based on market forces, and it should be modified to be driven by regulations.
P18	There is much room for improvement. For instance, there is too much emphasis on handling waste and not enough on the end product. Until the mandatory legislation that can stimulate the market are introduced, suppliers of recycled materials continue to struggle with accepting their production by end-users.
P19	The current legislation has improved, which has resulted in a significant reduction in waste disposal. However, the issue of redistributing landfill levy revenue continues to act as a barrier in developing markets. Currently, the revenue does not go back to implementing waste strategies across the state.
P20	The issue with the current legislation is that the landfill levy as an effective waste strategy is not accompanied by supporting the use of recycled materials. There is excellent potential in WA to use recycled materials as many recyclers in the state have invested in technologies and modern processes to produce high-quality materials, and the legislation should support these efforts.
P21	The end-of-life waste guideline was effective a few years ago; it was a supportive policy instrument that was removed after a private entity sued regarding the disposal of unprocessed waste that conformed to the policy at that time. The participant preferred policies that drive sustainable procurement rather than landfill levies. Furthermore, increasing the landfill levy in future legislation risks the operation of recycling facilities due to the imposition of the landfill levy on residual

recycling waste. Moreover, specifications on using recycled waste in new construction materials need to capture a broader range of materials in the state.

- P22 The current legislation only addresses hazardous materials and focuses on regulated waste categories, and there is no legislation about nonhazardous materials such as C&D waste materials. Legislation needs to be introduced to define expectations of waste management lucidly.
- P23 The current legislation on C&D waste needs to be pushed to reflect real-world conditions in the state, given a boost in the state economy and, notably, the construction industry. Such a boom in the industry, generating so much waste, and the scarcity of construction resources justify the urgent need for revisiting waste regulations. Conversely, there is less appetite to reform regulations required for addressing resource constraints during quiet times. In revisiting the legislation, the government should send strong signals to those who oppose reforms. The industry is accountable for communicating the current issues, such as the shortage of some construction materials that could be fixed by new legislation.
- P24 The Department of Water and Environmental Regulation has been leading an initiative called the Waste Forum program since 2019 that implements a series of reforms throughout our Environmental Protection Act. These reforms aim to make the entire material recovery system work better. This initiative attempts to look at the range of regulations and ensure that they are updated, more consistent, and more reliant on or supportive of our new Waste Strategy objectives. For instance, a product of these reforms is a paper called "Close the Loop", which aims to move the state towards a more sustainable economy. However, there is some work to be done.
- P25 The current regulations are not good enough. The current setup does not require builders and developers to source separate C&D waste and indirectly encourages mixed load waste at construction sites. The government should devise an extremely high penalty for dumping waste in landfills, and builders should be strongly incentivised to reduce the amount going into landfills.
- P26 The policies about waste in their organisation are being reviewed. However, the big problem is the distinction between resource and waste, and eventually, what materials should attract the landfill levy and how a waste ceases to be a waste. Hence, clarity around definition and expectation is a priority in improving waste regulations. Clarification gives a good understanding of waste handling requirements and will result in minimising unsustainable waste management.
- P27 The state could probably get better outcomes if we had slightly more clarity on the legislation. Notably, legislation is required to stimulate better management of end-of-life management of C&D waste.

### *3.3. Issues & reforms for waste regulations*

The following diagram shows the main issues in the waste regulations identified by respondents that hinder the creation and stimulation of end markets. Furthermore, reforms to address these issues are summarised below (Figure 1).



**Figure 1.** Common issues and reforms identified for C&D waste regulations.

This study contributes to the body of knowledge with identified issues & reforms for waste regulations. Drawing on the interview findings, it is evident that there are key issues related to strict regulations, inconsistencies around definitions, complex approval processes, limited focus on C&D waste, lack of mandatory requirements to segregate waste at the sources in the AEC industry. To support better management of C&D waste and to increase the uptake of recycled waste policy reforms must focus on the application of Engineering Science in (EPA) waste policy and regulations, clarity in language/ definitions (to identify waste as a resource material), appropriate testing regimes, incentivisation, effective extended produce responsibility with a clear road map and actionable recommendations for market players.

### 3.4. Means to reform regulations

According to responses obtained in this study, it seems that reforms to current regulations are vital to ensure they support sustainable creation and stimulation of markets for C&D waste materials and circular economy. Hence, some strategies for managing reforms to the current regulations are recommended in this section. As summarised in Table 6, these strategies include research and development, consultation workshops, and white paper development. Through these strategies, current regulations' reform and development direction can achieve industry-oriented, scientific research management reform ideas. These ideas will enable evidence-based decision-making according to the law and promote sound policy development reforms to create a conducive environment for better C&D waste management practices. Co-creating the ideas through the involvement of key stakeholders will be critical during this process.

**Table 6.** Strategies for managing reforms.

Strategy	Summary	References
Research & Development (R&D)	Research and development to be improved through collaboration with industry experts and University-Industry (U-IE). This type of R&D activities will facilitate knowledge transfer between research institutes and the industry/ government.	Henningsson and Geschwind (19)
Consultation workshop	Consultation with state and territory authorities will help ensure their potential specific conditions and concerns are properly reflected in any policies emerging from regulations reforms	Shooshtarian, Maqsood (16)
White paper	A high level, top-down, policy review by governments and think tanks will help consider topics of national and local challenges and needs.	Allwood, Ashby (20)

#### 4. Conclusions and Further Research

Domestic market development and stimulation significantly impact the proper management of C&D waste in Australia. Among various factors, waste regulations are determinants of successful market operation. This study aimed to understand stakeholders' opinion on the impact of current waste regulations on market creation and stimulation in four Australian states (i.e., NSW, QLD, VIC and SA). The research revealed the main issues related to and reforms needed for the current regulations to support the use of RC in the Australian AEC industry. The study contributes to the body of knowledge in the field of built environment and design by providing first-hand information about regulatory mechanisms involved in utilising RPs. Some research findings may not be generalisable beyond Australia, but exciting insights for an international audience. Domestically, the outcomes will benefit all state and territory jurisdictions within Australia. According to the current state and territory waste strategy documents, public authorities have started implementing some waste management techniques presented in this research. Hence, it is proposed that further studies investigate how such strategies remove significant barriers and enable the emergence of a CE in the construction materials lifecycle. Furthermore, such studies should compare waste management systems in Australia with those overseas. These comparisons can help Australian authorities benchmark their waste management activities against schemes elsewhere and learn from international best practice examples.

#### References

- [1] Shooshtarian S, Maqsood T, Wong SP, Yang JR and Khalfan M 2020 Review of waste strategy documents in Australia: Analysis of strategies for construction and demolition waste *Int J Environ Technol Manag* **23** 1-21
- [2] National Waste Report. National Waste Report. Canberra, Australia: Department of Agriculture, Water and the Environment; 2020.
- [3] Doust K, Battista G and Rundle P 2021 Front-end construction waste minimization strategies *Aust J Civ Eng* **19** 1-11
- [4] National Waste Policy. Less Waste. More Resources. In: Department of Agriculture WatE, editor. Canberra, Australia2018
- [5] Caldera S, Ryley T and Zatyko N 2020 Enablers and barriers for creating a marketplace for construction and demolition waste: A systematic literature review *Sustainability* **12** 9931
- [6] Shooshtarian S, Caldera S, Maqsood T, Ryley T and Khalfan M 2021 An investigation into challenges and opportunities in the Australian construction and demolition waste management system *Eng Constr Archit*

- [7] Udawatta N, Zuo J, Chiveralls K, Yuan H, George Z and Elmualim A 2018 Major factors impeding the implementation of waste management in Australian construction projects *J Green Build* **13** 101-21
- [8] Shooshtarian S, Khalfan M, Maqsood T, Wong PS and Yang RJ 2020 Market development for construction and demolition waste stream in Australia *J Constr Eng Manag Innov* **3** 220-31
- [9] Ratnasabapathy S, Alashwal A and Perera S 2021 Exploring the barriers for implementing waste trading practices in the construction industry in Australia *Built Environ Proj Asset Manag* **11** 559-76
- [10] Corder GD, Golev A, Fyfe J and King S 2014 The status of industrial ecology in Australia: Barriers and enablers *Resources* **3** 340-61
- [11] King S, Lusher D, Hopkins J and Simpson GW 2020 Industrial symbiosis in Australia: The social relations of making contact in a matchmaking marketplace for SMEs *J Clean Prod* **270** 122146
- [12] Hyder Consulting Pty Ltd. Construction and demolition waste status report: Management of construction and demolition waste in Australia Australia Department of Energy and Environment (Department of Sustainability, Environment, Water, Population and Communities); 2011.
- [13] Wu H, Zuo J, Yuan H, Zillante G and Wang J 2020 Cross-regional mobility of construction and demolition waste in Australia: An exploratory study *Resour Conserv Recycl* **156** 104710
- [14] Shooshtarian S, Maqsood T, Wong PSP, Yang RJ and Khalfan M 2020 Review of waste strategy documents in Australia: analysis of strategies for construction and demolition waste *Int J Environ Technol Manag* **23** 1-21
- [15] Papastamoulis V, London K, Feng Y, Zhang P, Crocker R and Patias P 2021 Conceptualising the circular economy potential of construction and demolition waste: An integrative literature review *Recycl* **6** 61
- [16] Shooshtarian S, Maqsood T, Caldera S and Ryley T 2022 Transformation towards a circular economy in the Australian construction and demolition waste management System *Sustain Prod Consum* **30** 89-106
- [17] NVivo (released in March 2020) [Internet]. 2020. Available from: <https://bit.ly/3Th6V80>.
- [18] Braun V and Clarke V 2006 Using thematic analysis in psychology *Qual Res Psychol* **3** 77-101
- [19] Henningsson M and Geschwind L 2019 Senior industry practitioners as part-time visiting professors: the various benefits of collaboration *High Educ Policy* **32** 109-28
- [20] Allwood JM, Ashby MF, Gutowski TG and Worrell E 2011 Material efficiency: A white paper *Resour Conserv Recycl* **55** 362-81

### Acknowledgement

This research has been developed with support provided by Australia's Sustainable Built Environment National Research Centre (SBEnrc). SBEnrc develops projects informed by industry partner needs, secures national funding, project manages the collaborative research and oversees research into practice initiatives. Core Members of SBEnrc include ATCO Australia, BGC Australia, Government of Western Australia, Queensland Government, Curtin University, Griffith University, RMIT University and Western Sydney University. This research would not have been possible without the valuable support of our core industry, government and research partners.