

Circular value chain transition in office fit-outs: best practices, opportunities and key performance indicators

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Abstract

Purpose – The purpose of this study is to explore how the office fit-out sector can transition from a linear to a circular value chain to mitigate environmental impacts. It aims to identify practical circular economy initiatives, examine enabling conditions for their adoption and propose conceptually grounded key performance indicators. The study addresses the industry's significant contribution to waste and emissions by offering insights into scalable solutions that integrate design innovation, business models and policy mechanisms.

Design/methodology/approach – This study adopts a constructivist grounded theory approach to investigate circular economy opportunities within the office fit-out sector. Twenty-three case studies were selected and analysed, encompassing a range of projects, programs, policies and products aligned with circular economy principles. The analysis identifies and categorises circular initiatives, focusing on their implementation across pre-use, use and post-use life-cycle stages. Key performance indicators (KPIs) are developed and systematically linked to these initiatives and enabling mechanisms, aiming to evaluate circular performance comprehensively.

Findings – The study identifies three primary areas for enhancing circularity: design strategies, business models and policy/societal transitions. Thirteen KPIs are proposed and linked to specific opportunities and enabling actions. Most initiatives emphasize slowing and closing the loop through reuse and recycling. However, early-stage strategies such as refuse and reduce remain largely untapped. The findings also demonstrate that achieving circular outcomes depends not only on design choices but also on supportive business and policy environments.

Originality/value – This study provides a novel, system-wide perspective on circular economy implementation in office fit-outs by integrating diverse case studies and mapping them to actionable KPIs. Unlike prior research that focuses on isolated interventions, this work reveals the interdependencies between design, business models and policy and societal supports across the asset life cycle. The proposed framework offers both theoretical advancement and practical value by enabling stakeholders to evaluate and accelerate circular practices in fit-out projects.

Keywords Circular economy, Fit-out, Grounded theory, Key performance indicators, Office buildings, Sustainability

Paper type Research article



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1. Introduction

The construction industry, a backbone of global economic and societal development, has historically been a significant contributor to environmental impacts, including resource depletion, waste generation and greenhouse gas emissions (Ahmadi *et al.*, 2024). As the most resource-intensive sector, it consumes over half of all extracted materials, generates approximately one-third of global waste (EEA, 2012; WGBC, 2023) and is responsible for 39% of global carbon emissions, with 28% and 11% from building operations and embodied carbon in materials respectively (WGBC, 2019). Furthermore, rising urbanisation is expected to intensify these environmental impacts, with the global floor area projected to more than double by 2060 (UNEP, 2022).

Among all building types, office buildings hold a unique position due to their central role in business and commerce, serving as hubs for a substantial portion of the workforce (Bouncken and Reuschl, 2018). For example, office buildings in the USA comprised approximately 18% of total commercial floor space, totalling an estimated 520 million m², with projections indicating a growth of over 30% by 2050 (EIA, 2022). Similarly, in Australia, they accounted for 20% of commercial properties, with expansion of 63% projected for 2050 (SPR, 2022). Their large size, high occupancy densities and operational intensity make office buildings central to efforts aimed at improving environmental performance in the construction sector (Motuzienė *et al.*, 2024; Ahmadi *et al.*, 2025).

Within office buildings, the most frequent material replacements occur during fit-outs, which involve the removal and installation of interior components such as floor coverings, partitions, doors, furniture and occasionally mechanical and electrical systems (Rucińska *et al.*, 2020). Fit-out cycles typically occur every 3–7 years in office buildings (Brittain *et al.*, 2004; Treloar *et al.*, 1999), primarily due to lease churn, the regular turnover of tenants moving between office spaces, often at the end of lease periods (Forsythe and Wilkinson, 2015). This turnover has significant environmental impacts, including waste generation, carbon emissions and resource depletion (Wilmot *et al.*, 2014). For example, in a Swedish case study, office fit-out activities are estimated to generate approximately 70 kg/m² of waste from demolished components (Liljenström and Malmqvist, 2016), while new material waste from installation adds another 64 kg/m². Strip-out activities in Australian offices, yield approximately 63 kg/m² of waste (Host, 2018), whereas office interiors in the UK, produce around 77 kg/m² of waste per cycle (RESET, 2022). This waste accumulation can equate to an entire office floor's worth of discarded materials each year in a single building. In a 30-story office tower, for instance, this could result in a vertical landfill equivalent to 30 stories within three decades (RESET, 2022).

On the other hand, estimates indicate that 9.7 million tons or 80% of office furniture waste ends up in landfills annually in the USA (EPA, 2024). Similarly, 75% of fit-out waste is estimated to be landfilled in Australia (Fini and Forsythe, 2020). This substantial disposal rate drives increased demand for virgin resources and contributes significantly to greenhouse gas (Host, 2018). Furthermore, fit-out cycles are estimated to emit 65–135 kg CO₂ eq./m², indicating that the total embodied carbon from fit-out products over approximately four cycles may exceed the upfront carbon emissions associated with the whole building's core and shell (CLF, 2019).

The environmental impacts associated with office fit-outs are largely attributed to the adoption of the traditional linear economy model across the fit-outs value chain (Pieroni *et al.*, 2019). In this model, actors are typically connected only through a linear value chain (See Figure 1a) where materials are extracted, processed and manufactured in the pre-use stage, used during the operational stage and eventually discarded as waste at their end-of-use (EoU) or end-of-life (EoL) in post-use stage (Eisenreich *et al.*, 2022). Consequently, all value added in the pre-use stage, through consumption of materials, energy and labour, is lost when these materials are discarded in landfills (CIRCO, 2024). Therefore, in the context of office buildings, where frequent fit-outs are routine, this approach results in substantial

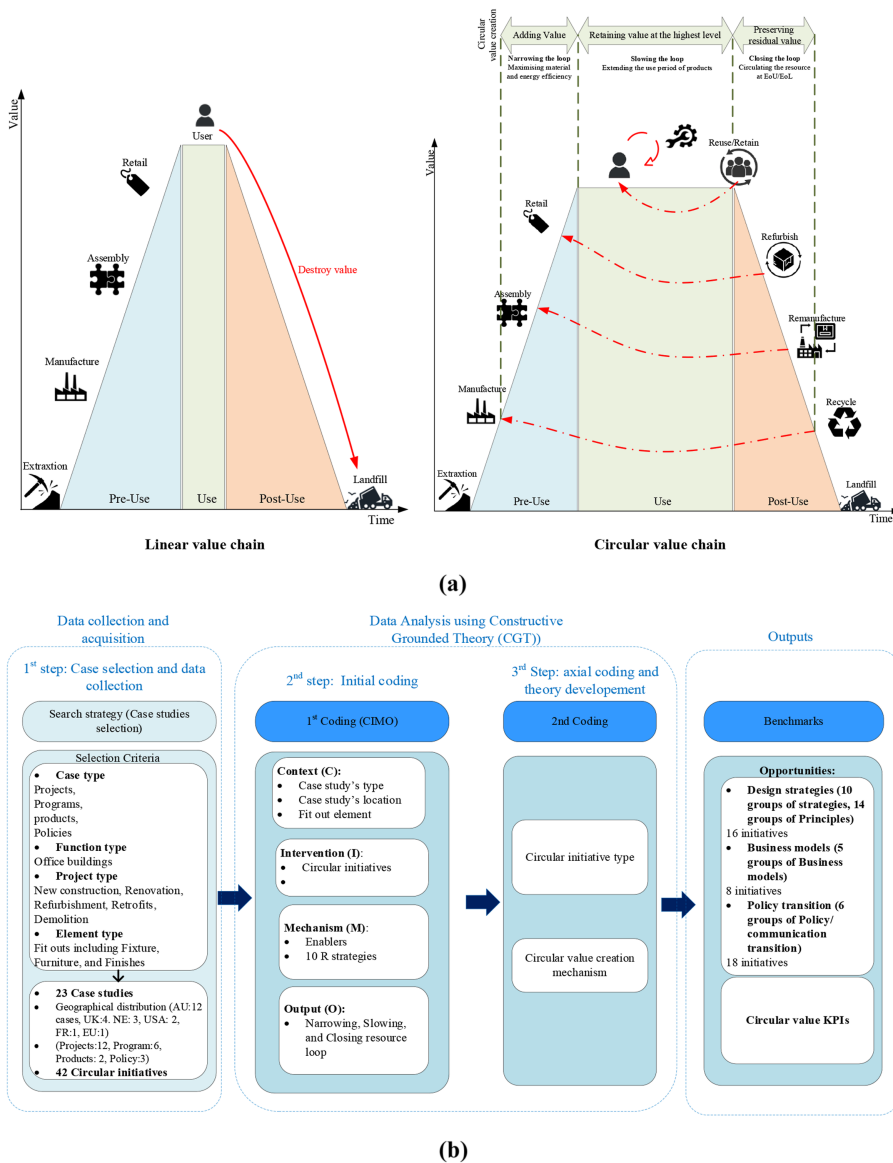


Figure 1. Concept of research context: (a) Schematic demonstration of value chain in conventional approach of linear economy compared with proposed circular value chain selected as main core of the research (inspired from Bocken *et al.*, 2016); (b) Research workflow for identifying opportunities and KPIs

environmental impacts, including resource depletion and increased landfill waste (Menzies and Tsolaki, 2016).

Alternatively, a promising solution is the adoption of the circular economy (CE) model by the value chain's actors (Fini and Forsythe, 2020). In a circular value chain, illustrated schematically in Figure 1a, a more sustainable approach is achieved by enhancing value across all segments of the fit-out ecosystem. This model, grounded in CE principles, adds value in the

pre-use stage by optimising material and energy efficiency as well as reducing the reliance on virgin materials, aligning with the “narrowing the loop” principle. During the use stage, extending product lifespans retains value and reduces the demand for new materials, following the “slowing the loop” principle. Finally, in the post-use stage, resources are recirculated through reverse logistics at EoU or EoL, fulfilling the “closing the loop” principle (EMF, 2021; Konietzko *et al.*, 2020a, b).

In the context of office fit-outs, this shift from linear to circular value chain promises to minimise waste, reduce virgin resource demand and lower carbon emissions. However, recent studies highlight persistent challenges in implementing circular approaches, emphasising the need for more structured and operational frameworks. While existing industry toolkits and studies, such as Arup toolkit (Arup, 2022) and GBCA toolkit (GBCA, 2024) provide valuable guidance on circular design principles and best practices, they lack a systematic integration of circular initiatives, enabling mechanisms and performance measurement frameworks across lifecycle stages. Moreover, limited attention has been given to linking circular interventions to quantifiable indicators that enable consistent evaluation of circular performance, limiting the ability to systematically evaluate, compare and prioritise circular interventions. Addressing this gap enables the translation of conceptual guidance into operational decision-support, supporting the consistent assessment and scaling of circular initiatives across projects.

To address this gap, this study addresses the following research question: What circular initiatives are currently implemented by office fit-out value chain actors and how do they support the transition toward a circular value chain? It aims to identify and systematically classify these initiatives based on global case evidence, examine their contribution to circular value creation and translate them into indicative KPIs to support the evaluation of circular performance. By linking circular initiatives, enabling mechanisms and indicative KPIs, the framework supports decision-making in office fit-out projects and informs the development of procurement strategies, design approaches and policy instruments for advancing circularity.

Rather than focusing on stakeholder-specific roles, the framework is positioned as a decision-support tool that can inform design, procurement and policy-related processes in different project contexts. In doing so, the study contributes to bridging the gap between circular economy theory and practice by enabling a more consistent and measurable evaluation of circular performance within the office fit-out sector.

2. Methodology

Constructivist Grounded Theory (CGT) is adopted as the methodological approach for this study because it enables the identification of patterns and conceptual categories that emerge inductively from empirical data, particularly in research areas where existing theoretical explanations remain limited (Charmaz and Thornberg, 2021). CGT is specifically designed for exploring complex and evolving social and organisational processes and for generating theory grounded in empirical observations rather than testing predefined hypotheses (Charmaz, 2014). This approach is particularly suitable for examining emerging phenomena where theoretical frameworks are still developing, as it allows researchers to iteratively analyse diverse data sources and construct explanatory concepts grounded in practice (Chun Tse *et al.*, 2019). Circular economy transitions in office fit-outs represent such an evolving domain, where practical innovations and industry initiatives are advancing more rapidly than consolidated theoretical models. CGT therefore provides an appropriate methodological framework for systematically analysing case evidence and developing an empirically grounded understanding of circular initiatives, enabling mechanisms and value creation processes across the fit-out value chain.

This study adopts a three-step research workflow (Figure 1b) grounded in CGT to systematically analyse global case evidence and derive an empirically informed framework linking circular initiatives to measurable performance indicators.

The first step involves case selection and data collection, using a defined search strategy and selection criteria across different types of datasets. The second step focuses on initial coding using the CIMO logic (Context, Intervention, Mechanism and Output), allowing the identification of enablers and strategies that contribute to circular outcomes such as narrowing, slowing and closing resource loops. The third step involves axial coding and theory development to refine the typologies of circular initiatives and the mechanisms for circular value creation.

It should be noted that this study focuses on framework development using CGT and CIMO logic rather than empirical validation of a current theory; therefore, the proposed opportunities and KPIs in the next sections are derived from case-based analysis and have not been tested through stakeholder application, representing a key direction for future research.

2.1 Step 1: case selection and data collection

The office fit-out sector represents an emerging and practice-driven domain in which practical innovations and industry initiatives are advancing more rapidly than consolidated academic theory. As a result, many circular practices are primarily documented in industry reports, organisational case studies and policy documents rather than peer-reviewed literature. In line with CGT, which is well suited to exploring under-theorised and evolving phenomena, the use of diverse data sources enables the capture of real-world practices that are not yet fully represented in academic discourse. Accordingly, this study adopts a systematic review of secondary and grey literature to identify relevant CE initiatives in the office fit-out sector. A comprehensive search was conducted across sustainability platforms, industry reports and government guidelines, ensuring broad coverage of documented practices and innovations within the field.

Case studies were identified through a targeted keyword search conducted between January 2024 and November 2024 using the Google search engine with a keyword search using [(“circular economy” OR “circularity”) AND (“fit out” OR “fit-out” OR “interior” OR “office” OR “building”)]. This search initially generated a broad pool of potential cases documented in industry reports, company publications, sustainability reports and governmental or institutional sources.

In addition to the initial keyword-based search, a snowballing-inspired approach was applied to expand the dataset, inspired by the method proposed by [Du and Costello \(2025\)](#). Specifically, relevant cases identified through Google searches were used as entry points to locate additional sources by examining embedded references, hyperlinks, cited reports and related organisational publications. This included following links to project pages, partner organisations, policy documents and sustainability reports connected to each case. The process was conducted iteratively, with newly identified sources subjected to the same screening and exploration procedure. To ensure transparency and consistency, a stopping criterion was applied whereby the search was discontinued after reviewing three consecutive result pages (approximately 25 results per page) that yielded no new relevant cases. This stopping rule, combined with the absence of novel patterns or categories emerging from additional sources, was taken as an indication of theoretical saturation ([Markou et al., 2025](#)). This approach is particularly suited to grey literature, where formal citation structures are limited and enabled the identification of additional relevant initiatives that may not be captured through keyword searches alone while maintaining a systematic and bounded search process ([Piadeh and Pournaghshband, 2026](#)).

The identified cases were subsequently screened based on three inclusion criteria: (1) the initiative had to explicitly address circular economy strategies consistent with narrowing (reducing resource input through efficient design and material selection), slowing (extends product lifespans via maintenance, repair and refurbishment), or closing (material recovery and recycling to minimise waste and virgin resource extraction) resource loops, as recommended by Ellen MacArthur Foundation ([EMF, 2021](#)) (2) the initiative needed to be

associated with office fit-out or interior refurbishment activities, and (3) sufficient documentation had to be available to clearly identify the intervention, actors involved and circular mechanisms. Cases lacking sufficient documentation or not directly related to office fit-outs were excluded. Finally, only sources verified by scientific, industrial or authoritative entities (e.g. Green Building Council, Circular Building Toolkit) were retained to ensure the reliability of the dataset.

2.2 Step 2: CGT and initial coding

CGT is employed as a methodological approach to analyse real-world innovations that support CE transitions within the office fit-out sector as it is well suited for exploring phenomena with limited prior knowledge (Charmaz, 2014). This approach enables an iterative inductive analysis where theoretical categories emerge throughout data engagement making CGT an ideal choice for developing a theory rooted in practical applications and stakeholder driven processes (Bryant and Charmaz, 2007). The process begins with initial coding, aimed at structuring solution-oriented insights using the CIMO logic (Denyer et al., 2008). It is particularly valuable in design science research, where the objective is to develop prescriptive knowledge applicable to practitioners (Konietzko et al., 2020a, b).

The CIMO elements are operationalised as follows: (1) Context refers to the setting in which actors operate, including the geographic location, type of case and specific fit-out elements involved; (2) Intervention represents the specific actions undertaken by stakeholders to implement circular strategies; (3) Mechanism corresponds to the enablers and circular strategies embedded within the intervention. These strategies are adapted from the 10R hierarchy of circular strategies (Arup, 2022; Bocken et al., 2016) and include: R0 (Refuse): eliminating unnecessary materials, (R1) Rethink: enhancing asset utility and efficiency, (R2) Reduce: minimising material use through improved efficiency, (R3) Reuse: extending the life of materials in their original form, (R4) Repair: restoring materials for continued use, R5 (Refurbish): Updating materials to meet new performance standards, R6 (Remanufacture): transforming used materials into new products with equivalent function, (R7) Repurpose: redirecting discarded materials to alternative uses, (R8) Recycle: processing materials for reintegration into production cycles, and (R9) Recover: extracting energy from waste materials; (4) Outcome reflects the intended circular outputs, including narrowing (aligned with R0, R1 and R2), slowing (aligned with R3, R4 and R5) and closing (aligned with R6, R7, R8 and R9) resource loops. Each case study's initiative was examined using initial coding, allowing emergent relationships between CE innovations and CIMO elements.

2.3 Step 3: axial coding and theory development

Following initial coding, the analysis progressed into axial coding and was conducted iteratively through comparisons of initiatives within CIMO contexts, with continuous movement between data and emerging concepts. Categories were refined using constant comparative analysis across cases, enabling patterns to be validated, merged, or redefined. This iterative refinement process supported the development of robust typologies and ensured that they were grounded in recurring empirical evidence rather than isolated observations.

To further enhance rigour, analytical memos were employed throughout the coding process to capture emerging interpretations and relationships between interventions, mechanisms and outcomes. In addition, a reflexive approach was adopted throughout the analysis. The researchers critically examined the context, source and purpose of each case to account for potential reporting biases inherent in secondary and grey literature. This included cross-checking information across multiple sources where possible and assessing the credibility of originating organisations. Furthermore, the researchers continuously reflected on their own interpretive role during coding and categorisation, revisiting and refining codes and categories to minimise subjective bias and ensure consistency in the analytical process.

Two key analytical categories were identified as the basis for axial coding in this stage:

(1) Circular value creation mechanism: By comparing real-world interventions with their mechanism as well as outcomes, the analysis identified how these initiatives enhance circularity and generate value throughout the fit-out lifecycle. This process informed the development of KPIs. To achieve this, a comprehensive inventory of both established and novel indicators is first compiled to capture the full spectrum of circularity performance. Subsequently, a clustering approach, inspired by [Panahi et al. \(2025\)](#), is applied to systematically integrate these indicators into a set of meaningful and distinct KPIs. While initial KPI formulations may exhibit overlap or redundancy due to similarities in underlying metrics, the clustering method enables a critical refinement process by grouping indicators with shared conceptual characteristics. This approach not only reduces duplication but also enhances the interpretability and robustness of the resulting KPIs. As a result, the final set of KPIs provides a comprehensive and balanced assessment of circular performance across pre-use, use and post-use stages, while ensuring that each KPI is uniquely defined, non-redundant and representative of a specific dimension of circularity, resulting in a concise and non-overlapping set of 13 lifecycle-aligned KPIs.

For example, in one case, modular, movable sliding partitions improved layout flexibility, enabling office spaces to serve multiple purposes. This adaptability reduced the need for additional office units dedicated to specific functions, thereby lowering resource consumption. By minimising material demand upfront, this strategy contributes to narrowing the loop in the pre-use stage. As a result, reducing the “number of office units per function” emerged as a KPI for assessing the circularity in the fit-out value chain;

(2) Circular initiative types: which is another key coding theme in this stage emerged from comparing interventions with key enablers (within mechanism) that drive circular outputs. These enablers, such as design innovations, process improvements, actor collaborations and policy shifts, helped contextualise initiatives by categorising them into distinct groups of circular transition opportunities.

2.4 Positioning the framework in relation to transition and organisational theories

This study, grounded in CGT, can be positioned in relation to key theoretical perspectives on sustainability transitions, particularly transition theory, institutional theory and organisational change. Transition theory, especially the Multi-Level Perspective, conceptualises sustainability transitions as interactions across niche innovations, socio-technical regimes and broader landscape pressures ([Geels, 2020](#)). This aligns with the present study’s focus on the systemic shift from linear to circular value chains and the identification of multi-level enablers such as design strategies, business models and policy mechanisms. Similarly, institutional theory highlights how organisational practices are shaped by regulative, normative and cultural pressures, influencing the adoption of circular economy practices and business models ([Richard, 2008](#)). Organisational change perspectives further complement this view by explaining how firms adapt structures, capabilities and strategies in response to sustainability transitions, particularly through the adoption of circular business models and the development of dynamic capabilities that support innovation processes.

While these perspectives provide important explanations of why transitions occur and how organisations respond, they offer less guidance on how circular strategies are operationalised and assessed across specific lifecycle stages in practice. For instance, transition theory emphasises long-term systemic shifts ([Geels, 2020](#)), while institutional theory focuses on legitimacy and conformity to external pressures ([Bitektine and Haack, 2015](#)) and organisational change theory largely addresses internal transformation processes ([Helfat and Peteraf, 2015](#)). However, the contribution of this study lies in addressing that gap through an exploratory analytical framework that links circular initiatives to enabling mechanisms and proposed KPIs across the office fit-out lifecycle. In this sense, the study is positioned not as a test of existing theory, but as a practice-oriented framework that complements established

transition and organisational perspectives by connecting broader theoretical explanations to implementation-level analysis.

3. Results and discussion

3.1 Circular initiatives

In the first stage, 23 case studies were selected from diverse global contexts to identify the circular initiatives they proposed. This analysis resulted in a comprehensive set of 42 distinct initiatives. Collectively, these cases offer a broad spectrum of circular interventions, providing valuable insights into varied strategies for advancing circularity in office fit-outs. The contextual characteristics of the selected case studies and the identified initiatives are then extracted accordingly.

3.2 Outputs of the first round coding

In the first round of coding, the 42 circular initiatives were systematically analysed using the CIMO logic to structure emerging insights (see [Table A1](#) in appendix). This structured coding not only supported consistent comparison across diverse case contexts but also served as a foundation for identifying thematic patterns and informing the subsequent theory development.

3.2.1 Context of circular initiatives. [Table 1](#) outlines the contextual characteristics of the case studies selected during the initial stage of this study. Spanning from 2013 to 2024, these cases reflect over a decade of evolving circular practices in fit-out elements. They also represent a diverse geographical spread across Australia (12cases), the UK (4cases), the Netherlands (3cases), the US (2cases), France (1case) and one case from the broader EU. This diversity would highlight region-specific enablers and barriers to circular transitions, including differences in policy, market conditions and industry practices, and also would strengthen the study's capacity to capture both shared challenges and contextually adapted solutions, offering a broad foundation for generalising CE practices in office fit-outs. However, a key limitation is that all cases are drawn from developed countries, where circular practices are more established; broader applicability would require further exploration in emerging and developing regions to ensure global relevance.

Furthermore, the case studies encompass a range of types, including projects (12 cases), programs (6 cases), policies including governmental regulations, tender and contractual policies, procurement policies and guidelines (3 cases) and products (2 products), reflecting the multi-scalar nature of circular interventions across the fit-out value chain. However the relatively low number of policy and product-based cases may limit insights into regulatory frameworks and material innovations, both of which play critical roles in shaping circular outcomes at scale. Finally, while some cases address specific fit-out components such as furniture, fixtures, or finishes, others target the entire fit-out system. This variation illustrates the multiple entry points and implementation scales through which circular initiatives can be pursued, from regulatory frameworks to design innovation and business models.

3.2.2 Interventions. [Table 2](#) presents 42 extracted interventions. While some case studies proposed a single initiative, others incorporated multiple initiatives, often interrelated interventions, highlighting that the successful implementation of a circular initiative may depend on complementary actions to enhance its effectiveness. For example, in case 23, the implementation of a Furniture-as-a-Service (FaaS) model by producer necessitates additional investment in downstream infrastructure to support reverse logistics and facilitate product circulation.

Furthermore, some initiatives marked with “#” indicate opportunities that, while not yet implemented, are suggested in the case study document as potential demanded ways to enhance circularity. For example, in case 2, limited time and space for dismantling removed products posed a challenge. To address this, provision of offsite storage, giving enough time

Table 1. Context analysis of selected case studies

Case No	Case title	Documentation year	Location	Case type*	Fit-out type**	Reference
1	Governor Macquarie Tower	2015	Australia	Project	All	BBP (2015)
2	Stockland flight centre	2023	Australia	Project	All	FTD (2023)
3	University of Technology Sydney	2016	Australia	Project	All	BBP (2016)
4	White Collar Factory	2023	UK	Project	Finishes	EMF and Arup (2023)
5	Town hall Brummen	2016	Netherland	Project	Finishes	Arup (2016)
6	Sky Believe	2016	UK	Project	Fixtures	Arup (2016)
7	LWARB Office	2013	UK	Project	Finishes	EMF and Arup (2023)
8	Google REWS	2023	USA	Project	Furniture	EMF and Arup (2023)
9	Desso Carpet Lease™	2016	Netherland	Program	Finishes	EMF (2016)
10	Globchain	2024	UK	Program	All	Globchain (2024)
11	Hub Australia	2024	Australia	Program	All	Hub Australia (2024)
12	Living Edge Lifecycle	2024	Australia	Program	Furniture	Living Edge (2024)
13	City San Francisco's "green carpet"	2017	USA	Policy	Carpets	EMF (2017)
14	Nyaal Banyul GCEC	2024	Australia	Project	All	Built Australia (2024)
15	Club Catalina	2024	Australia	Project	Furniture	GBCA (2024)
16	Charter Hall workplace	2024	Australia	Project	Finishes, Fixtures, Furniture	Charter Hall Group (2024)
17	LuxBoard's Worktops	2024	Australia	Policy	Fixtures	GBCA (2024)
18	Durra Panels	2024	Australia	Product	Finishes	GBCA (2024)
19	Wall and cladding systems	2024	Australia	Product	Fixtures	Xfram (2024)
20	ESP procurement policy	2024	Australia	Policy	Furniture, Fittings and Equipment, Textures	DCCEEW (2024)
21	Repurposing of a historic house into office building	2016	France	Project	Fittings	EMF (2016)
22	BAMB	2019	EU	Program	Fitting, Fixtures	Durmisevic (2019), Heinrich and Lang (2019)
23	Ahrend	2021	Netherland	Program	Furniture	EMF (2021)

Note(s): *(1) project: site-specific fit-out applications, (2) program: broader organisational or platform-based initiatives, (3) policy: including governmental regulations, tender and contractual policies, procurement policies and guidelines and (4) product: specific material or component innovations within the fit-out elements

** (1) Finishes (e.g. ceiling covering, wall covering, floor covering), (2) Fixture (e.g. cabinets, counters, ceiling suspension systems, doors and partition walls, interior glazing) and (3) Furniture (e.g. chairs, cubicles and tables). Some cases may focus on a specific product within these categories, such as carpets

BAMB: Buildings as Material Banks, ESP: Environmentally Sustainable Procurement GCEC: Geelong Convention and Event Centre

LWARB: London Waste and Recycling Board. REWS: Real Estate and Workplace Services

Table 2. Extracted circular initiatives described as interventions proposed throughout the selected case studies

Case no.	Code*	Description	Reference
1	Act1.1	Auditing waste streams and their destinations as well as reporting waste recovery rate	BBP (2015)
2	Act2.1	Allowing sufficient time and staff in make good clause to plan and organise loose furniture, re-use, donation and recycling	FTD (2023)
	Act2.2	Creating asset inventories in advance by tenants or their representatives	
	Act2.3#	Offsite storage provisions in lease contracts to ensure sufficient time for dismantling, reselling, donating and other related activities	
	Act2.4#	Regulations/laws that enforce transparency in waste streams and their destinations, requiring recycling transfer stations to provide documentation verifying the actual recycling of goods, not just receipts	
	Act2.5#	Evaluate potential value returns from sell-back schemes and components' high residual value	
	Act2.6#	Defining revenue comes from landfill diversion at products' EoL in companies' accounting system and educating them	
	Act2.7#	Defining non-monetary and social values resulting from donations or social initiatives and recognising them as privileged criteria in tenders or lease contracts	
	Act2.8#	Modular carpet tiles allowing for easy reuse in different locations	
	Act2.9#	Modular carpet tiles that can be installed without glue, allowing for easy repair and replacement of damaged sections	
3	Act3.1	Allowing sufficient time for contractors to remove and dismantle fit-outs properly, enhancing the potential for re-use, donation and recycling	BBP (2016)
	Act3.2	Including requirements in tender documents and clauses in the demolition/strip-out contract that stipulate the contractor must use and comply with the Strip-out Guidelines	
	Act3.3	Targeting a minimum landfill diversion rate for contractors	
	Act3.4#	Setting minimum requirements for Marshalling area, especially in commercial buildings	
4	Act4.1	Integrating HVAC systems in RAF to give access to repair and maintain, minimising demolition and reducing waste generation	EMF and Arup (2023)
5	Act5.1	Designing and custom ordering all partitions, ceiling and floor coverings in a modular, dismantlable form to accommodate future deconstruction, considering the building's potential removal within the next 20 years due to shifting district boundaries	Arup (2016)
	Act5.2	The valuable raw materials and building elements are taken back by their suppliers and manufacturers after use	
6	Act6.1	Using modular movable sliding partitions making the layout more flexible, allowing the space to be adapted for various purposes – from community outreach/teaching to training/general office use – thereby enhancing the building's overall usage efficiency and reducing resource consumption	Arup (2016)
7	Act7.1	Producing a kitchen worktop from LWARB's stripped-out glazed partitioning	EMF and Arup (2023)
	Act7.2	Making timber flooring to the breakout area from reclaimed woods in another project	

(continued)

Table 2. Continued

Case no.	Code*	Description	Reference
8	Act8.1	Using Rheaply, a reuse platform connecting organisations (companies, social communities) easing reselling, donating and exchanging the resources	EMF and Arup (2023)
9	Act9.1	Leasing C2C carpets for 5–7 years, removing carpets at the end of the leasing period, taking back, recycling them into new flooring product through recycling facility by manufacturer	EMF (2016)
10	Act10.1	Using a reuse platform connecting corporates to charities and SMEs finding uses for old materials and therefore improving social, economic and environmental impacts	Globechain (2024)
11	Act11.1	Leasing and sharing flexible working spaces, through open-plan design, flexible and versatile design, hot desking, increases assets' usage intensity, reducing resource consumptions and waste generation	Hub Australia (2024)
12	Act12.1	Developing the FaaS model, a leasing model by supplier/producer, allowing the customers to benefit from using furniture products whilst retains ownership of, and ultimately responsibility for, those assets to supplier/retailer/producer	Living Edge (2024)
13	Act13.1	Regulation for city departments specifying requirements for carpet procurements to (1) all carpets would be at least C2C Certified Silver, (2) carpet tiles are to be used for ease of replacement and waste avoidance, (3) carpet fibres and backing materials must contain maximum amounts of recycled materials and ultimately be recyclable at EoU	EMF (2017)
14	Act14.1	DfD report in design stage providing information for each product/asset on materials location, disassembly method, how to recovery	Built Australia (2024)
15	Act15.1	Design meet and connect spaces, including public areas and meeting rooms, to be easily themed for various corporate and private events, achieved by (1) avoiding the integration of short-term aesthetic trends into long-lasting, costly fit-out elements, (2) creating a timeless foundation allowing for lightweight brand updates and aesthetic alterations	GBCA (2024)
16	Act16.1 Act16.2	Retain existing fit-out elements by adaptive design Specifying components and systems that are flexible for use by other occupiers <i>in situ</i> or are durable enough to be transported to other locations, e.g. reusing timber from one floor to make flooring for a connecting stairwell	Charter Hall Group (2024)
17	Act17.1 Act17.2 Act17.3	Procuring products with a circular lifecycle guarantee allowing for their taking back and recycling at a nominal ex-factory cost at the EoL Ensuring suppliers to use responsible materials product by prioritising low-carbon and long-lasting options, easy to disassemble, made from recycled content, locally manufactured, non-hazardous, or certified as eco-friendly as well as materials supporting CE initiatives, such as repair, refurbishment, PaaS and take-back schemes Requiring suppliers to provide detailed product specifications, including sustainability credentials such as EPDs, ecolabels (e.g. GBCE) and C2C certifications	GBCE (2024)

(continued)

Table 2. Continued

Case no.	Code*	Description	Reference
18	Act18.1	Durra Panels made from compressed wheat and rice straw, an agricultural waste by-product, 100% recyclable and biodegradable	GBCA (2024)
	Act18.2	Collaborating closely with the design team to select components that have an established end-of-use market and recovery pathway, ensuring they can be reused, easily disassembled, repaired, remanufactured, or recycled once they reach the EoL	
19	Act19.1	Using the system to attach linings and claddings to the frame with easily reversible fixings allowing for quick and clean modifications, reducing changes waste and mess	Xfram (2024)
20	Act20.1	Enforcing requirements for sub-departments within governmental sectors to ensure fit-outs meet criteria: (1) buildings and fit-outs use less materials, minimise waste, can be deconstructed and reused, designed for adaptability and flexibility, (2) durable, repairable, reusable and/or recyclable products, (3) products have been refurbished or existing goods are reused, (4) using products containing recycled content /recycled materials, (5) products are recycled at the EoL, (6) products are returned for resource recovery through a take-back or EoL scheme, (7) products are available for lease, rent or PaaS as an alternative	DCCEEW (2024)
21	Act21.1	Using eco-materials for insulation: (1) vegetal made: wood or flax fibre, hemp bricks, expanded cork; (2) animal made: sheep wool; (3) others: loose-filled cellulose, recycled textile or cellular glass	EMF (2016)
22	Act22.1	Developing a BIM model for data management incorporating material passports and reversible building design codes to enhance buildings circularity	Durmisevic (2019), Heinrich and Lang (2019)
23	Act23.1	Producing modular furniture, such as office chairs, with interchangeable components akin to a Lego model, allowing for easier maintenance and upgrades, maximising the conservation of embedded value in products, components and materials	EMF (2021)
	Act23.2	Using FaaS by manufacturer through using (1) QR codes on products, along with a new internal database allowing to continually log, store and track the history of all assets under their ownership; (2) an alternative financing model allowing the business to create a separate financial entity called circular interiors that owns the products. This allows the private furniture company, to free themselves from certain financial constraints, such as the need to generate short-term returns, which can often limit companies from piloting and implementing similar access-over-ownership business models	
	Act23.3	Implementing the FaaS model alongside investment in reverse logistics infrastructure by piloting a facility in a small area to better understand challenges and optimise operations	
Note(s): * Act i.j = j th circular initiative of i th case study # (italic coded) indicates opportunities that are suggested in the report as potential ways to enhance circularity and have not yet implemented BIM: Building Information Modelling, C2C: Cradle-to-Cradle DfD: Design for Disassembly, EPD: Environmental Product Declarations, FaaS: Furniture-as-a-Service GBCA: Green Environmental Council Australia HVAC: Heating, Ventilation, Air Conditioning PaaS: Product-as-a-Service, QR: Quick Response RAF: Raised Access Floors SMEs: Small and Medium-sized Enterprise			

and space for dismantling and upgrading them, was suggested as part of lease agreements, extending the timeframe for repurposing, reselling or donating reusable components. These demand-oriented initiatives were included in the qualitative analysis alongside implemented initiatives to explore potential mechanisms and circular outcomes within the fit-out value chain. Insights from both types of initiatives informed the identification of circular transition opportunities and the development of the proposed KPI framework.

3.2.3 Mechanism and outputs. Building on the CIMO logic, this phase of analysis focuses on the mechanism, comprising the enablers and circular strategies based on the 10R framework, as well as the circular value outcomes. These outcomes correspond to narrowing resource loops in the pre-use stage, slowing them during the use stage and closing them in the post-use stage. These elements are detailed in Table A1 in the Appendix, which served as the basis for mapping Figure 2. Figure 2a illustrates the alignment between circular interventions and their intended outcomes by mapping the application of 10R strategies across the interventions. The distribution of outputs reveals a clear emphasis on circular values during the

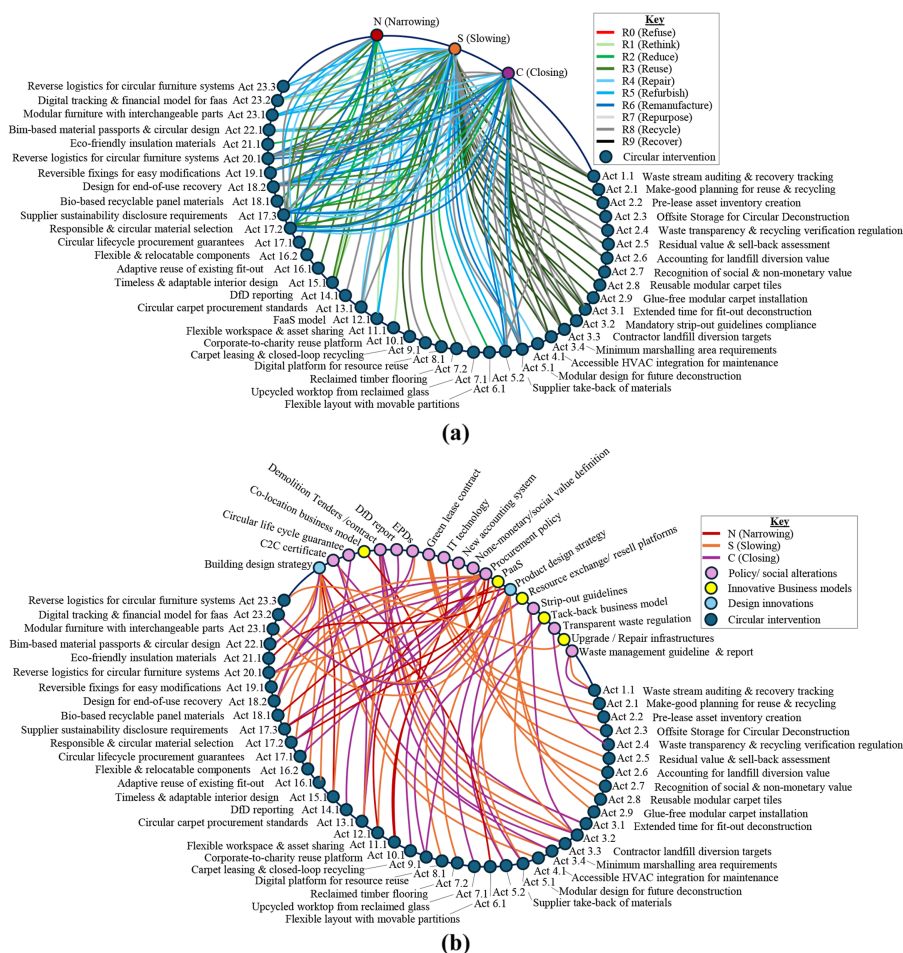


Figure 2. Mechanisms and Outputs of circular initiatives in office fit-outs: (a) alignment of 10R circular strategies with circular economy outputs, (b) key enablers supporting the implementation of circular strategies

use stage by focusing on retaining products at their highest value through slowing the loop (with 30 interventions), as well as post-use stage by focusing on preserving residual value through closing the loop (with 24 interventions). In contrast, fewer initiatives target pre-use stage outcomes through narrowing the loop (with 10 interventions), which aim to add value by maximising material and energy efficiency at early stages such as manufacturing, design and retail. This imbalance reflects the relatively limited attention given to upstream processes in the fit-out value chain. This trend is particularly evident in the dominance of reuse (R3) and recycle (R8) strategies. Reuse, applied in at least 24 interventions, through reuse platforms, adaptable design and green lease contracts. Followed by recycle, featured in 16 interventions, is mainly implemented through take-back schemes and procurement policies that support recyclability at the end of product life.

Moderately frequent strategies include repair and refurbish, each appearing in 10 and 9 interventions respectively, often associated with modular design and quality enhancements that support ongoing maintenance and upgrades. In contrast, rethink and reduce are applied less frequently (3 and 7 instances respectively), typically through strategies that promote spatial efficiency and material minimisation during design. repurpose is rarely observed, reflecting the greater complexity of these approaches in the office fit-out context. Notably, refuse and recover are entirely absent. While recover is less valuable in 10-R hierarchy, the absence of refuse highlights practical limitations in eliminating unnecessary materials or products.

This analysis reveals that the success of circular interventions depends not only on the adoption of circular strategies but also on the presence of specific enablers that support their implementation in real-world contexts. As illustrated in [Figure 2b](#), these enablers map the linkages between interventions and outcomes, and can be grouped into three thematic categories: design innovations (16 interventions), innovative business models (8 interventions) and policy and societal transitions. Policy and societal transitions (18 interventions), such as regulations, standards, certifications, mandatory reporting and required technological shifts, are the most frequently connected enablers. This trend reflects the growing recognition that top-down institutional and behavioural shifts are critical for embedding circular practices within actors' organisations or across the value chain. Design innovations, the second most frequent group, occur at both the product and building levels. For example, the modular furniture in case 23 represents a product-level design intervention, while the flexible layout in case 6 reflects a building-level design strategy to enhance adaptability. Finally, innovative business models such as Product-as-a-Service (PaaS), take-back schemes and digital reuse platforms, although least frequently observed. Despite their lower frequency, these models are essential for bridging the gap between design intent and circular value delivery. This gap highlights an urgent need to integrate circular business models into organisational processes and to strengthen collaboration across the value chain.

3.3 Circular initiative benchmarking

3.3.1 Proposed KPIs for circular performance. 13 KPIs were developed across three key life-cycle stages: (1) adding value in the pre-use stage (narrowing the loop), (2) retaining value during the use stage (slowing the loop) and (3) preserving residual value in the post-use stage (closing the loop) (see [Table 3](#)). As summarised in [Table 3](#), the pre-use stage focuses on narrowing the loop by reducing the demand for office spaces and fit-out products through increased functionality and usage intensity of office units and their components. At the material level, minimising material usage, particularly of virgin resources, is essential. In the use stage, enhancing durability through quality improvements, retaining products for multiple cycles and reducing the frequency of replacements help to slow resource consumption. Finally, in the post-use stage, achieving a high recovery rate during office building strip-outs and increasing the potential for reusing and recycling products' elements support closing the loop.

Table 3. Proposed circular value KPIs extracted from selected initiatives

Circular principles/ Value proposition	Circular value KPI		Impact*	Unit
	Code	Description		
Narrowing the loop				
Reducing used material or virgin resources in a product	N1	Material per product	↓ Negative	kg/product
	N2	Virgin/non-bio-based resources per material (used material in a product)	↓ Negative	% of total material mass
Reducing fit-out products in an office unit	N3	Product per function	↓ Negative	Number of products/function
	N4	Product per office unit	↓ Negative	Number of products/office unit
Reducing office units or office building	N5	Office units per function	↓ Negative	Number of units/function
	N6	Office units per user	↓ Negative	Number of units/person
Slowing the loop				
Increasing estimated life span of products	S1	Durability: The life span of fit-out products through fit-out product's quality	↑ Positive	Years
	S2	Reuse/retain rate in the building: Number of cycles that a product is retained/reused in the same building	↑ Positive	cycles/product
	S3	reuse/retain rate in fit-out cycles: Retained/reused product in a refit- defit cycle per total fit-out products	↑ Positive	% of reused items/total fit-out items
	S4	Refit-defit cycles in buildings life span	↓ Negative	cycles/building life
Closing the loop				
Increasing the recovery potential in an office building/unit	C1	Recovery rate: reused or recycled material per removed material) in a strip out/ demolition project	↑ Positive	% (recovered mass/total removed mass)
	C2	Product parts recyclability: Recyclable elements/parts of a product per all parts	↑ Positive	% (by count or mass)
Increasing the potential of product's circulation at EoU or EoL	C3	Product parts reusability: Reusable elements/parts* of a product per all parts	↑ Positive	% (by count or mass)

Note(s): *: ↑ Positive (higher better) ↓ Negative (lower better)

Ni: KPIs affecting the pre-use stage by Narrowing the loop Si: KPIs affecting the use stage by Slowing the loop

Ci: KPIs affecting the post-use stage by Closing the loop * Reusable parts of a product for remanufacturing, and repurposing

Additionally, the impact of each KPI is specified either positive or negative. Positive KPIs indicate that higher values are desirable; for example, an increased recovery rate is beneficial. In contrast, negative KPIs, such as the number of products per function, should decrease, reflecting their negative nature. The proposed KPIs can be applied across different stages of the value chain to evaluate circular performance, supporting decision-making in design, procurement and end-of-use processes. Rather than being confined to a single lifecycle stage, these indicators are interrelated and should be considered collectively to enhance circular performance across the full fit-out lifecycle. For example, design-stage decisions, such as adopting modularity and designing for disassembly, directly influence post-use performance by enhancing the potential for reuse and recovery, while also contributing to pre-use objectives such as material reduction.

Furthermore, The final column in [Table 3](#) specifies the measurement scale applicable to each KPI. These include quantitative measures such as mass (e.g. kg/material), percentages, numbers and time, offering clarity on how each KPI is calculated and interpreted. Some of these KPIs in [Table 3](#), align with established sustainability metrics, such as “recovery rate at end-of-use” proposed by [Host \(2018\)](#). However, this study also introduces new KPIs specific to circular performance in office fit-outs, such as “number of office units per function” and “retained/reused product in a refit-defit cycle per total fit-out products”. These indicators are not directly adopted from existing frameworks but are systematically derived through the CIMO-based analytical process, linking interventions to circular mechanisms and measurable outcomes. A comprehensive mapping of all KPIs derived from each intervention using CIMO logic is provided in the final column of [Table A1](#), affected KPIs, in the [Appendix](#).

For example, in Case 5, Designing and custom ordering fit-outs in a modular, dismantlable form to accommodate future deconstruction (Intervention: Act 5.1) activates slowing and closing resource loops (R3, R5, R6, R8) as by enabling disassembly and reuse (Mechanism), leading to the outcome of retained and reused components across fit-out cycles, which informs the KPI “retained/reused product in a refit-defit cycle per total fit-out products.” Similarly, in Case 11 involving co-location and flexible workspace strategies, such as shared workstations and hot-desking arrangements (Intervention), office spaces are designed to accommodate multiple users per workstation. This activates a narrowing mechanism (R2) by increasing space utilisation efficiency and reducing the demand for individual office units. The resulting outcome is a reduction in the number of office units required to support a given number of users, which directly informs the KPI “number of office units per user.”

A comparison with major fit-out-related certification and rating systems, including LEED v4.1 ID + C ([USGBC, 2019](#)), BREEAM International Refurbishment and Fit-Out ([BRE, 2015](#)), SKA Rating ([RICS, 2016](#)), BEAM Plus Interiors- Non-Residential v2.0 ([HKGBC, 2023](#)) and Green Star Interiors v1.3 ([GBCA, 2019](#)), indicates that existing systems already address several themes reflected in the proposed KPI set, particularly material reuse, waste diversion, responsible sourcing and adaptable design. For example, LEED v4.1 ID + C and BEAM Plus Interiors include credits related to interior and furniture reuse as well as construction waste diversion, which align with the KPI “recovery rate at end-of-use”.

However, these systems are primarily structured as credit-based assessment tools rather than lifecycle-aligned KPI frameworks, and they provide limited support for evaluating space-use intensity, retention across multiple refit-defit cycles and other fit-out-specific dimensions of circular performance. For instance, while reuse is encouraged through threshold-based credits, existing systems do not capture the proportion of retained or reused components across successive fit-out cycles, as reflected in the KPI “retained/reused product in a refit-defit cycle per total fit-out products”, nor do they quantify space efficiency through indicators such as “number of office units per user”. Accordingly, the KPIs proposed in this study extend existing practice by translating circular initiatives into measurable indicators spanning pre-use, use and post-use stages, thereby enabling a more comprehensive and lifecycle-oriented evaluation of circular performance in office fit-outs.

These indicators can also be operationalised through digital design and asset-management platforms such as Building Information Modelling (BIM). For instance, the KPI “retained/reused product in a refit-defit cycle per total fit-out products” could be automatically calculated using BIM object data (e.g. component IDs, material quantities and reuse status) through Revit-based plug-ins or material passport integrations, enabling project teams to track reuse performance during refurbishment cycles.

3.3.2 Circular transition opportunities. Many of the identified initiatives have the potential to enhance circularity within fit-out value chains in similar contexts and can be viewed as opportunities for circular transition. To leverage these opportunities effectively, they should be framed into generalisable categories ([Santa-Maria et al., 2021](#)) and the value each category creates should be examined. This allows stakeholders and decision-makers to contextualise the initiatives based on their contribution to circular value creation.

The analysis of the case studies revealed that these initiatives can be grouped into broader categories based on their enabling factors. Circular transition opportunities can thus be classified according to these enablers. For example, in case 6 and case 7, value creation is achieved through changes in design, whether at the building or product level. Additionally, some transitions within the value chain are driven by changes in traditional processes (e.g. case 9), reorganisations among actors and their collaboration (e.g. case 11), or the establishment of new business entities (e.g. case 10). These enablers contribute to value propositions, a key component in defining business models (Eisenreich *et al.*, 2022). In addition to the two commonly recognised categories for framing opportunities, circular design strategies and circular business models, as outlined by studies such as (Bocken *et al.*, 2016; Den Hollander *et al.*, 2017), this study identified the need for a third category to facilitate circular transitions within the fit-out value chain. This additional category, termed policy and societal transitions, emphasises the role of changes in policies and the social behaviours of actors within the supply chain in driving circularity. It should be noted that these opportunities are not directly measured within the KPI set; rather, they act as enabling mechanisms that enhance KPI performance across different lifecycle stages and, consequently, improve overall circular performance outcomes.

3.3.2.1 Design strategies. Based on the best practices, the design strategies outlined in Table 4 can be organised into two levels: (1) Building level, which encompasses strategies that impact the overall building or its interior aimed at enhancing adaptability and longevity of interior elements (e.g. modular partitions, demountable walls) and (2) Product level, which focuses on strategies for improving circularity at the product scale. Real-world practices reveal that each strategy can be implemented in multiple ways. For example, at the building level, enhancing the potential for dismantling and disassembly of fit-out products can be achieved through solutions such as allocating more marshalling spaces (e.g. in case 3) or incorporating reversible joints between building and fit-out elements (e.g. XFrame in case 19). To capture this diversity, subcategories – referred to as *practices* – were introduced, providing additional clarity and specificity.

As shown in Table 4 and with reference to Table 2 and Figure 2, design-related interventions at both the building and product levels play a critical role in influencing circular performance across lifecycle stages, particularly by enabling adaptability, disassembly and reuse. This underscores the importance of design-oriented interventions in driving circular transition opportunities within the fit-out value chain. Furthermore, as demonstrated by the affected KPIs in Table 3, various KPIs across the pre-use, use and post-use stages, along with their associated actors, are impacted demonstrating alignment with circular outcomes. This broad scope underscores the significant influence of designers throughout the fit-out life cycle. Although primarily involved in the pre-use stage, designers have a lasting impact on subsequent stages, shaping outcomes well beyond initial design.

3.3.2.2 Circular business models. The circular business models applied within the fit-out value chain enhance circularity by either creating new businesses and actors – such as the exchange or resell markets in cases 8 and 10 or redefining and developing existing business models across various actors – such as running upgrade facilities within suppliers in case 23. These models may also involve reorganising processes within the value chain. For instance, sharing flexible workspaces, as demonstrated in case 11, is made possible through such reorganisations.

These business models are categorised into five groups (as shown in Table 5), including the take-back model, resource exchange/resell markets or platforms, co-location, PaaS and upgrade/repair models. In take-back models, valuable raw materials and building fit-out components are returned to suppliers and manufacturers after use, maximising the potential for recycling, remanufacturing and refurbishment (affecting index C1 in Table 3) (EMF, 2016). This approach allows suppliers to harness the residual value of materials by leveraging their capacity for circulation. To implement this model effectively, suppliers must not only invest in downstream infrastructure but also incorporate design principles that enhance the circularity

Table 4. Circular design strategies applied in fit-out value chain

Design strategy	Design practice	Representative interventions	Affected KPIs
Building design for retaining and reusing existing components	Adaptive design with existing reusable products: incorporating existing fit-outs into bespoke designs that emphasise adaptive reuse and the integration of salvaged materials	Case 16, Act 16.1	S3: reuse/retain rate in fit-out cycles
	Specifying components and systems that are flexible for use by other occupiers <i>in situ</i> or are durable enough to be transported to other locations	Case 16, Act 16.2	S2: Reuse/retain rate in the building
Building design for fit-out repairability/maintainability	Separation and accessibility: Separating building layers to enable easy access for repair and maintenance, minimising demolition and reducing waste generation	Case 4, Act 4.1	S2: Reuse/retain rate in the building
Building design for dismantlability and disassembly	Marshalling spaces	Case 3, Act 3.4	S3: reuse/retain rate in fit-out cycles; C1: Recovery rate
	Reversible connections and joints: Implementing reversible connection system for assembly and disassembly	Case 19, Act 19.1	S2: Reuse rate in the building; C2: Product parts recyclability; C3: Product parts reusability
Building design for function adaptability and compatibility	Function flexibility Adaptability with short term changes	Case 6, Act 6.1 Case 15, Act 15.1	N5: Units per function N5: Units per function; S2: Reuse/retain rate in the building
Building design as material banks	Material passports in design	Case 22, Act 22.1	S2: Reuse/retain rate in the building; C1: Recovery rate
	Reversible building design codes		
Product design for reusability	Modularity	Case 2, Act 2.8	S2: Reuse/retain rate in the building
	Dismantlability and disassembly	Case 5, Act 5.1	C2: Product parts recyclability; C3: Product parts reusability; S3: reuse/retain rate in fit-out cycles
Product design for repairability	Non-Adhesive installation	Case 2, Act 2.9	S2: Reuse rate in the building
Product design for refurbish/remanufacture	Modularity with interchangeable components	Case 23, Act 23.1	S3: reuse/retain rate in fit-out cycles; C3: Product parts reusability
Product design for maximising recovered/biobased material usage	Using agricultural waste by-product and biobased material and cellular material	Case 18, Act 18.1	N2: Virgin/non-bio-based resources per material; C2: Product parts recyclability
		Case 21, Act 21.1	N2: Virgin rate
Customised product design for repurposing	Bespoke manufacturing from other projects' outflows	Case 7, Act 7.1 Case 7, Act 7.2	C1: Recovery rate; C3: Product parts reusability S2: Reuse/retain rate in the building

Table 5. Circular business models applied in fit-out value chain

Business models	Representative Interventions	Affected KPIs
Tack-back model	Case 5, Act 5.2	C1: Recovery rate; C2: Product parts recyclability; C3: Product parts reusability
Resource exchange/ resell markets/ platforms	Case 9, Act 9.1	C1: Recovery rate; C2: Product parts recyclability
	Case 8, Act 8.1	S2: Reuse/retain rate in the building
	Case 10, Act 10.1	S2: Reuse/retain rate in the building
Co-location model	Case 11, Act 11.1	N5: Office units per function; N6: Office units per user
Product-as-a-service model	Case 12, Act 12.1	N4: Product per office unit
	Case 23, Act 23.2	S3: reuse/retain rate in fit-out cycles; C3: Product parts reusability
Upgrade / Repair model	Case 23, Act 23.3	S3: reuse/retain rate in fit-out cycles; C3: Product parts reusability

potential of their products (affecting indexes C2 and C3 in [Table 3](#)). For example, in case 9, suppliers prioritise Cradle-to-Cradle (C2C) carpets, which are designed with recyclable fibres (affecting index C2 in [Table 3](#)), ensuring their compatibility with circular processes.

Resource exchange/resell markets or platforms serve as intermediaries, connecting different parties based on their business models and strategic objectives. For example, in case 8, the Rheaply platform connects fit-out owners with social communities, facilitating donations and supplying these communities with essential items. Similarly, in case 10, Globechain assists small and medium-sized enterprises (SMEs) by providing access to essential items at a lower price. From a circularity perspective, these platforms play a crucial role in retaining product value for a longer period by facilitating reuse and extending product lifespans (affecting index S2 in [Table 3](#)).

The Co-location business model features shared, flexible workspaces designed to accommodate more users while reducing environmental impact by increasing the intensity of office usage. By providing 24-hour access and shared facilities/fit-outs, co-location enables multiple users to efficiently share the same space ([Arup, 2016](#)). Implementing concepts like hot desking, where users select from a pool of available seating, however, requires open-plan, flexible and versatile designs ([Colenberg et al., 2024](#)). This model, which is gaining popularity in large cities, aligns with the “rethink” circular strategy. It narrows the loop by enhancing the functionality and use rate of office buildings (affecting index N5 and N6 in [Table 3](#), respectively). However, successful implementation of these models requires enabling factors such as shared platforms and IT services as key enablers ([Hub Australia, 2024](#)).

The PaaS model transforms the traditional ownership approach to a subscription-based approach ([Ghafoor et al., 2023](#)). In this model, users pay for access to office fit-outs – primarily furniture and equipment – rather than owning them outright ([Tukker, 2004](#)). PaaS offers significant advantages, including flexibility, scalability and customisation, which allows businesses (as the user-actor role) to adapt their workspaces easily based on changing needs without the burden of asset ownership ([Besch, 2005](#)). From a circularity perspective, PaaS reduces resource consumption (affecting index N4 in [Table 3](#)) by increasing usage intensity and minimising waste via designing products to be durable, repairable and recyclable, as the suppliers retain ownership and responsibility throughout the products’ lifecycle ([Tukker, 2015](#)).

Finally, from a top-down perspective, fiscal incentives and investments in downstream infrastructure are essential to support CE efforts ([Guzzo et al., 2022](#)). Despite maximising circularity potential, facilities for product upgrade and material recycling are necessary to

support these efforts. Such facilities can be developed as new businesses or integrated within the strategic plans of current suppliers. For instance, in case 23, Ahrend, an office furniture producer in the Netherlands, has strengthened its FaaS model by investing in reverse logistics infrastructure. The company piloted a facility in a small area to identify challenges and optimise operations, demonstrating how targeted investments on upgrade facilities can strengthen circular practices (EMF, 2021).

3.3.2.3 Policy and societal transitions. Policy-driven interventions and behavioural shifts play a pivotal role in accelerating CE adoption. Examining the experiences of front runners reveals that the circular transition in fit-outs is more than just alterations and innovations in design strategies or business models. It demands policy changes, such as regulations, standards and certifications (Ahmadi *et al.*, 2024; Sharp *et al.*, 2019), alongside shifts in the societal dynamics of the ecosystem. Incorporating policies into lease contracts, demolition tenders, fit-out procurements, or any other formal agreements can significantly enhance circularity within the value chain (Delai and Alcantara, 2022). Additionally, enabling transparency across the value chain plays a crucial role in ensuring the alignment of efforts and reporting mechanisms (Host, 2018). For businesses, particularly fit-out users, accounting systems need to be redefined to reflect residual economic values, such as revenue from product reselling (FTD, 2023). Furthermore, on a social level, efforts like donations or other socially valuable actions can be incentivised by recognising and rewarding non-monetary or social value contributions for companies (FTD, 2023).

These opportunities are categorised into six groups, as shown in Table 6, including (1) green lease contracts/ guidelines, incorporating contractual provisions, particularly related to

Table 6. Policy and societal transitions applied in the fit-out value chain

Change in policy and society	Representative interventions	Affected KPIs
Green lease contracts/ guidelines	Case 2, Act 2.1	S3: reuse/retain rate in fit-out cycles
	Case2, Act 2.2	S3: reuse/retain rate in fit-out cycles
	Case 2, Act 2.3	S3: reuse/retain rate in fit-out cycles
Demolishing tenders/ contracts	Case 3, Act 3.1	S3: reuse/retain rate in fit-out cycles, C1: Recovery rate
	Case 3, Act 3.2	S3: reuse/retain rate in fit-out cycles, C1: Recovery rate
	Case 3, Act 3.3	C1: Recovery rate
Circular procurement policy/guideline	Case 13, Act 13.1	N2: Virgin/non-bio-based resources per material; S2 Reuse/ retain rate in the building; C2: Product parts recyclability
	Case 17, Act 17.1	C2: Product parts recyclability
	Case 17, Act 17.2	S1: Durability; N2: Virgin/non-bio-based resources per material; C2: Product parts recyclability; C3: Product reusability
	Case 18, Act 18.2	S2: Reuse/retain rate in the building; C2: Product parts recyclability
	Case 20, Act 20.1	N1: Material per product; N3: Product per function; S2: Reuse/retain rate in the building; C2: Product parts recyclability; C3: Product reusability
	Case 14, Act 14.1	S3: reuse/retain rate in fit-out cycles, C1: Recovery rate
Transparency enhancement	Case 1, Act 1.1	C1: Recovery rate
	Case 2, Act 2.4	C1: Recovery rate
Companies' accounting systems	Case 17, Act 17.3	N2: Virgin/non-bio-based resources per material; S1: Durability; C1: Recovery rate
	Case 2, Act 2.5	S3: reuse/retain rate in fit-out cycles, C1: Recovery rate
	Case 2, Act 2.6	C1: Recovery rate
	Case 2, Act 2.7	S2: Reuse rate in the building
Defining non-monetary/ social values		

the make-good clause, into lease agreements to promote circularity, (2) demolishing tenders/ contracts, i.e. establishing regulatory requirements in demolition contracts and tendering processes to guide the selection of demolition or strip-out contractors, (3) circular procurement policy/guideline, i.e. implementing regulations that mandate the procurement of sustainable and responsibly sourced materials or products, (4) transparency enhancement, i.e. tracking material flows and their actual destinations transparently to ensure accountability and support circular practices, (5) companies' accounting systems, i.e. modifying accounting systems to account for costs and revenue flows of assets at their EoU, including residual asset values, revenues from reselling products, and so forth and (6) defining none-monetary/ social values, i.e. establishing incentives to encourage the donation of used fit-outs at their EoU, thereby emphasising social and environmental benefits beyond monetary gains.

Additionally, [Table 6](#) indicates representative interventions (Act.i.j), in the second column, derived from [Table 2](#) that informed the identification of each mechanism. Furthermore, the final column of [Table 6](#) shows how policy and societal transitions contribute to circular economy performance by influencing specific KPIs. These interventions are not directly measured but act as enabling mechanisms affecting outcomes related to narrowing, slowing and closing resource loops. For instance, updating accounting systems to incorporate whole-life and residual material value can incentivize recovery practices. This, in turn, improves recovery rates (KPI: C1) and enhances circularity by improving closing loop.

3.4 Limitations and future directions

Here are the main limitations identified in this study that should be acknowledged:

- (1) Empirical validation: The proposed KPIs and opportunities have not been empirically validated or tested through stakeholder application. As this study focuses on framework development, future research should undertake pilot implementation and industry-based validation to assess the practical applicability, robustness and effectiveness of these indicators in real-world contexts.
- (2) Data gaps and scalability of the models: The case study data was sourced from developed economies, where documented case studies are more readily available, where circular practices, supporting infrastructures and institutional mechanisms are generally more established. However, this necessitates further research into how the proposed framework and KPI system perform in other geographic and socio-economic contexts, particularly in developing countries. Insights from local experts through interviews and focus groups can help uncover contextual variables that merit closer examination in such settings.

For example, regulatory and socio-economic gaps, including high upfront costs associated with changing production processes or business models, outdated or prescriptive regulations ([Productivity Commission, 2025](#)), limited institutional capacity and training and coordination failures ([Fini and Forsythe, 2020](#)) and infrastructure and market readiness constraints, including limited reverse-logistics capacity, material traceability systems ([van der Lans et al., 2023](#)) and secondary-market channels ([Shooshtarian et al., 2020](#); [Zaman et al., 2022](#)) may significantly affect the feasibility of reuse, take-back and recovery pathways. Aiming these contextual factors would help refine the transferability of the proposed framework and provide a clear direction for subsequent research in diverse contexts.

- (3) Lack of longitudinal performance evidence: While this study proposes a set of lifecycle-aligned KPIs derived from real-world circular initiatives, the analysis is primarily based on documented case evidence at a specific point in time. As a result, the long-term effectiveness of these circular initiatives, such as take-back programs and leasing models, across multiple fit-out cycles could not be empirically assessed. Circular value creation in office fit-outs, particularly strategies related to reuse,

product lifespan extension and recovery pathways, often unfolds over extended time horizons. Future research should therefore focus on longitudinal monitoring of the proposed KPIs across multiple fit-out cycles, enabling researchers and practitioners to evaluate the sustained performance.

- (4) Uncertainty in scalability and adaptability of circular business models: the scalability of circular business models remains uncertain due to contextual factors such as financial, regulatory and market barriers. While this research highlights their potential, large-scale adoption depends on financial mechanisms and policy incentives. Future research should explore economic viability, financial incentives, subsidies and taxation models, as well as the role of government regulations in standardising circular procurement practices to drive industry-wide adoption.
- (5) Scope of KPI framework: The proposed KPIs focus on evaluating material circularity performance across the lifecycle of office fit-outs, particularly in terms of narrowing, slowing and closing resource loops. Policy, societal and economic factors are not directly measured but act as enabling mechanisms that influence improvements in these indicators. Future research may expand the framework by incorporating complementary metrics to capture social and economic value more explicitly.
- (6) Limited analysis of stakeholders' roles: this study does not explicitly examine the role of stakeholders and collaborative dynamics, and interaction structures among actors within the fit-out value chain. However, the successful implementation of circular practices depends on how actors coordinate, exchange information and redistribute roles across the system. Future research should therefore investigate configuration and patterns of collaboration, and structural gaps, to better understand how circular value chains can be operationalised in practise.
- (7) Lack of Empirical Validation and Stakeholder Testing: This study focuses on conceptual framework development through an inductive, Grounded Theory-based framework rather than on the empirical testing of an existing theory. Accordingly, the proposed opportunities and KPIs, derived from case-based analysis, constitute an initial conceptual framework that has not yet been validated through stakeholder application or consultation. This represents an important direction for future research to assess the framework's practical applicability, robustness and effectiveness in real-world contexts.

4. Conclusion

The findings demonstrate that circular performance in office fit-outs can be enhanced through the integration of design strategies, business models and policy mechanisms, each contributing to value creation across lifecycle stages. The proposed framework supports decision-making by linking circular initiatives to measurable outcomes, enabling the evaluation and prioritisation of interventions in different project contexts.

Drawing on 23 global case studies, this research identifies 42 circular initiatives and proposes 13 lifecycle-aligned KPIs to enhance circularity in office fit-outs. It also introduces enablers as opportunity areas, structured across three categories of design strategies, circular business models and policy and societal transitions, which act as enabling mechanisms that enhance KPI performance across lifecycle stages.

The analysis reveals that most initiatives focus on slowing and closing resource loops, primarily through reuse and recycling. However, early-stage strategies such as refuse, rethink and reduce remain underrepresented, suggesting a need to strengthen upstream interventions in future transitions. Importantly, the study finds that the success of circular initiatives depends not only on the circular strategies but also on enablers, which can be thematically grouped into design innovations, innovative business models and supportive policy and societal transitions.

13 KPIs are proposed to guide and evaluate circular performance across the value chain, offering a measurable framework for assessing value creation across the pre-use, use and post-use stages. The categorisation of circular initiatives by enabler themes provides a structured approach to support decision-making in diverse project contexts: (1) Design strategies, particularly those led by interior designers and suppliers play a foundational role by enabling adaptability, disassembly and reuse across both building and product levels; (2) circular business models, such as PaaS, take-back schemes, co-location models, exchange/resell platforms and Upgrade/Repair infrastructure in supplier parties, operationalise circularity through new value propositions and redefined actor roles; (3) Finally, policy and societal transitions institutionalise circular practices by embedding them into contracts, procurement systems and transparency protocols. The study highlights that, while design innovation is critical, large-scale circular transformation in office fit-outs depends on the collective evolution of business models, policy instruments and stakeholder behaviours, paving the way for a more resilient and sustainable built environment. Achieving such a systemic transition will require coordinated action across the value chain. In particular, integrating circular KPIs into digital building platforms such as BIM-based monitoring systems, aligning them with public procurement requirements and embedding them within regulatory and certification frameworks can help translate circular economy principles from isolated initiatives into scalable industry-wide practices.

(The Appendix follows overleaf)

Table A1. Categorized insights within CIMO logic

Case studies Case no.	Context		Case type	Fit-out type	Documentation year	Intervention		Mechanism		10-R strategies	Outputs	Affected KPIs	Ref
	Location					Ini. Code	Description	Enablers					
1	Australia	Project	All*		2015	Act 1.1**	Auditing waste streams and their destinations as well as reporting waste recovery rate	Waste management guideline and report	R3, R8	S, C	S3, C1	BBP (2015)	
2	Australia	Project	All	2023	Act 2.1	Allowing sufficient time and staff in make good clause to plan and organise loose furniture, re-use, donation, and recycling	Green lease contract	R3	S	S3	FTD (2023)		
					Act 2.2	Creating asset inventories in advance by tenants or their representatives	Green lease contract	R3	S	S3			
					Act 2.3#	Offsite storage provisions in lease contracts to ensure sufficient time for dismantling, reselling, donating, and other related activities	Green lease contract	R3	S	S3			
					Act 2.4#	Regulations/laws that enforce transparency in waste streams and their destinations, requiring recycling transfer stations to provide documentation verifying the actual recycling of goods, not just receipts	Transparent waste regulation	R8	C	C1			
					Act 2.5#	Evaluate potential value returns from sell-back schemes and components' high residual value	New accounting system	R3, R8	S, C	S3, C1			
					Act 2.6#	Defining revenue comes from landfill diversion at products' EoL in companies' accounting system and educating them	New accounting system	R6 to R8	C	C1			
					Act 2.7#	Defining non-monetary and social values resulting from donations or social initiatives and recognising them as privileged criteria in tenders or lease contracts	None-monetary/ social value definition	R3	S	S2			
					Act 2.8#	Modular carpet tiles allowing for easy reuse in different locations	Product design strategy	R3	S	S2			
					Act 2.9#	Modular carpet tiles that can be installed without glue, allowing for easy repair and replacement of damaged sections	Product design strategy	R3	S	S2			

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Table A1. Continued

Case studies Case no.	Context		Fit-out type	Documentation year	Intervention		Mechanism		10-R strategies	Outputs	Affected KPIs	Ref
	Location	Case type			Ini. Code	Description	Enablers					
3	Australia	Project	All	2016	Act 3.1	Allowing sufficient time for contractors to remove and dismantle fit-outs properly, enhancing the potential for re-use, donation, and recycling	- Demolition Tenders /contract	R3, R8	S, C	S3, C1	BBP (2016)	
					Act 3.2	Including requirements in tender documents and clauses in the demolition/strip out contract that stipulate the contractor must use and comply with the Strip-out Guidelines	- Demolition Tenders /contract - Strip-out guidelines	R3, R8	S, C	S3, C1		
					Act 3.3	Targeting a minimum landfill diversion rate for contractors	Demolition Tenders /contract	R8	C	C1		
					Act 3.4#	Setting minimum requirements for Marshalling area, especially in commercial buildings	Building design strategy	R3, R8	S, C	S3, C1		
4	UK	Project	Finishes ¹	2023	Act 4.1	Integrating HVAC systems in RAF to give access to repair and maintain HVAC, minimising demolition and reducing waste generation	Building design strategy	R4	S	S2	EMF and Arup (2023)	
5	Netherlands	Project	Finishes Fixtures	2016	Act 5.1	Designing and custom ordering all partitions, ceiling, and floor coverings in a modular, dismantlable form to accommodate future deconstruction, considering the building's potential removal within the next 20 years due to shifting district boundaries	Product design strategy	R3, R5, R6, R8	S, C	S3, C2, C3	Arup (2016)	
					Act 5.2	The valuable raw materials and building elements are taken back by their suppliers and manufacturers after use	Take back business model	R6- R8	C	C1, C2, C3		
6	UK	Project	Fixtures ²	2016	Act 6.1	Using modular movable sliding partitions making the layout more flexible, allowing the space to be adapted for various purposes – from community outreach/teaching to training/general office use – thereby enhancing the building's overall usage efficiency and reducing resource consumption	Building design strategy	R2	N	N5	Arup (2016)	

(continued)

Table A1. Continued

Case studies Case no.	Context Location	Case type	Fit-out type	Documentation year	Intervention		Mechanism		10-R strategies	Outputs	Affected KPIs	Ref
					Ini. Code	Description	Enablers					
7	UK	Project	Finishes	2013	Act 7.1	Producing a kitchen worktop from LWARB's stripped out glazed partitioning	Product design strategy	R7	C	C1, C3	EMF and Arup (2023)	
					Act 7.2	Making timber flooring to the breakout area from reclaimed woods in another project	Product design strategy	R3	S	S2		
8	USA	Project	Furniture	2023	Act 8.1	Using Rheaply, a reuse platform connecting organisations (companies, social communities) easing reselling, donating and exchanging the resources	Resource exchange/ resell platforms	R3	S	S2	EMF and Arup (2023)	
9	Netherland	Program	Finishes	2016	Act 9.1	Leasing C2C carpets for 5–7 years, removing carpets at the end of the leasing period, taking back, recycling them into new flooring product through recycling facility by manufacturer	- Tack-back business model - C2C certificate	R8	C	C1, C2	EMF (2016)	
10	UK	Program	All	2024	Act 10.1	Using a reuse platform connecting corporates to charities and SMEs finding uses for old materials and therefore improving social, economic and environmental impacts	Resource exchange/ resell platforms	R3	S	S2	Globechain (2024)	
11	Australia	Program	All	2024	Act 11.1	Leasing and sharing flexible working spaces, through open-plan design, flexible and versatile design, hot desking, increases assets' usage intensity, reducing resource consumptions and waste generation	- co-location business model - IT technology	R1	N	N5, N6	Hub Australia (2024)	
12	Australia	Program	Furniture	2024	Act 12.1	Developing the FaaS model, a leasing model by supplier/producer, allowing the customers to benefit from using furniture products whilst retains ownership of, and ultimately responsibility for, those assets to supplier/retailer/producer	Product as a service model	R1, R5	N, S	N4, S3	Living Edge (2024)	
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Table A1. Continued

Case studies Case no.	Context Location	Case type	Fit-out type	Documentation year	Intervention		Mechanism		10-R strategies	Outputs	Affected KPIs	Ref
					Ini. Code	Description	Enablers					
13	USA	Policy	Carpets	2017	Act 13.1	Regulation for city departments specifying requirements for carpet procurements to 1) all carpets would be at least C2C Certified Silver, 2) carpet tiles are to be used for ease of replacement and waste avoidance, 3) both the carpet fibres and backing materials must contain maximum amounts of recycled materials and ultimately be recyclable at EoU	- Procurement policy - C2C certificate		R2, R4, R8	N, S, C	N2, S2, C2	EMF (2017)
14	Australia	Project	All	2024	Act 14.1	DfD report in design stage providing information for each product/asset on 1) materials location 2) disassembly method, 3) how to recovery	DfD report		R8	C	C1	Built Australia (2024)
15	Australia	Project	Furniture	2024	Act 15.1	Design meet and connect spaces, including public areas and meeting rooms, to be easily themed for various corporate and private events, achieved by 1) avoiding the integration of short-term aesthetic trends into long-lasting, costly fit-out elements, 2) creating a timeless foundation allowing for lightweight brand updates and aesthetic alterations	Building design strategy		R1, R3	N, S	N5, S2	GBCA (2024)
16	Australia	Project	Finishes ⁴ Fixtures ⁵ , Furniture	2024	Act 16.1	Retain existing fit-out elements by adaptive design	Building design strategy		R3	S	S3	Charter Hall Group (2024)
					Act 16.2	Specifying components and systems that are flexible for use by other occupiers <i>in situ</i> or are durable enough to be transported to other locations, e.g. reusing timber from one floor to make flooring for a connecting stairwell	Building design strategy		R3	S	S2	

(continued)

Table A1. Continued

Case studies Case no.	Context Location	Case type	Fit-out type	Documentation year	Intervention		Mechanism		10-R strategies	Outputs	Affected KPIs	Ref
					Ini. Code	Description	Enablers					
17	Australia	Policy	Fixtures	2024	Act 17.1	Procuring certain products with a circular lifecycle guarantee allowing for their taking back and recycling at a nominal ex-factory cost at the EoL	- Procurement policy - Circular life-cycle guarantee		R8	C	C2	GBCA (2024)
					Act 17.2	Ensuring suppliers by designers to use responsible materials product by prioritising low-carbon and long-lasting options, easy to disassemble, made from recycled content, locally manufactured, non-hazardous, or certified as eco-friendly as well as materials supporting CE initiatives, such as repair, refurbishment, PaaS, and take-back schemes	- Circular life-cycle guarantee Procurement policy		R2, R3, R4, R5, R6, R8	N, S, C	N2, S1, C2, C3	
					Act 17.3	Requiring suppliers to provide detailed product specifications, including sustainability credentials such as EPDs, ecolabels (e.g. GBCE), and C2C certifications	Procurement policy		R2, R3, R4, R5, R8	N, S, C	N2, S1, C1	
18	Australia	Product	Finishes ⁶		Act 18.1	Durra Panels made from compressed wheat and rice straw, an agricultural waste by-product, 100% recyclable and biodegradable	Product design strategy		R2	N	N2	GBCA (2024)
					Act 18.2	Collaborating closely with the design team to select components that have an established end-of-use market and recovery pathway, ensuring they can be reused, easily disassembled, repaired, remanufactured, or recycled once they reach the EoL	- Procurement policy - EPDs		R3, R4, R5, R8	S, C	S2, C2	
19	Australia	Product	Fixtures ⁷	2024	Act 19.1	Using the system to attach linings and claddings to the frame with easily reversible fixings allowing for quick and clean modifications, reducing changes waste and mess	Building design strategy		R3, R4, R6	S, C	S2, C2, C3	Xfram (2024)

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Table A1. Continued

Case studies Case no.	Context Location	Case type	Fit-out type	Documentation year	Intervention		Mechanism		10-R strategies	Outputs	Affected KPIs	Ref
					Ini. Code	Description	Enablers					
20	Australia	Policy	Furniture, Fittings, and Textures ³	2024	Act 20.1	Enforcing requirements for sub-departments within governmental sectors to ensure fit-outs meet criteria: 1) buildings and fit-outs use less materials, minimise waste, can be deconstructed and reused, designed for adaptability and flexibility, 2) durable, repairable, reusable and/or recyclable products, 3) products have been refurbished or existing goods are reused, 4) using products containing recycled content /recycled materials, 5) products are recycled at the EoL, 6) products are returned for resource recovery through a take-back or EoL scheme, 7) products are available for lease, rent or product-as-a-service as an alternative to buying outright	Procurement policy		R2, R3, R5, R6, R8	N, S, C	N1, N3, S2, C2, C3	DCCEEW (2024)
21	France	Project	Fittings ⁶	2016	Act 21.1	Using eco-materials for insulation: 1) vegetal made: wood fibre, flax fibre, hemp bricks, expanded cork; 2) animal made: sheep wool; 3) others: loose-filled cellulose, recycled textile, recycled cellular glass	Product design strategy		R2	N	N2	EMF (2016)
22	EU	Program	Fitting, Fixtures	2019	Act 22.1	Developing a BIM model for data management incorporating material passports and reversible building design codes to enhance buildings circularity	Building design strategy		R3, R4, R8	S, C	S2, C1	Durmisevic (2019), Heinrich and Lang (2019)
(continued)												

Table A1. Continued

Case studies Case no.	Context Location	Case type	Fit-out type	Documentation year	Intervention		Mechanism		10-R strategies	Outputs	Affected KPIs	Ref
					Ini. Code	Description	Enablers					
23	Netherland	Program	Furniture	2021	Act 23.1	producing modular furniture, such as office chairs and tables, with interchangeable components akin to a Lego model, allowing for easier maintenance and upgrades, maximising the conservation of embedded value in products, components, and materials over time	Product design strategy		R4, R5, R6	S, C	S3, C3	EMF (2021)
					Act 23.2	Using FaaS model by manufacturer through 1) using QR codes technology on products, along with a new internal database allowing to continually log, store, and track the history of all assets under their ownership; 2) creation of an alternative financing model allowing the business to create a SPV (a separate financial entity called circular interiors) that owns the products. This allows the private furniture company, to free themselves from certain financial constraints, such as the need to generate short-term returns, which can often limit companies from piloting and implementing similar access-over-ownership business models	Product as a service model		R4, R5, R6	S, C	S3, C3	
					Act 23.3	Implementing the FaaS model alongside investment in reverse logistics infrastructure by piloting a facility in a small area to better understand challenges and optimise operations	Upgrade / Repair infrastructures		R4, R5, R6	S, C	S3, C3	

Note(s): * All fit-out elements including 1) Finishes (e.g. ceiling covering, wall covering, floor covering), 2) Fixture (e.g. cabinets, counters, ceiling suspension systems, doors, and partition walls, interior glazing), and 3) Furniture (e.g. chairs, cubicles, and tables), ** Act i.j = j th circular initiative of i th case study, #: Demand: Indicate opportunities that, while not yet implemented, are suggested in the report as potential ways to enhance circularity

(continued)

Table A1. Continued

Fit-out elements				
1: Floor covering 6: Wall and ceiling covering	2: Partition 7: Partitions and cladding	3: Carpet	4: Floor covering, wall covering	5: Partitions, Joinery
<i>Abbreviations</i>				
BAMB: Buildings as Material Banks	BIM: Building Information Modelling	C2C: Cradle-to-Cradle	DfD: Design for Disassembly	EPD: Environmental Product Declarations
FaaS: Furniture-as-a-Service	GCEC: Geelong Convention and Event Centre	GBCA: Green Environmental Council Australia	HVAC: Heating, Ventilation, Air Conditioning	
PaaS: Product-as-a-Service	QR: Quick Response	RAF: Raised Access Floors	SMEs: Small and Medium-sized Enterprise	
N: Narrowing	S: Slowing	C: Closing	R0: Refuse	R1: Rethink
R2: Reduce	R3: Reuse	R4: Repair	R5: Refurbish	R6: Remanufacture
R7: Repurpose	R8: Recycle	R9: Recover		

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