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25 February 2025

Re: Inquiry into the Supply of Homes in Regional Victoria

The RMIT Construction Waste Lab (CWL) welcomes the opportunity to provide a submission to the Legislative Assembly Environment and Planning Committee inquiry into the Supply of Homes in Regional Victoria.

Since 2018, RMIT CWL has been at the forefront of researching the circular economy of construction and demolition (C&D) waste. Our industry-driven research covers a wide range of C&D waste management aspects, including policy, education, circular supply chains, and innovative waste solutions and technologies. With the support of the Sustainable Built Environment National Research Centre (SBEnrc) and in collaboration with various state public agencies and private organsations, we have actively raised awareness in both sectors. To maximise our impact, we have collaborated with researchers from Griffith University and Curtin University, resulting in a prolific output of academic and industry publications, including three books addressing C&D waste management, market development for waste resources, and the utilisation of products with recycled content in the building and construction sector.

Members at RMIT CWL have been deeply involved in analysing state and national waste policies, leading to a set of recommendations aimed at enhancing the C&D waste management system in Australia. Please find below our perspectives regarding the following term of reference:

The supply of homes in regional Victoria including the methods of building them and the mix of housing forms and types

Modular Integrated Construction (MiC) and/or other forms of volumetric modular construction approach have been advocated as a feasible solution to improve productivity and accelerate construction process to address the housing supply problems in Vicotria and across Australia. The use of modular construction provides several benefits as outlined in ***Table 1***. These advantages encompass social, environmental and economic aspects, offering a more sustainable construction approach overall.

Table 1. Summary of the major advantages and disadvantages of modular construction

	Advantages	Description	References	Disadvantages	Description	References
Economic benefits	Faster construction	Modular construction involves simultaneous off-site fabrication and on-site foundation work, reducing overall construction time.	Lee et al. (2019), Salama et al. (2021)	Transportation costs	Shipping large modules to the site can be expensive	Mignacca et al. (2019), Almashaqbeh and El-Rayes (2022)
	Cost-effective (affordable)	Prefabricated modules are produced in a controlled environment which may result in reducing labour and material costs. Furthermore, with a wide range of designs and inclusions, the final cost of the project may be lower than expected, depending on the contextual factors.	Chauhan et al. (2022), Almashaqbeh and El-Rayes (2021)	Limited customisation	Modular designs often have limitations in terms of architectural creativity and flexibility due to the predetermined transportation height/width limitations.	Jansson et al. (2018), Ali et al. (2023)
	Improved construction quality	Factory-controlled construction ensures higher quality control compared to traditional on-site construction. Design for manufacturing and assembly (DfMA) advantages are exploited for subassemblies reducing errors and quality hold points.	Gao et al. (2020), Rankohi et al. (2022)	Dependency on factory production and limitations on the material selections	Delays in the factory can lead to project delays.	Mossman and Sarhan (2021), Ji et al. (2018)
Socio-environmenta	Less disturbance to building site local residents' everyday lives	Less disturbance to the building site's neighbours by minimising on-site noise and dust pollution and project completion time.	Loo et al. (2023), prefabAUS (2023)	Size limitations	Restrictions on the dimensions of a prefabricated structure might exist due to regulations concerning the width of roads allowable for transportation.	Almashaqbeh and El-Rayes (2022), Sobczyk et al. (2018)

Reduced material waste	Precise manufacturing processes minimise waste or reuse/repurpose waste that would otherwise be disposed of.	Tam and Hao (2014), Ajayi (2017)	Potential for damage	Modules can be susceptible to damage during transportation and installation.	Valinejadshoubi et al. (2022), Godbole et al. (2018)
Safer working conditions	With much of the construction work done off-site, on-site workers are exposed to fewer hazards and other conditions such as weather.	Ahn et al. (2020), Broadhead et al. (Lille, France 2023)		Specialised skills and expertise are needed for module fabrication and on-site assembly and commissioning.	Ginigaddara et al. (2024)
Post-disaster housing management	Rapid deployment of housing units to areas affected by disasters, providing quick and efficient temporary housing solutions for displaced individuals and communities.		High running costs	It requires high investment and running costs as well as additional project planning.	Xue et al. (2018), prefabAUS (2023)

Implementation of circular economy principles in modular construction of housing

We believe that the supply of homes in regional Victoria by the state government is also an excellent opportunity to plan, design and practice high-end sustainability initiatives in the Built Environment sector. Among various initiatives, transitioning housing system towards circular economy has been highlighted as a solution to several sustainability issues that the sector currently faces. These issues primarily emerge from climate change, the sector's carbon footprint, ineffective waste management and poor resource efficiency and resilience. The following paragraphs outline how the circular approach combined with modular construction can improve the sustainability aspects of homes delivery in regional Victoria.

The current policy set up both in Victoria and nationally emphasises the use of circular economy principles in housing sector. For instance, the recently published Australia's Circular Economy Framework[1] indicates that circular economy is necessary for Australia as it experiences a high population growth rate:

> *'Australia is also much more geographically dispersed and has a higher population growth rate than most developed countries. Both factors drive a higher use of materials for residential and commercial buildings, roads, and infrastructure. These factors mean that every 1% improvement in circularity for Australia is significant, and doubling our circularity is more ambitious than other countries. They also help to inform our circular economy priorities, which will differ from country to country' (p.8).*

This framework also highlights the Australia's sectoral priorities for transitioning to circular economy. The sectors include Industry, Built Environment, Food and Agriculture and Resources. In the Built Environment sector, '*the manufacture and use of circular, low carbon, and climate resistant construction materials*' has been recognised among the two main priorities. According to this framework and in alignment with this priority area, the enablers of circular economy in this sector include:

1) Embedding the circular economy in new builds
2) Developing recycled content markets
3) Better (circular) design

Circular materials are typically referred to products with recycled content (PwRC). While ideally it is less favourable strategy in waste management hierarchy model[2] compared to avoidance, the use of PwRC is currently at the heart of practical application of circular economy in the Built Environment sector. Therefore, the housing projects in regional Victoria have an opportunity to leverage the application of these materials in their builds to enhance construction sustainability.

Research findings into the use of PwRC in modular construction

In our recent national research project, supported by SBEnrc (Project 1.95), we explored the integration of PwRC in modular construction. The following sections highlight the sustainability benefits, key challenges, and strategic approaches for optimising its use. As shown in ***Figure 1***, our research identified ten key benefits of this application, contributing to enhanced social, environmental, and economic sustainability outcomes in modular construction.

[1] Australian Government (2024) 'Australia's Circular Economy Framework'. DCCEEW. Accessed via https://bit.ly/40712iQ

[2] Ellen MacArthur Foundation (2022) 'What is circular economy'. EMF. Accessed via https://bit.ly/4qy4ata

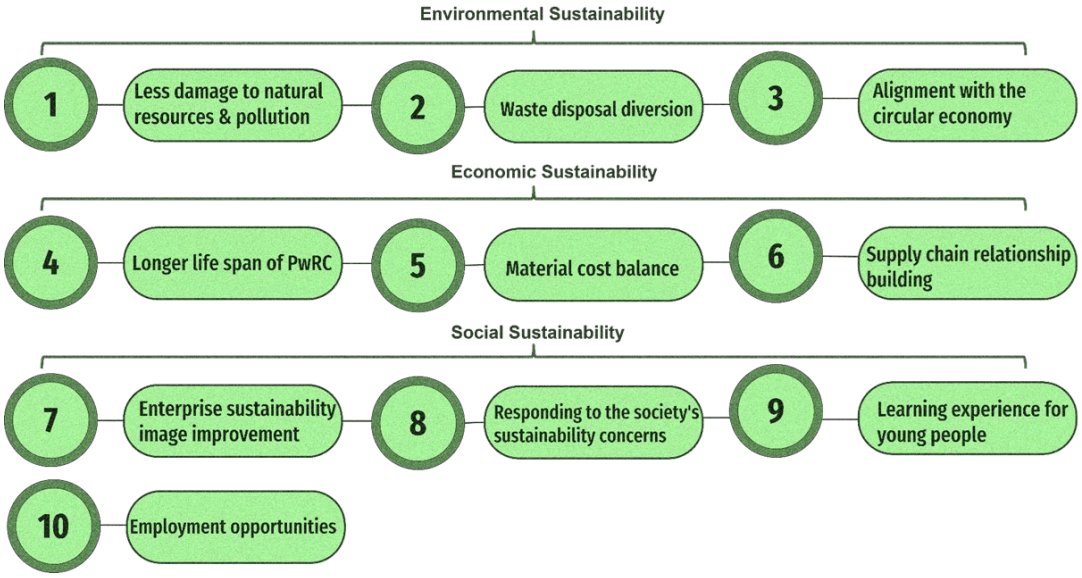

Figure 1. The major sustainability benefits of using PwRC in modular construction

The number of challenges identified as hindering the application of PwRC in the modular construction sector far exceeded our expectations. After consolidating some challenge categories, 16 categories emerged. These categories include a broad range of issues, including supply chain, cost, organisational limitations and technical complexities. ***Figure 2*** illustrates these ten categories. The most commonly mentioned challenge category among these is 'cost complexities' followed by the 'industry conservative approach' and 'availability of PwRC'. The following sections provide insights into the industry perceptions regarding these challenge categories; they are presented in no specific order. The challenges visualised in this section offer a foundation for advancing the modular construction industry, particularly in enhancing the incorporation of PwRC in modular products.

Figure 2. The main challenges of using PwRC in modular construction

Our research also focused on strategies to effectively remove or minimise the impact of challenges identified above. The findings reveal ten key strategies that organisations engaged in modular construction in Australia can adopt to enhance the integration of PwRC into their products. These strategies fall into three key domains: 'organisational capacity building', 'supply chain management assessment' and 'improvement and sustainable business decision-making'. Among these, the categories of 'attitudinal changes and awareness raising' and "internal opportunities for material recyclability and reuse' were found to have the most significant positive impacts. The identified categories are illustrated in ***Figure 3***.

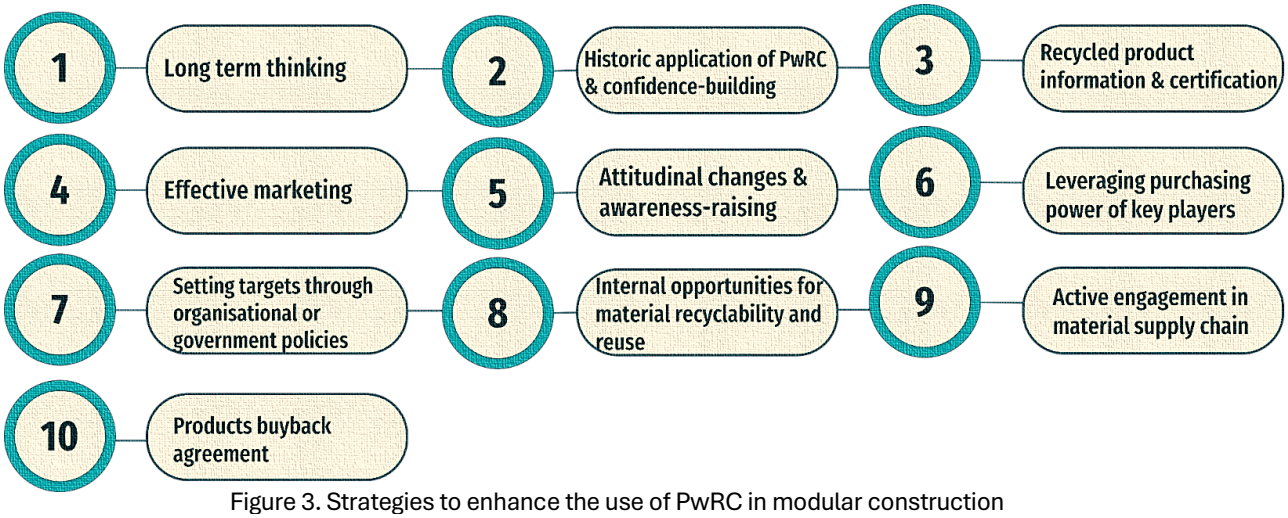

Figure 3. Strategies to enhance the use of PwRC in modular construction

Building on our research findings and a comprehensive analysis of relevant literature and policies, we have developed a framework to guide efforts in overcoming key barriers to the sustainable and effective adoption of PwRC in modular construction. As outlined in ***Figure 4***, the framework consists of four components: 'organisational capacity', 'supply chain development and stimulation', 'quality of recycled products' and 'developing supportive regulations and policies'. These components address multiple facets of the transition to a circular economy by strengthening the industry's overall capacity to adopt and integrate PwRC effectively.

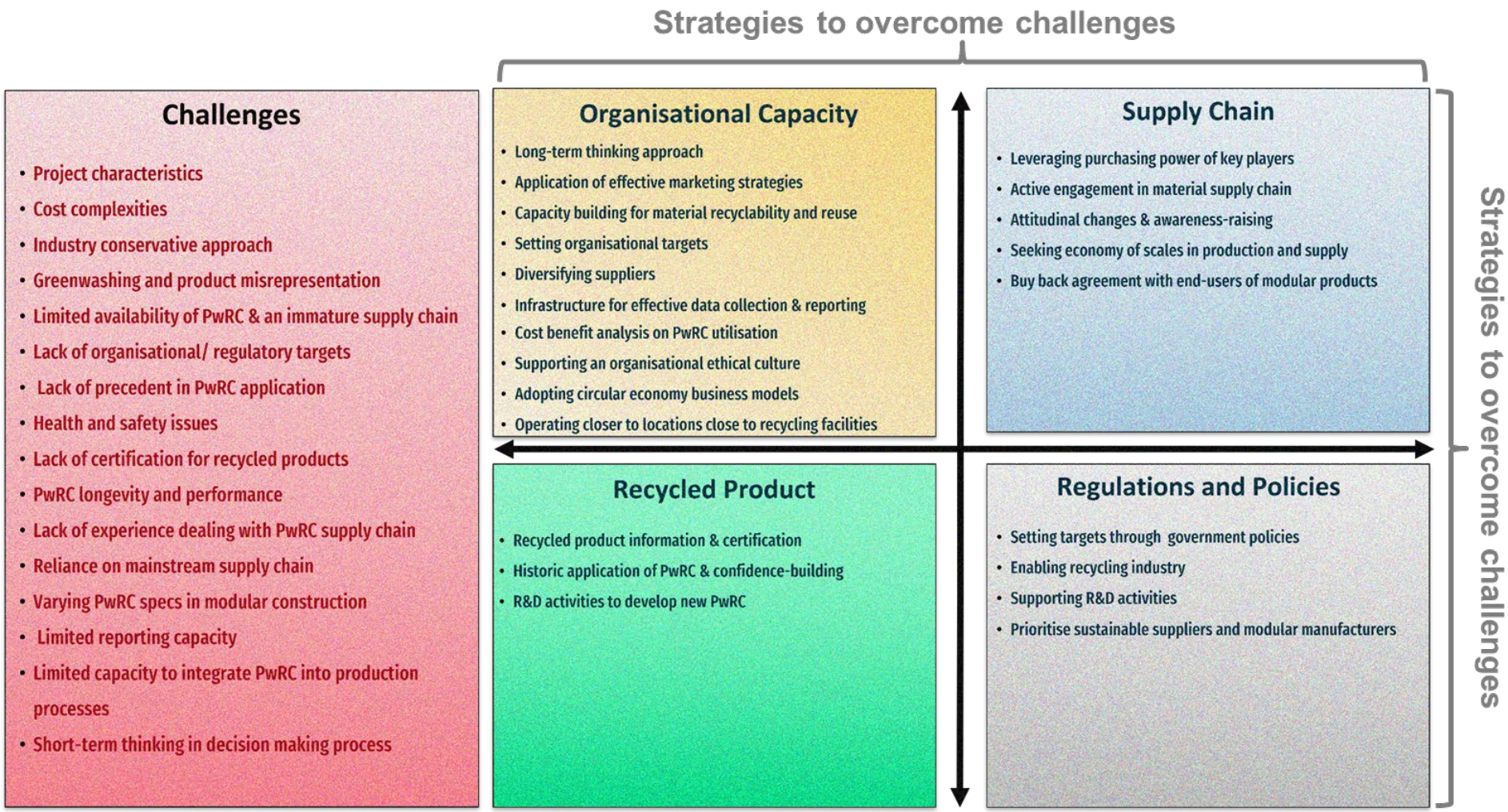

Figure 4. framework to influence stakeholders for optimal uptake of PwRC in modular construction

Conclusion

The use of PwRC in the building and construction sector is reported as a vital step towards transitioning to a circular economy. We believe that the use of PwRC can offer several sustainability benefits in social, environmental and economic domains. However, its application in housing sector faces some challenges that we identified in our research and highlighted in this submission. This submission also proposes a framework (see Figure 4) aimed at guiding industry efforts to overcome these challenges. Additionally, our industry-informed research suggests that PwRC use in modular construction is expected to grow as its availability increases and more buildings are developed.

The submission also offers valuable insights for the policy-making sector. Currently, in many countries, policymakers are exploring strategies to mainstream materials reuse in businesses operating within industrial buildings and other sectors of the built environment. We observed that the absence of regulatory targets and the prevalence of greenwashing activities should be taken into account when developing new policies. We believe that industry, government, and research institutes must collaborate to drive the development and validation of specialised circular business models for modular products, enhance the education of key stakeholders influencing PwRC reuse, and develop a robust Multi-Criteria Decision-Making (MCDM) tool to support the transition to a circular economy.

Yours sincerely

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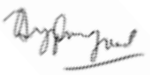

Further readings

[1] **Shooshtarian S, Wong PSP and Maqsood T** (2025) 'Circular economy in modular construction: An Australian case study'. *Journal of Building Engineering*. 103 (2025): 112182. DOI: 10.1016/j.jobe.2025.112182

[2] **Shooshtarian S, Wong PSP, Maqsood T** (2025) 'Circular economy policies for the optimal use of recycled content in built environment'. *Construction Waste Lab (CWL)*. RMIT University, Melbourne, Australia. URL: https://bit.ly/3Zrfi4H

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