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Research article

Circular economy policies and the use of recycled materials in the Australian built environment

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ABSTRACT

The built environment sector is a major contributor to global waste generation, prompting urgent calls for the sector's transition towards a circular economy (CE). Utilising products with recycled content (PwRC) in construction activities is widely recognised as an effective strategy to support this transition. The opimal utilsiation of these resources warrants supportive policies. There is a limited understanding of how the key stakeholders in the sector perceive these policies. This study investigates the perceptions of key stakeholders regarding the relevance, effectiveness, and limitations of 17 CE policies influencing the uptake of PwRC in Australia. The study employed a semi-structured survey and captured 62 responses representing various stakeholders on 17 CE policies. The findings reveal varying levels of familiarity with the CE policies studied. Furthermore, most survey respondents view current policy frameworks as insufficient in promoting the use of recycled content in construction, underscoring gaps in perceived CE policy effectiveness, particularly in national versus state-level prioritisation. Key policies such as *Extended Producer Responsibility*, *Sustainable Procurement* and *Carbon Pricing Scheme* were identified as having the most significant positive impacts for PwRC optimal uptake in construction projects. The study provides actionable insights for policymakers to clarify and standardise specific areas, enhancing stakeholders' confidence and engagement in circular practices and PwRC utilisation. Furthermore, it highlights the need for integrated policy approaches that address unintended consequences and foster a supportive policy mix for circular practices in the sector.

1. Introduction

There is a significant growth of construction and demolition (C&D) activities around the world, generating a substantial amount of waste. In Australia, the C&D waste stream contributes to 38 % of the total waste generated, reaching 29 megatonnes (Mt) annually (Blue Environment, 2023). Within this context, the use of products with recycled content (PwRC) in the built environment sector, (hereafter referred to as 'the sector'), has been identified as a targeted intervention towards a circular economy (CE), as it helps with a reduction of natural resource extraction and environmental problems (Oyedele et al., 2014). Researchers identified several benefits of using PwRC in this sector, such as reducing construction costs, avoiding landfill tax and illegal dumping, reducing energy consumption, reducing greenhouse gas emissions (GHG), preserving land areas, and job creation (Islam et al., 2019; Wang et al., 2018; Ulubeyli et al., 2017). Specifically, every ton of PwRC reduces the demand for landfilling or backfilling while it conserves resources like sand, gravel, and aggregates, mitigating negative impacts on air, noise and climate (EuRIC, 2023).

The most recent Circularity Gap Report 2024 states that our current economy is only 7.2 % circular, leaving space for CE policies that (Circle Economy, 2024), combined with the climate agenda, can foster a path towards sustainable use of resources globally (Fraser et al., 2023). Considering the global context, the European Union (EU) takes the lead

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in using PwRC in construction projects and countries like the US, Japan, and Australia are also heading towards the optimal use of PwRC. To further promote CE by increasing the use of recycled content in new products, some countries have mandated various regulations. For example, the EU has introduced the Waste Framework Directive (2008/98/EC) to promote this, and its mandatory Green Public Procurement helps create and stimulate end-markets for PwRC (EuRIC, 2023). In Australia, the National Waste Policy (2018) encourages the use of PwRC and some of the states set recycling rate targets for C&D waste materials (Shooshtarian et al., 2020c). Even though using PwRC is technically feasible and partially regulated, it is not yet widely sourced in most construction projects (Shooshtarian et al., 2020a). Bocken et al. (2016) argue that transitioning to CE practices (including the uptake of using PwRC) in construction requires addressing not only technical but also cultural and organisational inertia that resists change. In addition, the limited uptake of PwRC can be attributed to uncertainty about quality, lack of information, cost complications and encumbering regulations (Udawatta et al., 2015; Tang et al., 2020; Park and Tucker, 2017; Shooshtarian et al., 2024b). While there are increasing efforts to recover C&D waste to produce PwRC, there is limited utilisation of these resources in private and public sectors, highlighting the inadequate policy approaches to enhancing their application in the sector (Shooshtarian et al., 2022b).

Stakeholders' perceptions significantly influence the use of PwRC in construction projects (Shooshtarian et al., 2020a). However, it is not yet clear how key stakeholders in this sector perceive the use of PwRC in construction projects. Therefore, this study aims to understand how the sector's key stakeholders perceive the relevance, significance and impact of the policy approach in optimising the use of PwRC in construction projects using a survey from Australian stakeholders. The rationale for this research is the critical need to inform, empower and engage key stakeholders in order to advance the agenda for increased utilisation of PwRC in both government and industry sectors. Such efforts are pivotal for supporting the transition to a more CE. To achieve this research aim, the following objectives were explored.

1. To understand CE stakeholders' familiarity with CE policies impacting PwRC optimal use in the sector
2. To identify the main benefits and impact mechanisms of these policies for optimal uptake of PwRC in construction projects
3. To explore the main challenges related to the study policies as well as the scope of their application

1.1. Research gap, rationale and contribution

This paper presents the findings of a scientific study conducted for the first time in the Australian context with an explicit focus on the impact of CE policies for optimal use of PwRC in the sector. In terms of scope, this study only attempted to investigate PwRC's application for construction materials recovered from C&D waste resources in the Australian context. However, through their survey responses, the participants were able to reflect on and share their understanding of how CE policies are implemented overseas, as well as for other materials.

This study makes several contributions to the fields of waste recovery, urban policy and construction management. First, it presents an opportunity for further assessment of the sector's stakeholder knowledge of CE policy development and implementation in the sector. Second, it provides a foundation for future research aimed at determining the efficacy of these policies in facilitating the optimal uptake of PwRC in construction projects. Third, industry professionals can draw on these research findings to optimize their operational strategies and practices, ultimately increasing the widespread use of PwRC in construction projects. Finally, the insights generated by this research can guide policy-makers in formulating evidence-based regulations that ensure level playing field for all stakeholders engaged in the PwRC supply chain.

1.2. Literature review: Australian policy context for CE in the sector

Australia's National Waste Policy (2018) identified avoiding waste, improved resource recovery, and increased use of PwRC as core principles of CE (Iyer-Raniga et al., 2023). To implement this Policy, the National Waste Policy Action Plan (2019) sets targets and actions, including an 80 % average resource recovery rate from all waste streams by 2030, and to significantly increase governments' and industry's use of PwRC (Office of Energy and Climate Change, 2023). Although no specific targets in relation to the sector are provided in the Action Plan, the increase in PwRC in the sector, including determining their use in road construction, and the development of associated national standards and specifications to improve demand for them in buildings and infrastructure, are highlighted in the Policy (Iyer-Raniga et al., 2023).

In line with the National Waste Policy, other state governments and territories developed their own waste strategies focusing on CE. New South Wales (NSW) CE policy statement (NSW Government, 2019) identified eight focus areas to guide government action to support the transition towards CE within the sector. From October 2023, NSW mandated the reporting of embodied emissions as part of the State Environmental Planning Policy (Sustainable Buildings) 2022 and associated Environmental Planning & Assessment Act regulations amendments (Office of Energy and Climate Change, 2023).

Northern Territory (NT) CE strategy (2022–2027) provides a regulatory framework for protecting the environment, and direction for transition to a CE (Northern Territory Government, 2024). Though the waste generated in NT is largely comprised of C&D waste, no specific targets or actions have been identified in relation to the sector. Queensland Waste Management and Resource Recovery Strategy sets out clear strategic priorities for transitioning to CE, specifying the target recovery rate of C&D as 75 % by 2025 (Queensland Government, 2020).

South Australia's Waste Strategy outlines actions that can contribute to the development of CE, specifying resource recovery targets for C&D as 95 % by 2025 (SA Government, 2020). Western Australia's Waste Avoidance and Resource Recovery Strategy 2030 sets out goals and priorities for transitioning the state towards a CE targeting an increase in resource recovery in the C&D by 80 % by 2030 (Waste Authority, 2024). Though all states and territories of Australia have initiated developing their waste strategies in line with the National Waste Policy and focusing on CE, not all have specifically focused on the sector in setting up their waste targets.

Three key types of policy instruments enable the sector to achieve CE outcomes: administrative, economic and informative (Sadiq and Khalfan, 2024). Licenses, bans, benchmarks and voluntary agreements between industry and government are examples of administrative or regulatory instruments, while economic instruments include fees, subsidies, taxes and other charges. Informative instruments comprise labelling, reporting obligations, certification initiatives and awareness-raising campaigns.

At the international level, growing evidence has underscored the crucial role of developing CE policies in promoting the use of PwRC within the sector (Swarnakar and Khalfan, 2024). Nuβholz et al. (2020) proposed that public policies can support organisations to address CE barriers by incorporating higher recovery goals and incentivising the PwRC market. In China, Bao and Lu (2020) pointed out that strong governmental interventions combining penalties and subsidies are an important factor contributing to successful CE implementation. In the Nordic region, a study by Zu Castell-Rüdenhausen et al. (2021) indicates that many business opportunities in the sector are supported by national and local policies. Consequently, translating CE principles into actionable policies can indeed drive the sector's transition toward a CE.

It should be acknowledged that not all CE policies necessarily yield positive results for optimal PwRC utilisation. Existing research shows that, depending on various internal and external factors, CE policies can produce either beneficial or detrimental outcomes (Shooshtarian et al., 2020b; Yu et al., 2022; Ma et al., 2020). For instance, Shooshtarian et al.

(2020b) contend that while landfill levies may be the preferred policy approach in certain scenarios, they can also inadvertently discourage best waste management practices. These levies may lead to increased illegal dumping, shifting of waste to other regions, and a reduction in overall recycling efforts. Rameezdeen et al. (2016) show that illegal dumping can be an unintended consequence of a higher landfill levy rate. Hence, it is crucial to assess the unintended consequences associated with developing and implementing CE policies within the context of the sector. The most effective way to gain this understanding is through systematically gathering insights and perceptions from both industry and government stakeholders.

2. Methodology

The study employed a mixed-method approach to collect quantitative and qualitative data (Fig. 1). By using both types of data, researchers can gather valuable numerical measures and uncover the deeper significance of text-based responses. Surveys are an appropriate data collection method to obtain both quantitative and qualitative information using well-planned questionnaires and are increasingly used by researchers within the CE and policy analysis domains (Klein et al., 2022; Shooshtarian et al., 2023a; Ren and Albrecht, 2023). This study employed an online survey because it offers a cost-efficient approach to distributing and managing the questionnaire, and it can easily reach a large pool of geographically dispersed participants (Mesch, 2012). Furthermore, it maintains participant confidentiality (Saez et al., 2013) and, because it is a widely used delivery method, participants are more familiar with it and are more inclined to participate.

The survey consisted of open- and close-ended questions. Close-ended survey questions offer a set of answer alternatives for participants to choose from (Mrug, 2010). Open-ended questions allow researchers to hear directly from both public and private sectors how current policies can either help or hinder the successful application of PwRC in construction projects, revealing the reasons behind these views. By using thematic analysis of the qualitative responses from these open-ended questions, the researchers were able to gain a more meaningful understanding of the respondents' perspectives.

2.1. Survey design

The development of the survey emerged from the extensive review of relevant literature, regulations, and policies both nationally and internationally as well as the expert opinions regarding the main issues of using PwRC in Australia and overseas captured in the researchers' previous research projects conducted in 2022 (Shooshtarian et al., 2022a) and 2024 (Shooshtarian et al., 2024b). The survey questions assess participants' views on how 17 CE policies (Fig. 2) can be applied to make optimal use of PwRC in the sector.

The following table presents a summary of the study policies with direct (in grey) and indirect impacts (in black) on the use of these materials in the sector. These policies are currently imposed or proposed to be implemented in the Australian context and are visually presented. A full review of these policies is provided before in Shooshtarian et al. (2024a, 2025).

The questionnaire included multiple questions for each policy, addressing participants' familiarity with it, their perceptions of its effectiveness, any unintended negative outcomes, suggestions for improvement, and the scope of its applicability. The survey design consisted of a range of question types: multiple-choice questions, 5- and 7-point Likert scales (e.g. 1 = 'strongly agree' to 7 = 'strongly disagree'), single and multiple text entry(ies), and rank ordering (1–5).

This paper presents four sections of the questionnaire: (1) participants' profiles, (2) familiarity with policies, (3) benefits and impact mechanisms and (4) limitations. The impact mechanisms were identified review of the relevant literature, consultation with CE experts and findings from authors' previous research. Responses to these questions contribute to our understanding of Australians' knowledge of CE (Objective 1), the main benefits of these policies for optimal uptake of PwRC in the sector (Objective 2) and the scope and challenges associated with the application of these policies in the Australian context (Objective 3).

The latest version of Qualtrics was used to design the questionnaire (Qualtrics, 2014). Prior to distribution, a group of four CE professionals and experienced researchers reviewed the final questionnaire to evaluate content validity, online accessibility and comprehension. The survey's content, clarity and length were then adjusted based on their feedback.

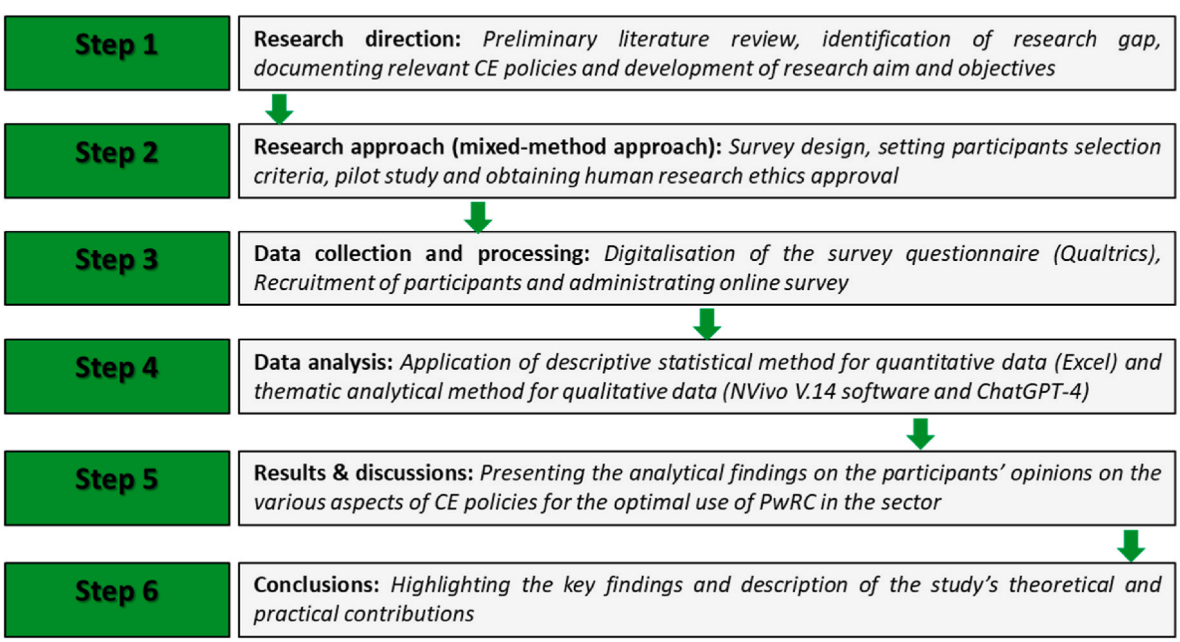

Fig. 1. A simplified overview of the research process.
Source: Authors

Fig. 2. CE polices (with direct and indirect impacts on the use of PwRC) investigated in this study.
Source: Authors

2.2. Recruitment and data collection

A cross-sectional survey of a purposeful sample of relevant stakeholders interested in advancing Australia's transition to a CE across various jurisdictions was conducted from November 2023 to June 2024. A purposeful sampling strategy is the most time-effective sampling approach available (Creswell and Creswell, 2023). It also ensures the views of a wide range of participants across the PwRC waste supply chain are captured. Purposeful sampling is employed so that participants who are selected will help researchers better understand the research problems and research questions. Recruitment was conducted following the Australian National Statement on Ethical Conduct in Human Research (National Health and Medical Research Council, 2023) and RMIT University Human Ethics Committee requirements.

During the recruitment phase, various recruitment methods were used. First, the research team contacted several industry associations including the Australian Council of Recycling (ACOR), and the Victorian Waste Management Association (VWMA) to help promote and distribute the survey. Second, they sent email communications through existing networks; an email with the online survey link and the project information sheet were sent to a list of participants compiled by the research team in one round. Finally, the researchers used the LinkedIn platform to identify and directly contact experts whose affiliations indicated they had relevant CE expertise in the sector. In all of the methods described above, follow-up communications were sent at appropriate intervals to maximise participation and achieve the largest possible sample size.

Survey participation was voluntary, and completing the survey was taken as informed consent. The research team protected the privacy and confidentiality of all survey data in accordance with human ethics requirements. Survey completion times ranged from about 1 h to several hours.

2.3. Data analysis and presentation

Overall, 62 responses were captured in the Qualtrics database, corresponding to a 58 % response rate. Both quantitative and qualitative responses were analysed. Descriptive statistical methods were applied to explore participants' demographic information and their perspectives on the policies under study (Holcomb, 2016).

For the quantitative data, frequency distributions were analysed to identify and compare different response categories. For the qualitative data, each question's responses underwent a thematic analysis (Braun and Clarke, 2006) to interpret underlying patterns and meanings. Thematic analysis is a useful approach to analyse qualitative data as it facilitates the organisation of data and the capturing of valuable information (Braun and Clarke, 2006). NVivo V.14 software and ChatGPT-4 were concurrently used to generate codes and labels for participants' qualitative responses. NVivo is a widely used software that enables researchers to conduct thorough analyses of qualitative and mixed methods data.

We then adopted a data visualisation technique to demonstrate the interconnections between various CE policies, as shown in Section 3.6. The purpose of the visual display of qualitative data is to depict relationships between themes and subthemes or categories and subcategories. Visual displays such as network diagrams serve as valuable tools for complementing extended textual content by illustrating connections between key concepts (Yin, 2015; Verdinelli and Scagnoli, 2013).

ChatGPT and other AI tools have recently gained popularity for qualitative data analysis and they are recommended for their ease of use and significant time savings compared to traditional manual coding (Morgan, 2023; Sen et al., 2023).

3. Results

3.1. Participants profile

The administration of the survey resulted in 92 responses, of which 62 were complete and therefore were included in the data analysis. Table 2 presents a summary of the survey participants' profiles. The majority of respondents were in the age groups of 35–44 and 45–54 (61.3 %), and almost half of this population had been engaged in promoting material circularity within the sector for between 1 and 5 years (54.9 %). Their main locations of operation were in four major Australian states, with Victoria having the greatest number of respondents.

The main employer sectors among the survey participants were 'Government' (25.8 %) followed by 'Consultation', 'Construction' and 'Academia' (14.5 %). Participants from academia were those recently engaged in research on C&D waste management and the implementation of CE principles within the sector. The sub-sectors of the government category included general, infrastructure delivery, policymaking and enforcement.

3.2. General knowledge of CE policies

Prior to presenting participants with the policies outlined in Table 1, they were asked to self-assess their knowledge of Australian CE policies that influence the use of PwRC in the sector. Nearly two-thirds indicated a moderate to extensive understanding of these policies (Fig. 3a). When asked whether existing Australian policies actively support the optimal use of PwRC, only 35 % of participants agreed that these policies effectively serve this purpose. This suggests that the majority view current policy frameworks as insufficiently aligned with promoting the use of recycled content in construction (Fig. 3b).

A comparative analysis was conducted to determine which policy is most familiar to research participants. As shown in Fig. 4, the level of

Table 1
Summary of the study CE policies. Note: Policies with a direct impact (grey) and those with an indirect impact (black).

Policy	Description	Policy	Description
Sustainable Procurement	It involves sourcing and purchasing recycled products while considering their environmental, social, and economic implications.	***Penalty on Illegal Waste Dumping***	*It refers to a financial or legal consequence imposed on individuals, businesses, or entities that engage in the improper disposal of waste materials in an unauthorised or environmentally harmful manner.*
Recycled Product Certification	This policy is a CE-based strategy that is designed to assure the quality, performance, environmental friendliness and safety of recycled products.	***Restriction on the Disposal of Priority Waste Resources***	*It refers to regulatory measures and policies implemented by governments or authorities to limit or prohibit the disposal of specific types of waste materials that are deemed valuable, scarce, hazardous, or environmentally damaging.*
Virgin Materials Tax	It is a financial mechanism that aims to discourage or penalize the use of virgin materials and encourage the use of recycled products.	***Accelerated Permission for On-Site Recycling***	*It is a regulatory or administrative process designed to expedite or fast-track the approval and permitting of recycling facilities or practices that are conducted on-site.*
Financial Incentive for using PwRC	It refers to a monetary or economic benefit provided to individuals, businesses, or organisations to encourage the use of recycled products.	***Demolition Deposit-Refund***	*It refers to financial security or collateral mandated on eligible construction and/or demolition projects, with the primary objective of guaranteeing the appropriate recycling and disposal of C&D waste materials.*
Harmonised Recycled Product Specifications	These specifications are designed to establish common guidelines and requirements that define the quality, composition, and performance standards of products with recycled content.	***Proximity Principle***	*It is a waste management concept that emphasises the importance of handling waste as close to its source of generation as possible. It encourages minimising the transportation of waste over long distances and promoting the management of waste near its point of origin.*
Environmental Sustainability Rating	It is a systematic framework used to assess, measure, and rate the environmental sustainability of various entities, such as buildings, products, services, and organisations. Examples include Green Star, LEED, IS Rating.	***Product Stewardship***	*It is a comprehensive and proactive approach to managing the environmental and social impacts of a product throughout its entire life cycle, from design and production to use and disposal.*
Carbon pricing scheme	*It is an economic mechanism implemented by governments or regulatory bodies to incentivize and promote the use of recycled materials in construction projects while simultaneously imposing a tax or fee based on the carbon emissions associated with using virgin materials.*	**Ban on the export of C&D waste resources**	*It refers to a regulatory policy or legal measure implemented by a government or authority to prohibit or restrict the export of C&D waste materials to other countries.*
Landfill levy	*A landfill levy is a financial charge or fee imposed by a government or regulatory bodies on the disposal of waste materials in landfills.*	**Recycling residual waste levy waiver**	*This waiver allows a specific entity to be excused from certain requirements or obligations related to the disposal of residual waste materials when they can demonstrate a significant commitment to recycling practices.*
Extended producer responsibility	*It is a policy approach that places the responsibility for the entire life cycle of a product on the manufacturer or producer, including the collection, recycling, and proper disposal of the product once it becomes waste.*		

Table 2
Summary of participants' profile.

Gender	Female 46.8 % (n = 29)			Male 51.6 % (n = 31)		Prefer not to say 1.6 % (n = 1)		
Age	**18–24** 1.6 % (n = 1)		**25–34** 19.4 % (n = 12)	**35–44** 33.9 % (n = 21)	**45–54** 27.4 % (n = 17)	**55–64** 8.1 % (n = 5)		**>65** 9.7 % (n = 6)
Experience	**<1 year** 19.4 % (n = 12)		**1–5 years** 35.5 % (n = 22)		**5–10 years** 25.8 % (n = 16)			**> 10 years** 19.4 % (n = 12)
Employer sector	**Academia** 14.5 % (n = 9)	**Construction**Ƭ 14.5 % (n = 9)	**Consultation**⊦ 14.5 % (n = 9)	**Government*** 25.8 % (n = 16)	**Industry Association** 6.5 % (n = 4)	**Material supply**♣ 9.7 % (n = 6)	**NGO** 6.5 % (n = 4)	**Waste Management**◆ 8.1 % (n = 5)
Location	**ACT**♠ 1.6 % (n = 1)		**NSW** 19.4 % (n = 12)	**Queensland** 19.4 % (n = 12)	**Victoria** 40.3 % (n = 25)	**SA** 3.2 % (n = 2)		**WA** 16.1 % (n = 10)

Ƭ**Construction:** Architecture and design, and construction.
⊦**Consultation:** Consultancy, product certification and procurement services.
***Government:** General, infrastructure delivery, housing construction, policymaking and enforcement.
♣**Material supply:** Material manufacturing, material engineering and material supplying.
◆**Waste Management:** Waste collection, waste recovery and waste management.
♠**Location:** ACT (Australian Capital Territory), NSW (New South Wales), SA (South Australia), WA (Western Australia).

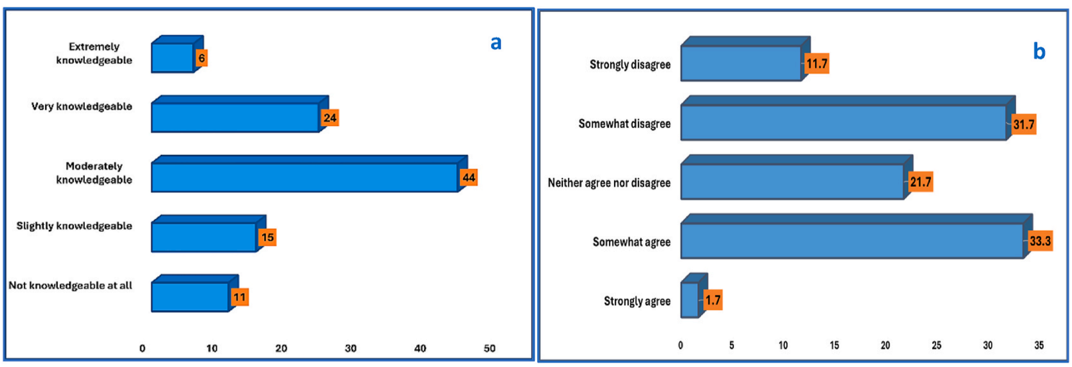

Fig. 3. Frequency distribution (%) of participants' responses. (a) their level of general knowledge of CE policies and (b) perceptions on whether existing Australian policies support the use of PwRC in construction projects.
Source: Authors

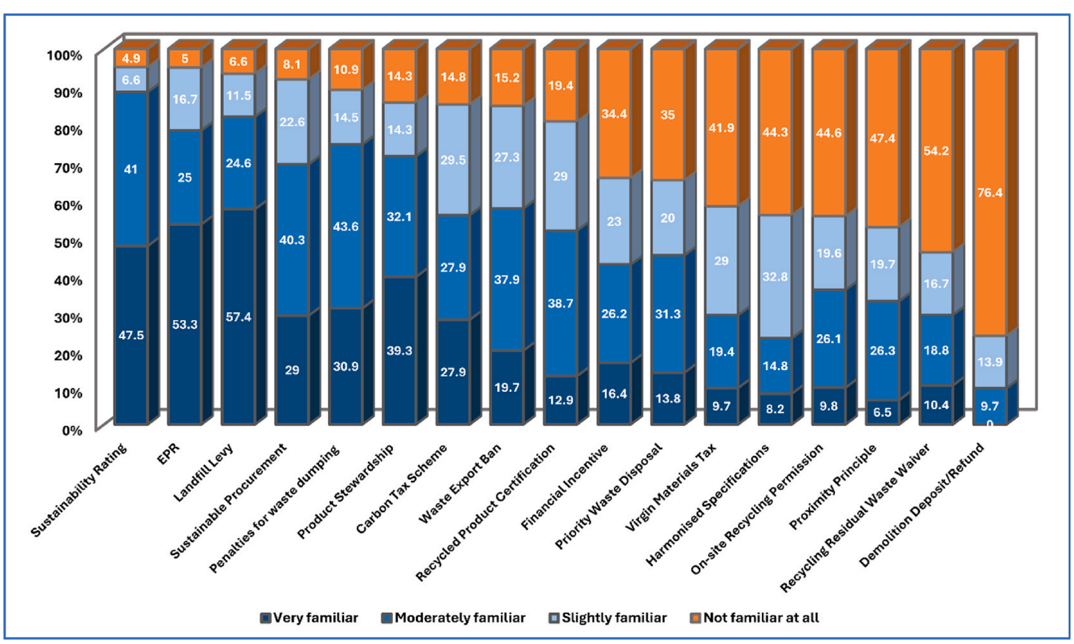

Fig. 4. Comparative overview of familiarity levels across the study policies (frequency distribution %).
Source: Authors

participants' understanding of each policy varies significantly, ranging from ~10 % for the *Demolition Deposit-Refund* policy (moderately familiar) to ~88 % for the *Environmental Sustainability Rating Policy*. Consequently, the least known policies—where fewer than one-fourth of participants reported moderate to high familiarity—included the *Demolition Deposit-Refund*, *Waiver for Recycling Residual Waste*, *Proximity Principle*, and *Harmonised PwRC Specifications*.

3.3. Policy application scope

In response to the question regarding the scope of application for the study's policies, over 65 % of participants suggested that certain policies should be implemented at a national level (Fig. 5a). Among those advocating for national application, participants identified specific policies they deemed most critical for national implementation. The results indicate that *Sustainable Procurement* (80 %), *Recycled Product Certification* (~71 %), *Financial Incentives* (~66 %), and a *Carbon Pricing Scheme* (~63 %) are prioritised for application on a national scale (Fig. 5b).

3.4. Benefits, challenges and impacts of policies

The following figure provides a comparative overview of the positive versus negative impacts of the study's policies (Fig. 6). Participants identified *Sustainable Procurement*, *Financial Incentives*, *Recycled Product Certification*, and *Product Stewardship* as the top four policies with significantly more positive than negative impacts. Conversely, participants noted that the *Proximity Principle* and *Virgin Material Tax* are the most challenging policies, potentially hindering the optimal use of PwRC in the sector.

The participants' responses on the impact mechanism for each policy were comparatively analysed to identify the five most pivotal policies that have the greatest impact on each impact mechanism. The results are shown in Table 3; the top five policies identified for each impact mechanism are highlighted in green.

As outlined in Table 3, the key policies with the highest impacts on the optimal use of PwRC in construction projects include *EPR*, *Carbon Pricing Scheme*, and *Sustainable Procurement*.

3.5. Negative impacts of CE policies

To address objective 3, participants were asked about the negative impacts and challenges they were aware of when implementing each policy at the time of the survey. The following table summarises their responses. While some policies were reported to have multiple negative effects (e.g. *Sustainable Procurement* and *Virgin Material Tax*), only a few policies (e.g. *Demolition Deposit-Refund*) were associated with a small number of negative impacts—possibly due to limited awareness of these policies. For clarity and manageability, the table includes up to nine negative impacts for each policy (Table 4). Some negative impacts are associated with the PwRC itself, rather than the policy mechanisms. For example, some respondents stated concerns regarding the quality/

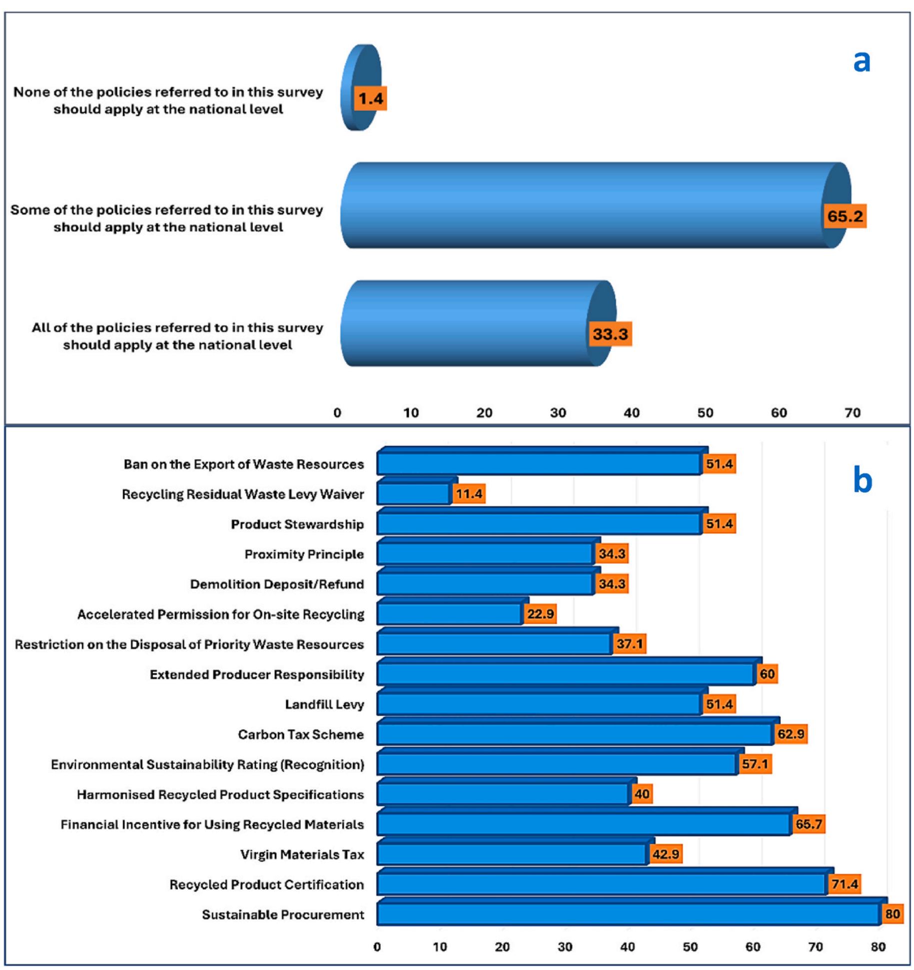

Fig. 5. Participants' perspectives on the implementation of each CE policy at a national scale (frequency distribution %). (a) The extent to which policies should be implemented at a national level, (b) The CE policy that should be prioritised at a national level.
Source: Authors

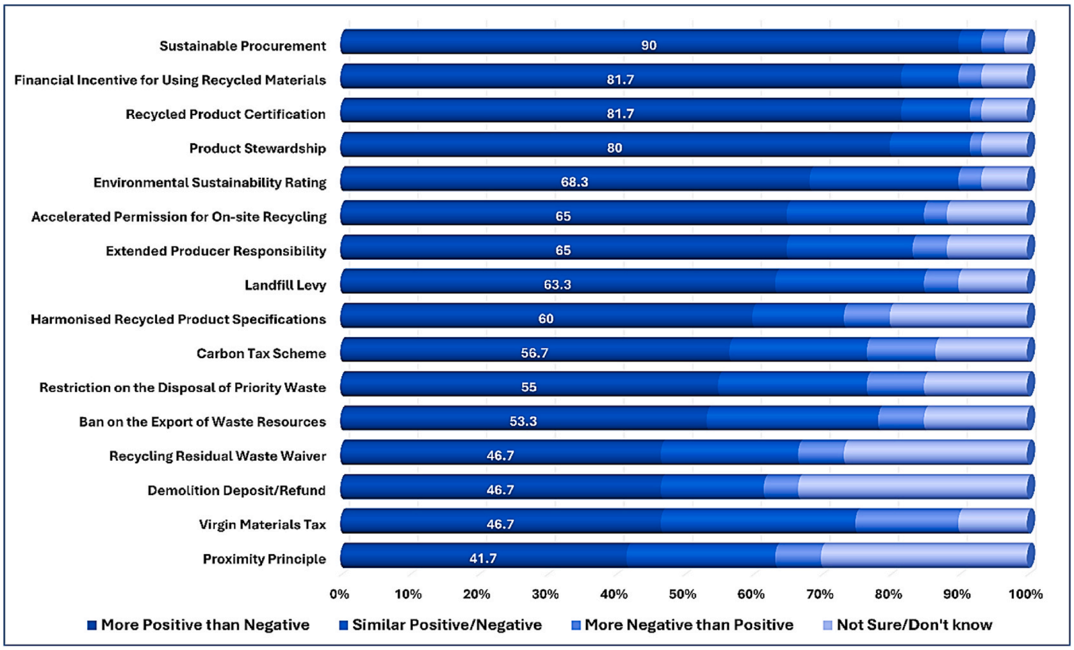

Fig. 6. Participants' perspectives on the positive versus negative impacts of each CE policy (frequency distribution %).
Source: Authors

Table 3
The frequency distribution (n) of responses for the policies' impact mechanisms.

Impact mechanism / CE policy	Build confidence among end users	Create demand for PwRC	Create sustainable supply chains	Improve the environmental sustainability	Improve the quality of PwRC	Improve the social image of end user organisations	Improve the working conditions	Influence decision making process	Provide sustainable supply of PwRC	Reduce the cost of PwRC	Others
Sustainable Procurement	**21**	**29**	**31**	27	**17**	**18**	3	**27**	21	18	3
Recycled Product Certification	**21**	10	16	20	**15**	**17**	4	16	14	6	2
Virgin Materials Tax	6	**36**	**26**	31	11	14	2	24	18	18	5
Financial Incentive for Using PwRC	7	**32**	**27**	23	8	15	4	23	19	**23**	3
Harmonised Recycled Product Specifications	**24**	14	21	23	**22**	13	**10**	19	12	6	4
Environmental Sustainability Rating	**25**	24	19	29	12	**25**	**11**	**29**	15	9	4
Carbon Pricing Scheme	2	**29**	21	**36**	**15**	16	4	**28**	17	**20**	**12**
Landfill Levy (Tax)	5	13	21	34	7	3	3	20	15	10	3
EPR	**36**	**34**	**33**	**39**	**32**	**28**	6	**28**	**35**	**20**	6
Penalties for illegal waste dumping	3	5	6	15	0	10	4	8	5	3	7
Restriction on the Disposal of Priority Waste	7	12	22	**37**	11	10	**10**	23	**24**	13	6
Accelerated Permission for On-site Recycling	9	15	24	**38**	15	**20**	**11**	25	**23**	**25**	6
Demolition Deposit/Refund	6	18	23	31	8	14	**9**	**26**	**27**	17	7
Proximity Principle	2	9	18	**40**	3	14	6	22	15	**21**	**10**
Ban on the Export of C&D Waste Resources	7	15	**31**	25	6	10	6	16	**25**	13	**12**
Product Stewardship	6	26	9	34	12	14	7	20	19	10	5
Recycling Residual Waste Levy Waiver	4	5	3	25	3	7	5	15	9	12	**8**

functionality including.

- *'There are no studies to ensure that there are no long-term structural or environmental issues in using these materials'* on sustainable procurement policy.
- *'Absence of research confirming that PwRC use does not result in chemical leaching or the creation of harmful by-products over time'* on Financial Incentive for Using PwRC.

Similarly, there are PwRC costs-associated issues.

- *'Rising costs in construction can strain budgets and make recycled options less attractive'* on virgin material tax.
- *'Need to maintain a balance between the costs of virgin, PwRC and associated taxes'* on *Financial Incentive for Using PwRC.*

The risk of illegal dumping was often mentioned as a potential negative impact in various policy mechanisms namely *Landfill Levy*, *Penalties for Illegal Waste Dumping*, *Proximity Principle*, and *Ban on the Export of C&D Waste Resources*. The main reasons for such risk include a lack of local markets for PwRC, and costs, fees or levy avoidance.

Another unfavourable impact observed across different policies is the risk of greenwashing. The misleading impression of supporting

Table 4
Summary of the negative impacts of implementing CE policy, as observed by survey participants.

Policy	1	2	3	4	5	6	7	8	9
Sustainable Procurement	Until Australian standards address PwRC application in construction and wherein the design in the buildings, it can have some adverse effects such as lack of durability and unfavourable mechanical properties	There are no studies to ensure that there are no long-term structural or environmental issues in using these materials	Incorrect and/or inadequate application of the policy for its intended purpose	Gives the impression that government is doing more than it actually is. A form of greenwashing	Lack of materials testing has led to some materials being rejected for use	It limits the number of suppliers as not all of them source PwRC	Time-consuming, expensive, with more reliance on imports	No other actions will take place	It may take some time to adopt this policy and receive the positive consequences
Recycled Product Certification	Mixed opinions on the reliability of certifying bodies, potentially diminishing credibility (e.g., Green Tag)	More administrative processes, potentially slow down project timelines	Additional expenses on builders already facing financial pressure	Certification requirements may discourage suppliers due to time and cost burdens	Hinders the development of more economically supportive policies	Creates a new hurdle for new entrants in the sustainable materials market			
Virgin Materials Tax	Not all PwRC are suitable replacements for virgin materials in certain applications	Rising costs in construction can strain budgets and make recycled options less attractive	Effective implementation of the policy requires an adequate PwRC supply; otherwise, a tax could be unfair	Policies may indirectly place additional financial pressures on citizens	Incentivising PwRC could lead some builders to misuse them in critical areas, risking structural integrity	Incentivising PwRC suppliers may drive others to exploit loopholes to continue supplying non- PwRC	Penalising suppliers without a constructive approach may not effectively support the policy's goals	In the UK, businesses often find paying a tax more affordable than adapting to PwRC use, reducing policy impact	Businesses tend to absorb or pass on tax costs if the tax rate isn't substantial enough to incentivise sustainable practices
Financial Incentive for Using PwRC	Ensuring that genuine PwRC are used, preventing the misuse of "fake" PwRC	Concerns over the quality and durability of some PwRC compared to virgin materials	Risk of improper policy application by stakeholders aiming for financial gains without achieving true sustainability	Builders may misuse PwRC in unsuitable applications, potentially compromising safety	Need to maintain a balance between the costs of virgin, PwRC and associated taxes	Current policies may inadvertently favour heavier materials, potentially unbalancing sustainable material choices	Subsidies provided to producers may not incentivise actual material use unless extended to builders or developers with compliance checks	Absence of research confirming that PwRC use does not result in chemical leaching or the creation of harmful by-products over time	
Harmonised Recycled Product Specifications	Policies may inadvertently limit creative applications of PwRC, restricting innovation	Excessive bureaucracy and regulatory requirements could stifle innovation over time	High standards and regulations may deter new entrants from participating, limiting diversity in the market	Different states have unique legislative approaches and perceptions, complicating unified policy implementation					
Environmental Sustainability Rating	Misalignment of policy application, focusing on construction/ design instead of operational performance	Additional expenses incurred to achieve higher star ratings, impacting project budgets	Significant costs associated with training personnel in green star qualifications and maintaining certifications	Practices that create an impression of supporting PwRC without substantial impact	Policies contributing to higher overall construction costs	Strict standards may prevent the use of innovative PwRC in construction, necessitating subsidies to offset costs for compliance	Lack of adequate enforcement and the presence of loopholes reduce policy effectiveness	More work is required to incorporate PwRC, adding complexity to construction processes	Initial failures in recycled polymer products highlighted the need for thorough testing and adaptation, now leading to successful application in suitable use cases
Carbon Pricing Scheme	Traditional LCA often shows higher GGE for PwRC compared to virgin materials, potentially disadvantaging some PwRC	Emphasis on carbon-neutral materials may lead to the use of less sturdy materials unable to withstand extreme conditions	Risk of greenwashing and reliance on ineffective methods, like carbon offsetting, rather than true sustainable practices						

(*continued on next page*)

Table 4 (*continued*)

Policy	1	2	3	4	5	6	7	8	9
Landfill Levy (Tax)	Non-uniform levies may lead to waste being transported to low-levy areas, avoiding proper waste management in high-levy regions	Higher landfill levies incentivise illegal dumping and disposal, increasing environmental risks	Incorrect categorisation, such as labelling contaminated materials as "Clean," can lead to cross-contamination and hidden hazardous materials (e.g., asbestos)	Landfill levies encourage stockpiling, particularly of C&D waste in regions like WA, where demand and supply chains are insufficiently developed	Local governments may see an increase in illegal dumping due to levy avoidance tactics	Higher levies might also encourage the illegal export of waste materials	Encouraging PwRC use without careful consideration may lead to the use of less beneficial or unsuitable PwRC	The balance of costs (levy vs. incorporating recycled content) impacts compliance, with higher landfill taxes increasing the motivation for illegal disposal	Levy structures inadvertently push certain lightweight materials, like textiles, towards landfilling due to a lack of recycling incentives
EPR	Many EPR schemes in construction are theoretical only, with limited practical application, as post-use recycling often isn't feasible due to contamination issues	Risk of greenwashing, with schemes possibly altering reported volumes of PwRC to appear more effective	Inadequate EPR schemes can lead to cost shifting to non-responsible parties and create 'free-rider' problems with unregulated operators	Challenges with accessing global spare parts and shortages of skilled labour may hinder effective implementation	Placing full life-cycle responsibility on manufacturers is complex and may not be easily achievable	Due to the long lifespan of construction materials (10–20 years), it can be easy to neglect responsibilities over time	Policies may result in higher overall construction costs, impacting budgets and project viability	In Australia, many EPR schemes are voluntary, apply only to select products, and thus have limited impact	These policies can create a false perception that the waste problem is solved, while also shifting landfill and recovery costs from councils back to manufacturers
Penalties for illegal waste dumping	Illegal dumping and disposal practices continue despite regulatory efforts, undermining waste management initiatives		The policy inadvertently encourages the establishment of concealed dumping locations to avoid detection and regulatory fees						
Restriction on the Disposal of Priority Waste	Significant effort is needed to safely utilise potentially hazardous materials, with consideration of long-term environmental impacts	Large corporations may lobby regulators or governments for exemptions, which could undermine policy effectiveness	The policy could drive an increase in illegal dumping activities as entities seek to bypass legal disposal methods	Policies may inadvertently encourage the development of a black market for illegal dumping to avoid fees and regulations	Strict policies may restrict innovation in recycling and reuse methods, limiting advancements in sustainable practices				
Accelerated Permission for On-site Recycling	Use of contaminated materials on construction sites, due to lower costs, poses safety and environmental risks if not properly managed	Not all projects have the capacity or resources to effectively implement this policy, reducing its overall impact	There is a risk that PwRC may not meet minimum quality requirements, potentially compromising construction integrity	Fast-tracked projects may overlook necessary safety considerations, which could result in long-term environmental and structural issues	Policies are not yet applied at a large enough scale to achieve optimal efficiency and effectiveness	Australia's status as a net importer limits the impact of local recycling efforts	Potential for contamination, especially if recycling activities occur onsite, leading to local environmental issues like noise and odour Policies can lead to local impacts, such as increased noise, dust and potential safety hazards, affecting surrounding communities Local residents may experience inconvenience from policy impacts, including noise, odour and dust from nearby construction or recycling activities		
Demolition Deposit/ Refund	Businesses with limited cash flow may resist implementing the policy due to the financial strain it imposes, potentially reducing overall compliance								
Proximity Principle	The policy may not be feasible for regional areas where access to recycling facilities and resources is limited	The policy might unintentionally incentivise illegal dumping as businesses seek to avoid costs and restrictions	Treating recyclable materials as waste can undermine recycling efforts and result in lost opportunities for reuse	Waste continues to be sent to Qld, highlighting enforcement challenges and difficulty in administering cross-border regulations	The current economic setup may not fully support the policy's recycling and CE initiatives, limiting its effectiveness	The need for proximity to recycling facilities may limit options for projects, particularly those outside the policy's boundary, stifling some opportunities		The policy may be inappropriate for certain areas, such as highly developed suburbs, where recycling and waste management infrastructure is limited or unsuitable	
Ban on the Export of C&D Waste Resources	Waste materials continue to be illegally dumped, bypassing proper disposal	Policies may incentivise avoiding transport to regions with better or cheaper treatment,	Certain recyclable wastes may not be processed due to a lack of local facilities capable of handling	Insufficient capacity in waste management facilities results in	Banning exports without restricting imports results in accumulating low quality materials	Contaminants, such as asbestos, need to be managed carefully to prevent	Contaminated waste may be exported illegally due to high domestic treatment	Bans on certain waste exports can lead to unintended consequences, such as increased	Without local markets for PwRC, waste may end up in landfills or be illegally dumped, increasing

(*continued on next page*)

Table 4 (*continued*)

Policy	1	2	3	4	5	6	7	8	9
	channels and causing environmental issues	leading to inequities in waste management	them, limiting recycling potential	improper handling of waste materials	domestically, worsening the waste problem	health hazards in PwRC	costs, circumventing regulations	stockpiling and local landfill use The industry struggles to manage the volume of waste generated, leading to stockpiling due to insufficient processing infrastructure	environmental risks The underdeveloped Australian market struggles to absorb all C&D waste generated, leading to difficulties in reclaiming valuable materials Without sufficient market demand, recycling may not occur, as global warming solutions require international collaboration
Product Stewardship	Companies may engage in greenwashing, giving a misleading impression of environmental responsibility without significant action	Poorly designed product stewardship can result in cost leakage, allowing free-riders and rogue operators to avoid financial responsibilities	Stewardship organisations must monitor the quality of materials processed to ensure the PwRC meets necessary standards	Policies and stewardship schemes can increase costs for businesses, potentially impacting compliance and profitability	Shortened stewardship cycles may result in reduced material quality, as procures rush to meet policy timelines	Low production capacity in Australia limits the effectiveness and scope of product stewardship schemes due to constrained supply	Limited availability of PwRC restricts the ability to meet demand, impacting policy success	Some policies actively hinder the reuse of materials, especially when dominated by new material producers who may design products to limit recyclability	
Recycling Residual Waste Levy Waiver	Some recycling facilities may not efficiently recycle all materials they receive, reducing the overall impact of recycling policies	It does not fully eliminate the production of residual waste, requiring continued disposal solutions	Policies are open to abuse, allowing some operators to exploit recycling schemes without contributing to genuine environmental outcomes	Some businesses may falsely claim recycling activities to receive levy waivers, especially in construction and demolition where material weight makes it financially beneficial Certain entities may engage in tax avoidance strategies to circumvent recycling levies and reduce costs					

sustainable practices without meaningful results was highlighted in policies including *Sustainable Procurement*, *Carbon Pricing Scheme*, *EPR* and *Product Stewardship*.

3.6. Relationship between policies

The social network diagram provided below (Fig. 7) illustrates the interconnections between various CE policies studied in this research. This diagram visualises the strength of the co-application need between each pair of policies, as well as the number of connections a single CE policy has with other CE policies. The value assigned to each arrow represents the frequency with which survey respondents indicated that two policies should be co-applied to achieve optimal impact.

The results show that policies like *Sustainable Procurement*, *Recycled Product Certification*, and *Harmonised Recycled Product Specifications* act as central nodes, highlighting their strong influence across the network. These policies are crucial for promoting the use of PwRC in the sector, reinforcing the impact of other CE policies. Furthermore, the strongest relationships were found between *EPR* and *Product Stewardship*, and *Demolition Deposit-Refund* and *Financial Incentives* for using PwRC'.

4. Discussion

4.1. Prioritisation of CE principles

Survey responses from the sector's experts underscore PwRC's role in facilitating the sector's transition to a CE. This contrasts with some critiques (Waste Authority, 2024, personal communications, October 30, 2024) that downplay recycling and PwRC in favour of other CE principles, such as refusing, rethinking, reducing, and redesigning (Bartl, 2014). In reality, this issue is multi-faceted and involves several factors influencing the decision-making process as to which CE principle should be adopted in the sector. Some of these factors are explained below.

First, while the industry may eventually be ready to implement long-term strategies aligned with higher-order CE principles, there is currently a need for short- and medium-term policies to manage existing material streams. This necessity justifies the continued focus on recycling activities and the development of policies that provide guidance and oversight for these endeavours. Sainsbury and Liu (2022) argue that *despite the recent increase in papers concerning recycling, we felt that it was* [is] *still significantly underestimated in the existing literature* (P. 2). Promoting the application of PwRC remains a significant component of CE frameworks and initiatives within the sector. For example, the recently published Australia's Circular Economy Framework emphasises that fostering recycled content markets, alongside integrating CE principles into new construction and improved design, are key enablers for advancing the CE in the Australian built environment in the next ten years (DCCEEW, 2024).

Second, given the current scale and complexity of construction activities, it is extremely challenging—if not impossible—to eliminate waste generation. Consequently, policies are needed to ensure that any waste produced is managed responsibly and reintegrated into construction projects wherever feasible, thereby contributing to a CE. Third, as long as materials are consumed and not properly managed at their end-of-life, waste will inevitably be generated, especially at the end of a product's service life when repair, reuse, or refurbishment is no longer technically or economically viable. Under these circumstances, recycling emerges as a practical means of retaining value and reducing environmental impact in this sector.

4.2. Education and awareness-raising

The research findings show that there is a limited understanding of

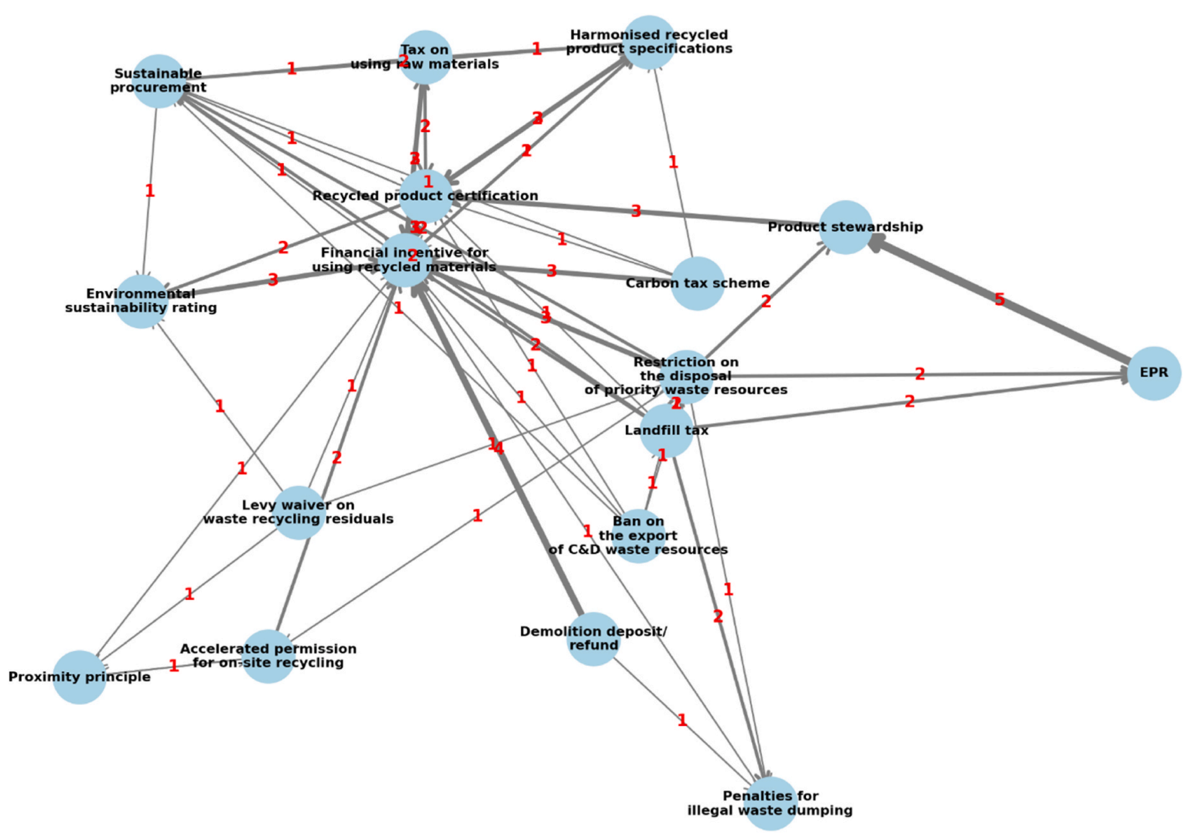

Fig. 7. Social network diagram showing the interaction between the study CE policies.
Source: Authors

some of the CE policies in the study sample (Fig. 4). This can be a major obstacle to the effective development and implementation of useful CE policies to support the optimal use of PwRC in the sector. If stakeholders involved in transitioning the sector to a CE are unaware of the variety of relevant policies and their potential impacts, it is not reasonable to expect them to push waste regulators and authorities to reform the policy framework accordingly. In this context, industry associations have a key role to play (Shooshtarian et al., 2023b). Leveraging their representative capacity, they can educate their members about these policies. Members, in turn, can advocate for changes to current policies or call for the development of new policies that support their efforts to overhaul their industry and organisations in favour of CE.

4.3. Integrated environmental policy approaches

Although policymakers strongly rely on a combination of policies, identifying and assessing the policy mix that fosters complementarities and positive synergies (Stechemesser et al., 2024), while overcoming the negative impacts of stand-alone policies, remains poorly understood (Wu et al., 2024). The results indicate that, in certain cases, the co-application of two or more CE policies can potentially lead to improved outcomes.

This finding aligns with previous research examining the effects of environmental policies. For instance, Stechemesser et al. (2024) identified a suite of effective policy interventions (i.e., 63) for emissions reduction across relevant economic sectors globally, including the building industry. The researchers found that policy instruments tend to be more effective when they are part of a mix rather than stand-alone, in sectors such as buildings and transport. For example, in the sector, complementary effects among policies included subsidy schemes (e.g., *Financial Incentive* for using PwRC) alongside regulatory measures such as bans (e.g., *Ban on the Export of C&D Waste Resources*), building codes (e.g., *Recycled Product Certification*, *Environmental Sustainability Rating*), mandates (e.g., *Landfill Levy*, mandatory *EPR*), and labels (e.g., product information). The review of the literature on environmental policies by Wu et al. (2024) showed that the combined application of environmental policies, including targeted environmental protection inspections and environmental product information disclosure, can have synergistic effects in reducing urban pollution and carbon emissions in China.

5. Conclusions

This study examined the stakeholders' perceptions of the effectiveness and limitations of 17 CE policies in promoting the use of PwRC within construction projects in Australia. The findings reveal varied levels of familiarity and nuanced views on the effectiveness of different CE policies (Fig. 4), highlighting certain limitations (Table 4) and potential strategies for improving their implementation. Responses regarding whether policies should be applied nationally or at the state level (Fig. 5) underscore the complexity of aligning CE approaches across Australia's diverse regulatory landscapes. Specifically, while most stakeholders advocate for a national framework to ensure uniformity and scalability, others argue that state-specific policies are better suited to address local resource recovery needs and infrastructure constraints.

The research findings make significant contributions to knowledge development by mapping current awareness gaps and perceived barriers to the application of CE policies (Table 4). These insights are essential for CE scholars and policymakers seeking to understand the obstacles to CE adoption and identify areas where targeted education or policy adjustments are necessary. The findings also serve as empirical evidence for policy development, pinpointing specific areas where policy clarity or standardisation is needed to boost stakeholder confidence and engagement in circular practices, the optimal utilisation of PwRC, and the need for optimal policy mix research and design.

For industry practice, the research provides actionable insights, particularly in identifying practical strategies that stakeholders believe could enhance CE policy effectiveness, such as improved incentives, clearer communication of policies and alignment of CE objectives across construction project phases. For the built environment and waste resource sectors, the study offers insights to refine current practices. Construction organisations can leverage these findings to integrate CE principles more effectively into project planning and material procurement, focusing on materials with established recycling pathways and minimal environmental impact. Waste management and resource recovery organisations may use these insights to align processing capabilities with the demand generated by new CE policies, supporting the industry's transition towards higher recycled content usage. Industry peak bodies have a crucial role in disseminating these findings to promote the CE. By developing guidelines, training programmes and policy recommendations informed by this research, industry peak bodies can encourage the optimal use of PwRC and foster collaboration between stakeholders, driving industry-wide progress towards sustainable resource management.

Overall, this study provides policymakers, industry leaders and peak bodies with a robust understanding of current perceptions and actionable pathways to enhance CE policy efficacy, supporting a sustainable transition for Australia's built environment and waste management sectors.

Designing an integrated policy approach is context-specific; therefore, there is a pressing need for future research on optimal policy combinations that support circularity strategies (e.g., the use of PwRC) in the sector. A similar approach to identify successful climate policy mixes may be utilised in future circularity policy mix research. Both climate policy and circularity aim to achieve sustainable societies and climate resilience.

An important area for future investigation is the cross-analysis of key stakeholders' perceptions on CE policies across various employment sectors. This analysis would help clarify knowledge gaps within each sector and inform targeted capacity-building initiatives aligned with sector-specific priorities.

Although several challenges identified in this study are common across developed, developing, and underdeveloped nations, this research primarily addresses the Australian and developed-country context. Future studies should therefore explore perspectives from the Global South, where distinct challenges and opportunities exist. Such research should aim to develop inclusive and socially just circular economy pathways by integrating informal sectors and addressing specific socio-economic realities.

CRediT authorship contribution statement

Salman Shooshtarian: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Data curation, Conceptualization. **Peter S.P. Wong:** Writing – original draft, Supervision, Software, Resources, Project administration, Methodology. **Savindi Caldera:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation. **Chamari Jayarathna:** Writing – review & editing, Writing – original draft, Resources, Formal analysis, Conceptualization. **Tim Ryley:** Writing – review & editing, Writing – original draft, Resources, Project administration, Funding acquisition. **Tayyab Maqsood:** Writing – original draft, Supervision, Investigation, Funding acquisition. **Atiq Zaman:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization. **Ana Maria Caceres Ruiz:** Writing – review & editing, Writing – original draft, Validation, Investigation.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Salman Shooshtarian reports financial support was provided by Sustainable Built Environment National Research Centre Australia. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

References

Bao, Z., Lu, W., 2020. Developing efficient circularity for construction and demolition waste management in fast emerging economies: lessons learned from Shenzhen, China. Sci. Total Environ. 724, 138264. https://doi.org/10.1016/j.scitotenv.2020.138264.

Bartl, A., 2014. Moving from recycling to waste prevention: a review of barriers and enables. Waste Manag. Res. 32 (9), 3–18. https://doi.org/10.1177/0734242X14541986.

Blue Environment, 2023. National Waste Report 2022", the Department of Climate Change. Energy, the Environment and Water, Canberra, Australia.

Bocken, N.M., De Pauw, I., Bakker, C., Van Der Grinten, B., 2016. Product design and business model strategies for a circular economy. J. Ind. Prod. Eng. 33 (5), 308–320.

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

Circle Economy, 2024. The Circularity Gap Report 2024. Circle Economy.

Creswell, J.W., Creswell, J.D., 2023. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications, Inc, Thousand Oaks, California issn: ISSN.

Dcceew, 2024. Australia's Circular Economy Framework: Doubling Our Circularity Rate. Australian Government, Canberra, Australia. https://bit.ly/40712iQ.

Euric, 2023. Increasing recycling in the EU construction sector. Eur. Recycl. Ind.' Confed.

Fraser, M., Haigh, L., Soria, A.C., 2023. The Circularity Gap Report 2023.

Holcomb, Z., 2016. Fundamentals of Descriptive Statistics. Routledge issn: ISSN.

Islam, R., Nazifa, T.H., Yuniarto, A., Uddin, A.S., Salmiati, S., Shahid, S., 2019. An empirical study of construction and demolition waste generation and implication of recycling. Waste Manag. 95, 10–21.

Iyer-Raniga, U., Gajanayake, A., Ho, O.T.-K., 2023. The transition to a circular built environment in Australia: an analysis of the jurisdictional policy framework. Environ. Pol. Law 53 (4), 233–246.

Klein, N., Deutz, P., Ramos, T.B., 2022. A survey of Circular Economy initiatives in Portuguese central public sector organisations: national outlook for implementation. J. Environ. Manag. 314, 114982. https://doi.org/10.1016/j.jenvman.2022.114982, 2022/07/15/.

Ma, M., Tam, V.W., Le, K.N., Li, W., 2020. Challenges in current construction and demolition waste recycling: a China study. Waste Manag. 118, 610–625.

Mesch, G., 2012. E-mail surveys. In: Gideon, L. (Ed.), Handbook of Survey Methodology for the Social Sciences. Springer New York, New York, NY.

Morgan, D.L., 2023. Exploring the use of artificial intelligence for qualitative data analysis: the case of ChatGPT. Int. J. Qual. Methods 22, 16094069231211248.

Mrug, S., 2010. In: Salkind, N.J. (Ed.), Encyclopedia of Research Design. Sage, Thousand Oaks, CA.

National Health and Medical Research Council, 2023. Australian national statement on ethical conduct in human research. National Health and Medical Research Council, the Australian Research Council and Universities Australia. Commonwealth of Australia, Canberra.

National Waste Policy, 2018. Less Waste. More Resources. W. a. T. E. Department of Agriculture, Canberra, Australia.

National Waste Policy Action Plan, 2019. 2018 National Waste Policy. From waste to resource, Canberra, Australia. https://bit.ly/3rVTf6f.

Northern Territory Government, 2024. Northern Territory Circular Economy Strategy 2022-2027.

Nsw Government, 2019. NSW Circular Economy Policy Statement. Sydney, Australia.

Nußholz, J.L., Rasmussen, F.N., Whalen, K., Plepys, A., 2020. Material reuse in buildings: implications of a circular business model for sustainable value creation. J. Clean. Prod. 245, 118546.

Office of Energy and Climate Change, 2023. Circular Design Guidelines for the Built Environment. NSW Government, NSW Treasury, Sydney, Australia.

Oyedele, L.O., Ajayi, S.O., Kadiri, K.O., 2014. Use of recycled products in UK construction industry: an empirical investigation into critical impediments and strategies for improvement. Resour. Conserv. Recycl. 93, 23–31. https://doi.org/10.1016/j.resconrec.2014.09.011.

Park, J., Tucker, R., 2017. Overcoming barriers to the reuse of construction waste material in Australia: a review of the literature. Int. J. Constr. Manag. 17 (3), 228–237. https://doi.org/10.1080/15623599.2016.1192248.

Qualtrics, 2014. In: Qualtrics, U. (Ed.), Qualtrics [software].

Queensland Government, 2020. Waste Management and Resource Recovery Strategy.

Rameezdeen, R., Chileshe, N., Hosseini, M., Lehmann, S., 2016. A qualitative examination of major barriers in implementation of reverse logistics within the South Australian construction sector. Int. J. Constr. Manag. 16 (3), 185–196.

Ren, Q., Albrecht, J., 2023. Toward circular economy: the impact of policy instruments on circular economy innovation for European small medium enterprises. Ecol. Econ. 207, 107761.

Sa Government, 2020. South Australia's Waste Strategy 2020-2025. supporting the circular economy, Adelaide, Australia. https://bit.ly/3FegI8g.

Sadiq, M., Khalfan, M.M.A., 2024. Transitioning to a circular economy in the construction demolition industry: a bibliometric analysis. Built. Environ. Proj. Asset. Manag.

Saez, P.V., Del Río Merino, M., González, A.S.-A., Porras-Amores, C., 2013. Best practice measures assessment for construction and demolition waste management in building constructions. Resour. Conserv. Recycl. 75, 52–62.

Sainsbury, V.A., Liu, R., 2022. Nothing new under the sun': rethinking recycling in the past–Editorial. Archaeometry 64, 1–7.

Sen, M., Sen, S.N., Sahin, T.G., 2023. A new era for data analysis in qualitative research: ChatGPT. Shanlax Int. J. Educ. 11, 1–15.

Shooshtarian, S., Caldera, H., Maqsood, T., Ryley, T., Wong, S.P., Zaman, A., 2022a. Analysis of factors influencing the creation and stimulation of the Australian market for recycled construction and demolition waste products. Sustain. Prod. Consum. 34 (2022), 163–176. https://doi.org/10.1016/j.spc.2022.09.005.

Shooshtarian, S., Caldera, S., Maqsood, T., Ryley, T., 2020a. Using recycled construction and demolition waste products: a review of stakeholders' perceptions, decisions, and motivations. Recycling 5 (4), 31. https://doi.org/10.3390/recycling5040031.

Shooshtarian, S., Caldera, S., Maqsood, T., Ryley, T., Wong, P.S.P., Zaman, A., 2022b. Analysis of factors influencing the creation and stimulation of the Australian market for recycled construction and demolition waste products. Sustain. Prod. Consum. 34, 163–176. https://doi.org/10.1016/j.spc.2022.09.005, 2022/11/01/.

Shooshtarian, S., Hosseini, M.R., Kocaturk, T., Arnel, T., Garofano, N.T., 2023a. Circular economy in the Australian AEC industry: investigation of barriers and enablers. Build. Res. Inf. 51 (11), 56–58.

Shooshtarian, S., Maqsood, T., Khalfan, M., Yang, J.R., Wong, S.P.P., 2020b. Landfill levy imposition on construction and demolition waste: Australian stakeholders' perceptions. Sustainability 12 (11), 4496. https://doi.org/10.3390/su12114496.

Shooshtarian, S., Maqsood, T., Wong, P., Anam, M., 2023b. The utilisation of products with recycled content in construction projects to combat urban heat island effects. In: Rajagopalan, P., Soebarto, V., Akbari, H. (Eds.), 6th International Conference on Countermeasures to Urban Heat Islands (IC2UHI). RMIT University, Melbourne, Australia.

Shooshtarian, S., Maqsood, T., Wong, P.S., 2024a. Policy intervention of waste management. In: Waste Management in the Circular Economy. Springer.

Shooshtarian, S., Maqsood, T., Wong, P.S., Caldera, S., Ryley, T., Zaman, A., Ruiz, A., 2024b. Circular economy in action: the application of products with recycled content in construction projects: a multiple case study approach. Smart Sustain. Built Environ. 13 (2), 370–394. https://doi.org/10.1108/SASBE-08-2023-0213.

Shooshtarian, S., Maqsood, T., Wong, P.S., Yang, R.J., Khalfan, M., 2020c. Review of waste strategy documents in Australia: analysis of strategies for construction and demolition waste. Int. J. Environ. Technol. Manag. 23 (1), 1–21.

Shooshtarian, S., Wong, P., Maqsood, T., 2025. Circular Economy Policies for Optimal Use of Recycled Cotent in the Built Environment", Construction Waste Lab. RMIT University, Melbourne, Australia.

Stechemesser, A., Koch, N., Mark, E., Dilger, E., Klösel, P., Menicacci, L., Nachtigall, D., Pretis, F., Ritter, N., Schwarz, M., 2024. Climate policies that achieved major emission reductions: global evidence from two decades. Science 385 (6711), 884–892.

Swarnakar, V., Khalfan, M., 2024. Circular economy in construction and demolition waste management: an in-depth review and future perspectives in the construction sector. Smart Sustain. Built Environ. No. ahead-of-print.

Tang, Z., Li, W., Tam, V.W., Xue, C., 2020. Advanced progress in recycling municipal and construction solid wastes for manufacturing sustainable construction materials. Resour. Conserv. Recycl. X 6, 100036.

Udawatta, N., Zuo, J., Chiveralls, K., Zillante, G., 2015. Attitudinal and behavioural approaches to improving waste management on construction projects in Australia: benefits and limitations. Int. J. Constr. Manag. 15 (2), 137–147. https://doi.org/10.1080/15623599.2015.1033815.

Ulubeyli, S., Kazaz, A., Arslan, A., 2017. Construction and demolition waste recycling plants revisited: management issues. Procedia Eng. 172, 1190–1197. https://doi.org/10.1016/j.proeng.2017.02.139.

Verdinelli, S., Scagnoli, N.I., 2013. Data display in qualitative research. Int. J. Qual. Methods 12 (1), 359–381.

Wang, T., Wang, J., Wu, P., Wang, J., He, Q., Wang, X., 2018. Estimating the environmental costs and benefits of demolition waste using life cycle assessment and willingness-to-pay: a case study in Shenzhen. J. Clean. Prod. 172, 14–26.

Waste Authority, 2024. Waste avoidance and resource recovery strategy 2030. https://bit.ly/4fXSTm2.

Wu, D., Ding, H., Cheng, Y., 2024. How does environmental policy affect operations and supply chain management: a literature review. Comput. Ind. Eng., 110580

Yin, R.K., 2015. Qualitative Research from Start to Finish. Guilford publications issn: ISSN.

Yu, S., Awasthi, A.K., Ma, W., Wen, M., Di Sarno, L., Wen, C., Hao, J.L., 2022. In support of circular economy to evaluate the effects of policies of construction and demolition waste management in three key cities in Yangtze River Delta. Sustain. Chem. Pharm. 26, 100625.

Zu Castell-Rüdenhausen, M., Wahlström, M., Astrup, T.F., Jensen, C., Oberender, A., Johansson, P., Waerner, E.R., 2021. Policies as drivers for circular economy in the construction sector in the Nordics. Sustainability 13 (16), 9350.