Construction Waste Recycling in Melbourne

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Keywords	building, construction, waste, recycling
City Population	5,464,920 [2026]
City Area	2,453 km^2
City GDP	$90 billion [2024]
Climate Zone	Cfb (temperate oceanic)
ARC3.3 Linkage	Infrastructure for a Net Zero and Resilient Future for Cities

Introduction. The focus of this report is to investigate the problems surrounding the effective and efficient handling of construction site waste through the lens of recyclable waste management. This case study looks at the construction of an inner city, seven-storey High Rise Building project in Melbourne Australia – a city with a population of 5,100,000.

The purpose of this report is to have maximum impact on the reduction of construction demolition waste (CDW) material to disposal by rerouting this CDW material through the most effective and efficient secondary recycling process and identifying the high value waste materials in terms of commercial return and potential volumetric/weight. Adopting a triple bottom line approach provides commercial benefits to contractor/builder/client stakeholders and social benefits to the community at large, improving the environmental footprint and creating a sustainable construction industry for future generations.

Problem. Context around the nature of construction and its associated impacts in Australia includes the following:

i. Australia has one of the globe's most urbanized populations, with one of the world's highest population growth rates of 1.5 underpinned by a permanent immigration quota of 200,000 people per annum (ABS, 2017; ABS, 2018). In 2022, there were 813 tower cranes working on multi-storey developments. By far the most tower cranes (443) were being utilized on residential apartment construction in all major regional centres in Australia and for the three months to 30 June 2021, 24,283 new apartments commenced construction in Australia (Bleby, 2022).

ii. Australia is drowning in waste. Australia's population in 2016 was 24 million people and from 1996 to 2015, the population grew by 28 per cent. However, during this corresponding 20-year period, Australia's solid waste increased by an astonishing 170 per cent.

iii. Australia's CDW profile is very symmetrical, with the same proportion of CDW waste to total solid waste of 40 per cent, typical of many countries including China and the USA (Chandler, 2016; WEF, 2016; Huang et al., 2018).

iv. Australia's reuse/recycling recovery rate of 67 per cent is comparable to the 70 per cent recovery benchmark set by the EU in 2008 to be reached by their 28 members by 2020 (EU, 2017; Wu et al., 2020). The EU is generally recognized as being in the vanguard of CDW management practices (Hickey, 2015).

v. As the world transitions into a predominantly urban habitation, accordingly, research data results from Australia on urban recyclable construction waste fulfil the research transferability and generalizability criteria for these findings, being suitable for global use.

vi. Efficacy issues surround CDW data generated from government sources in Australia and there is concern from trade sources regarding limited government support for CDW recycling, evidenced by a lack of a suitable environments to promote secondary processing of CDW products (Hickey, 2015; Chandler, 2016).

A seven-storey apartment building was to be constructed in the inner Melbourne Central Business District (CBD) commencing in February 2019. This report focuses on the development of a Construction Waste Recycling Management Plan for the work, followed by an analysis of the outcomes of a Recycling Management Plan.

Construction Waste Recycling Management Plan. In descending order of importance, the main areas of construction waste management are, noted as follows:

1. Entirely remove and/or mitigate creation of construction waste on site. After a thorough feasibility study to execute the work with involvement from the builder, architect, and owner, a reinforced concrete framed building with off-site precast concrete external cladding and prestressed concrete floors was agreed upon. The building roof comprised of a structural steel frame with a colorbond metal roof. The foundations comprised of bored concrete end-bearing piles and a shotcrete basement walled car-park. The architect, at the request of the builder, developed a design in which both the kitchen and bathroom units were prefabricated off-site. The owner was involved in internal finishes and fitment selection.

2. Reuse of construction materials. Careful planning with builder and design consultants resulted in metal

formwork column shutters and Bondek® steel flooring formwork, with only the beam formwork being fabricated from 19mm plywood, as spandrel beams, etc., were of differing dimensions to save concrete volumes.

3. Recycling Construction Materials.

- **Demolition.** An examination of the potential sources of waste was undertaken by the builder. As a public company, the builder had a commitment to providing shareholder value. The builder identified potential site waste from which a profit could be derived. The demolition phase, which entailed the destruction of a three-storey 1905 hardware store currently on the proposed apartment site, was assessed and the following materials were deemed potentially salvageable: (i) handmade bricks, (ii) timber doors and sash windows, (iii) feature stonework lintels to façade entry and all windows and structural steel building and roof frames, plus (iv) copper piping for water services and for roof downpipes and gutters.

- **Excavation of foundations.** Geotechnical drilling indicated that rock excavation would not be necessary on this project. Earthworks could be excavated to another building site.

- **Packaging and Pallet Materials.** A significant source of site waste that poses a particular problem on an inner city site is the cardboard, plastic wrap, polystyrene, etc., packaging material that protects construction material during transport and also the associated timber pallets. The confined site only allows for an extremely limited laydown area for recycling and waste bins.

Recycling Management Plan Outcomes & Analysis.

I. Entirely remove and/or mitigate creation of construction waste on site. Yates (2013) believes that construction techniques such as precast concrete, prefabrication and modularization are critical processes in reduction of waste management. Special attention to temporary works materials will also result in waste minimization and for both permanent works and temporary works, prudent design is important in waste reduction (Yates, 2013). We can see that the builder has been thoughtful in all the above areas.

One element needs to be evaluated for future projects and that is, the possible prefabrication of roof structure, including roof sheets to provide a safer and more efficient means to install the roof. Jaillon et al. (2009) posits that 52 per cent of wasted material is saved by prefabrication and modularization techniques, while Ameh and Daniel (2013) suggest that between 20 to 31 per cent of construction costs can be attributed to site waste.

As the owner was significantly involved in internal finishes and fitment selection, per the client's request, when the owner's project director was replaced, the new management ordered several changes to fit out. Carpet, ceramic tiles, and window furnishings were all altered and this resulted in these pre-purchased materials being sent to scrap. Rundle, Bahadori, and Doust (2019) argue that client design scope changes are a major cause of site material wastage.

2. Reuse of construction materials. Research by Yates (2013) has shown that care of reuse of concrete formwork is an important way to make effective use of materials, thus saving on wastage.

3. Recycling Construction Materials.

- **Demolition.** An examination of the potential sources of waste was undertaken by the builder. The builder, a public company, again prioritized providing shareholder value (Rundle et al., 2022). Studies in the UK have shown that the use of heavy equipment in modern demolition practice precludes the use of outdated labour intensive techniques entailing the careful salvage demolition and cleaning of wall bricks.

  The bricks were carted off-site to a mobile crusher and were crushed and blended into sub-base aggregate for industrial fire trails. The architect purchased masonry stonework, period doors, and sash windows for a period port building to an apartment refurbishment project.

  Scrap steel, aluminium, and copper are highly prized construction waste salvage materials that are typically significant cost earners for contractors. Smelting of scrap metals into billets results in the same product using raw materials, basically because there are no mining costs involved.

- **Excavation of foundations.** The builders' original assumption that foundation excavation required no rock excavation was correct. However, bulk excavated material was tested at the request of project safety officers and prescribed contaminated soil material from underground lead pipework had to be transported to a prescribed waste landfill, which cost $350 per metre to remove. Excavated earthworks were contaminated in a stockpile with the prescribed product and this material was also taken to a prescribed landfill site.

  The builder's failure to take soil material tests resulted in a cost blow out and also a sub-optimal utilization of site excavated waste material. As the builder was obligated in the contract to "make themselves aware" of substrata conditions, the builder bore these extra costs.

- **Packaging and Pallet Materials**. Rundle (2018) found that few participants in a construction industry survey had established specific arrangements for managing packaging and pallet waste, despite thematic analysis of qualitative responses identifying this waste stream as a recurring concern among building sector stakeholders. a recurring issue raised by those in the building sector.

  It was recommended that this issue needed further investigation and suggested that a panel from peak bodies, Australian Constructors Association, Australian

Australian Construction Industry Forum, and Master Builders Association, together with the building materials industry, packaging industry, and academia, form a panel with the federal government, to consider this matter.

Following the above research, one innovative academic proposal was to require that vendors for both permanent material and temporary material deliveries bear the responsibility for the removal of all packaging and pallets under contractual obligation. Another example of innovative waste reduction is the current recycling of pallet timbers to manufacture rustic furniture.

Conclusion. This report begins with a basic assumption that the project would prepare a Construction Waste Management Plan (CWMP) that included a section on recycling. Faniran and Caban's 1998 seminal research on sources of construction waste indicated that only about 50 per cent of construction projects even had a rudimentary CWMP. Disturbingly, research by Rundle, Doust, and Bahadori (2019) and also by Doust, Battista, and Rundle (2013) show that just under 50 per cent of participants surveyed have a CWMP for their project. Pursuant to the above, it can be concluded that a statutory framework for construction waste management, possibly in the form of a Best Practice code, needs to be developed and adopted as a mandatory document deliverable for all projects.

There are 813 tower cranes working in Australia at present with the construction industry generating an estimated AUD$437 billion in 2022 with 1,143,000 employees, which represent 8.7 per cent of Australia's workforce. With construction waste producing 40 per cent of solid waste in Australia and a similar amount in several other countries, governments need to promulgate suitable regulations to minimize construction waste.

The global knowledge acquisition base for the recycling of construction waste materials has by and large considered the most effective and efficient means to recycle these materials to be demolished concrete; scarified asphalt; waste timber, and scrap metal. To reduce landfill volumes, large volume waste items such as demolished concrete and bricks needed to be recycled, typically as aggregates or in fill areas, etc.

Contractors are driven by profit, and as Australian builders are regularly failing due to low margins, they experience even more pressure to generate profits, which includes site waste recycling by-products. Governments need to assist the construction industry in effective and efficient recycling material research.

***Note:** Refer to Rundle, Bahadori, & Doust (2019, pp. 253 & pp. 256-257) for background on follow-up research that drove Case study development, post-primary survey data synthesis interpretation.

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Acknowledgments

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Additional Data

- **Population Density:** 535.5/km^2
- **Per Capita Gross National Income (GNI):** 68,920 USD (High Income) [2024]
- **Gini Coefficient:** 51.6 [2023]
- **Human Development Index (HDI):** 0.958 (Very High) [2025]
- **Type of Climate Intervention:** Mitigation