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Repair in the Circular Economy: From Fragmented Practices to Strategic Repair Capability

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ABSTRACT

Repair is central to the circular economy, yet research remains fragmented across product design, consumer behaviour, business models, community initiatives and policy, limiting understanding of how these dimensions interact to enable repair at scale. This study systematically reviews 79 peer-reviewed articles using bibliometric mapping, qualitative content analysis and actor-network analysis. Three interconnected knowledge domains emerge: user and community practices; product design, manufacturing and business models; and policy and governance. Findings show that repair outcomes depend on the alignment of organisational capabilities, ecosystem actors, infrastructure and institutional conditions, while several potentially important actors remain underexplored. Integrating these findings, we conceptualise repair as an ecosystem-dependent strategic capability for value retention and develop a framework explaining its enabling conditions and interdependencies. The study highlights implications for firms seeking to integrate repair into circular strategies and for policymakers designing supportive repair systems, while identifying research priorities on capability development, ecosystem governance, policy effectiveness and inclusive repair systems.

1 | Introduction

The transition from a linear ‘take–make–dispose’ economy towards a circular economy (CE) is widely recognised as essential for reducing resource consumption, mitigating environmental impacts and improving economic resilience (Fussone et al. 2026; Geissdoerfer et al. 2017; Kirchherr et al. 2017). Within the hierarchy of circular strategies, repair occupies a particularly important position because it extends product lifetimes while retaining value with relatively low material and energy inputs. Unlike downstream strategies such as recycling, repair preserves product functionality and delays resource extraction, manufacturing and waste generation (MahmoudGonbadi et al. 2025; Potting et al. 2017).

Recent policy initiatives, including the European Union's Right-to-Repair (House of Commons 2021) and Ecodesign regulations

(European Commission 2016), have further elevated the strategic importance of repair. At the same time, firms face increasing pressure to incorporate repairability into product design, service provision and value-retention strategies. These developments suggest that repair should be viewed not only as a sustainability practice but also as an emerging organisational capability with implications for business models, ecosystem governance and CE transitions.

Despite its recognised importance, repair remains underdeveloped within both practice and research. Existing studies have examined repair from diverse perspectives, including product design and repairability, consumer behaviour, community initiatives and policy interventions. Research highlights the importance of technical factors such as modular design and spare-part availability, behavioural factors such as user motivations and skills, and institutional factors including

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regulation and market incentives (Börkey 2024; Vidal-Ayuso et al. 2023). However, these perspectives have largely developed in parallel, resulting in a fragmented understanding of how repair systems function and scale. This fragmentation is problematic because repair is inherently a multi-actor phenomenon. Repair outcomes depend not only on users' willingness to repair products but also on manufacturers' design choices, repair service provision, supporting infrastructures and policy frameworks. Consequently, repair cannot be understood solely as a technical activity, behavioural practice or regulatory issue. Rather, it emerges from interactions among actors, institutions, and value-retention processes.

From a strategic management perspective, organisational capabilities refer to firms' abilities to deploy, coordinate and combine resources through organisational processes in ways that support strategic objectives and potentially differentiate organisational performance (Amit and Schoemaker 1993; Collis 1994). Applied to repair, this perspective suggests that repair can extend beyond a discrete operational activity when firms systematically integrate repair-oriented product design, technical knowledge, spare-parts provision, service delivery, reverse logistics and external partnerships into their value-retention strategies. We conceptualise this higher-order organisational capacity as strategic repair capability.

Dynamic capability theory complements this capability-based perspective by explaining how such capabilities are developed and reconfigured in response to changing external conditions. Dynamic capabilities concern firms' abilities to integrate, build and reconfigure internal and external competences in response to rapidly changing environments (Teece et al. 1997). This perspective is particularly relevant to repair because firms must respond to evolving R2R regulation, CE policies, technological change, changing customer expectations and shifts in repair-service ecosystems. Strategic repair capability should therefore not be understood as a static bundle of repair activities, but as a capability that may require continuing adaptation and reconfiguration as technological, market and institutional conditions evolve. Accordingly, this study draws on capability-based strategy to conceptualise what constitutes strategic repair capability, while dynamic capability theory helps explain how firms may develop and reconfigure that capability over time.

Although several review studies have examined specific aspects of repair, they typically focus on specific sectors, actors or themes (Djeunang Mezafack et al. 2022; Sonogo et al. 2022). Consequently, the literature remains fragmented across technical, behavioural, organisational and policy perspectives, with limited understanding of how these dimensions interact to shape repair systems. As a result, the organisational capabilities, ecosystem relationships and institutional conditions required to enable, coordinate and scale repair remain insufficiently understood. To address this gap, this study undertakes a systematic review of repair research within the CE. Drawing on 79 peer-reviewed articles, the review adopts a system-level perspective to examine the repair research through three interrelated domains: (i) policy and governance; (ii) product design, manufacturing and business models; and (iii) user and community practices. The review is guided by three questions:

1. How do policy, design, and institutional frameworks shape repair systems within the CE?
2. How do different actors interact within repair systems?
3. What barriers and enablers influence the scaling of repair practices?

Existing research has established the importance of design for repairability, highlighted consumer motivations and barriers, and documented growing policy support through initiatives such as Right-to-Repair (R2R) legislation and Ecodesign requirements. Community repair initiatives have further illustrated the social, educational and cultural value of repair practices. These studies show that repair contributes to environmental sustainability while supporting broader CE objectives.

Despite these advances, the literature remains fragmented across technical, behavioural, policy and organisational domains. Policy research is dominated by discussions of regulatory instruments rather than empirical evaluations of their effectiveness (Ampe 2024). Similarly, while repairability is widely recognised as a design objective, evidence remains limited on how firms operationalise repair across their business models, supply chains and organisational processes. Research also continues to focus heavily on consumers and policymakers, while supporting actors such as repair providers, insurers, intermediaries, educators and infrastructure organisations receive comparatively little attention in the literature. Furthermore, the literature remains concentrated in European and North American contexts, with limited engagement with informal repair economies, particularly from Global South perspectives (Nagase and Uehara 2024).

Against this backdrop, this study makes three contributions to the CE and strategic management literature. First, it reconceptualises repair as a strategic ecosystem capability rather than a discrete technical activity or individual behaviour. This shifts attention from repairability at the product level towards the organisational and inter-organisational capabilities required to retain value throughout product lifecycles. Second, the study develops an integrative framework conceptualising how repair outcomes emerge through the interaction of three dimensions: circular economy strategies, repair activities and ecosystem actors, and institutional and infrastructural conditions. By linking firm capabilities, actor interdependencies and policy contexts, the framework provides an explanatory lens for understanding why repair remains underdeveloped despite increasing policy attention and growing recognition of its sustainability benefits. Third, the study identifies the organisational and governance mechanisms required to scale repair as a value-retention strategy, highlighting the importance of design-for-repair, service infrastructures, ecosystem coordination and supportive policy frameworks.

These contributions extend beyond sustainability scholarship. As regulatory pressures, resource constraints and changing customer expectations increasingly favour value retention over product replacement, repair represents a growing strategic challenge for firms. Developing repair capability requires organisations to integrate product design, service provision, supply chain coordination and external partnerships into broader circular

business models. Repair is therefore relevant not only to environmental performance but also to competitive advantage, organisational capability development and ecosystem strategy. By positioning repair as a strategic ecosystem capability, this study contributes to emerging debates on how firms create, retain and capture value during CE transitions while identifying key priorities for future research on governance, business models and ecosystem coordination.

2 | Theoretical Background

Repair usually refers to activities that restore a defective or degraded product to a functional condition so that it can continue to perform its original intended function (EMF 2015). Users, independent service providers, community initiatives and manufacturers may undertake repair, making it a distributed activity embedded within wider social, technical and institutional systems. Within the CE, repair is recognised as one of the most resource-efficient value-retention strategies because it extends product lifetimes while preserving functionality with relatively low material and energy inputs (Kirchherr et al. 2017; Potting et al. 2017). While repair is commonly framed as a technical intervention, its implementation depends on a broader set of organisational, institutional and behavioural conditions. Product design, spare parts availability, repair infrastructure, user skills and regulatory frameworks collectively influence whether repair occurs and can be sustained over time, achieving the expected environmental benefits. Consequently, repair should be understood not simply as an isolated activity, but as a socio-technical process situated within a wider system of actors and relationships (McQueen et al. 2022). This perspective aligns with socio-technical transition theory, which emphasises that sustainability transitions emerge through interactions among technologies, actors, institutions and infrastructures rather than through isolated technological innovations alone (Geels 2001, 2004). Repair outcomes are shaped not only by product characteristics but also by policy frameworks, market structures, cultural norms, and organisational arrangements and capabilities. Similarly, innovation systems theory highlights the importance of knowledge exchange, institutional support and capability development in enabling the diffusion of sustainable innovations (Edquist 2009; Lundvall 2010). Applied to repair, these perspectives suggest that the viability and scaling of repair depend on organisational capability to coordinate multiple actors across the value chain, including manufacturers, service providers, users, policymakers and community organisations.

Therefore, beyond its role as a sustainability strategy, repair should also be examined through the lens of organisational capabilities. Organisational capabilities refer to firm-specific processes through which resources are combined and deployed to achieve desired outcomes (Amit and Schoemaker 1993). Capabilities become strategically important when they enable organisations to develop distinctive ways of coordinating resources and competences that support long-term value creation and competitive advantage (Collis 1994; MahmoudGonbadi et al. 2021). From the dynamic capabilities perspective, this further involves the capacity to integrate, build and reconfigure internal and external competences in response to

changing technological, market and institutional conditions (Teece et al. 1997). Building on these perspectives, we conceptualise strategic repair capability as

an organisation's capacity to purposefully mobilise, integrate, and reconfigure resources, competences, processes, and external ecosystem relationships to embed repair as a value-retention strategy across the product lifecycle.

Repairability, therefore, extends beyond a technical product attribute and reflects an organisational capability that combines design, service, operational and relational competencies. From this perspective, repair capability encompasses at least four interrelated dimensions. These capabilities enable organisations to retain product value for longer and support circular business models that move beyond replacement-based consumption.

1. Firms require design capabilities that enable products to be repaired through modular architectures, ease of disassembly and access to spare parts (Amend et al. 2022).
2. Repair depends on service capabilities that support maintenance, diagnostics, warranties and after-sales activities (Russell et al. 2023).
3. Firms must develop value-retention capabilities that coordinate reverse logistics, spare-part supply chains and lifecycle management processes (Cobra et al. 2023).
4. Repair increasingly depends on ecosystem coordination capabilities that enable firms to collaborate with repair providers, regulators, users and other stakeholders (Cobra et al. 2023).

Despite growing policy attention through initiatives such as the Ecodesign Directive (European Commission 2016) and R2R Legislation (House of Commons 2021), existing repair research has rarely examined repair through a strategic management lens. Most studies focus on technical design, consumer behaviour, community initiatives or regulatory interventions in isolation (McLaren et al. 2020; Sonogo et al. 2022). While these contributions provide important insights, they offer a limited understanding of how firms develop repair capabilities, coordinate ecosystem actors and integrate repair into broader value-retention strategies. Emerging evidence suggests that repair often conflicts with conventional business models that prioritise product replacement over product longevity, creating tensions between sustainability objectives and commercial incentives (Cainelli et al. 2020). At the same time, manufacturers, repair providers, policymakers and communities collectively shape the conditions under which repair becomes viable, highlighting the need for a more systemic perspective.

Table 1 demonstrates the existing review studies which reflect this fragmentation. Previous reviews have examined repair cafés and community initiatives (Moalem and Mosgaard 2021), consumer repair behaviour (Sonogo et al. 2022), industrial repair systems (Djeunang Mezafack et al. 2022), national repair economies (Purkiss et al. 2024) and critical perspectives on repair within CE discourse (McLaren et al. 2020). Although

TABLE 1 | Literature review papers on repair.

Authors	Year	Main focus	Sector	Design and manufacturer perspective	Policy perspective	User-centred perspective	Key gaps identified in the respective review
Djeunang Mezafack, Di Mascolo and Simeu-Abazi	2022	Repair shops in industrial maintenance and CE integration	Manufacturing/ industrial equipment	✓	—	—	Limited integration of circular strategies; lack of models linking repair shops with CE
Moalem and Mosgaard	2021	Role of repair cafés in sustainable circular transition	Consumer electronics/ community	—	✓	✓	Lack of alignment in repair café stakeholder goals; limited empirical studies
Purkiss et al.	2024	Systems-level approach to developing the UK's electronics and appliance repair economy	Electronics and appliances	✓	✓	✓	Lack of coordinated policy support; data gaps on the repair sector's GDP impact
Sonego, Echeveste and Debarba	2022	Consumer repair behaviour and institutional initiatives in electronic product repair	Consumer electronics	—	✓	✓	Insufficient data on repair motivations; limited focus on emerging economies
McLaren, Niskanen and Anshelm	2020	Critical review of repair's role in CE; contrast between instrumental and political views	Cross-sectoral/ theoretical	✓	✓	✓	Dominance of technocratic CE narratives; underrepresentation of social/political framings
This Review	2025	Integrated analysis of repair systems in the circular economy	Cross-sectoral	✓	✓	✓	Fragmented understanding of actor interactions; limited attention to strategic capabilities, business models, and system-level governance

these studies advance understanding of specific aspects of repair, they remain largely confined to specific actors, sectors or analytical perspectives. Consequently, three gaps persist. First, research remains fragmented across technical, behavioural, organisational and policy domains. Second, limited attention has been paid to the interdependencies among actors that collectively shape repair systems. Third, the strategic role of repair as a capability for value retention and business model innovation remains underdeveloped. Addressing these gaps requires a more integrative perspective that connects policy frameworks, firm capabilities and user practices within a common analytical framework. Accordingly, this review adopts a repair ecosystem perspective to examine how actors, interdependencies and policy contexts collectively shape repair systems.

3 | Research Methodology

This study adopted a systematic literature review approach (Denyer and Tranfield 2009) to identify, evaluate and synthesise research on repair within the CE. Scopus¹ was selected as the primary database because of its extensive coverage of peer-reviewed research in sustainability, environmental management and CE studies. The review followed the four-stage process proposed by Hart (1998) and Kite and Whitley (2018): (1) source identification, (2) source selection, (3) source evaluation and (4) data analysis.

3.1 | Step 1: Source Identification

The review examined repair as a distinct phenomenon within the CE rather than as part of the broader family of value-retention strategies. To maintain conceptual precision, the search explicitly focused on the term 'repair' in article titles published from 2014 to 2024. Although related concepts such as repairability, maintenance, refurbishment, product longevity and service life extension are closely connected to repair, they encompass broader technical, organisational and economic processes that extend beyond the scope of this review. Including these terms would have substantially increased conceptual heterogeneity and shifted the focus from repair itself to the wider value-retention literature. Accordingly, the following search string was applied in Scopus:

TITLE (repair) AND TITLE-ABS-KEY ('circular economy').

The search returned 163 records. While this strategy may exclude studies that discuss repair indirectly under alternative terminology, it provides a focused and analytically coherent dataset centred on repair as the primary object of investigation.

3.2 | Step 2: Source Selection

The screening process followed established systematic review principles to enhance transparency and replicability. Studies were included if they: (i) explicitly addressed repair activities, repair systems or repair-related practices; (ii) were situated within the CE or closely related sustainability contexts; (iii) were

published as peer-reviewed journal articles; and (iv) provided conceptual, empirical or policy-relevant insights into repair. Studies were excluded if they (i) focused primarily on adjacent CE strategies, including recycling, remanufacturing, refurbishment, maintenance or reverse logistics, where repair was not the primary phenomenon of interest; (ii) examined repairability solely as a product design attribute in a very technical way without addressing repair implementation, services or ecosystem interactions; (iii) referred to repair in unrelated domains (e.g., medical procedures); or (iv) were not published in English. Screening was conducted in three stages: removal of duplicate and ineligible records, title and abstract screening, and full-text assessment. Applying these criteria reduced the dataset from 163 to 102 articles. Following the exclusion of 11 review papers, 91 articles remained for further evaluation. The screening process is summarised in Figure 1.

3.3 | Step 3: Source Evaluation

The remaining articles were assessed for their relevance to repair within the CE. Relevance was determined through abstract and full-text review to ensure that each study made a substantive contribution to understanding repair practices, actors, systems, business models or policy contexts. Articles that referred to repair only tangentially or without meaningful engagement with repair processes were excluded (e.g., Bunodiare et al. 2024; Huang et al. 2024; Mahmoudi et al. 2024). This resulted in a final sample of 79 articles.

3.4 | Step 4: Data Analysis

The final dataset was analysed using bibliometric analysis, qualitative content analysis and actor-network analysis. These methods enabled the identification of dominant research themes, actor relationships and emerging research gaps. The qualitative analysis followed an iterative and abductive coding process. A structured data extraction framework was developed to record key study characteristics, including research themes, objectives, methods, theoretical foundations, principal findings, policy implications and identified research gaps. Open coding was first used to identify recurring concepts related to repair activities, actors, enabling and constraining factors, organisational practices, and institutional conditions. Through iterative comparison and refinement, these codes were consolidated into higher-order themes. Three overarching domains emerged from the analysis: (i) user and community practices; (ii) product design, manufacturing and business models; and (iii) policy and governance. These domains formed the basis for the thematic synthesis presented in the findings.

The content analysis was complemented by bibliometric and actor-network analyses. Bibliometric analysis was used to map research clusters through keyword co-occurrence using VOSviewer,² while actor-network analysis examined relationships between stakeholders discussed in the literature. Actors were grouped into functional categories and visualised using Gephi,³ where node size represents actor prominence and edge thickness reflects the frequency of co-occurrence across studies. Although formal inter-coder reliability statistics were

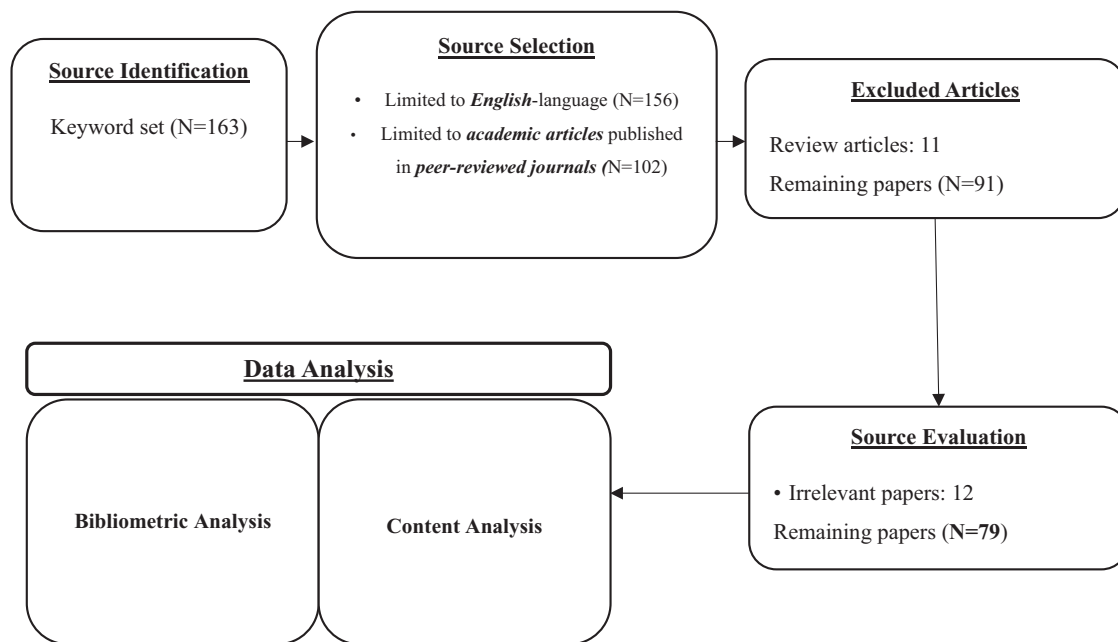


FIGURE 1 | Research methodology.

not calculated, analytical consistency was supported through iterative review and refinement of the coding framework, repeated comparison of emerging categories with the source articles and re-examination of coded studies to ensure that the final themes and actor groupings were consistently applied and remained grounded in the reviewed literature. Therefore, repeated review and refinement of the coding framework enhanced analytical consistency and strengthened the robustness of the findings.

4 | Findings

This section presents the findings of the systematic review and synthesises the evidence from the 79 selected studies through three stages. The three analytical approaches are complementary and collectively address the research questions. First, the bibliometric analysis provides a high-level overview of how repair research has evolved and identifies the dominant policy, design, technological, and organisational themes within the CE literature, thereby establishing the conceptual landscape underpinning RQ1. Second, the qualitative content analysis examines how these themes have been investigated, synthesising evidence on the policy, design, organisational, and institutional factors that shape repair systems while identifying the key barriers and enablers influencing their implementation and scaling, thereby addressing RQ1 and RQ3. Third, the actor-network analysis explores the relationships between key stakeholders involved in repair activities, revealing patterns of interaction, coordination and interdependence across the repair ecosystem. This directly addresses RQ2 while also providing insights into the ecosystem conditions that facilitate or constrain the scaling of repair practices (RQ3). These analyses provide an integrated understanding of how repair systems are structured, governed and scaled within CE. They move beyond isolated descriptions of repair practices and reveal the broader patterns, interdependencies and institutional conditions that shape repair systems. The

findings culminate in a conceptual framework that integrates these insights and provides a system-level understanding of repair within CE.

4.1 | Mapping the Repair Literature (Bibliometric Analysis)

Keywords co-occurrence analysis was conducted using VOSviewer to map the intellectual structure of repair research. Author keywords were extracted from the Scopus records of the 79 included studies yielding 145 unique keywords. Given the focused corpus and the exploratory purpose of the analysis the minimum occurrence threshold was set to one. This enabled less frequently occurring concepts which may represent specialised or emerging areas of repair research to remain eligible for inclusion. Keywords with no co-occurrence links to other terms were subsequently excluded from the network visualisation as isolated terms cannot contribute to identifying relational patterns through co-occurrence analysis. Figure 2 presents the resulting connected author-keyword network. Node and label sizes are weighted by keyword occurrence frequency with larger nodes representing terms that appear more frequently across the reviewed studies. Links indicate that two keywords co-occur within the same publication while link thickness represents the strength of this relationship with thicker links indicating more frequent co-occurrence. Node colours represent clusters generated by VOSviewer based on patterns of association among connected keywords. The visualisation therefore captures both the relative prominence of concepts within the literature and the relationships that connect different areas of repair research.

The network reveals a diverse but interconnected knowledge structure organised predominantly around the central concepts of 'circular economy' and 'repair'. Their prominent positions and extensive connections indicate that they provide important points of convergence among otherwise more specialised

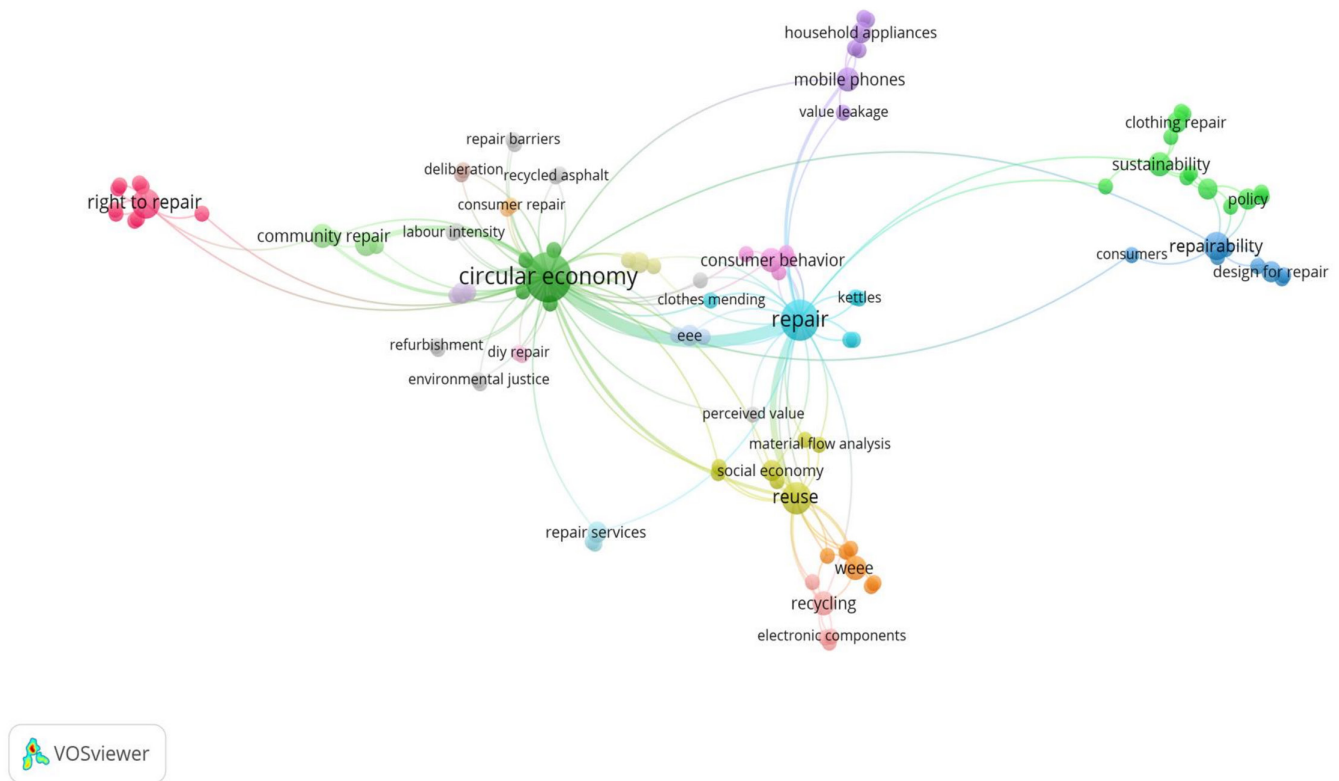


FIGURE 2 | Author-keyword co-occurrence network of repair research within the circular economy. *Note:* Node and label size represent keyword occurrence frequency; link thickness indicates the strength of keyword co-occurrence; and node colours represent clusters generated by VOSviewer. Isolated keywords with no co-occurrence links are not displayed.

areas of inquiry. Consumer- and community-oriented research is reflected in connections with concepts such as ‘consumer behaviour’, ‘community repair’, ‘DIY repair’, ‘clothes mending’, and ‘perceived value’. Product and technological perspectives are represented through ‘repairability’, ‘design for repair’, ‘household appliances’, ‘mobile phones’, and ‘electronic components’. Repair is also connected to wider circular value-retention and material-flow strategies through terms including ‘reuse’, ‘refurbishment’, ‘recycling’, ‘WEEE’, and ‘material flow analysis’. Policy and institutional concerns are visible through ‘Right to Repair’, ‘policy’, ‘sustainability’ and ‘environmental justice’, while the presence of ‘repair services’ and ‘repair barriers’ points to the practical and infrastructural conditions surrounding repair.

Two insights from this mapping are particularly relevant to the objectives of the review. First, repair research spans multiple technical, behavioural, community, organisational and institutional areas rather than constituting a single, clearly bounded research stream. Second, the connections across these areas suggest that repair is inherently relational: product design and repairability intersect with consumer behaviour and service provision, while repair practices are situated within wider value-retention strategies and policy environments. At the same time, the dispersed structure of the network indicates that these dimensions have largely developed through different areas of inquiry, reinforcing the need for an integrative examination of how they interact within repair systems. The bibliometric analysis therefore provides an initial response to RQ1 by mapping the principal areas through which the design, policy

and institutional conditions surrounding repair have been investigated. However, keyword co-occurrence can identify the structure and connectivity of the literature but cannot, on its own, explain the substantive mechanisms underlying these relationships, the roles and interdependencies of actors (RQ2), or the barriers and enabling conditions influencing the scaling of repair (RQ3). These questions are examined through the subsequent qualitative thematic synthesis and actor-level analysis.

4.2 | Repair as a Multi-Actor System

To complement the thematic analysis, an actor-network analysis was conducted to examine how repair is conceptualised as a system of interacting stakeholders (Table 2). Rather than focusing solely on individual actors, the analysis explores the relationships, interdependencies, and coordination mechanisms that enable or constrain repair activities. The resulting network, therefore, represents an analytical map of how repair systems are portrayed in the literature rather than a direct representation of real-world interactions. Figure 3 visualises the network actors derived from the 79 reviewed articles. In total, 64 stakeholders were identified and grouped into 15 functional categories spanning industrial, policy, civil society, educational and infrastructural domains. Node size represents the frequency with which an actor appears in the literature, while edge thickness reflects the strength of co-occurrence between actors across studies. These relationships provide insight into the relative prominence of actors and the degree of integration between different parts of the repair system.

TABLE 2 | Repair ecosystem layers, main stakeholders and actors.

Layer	Main stakeholders	Actors
Core actors	Consumers, social groups	Consumers/citizens
	Manufacturers, OEMs, brands, corporations, SMEs, retailers, designers, fast fashion, traders, products	Producers, brand owners, retailers
	Independent/professional repairers, repair businesses, repair centres, repair cafés	Repair providers
	Policymakers, EU commission, government bodies, municipalities, judiciary, standards bodies, international organisations, advisory boards	Policymakers and institutions
	NGOs, advocacy and right-to-repair groups, civil society, activists	Civil society and advocacy
Supporting/intermediary actors	Community initiatives, repair volunteers	Community actors
	Charity shops, second-hand shops, thrift shops, reuse centres, junk shops, refurbishers	Reuse and resale sector
	Donors, funders, investors	Funders and investors
	Insurance companies	Service intermediaries
	General education, schools, universities, students, jobseekers, researchers	Education and training sector
	Media, artists, cultural and creative institutions, awareness campaigns	Cultural and awareness actors
Peripheral/infrastructure players	Recyclers, waste pickers, waste management companies	End-of-life actors
	Digital platforms, online communities, data infrastructures	Digital and knowledge infrastructures
	Technology and telecom providers, spare parts suppliers	Technology and infrastructure providers
Contextual/structural elements (not actors per se)	Subsidy schemes, international reforms, copyright and IP law, social infrastructure, repair documentation, marketing	Policies, norms and context

The network reveals that repair research is concentrated around three highly connected actor groups: consumers, manufacturers and policymakers. Consumers occupy the central position, reflecting the strong emphasis on repair behaviour, motivations and decision-making in the literature. Manufacturers form a second major hub through their influence on repairability, product design, spare-part availability and service provision. Policymakers constitute a third central cluster, reflecting increasing attention to regulatory initiatives such as R2R legislation and Ecodesign requirements. Beyond these core actors, the analysis identifies a broader set of stakeholders that contribute to the functioning of repair systems. These include repair providers, civil society organisations, community initiatives, educational institutions, funders, insurers, reuse organisations and digital knowledge infrastructures. These actors provide the skills, resources, information and co-ordination mechanisms required to support repair activities. However, their positions within the network are comparatively

peripheral, indicating limited attention within the existing literature. The distribution of actors across the network reveals a notable imbalance in research focus. While manufacturers, consumers and policymakers dominate scholarly discussions, enabling actors such as insurers, educators, funders, digital platforms, repair café ecosystem and infrastructure providers are rarely examined. Similarly, relatively little attention is paid to the roles of service intermediaries, spare-part suppliers and informal repair networks, despite their importance in facilitating repair activities. This suggests that repair continues to be framed primarily as a behavioural or regulatory challenge, rather than as a broader system of interconnected actors and supporting infrastructures.

The analysis therefore highlights the need to move beyond actor-specific explanations toward a more systemic understanding of repair. Repair outcomes are shaped not only by consumer choices or policy interventions, but also by the

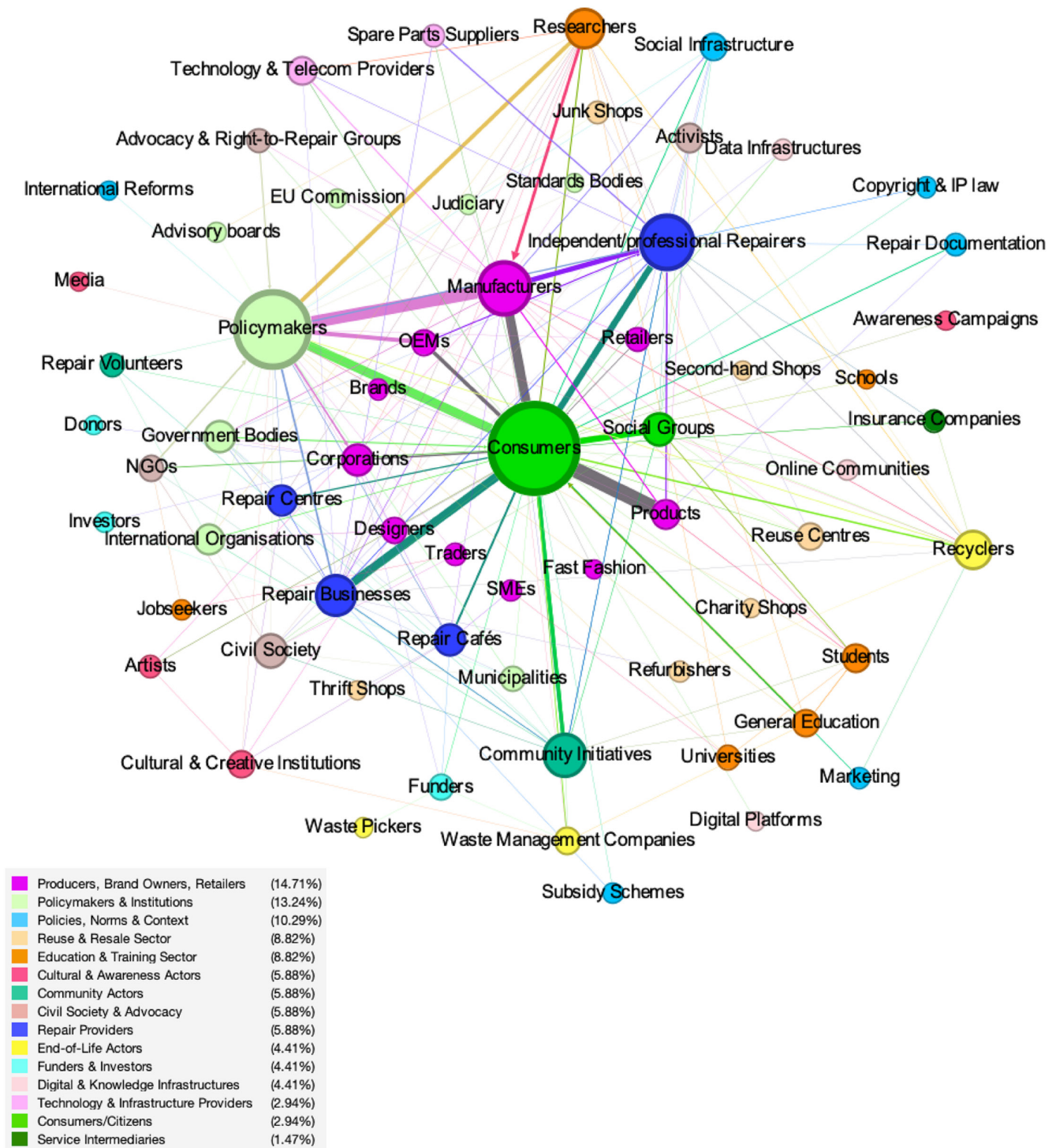


FIGURE 3 | Actor network of the repair literature.

alignment of design practices, business models, service networks, knowledge infrastructures and institutional support mechanisms. The network demonstrates that repair depends on coordination among multiple actors, whose contributions remain unevenly represented in the literature. These findings reinforce the view that repair should be understood as a multi-actor system embedded within wider socio-technical and institutional contexts.

4.3 | Thematic Domains of Repair Research

A structured extraction framework was used in Excel Worksheet to record study characteristics including research objectives, methods, theoretical foundations, principal findings, policy implications, research gaps and other relevant contextual attributes. Open coding was then applied to identify recurring concepts relating to repair activities, actors,

TABLE 3 | Key identified themes from the literature.

Domain	Key theme	Representative findings	Key gaps/limitations (reported by authors)
User and community practices	Consumer behaviour	(Korsunova et al. 2023; Lundberg et al. 2024; Maguire and Fahy 2022; McQueen et al. 2022, 2023; Rogers et al. 2021; Sandez et al. 2023)	Few longitudinal/field studies; limited revealed-behaviour data; the Global South is underrepresented.
	Motivations and drivers	(Diddi and Yan 2019; Fachbach et al. 2022; Jaeger-Erben et al. 2021; Nazlı 2021; Parajuly et al. 2024)	Overreliance on surveys and limited experiments; heterogeneity across products is not well modelled.
	Perceived value of repair	(Arias et al. 2024; Bayraktaroğlu and İdemen 2024; Russell and Nasr 2023; Sabbaghi and Behdad 2018)	Sparse pricing elasticity evidence; few studies of insurer roles or warranties; limited cost-to-serve data.
	Community and grassroots	(Colombijn and Egboko 2023; Luukkonen and van den Broek 2024; Spekkink et al. 2022; van der Velden 2021)	Scale and durability uncertain; funding fragile.
Product design, manufacturing and business models	Collaboration and alignment	(Gobert et al. 2021; Gobert and Allais 2021; Vallet et al. 2024)	Few comparative governance studies; limited measurement of user fit.
	Barriers and timing	(Hernandez et al. 2020; Laitala et al. 2021; Purkiss et al. 2024; Rudolf et al. 2022; Russell and Nasr 2023; Wagner et al. 2021)	Fragmented evidence; few time-series datasets.
	Design-led repair	(D'Urzo and Campagnaro 2023; Hernandez et al. 2020; Terzioğlu and Wever 2021; van den Berge et al. 2023; Wehbie and Semetey 2022)	Limited sector comparisons; OEM compliance seldom evaluated; standards uptake uneven.
	Transformative/creative repair	(Keulemans 2023)	Primarily qualitative case work; unclear diffusion potential.
	Business models and services	(Arredondo-Soto et al. 2022; Lechner et al. 2024; Reimann 2024; Türkeli et al. 2019; van der Velden et al. 2023)	Limited operational data (throughput, margins); supply-chain/parts access constraints persist.
	Resilience	(Cobra et al. 2023)	Single-country case; IP/liability barriers unresolved.
Optimisation and analytics	Product-specific insights	(Jayasiri and Herat 2024; Laitala et al. 2021; Purkiss et al., 2024; Ravindran et al. 2024; Vandekerckhove et al. 2021)	Patchy sector coverage; few comparative LCAs across repair options.
	Optimisation and analytics	(Karagiannopoulos et al. 2022, 2024)	Mostly prototype models; limited deployment in practice.
	Triple bottom line impacts	(Brusselaers et al. 2020; Gouveia et al. 2022; Jerome et al. 2023; Llorente-González and Vence 2020; Píbul et al. 2023; Priarone et al. 2021; Rogers et al. 2024; Sandez et al. 2024; Zakharova et al. 2023)	Social metrics are scarce; negative externalities in informal sectors are under-regulated.

(Continues)

TABLE 3 | (Continued)

Domain	Key theme	Representative findings	Key gaps/limitations (reported by authors)
Policy and governance	Policy and regulation	(Barkhausen et al. 2024; Barros and Dimla 2023; Blanco-Espeleta et al. 2024; Faludi et al. 2024; Hernandez et al. 2020; Jayasiri and Herat 2024; Lechner et al. 2021; Lloveras et al. 2024; Manwaring 2024; Nagase and Uehara 2024; Rosborough et al. 2023)	Lack of ex-post evaluations; weak linking of R2R with EPR; limited cross-country comparisons.
	Political economy of repair	(Ampe 2024; Graziano and Trogal 2023; Niskanen et al. 2021; Niskanen and McLaren 2023)	Northern bias; limited labour/justice metrics; scarce policy co-design with workers.

organisational practices, enabling and constraining factors, and institutional conditions; through iterative comparison and refinement, conceptually related codes were consolidated into three higher-order knowledge domains (as presented in Table 3): (i) user and community practices; (ii) product design, manufacturing and business models; and (iii) policy and governance. Although often studied separately, the findings suggest that repair outcomes are shaped by interactions across all three domains.

a. User and Community Practices

b. Product Design, Manufacturing and Business Models

Research on users and communities represents one of the largest strands of repair scholarship. Studies consistently show that repair behaviour is influenced by practical considerations such as cost, convenience, skills, access to tools and availability of repair services, often more strongly than environmental attitudes alone (Ackermann 2018; Laitala et al. 2021; van den Berge et al. 2023). An intention–action gap is frequently observed, indicating that positive attitudes towards repair do not necessarily translate into behaviour (Wieser and Tröger 2016). Recent studies have increasingly adopted systems-oriented perspectives, highlighting the importance of enabling infrastructures and supportive environments (Djeunang Mezafack et al. 2022; Sonogo et al. 2022). Community initiatives such as Repair Cafés and repair workshops contribute to skill development, social learning and the normalisation of repair practices (Charter and Keiller 2014; Parajuly et al. 2024). However, their long-term impact is often constrained by limited funding, reliance on volunteers and weak connections to formal policy and industry structures (Bradley and Persson 2022; Djeunang Mezafack et al. 2022). The literature demonstrates that repair behaviour is socially embedded, although evidence remains concentrated in high-income countries and relies heavily on self-reported data.

A second domain focuses on product design, manufacturing practices and business models. Design for repair, including modularity, ease of disassembly, access to spare parts and repair documentation, is consistently identified as a key enabler of repair (Bakker et al. 2014; Bovea and Pérez-Belis 2018; Cordella et al. 2018, 2019). However, the literature also shows that reparability is shaped by broader organisational decisions relating to pricing, warranties, software restrictions and control over repair information (Charter and Keiller 2014). These findings suggest that repair extends beyond technical design and can be understood as an organisational capability involving service provision, reverse logistics, knowledge management and ecosystem coordination (Bocken et al. 2016; Stahel 2016). Despite growing interest in product-service systems and repair services, research on business models remains limited. In particular, there is little evidence on how firms operationalise repair within broader value-retention strategies or leverage repair as a source of competitive advantage (Bocken et al. 2016; Konietzko et al. 2020).

c. Policy and Governance

The third domain examines the role of policy and governance in enabling repair. Regulatory initiatives such as

R2R legislation, Ecodesign requirements and repairability indices have received increasing attention as mechanisms for addressing structural barriers to repair (Charter and Keiller 2014; Djeunang Mezafack et al. 2022; European Commission 2016). However, most studies focus on policy design rather than implementation or effectiveness (Djeunang Mezafack et al. 2022; Sonogo et al. 2022). Extended producer responsibility (EPR) receives comparatively little attention despite its potential to align producer incentives with repairability and product longevity (Lifset and Lindhqvist 2008). The literature also highlights tensions between policy objectives and commercial interests, particularly around intellectual property, liability, software restrictions and product safety (Jin et al. 2023; Maitre-Ekern and Dalhammar 2016; Rivera and Lallmahomed 2016). These findings suggest that policy interventions alone are insufficient to scale repair without complementary changes in business practices, service infrastructures and user capabilities.

Across all three domains, a common pattern emerges: Repair is rarely examined as an integrated system. User-focused research emphasises behavioural barriers, design-oriented studies focus predominantly on technical enablers, and policy research concentrates on regulatory interventions, while relatively few studies examine how these dimensions interact (Djeunang Mezafack et al. 2022; Sonogo et al. 2022). This fragmentation limits understanding of how repair systems function and scale, highlighting the need for an integrated perspective that connects organisational capabilities, ecosystem actors, institutions and value-retention processes within a common analytical framework. From a business strategy perspective, this synthesis also suggests that firms could move beyond treating repair primarily as an operational, after-sales or regulatory compliance activity and instead consider developing it as a strategic organisational capability. Such a capability would require firms to integrate repair considerations across product design, service provision, spare-parts availability, reverse logistics, customer relationships, business models and ecosystem partnerships. When these activities are deliberately coordinated, repair may enable firms not only to retain product and resource value but also to strengthen customer relationships, develop differentiated service propositions, enhance resilience to regulatory and resource pressures, and potentially create sources of competitive differentiation. Repair should therefore be considered not simply as an environmental intervention, but as a potential component of circular business strategy whose value depends on firms' ability to develop and coordinate the organisational and inter-organisational capabilities required to support it.

4.4 | Towards a Conceptual Framework of Repair Systems

The preceding bibliometric, thematic and actor-network analyses collectively demonstrate that repair is not simply a technical activity or an individual behaviour, but a system-level phenomenon shaped by interactions among firms, users, repair providers, policymakers and supporting infrastructures (Charter and Keiller 2014; Sonogo et al. 2022). While previous studies have generated valuable insights into specific aspects of repair, they have largely examined repair through isolated

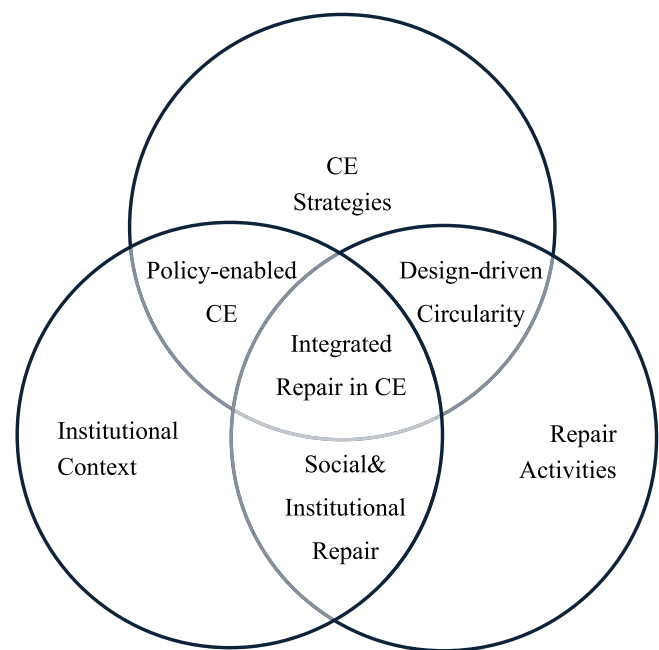


FIGURE 4 | Conceptual framework of repair in CE.

perspectives, including product design (Bakker et al. 2014; Cordella et al. 2019), consumer behaviour (Ackermann 2018; Wieser and Tröger 2016) or regulation (Djeunang Mezafack et al. 2022; European Commission 2016). Consequently, limited attention has been paid to how these dimensions interact to shape repair systems within the circular economy. Building on the evidence synthesised in this review, Figure 4 presents an integrative conceptual framework that explains how repair systems emerge through the interaction of strategic, organisational and institutional dimensions.

The framework is derived inductively from the synthesis of the 79 reviewed articles and interpreted through a system-level perspective, drawing particularly on socio-technical transitions and innovation systems research, which conceptualises sustainability transitions as emerging from interactions among technological, organisational and institutional elements rather than from isolated interventions (Edquist 2009; Geels 2001, 2004). The framework comprises three interdependent dimensions: (i) circular economy strategies, (ii) repair activities and ecosystem actors and (iii) institutional and infrastructural conditions. Their interaction highlights that effective repair depends not only on the technical capacity to restore product functionality, but also on firms' ability to integrate repair into organisational processes and coordinate with actors and conditions across the wider repair ecosystem. Building on this synthesis, we introduce the concept of strategic repair capability, defined as an organisation's capacity to purposefully mobilise, integrate and reconfigure resources, competences, processes and external relationships to embed repair as a value-retention strategy across the product lifecycle. This capability extends beyond operational repair activities by integrating repair-oriented product design, service provision, spare-parts availability, reverse logistics, customer relationships, business models and ecosystem partnerships. Strategic repair capability is therefore organisationally developed but ecosystem-dependent: Its effective development and deployment depend on coordination with repair providers,

consumers, supply-chain partners, policymakers, intermediaries, and supporting infrastructure and institutions.

The first dimension, circular economy strategies, represents the strategic rationale for repair. The literature consistently positions repair as an inner-loop value-retention strategy that preserves product functionality while requiring fewer material and energy inputs than remanufacturing or recycling (Kirchherr et al. 2017; Potting et al. 2017; Stahel 2016). Beyond its environmental benefits, repair is increasingly recognised as supporting product longevity, resource productivity and circular business models (Bocken et al. 2016; Konietzko et al. 2020). These studies suggest that repair should not be viewed merely as an operational activity but as a strategic mechanism through which organisations retain value, respond to regulatory pressures and contribute to CE transitions.

The second dimension, repair activities and ecosystem actors, captures the operational processes through which repair is implemented. The review identifies a diverse ecosystem comprising manufacturers, repair providers, users, community organisations, policymakers, educators, intermediaries and digital platforms (Charter and Keiller 2014; Corsini et al. 2022). Across the literature, repair outcomes are shown to depend on interactions among these actors rather than on the actions of any single stakeholder. Product repairability, access to spare parts, technical knowledge, repair services, information sharing and user engagement collectively influence the feasibility and effectiveness of repair (Bakker et al. 2014; Cordella et al. 2019). Building on these findings, the framework conceptualises repair as an ecosystem capability that emerges through coordination across organisational boundaries rather than residing within individual organisations.

The third dimension, institutional and infrastructural conditions, represents the broader regulatory, economic, and social environment within which repair systems operate. The literature identifies regulatory initiatives such as R2R legislation, Ecodesign requirements, repairability indices, and R2R as important mechanisms for improving repairability and encouraging longer product lifetimes (Djeunang Mezafack et al. 2022; European Commission 2016). Equally important are enabling infrastructures, including spare-part supply chains, repair information systems, digital platforms, repair service networks, educational initiatives and community repair organisations that provide the knowledge, resources and capabilities necessary to support repair activities (Charter and Keiller 2014; Parajuly et al. 2024). These institutional arrangements shape the opportunities and constraints facing firms and users.

The explanatory value of the framework lies in the interactions between these three dimensions rather than within any individual component. The overlap between CE strategies and institutional conditions represents a policy-enabled circular economy, where regulatory frameworks translate CE objectives into organisational and market incentives. Policy instruments such as R2R legislation, Ecodesign requirements, repairability indices and R2R encourage firms to integrate repair into product design, service provision and lifecycle management (European Commission 2016). This interaction explains how policy creates the institutional conditions under which repair becomes economically and organisationally viable.

The intersection between circular economy strategies and repair activities represents design-driven circularity, where strategic CE objectives are translated into operational practices. The literature consistently demonstrates that repairability depends on modular product architecture, ease of disassembly, access to spare parts, repair documentation and service design (European Commission 2016). At the organisational level, this intersection also encompasses business model innovations such as repair services, product-service systems, warranty strategies and lifecycle management approaches that embed repair within broader value-retention strategies (Bocken et al. 2016; Konietzko et al. 2020). These mechanisms explain how strategic intentions are operationalised through organisational capabilities.

The overlap between repair activities and institutional conditions reflects social and institutional repair practices. The literature demonstrates that repair behaviour depends not only on technical feasibility but also on access to skills, repair knowledge, community support, cultural norms and enabling infrastructures (Ackermann 2018; Laitala et al. 2021; Wieser and Tröger 2016). Community initiatives, including Repair Cafés, educational programmes, repair workshops and digital knowledge-sharing platforms, play an important role in developing repair capabilities and expanding participation in repair activities (Charter and Keiller 2014; Corsini et al. 2017). This interaction highlights the importance of social learning and institutional support in sustaining repair systems.

At the centre of the framework lies integrated repair within the CE, where the three dimensions reinforce one another. Building on the evidence synthesised in this review, the framework proposes that strategic repair capability emerges when CE strategies provide strategic direction, ecosystem actors coordinate repair activities and institutional conditions create an enabling environment. In such systems, organisations develop repair-oriented design and service capabilities, users have access to repair infrastructure and knowledge, and policy frameworks reinforce value-retention objectives. Conversely, where these dimensions are misaligned, for example, when supportive regulation exists without business incentives, repairable products lack service infrastructure, or motivated users have limited access to repair services, the ability to scale repair remains constrained.

Rather than viewing repair as the responsibility of individual actors or isolated interventions, the framework conceptualises repair as a strategic ecosystem capability that emerges through the alignment of organisational capabilities, ecosystem relationships and institutional conditions. In doing so, it provides an integrative explanation of how repair systems operate within the CE and offers a theoretical foundation for future research on business strategy, ecosystem governance and value-retention systems.

5 | Discussion

The findings extend existing repair scholarship by showing that the technical, behavioural, organisational and institutional dimensions identified across previous studies are not independent determinants of repair but interconnected conditions that collectively shape whether repair can

be implemented and scaled. Existing research has established the importance of repairable product design and access to spare parts (Barros and Dimla 2023; Blanco-Espeleta et al. 2024), consumer motivations and perceived value (Arias et al. 2024; Diddi and Yan 2019), community and DIY repair practices (Bayraktaroğlu and İdemen 2024; Colombijn and Egboko 2023) and repair-related policy interventions. However, previous reviews have generally concentrated on particular elements of this system, including repair shops (Djeunang Mezafack et al. 2022), consumer repair behaviour and institutional initiatives (Sonego et al. 2022), Repair Cafés (Moalem and Mosgaard 2021), and national repair economies (Purkiss et al. 2024).

Our synthesis connects these strands and suggests that the effectiveness of repair depends on their alignment. A technically repairable product has limited circular value if consumers lack access to affordable repair services, spare parts or information; consumer willingness has limited effect where manufacturers restrict repairability or service access; and regulatory interventions may have limited impact where firms and repair infrastructures lack the capabilities required for implementation. This interpretation is consistent with socio-technical perspectives in which sustainability transitions arise through interactions among technologies, actors, institutions and infrastructures rather than isolated interventions (Geels 2001, 2004). It also resonates with innovation systems research emphasising knowledge exchange, institutional support and interactions among heterogeneous actors (Edquist 2009; Lundvall 2010). The contribution of this review is therefore to bring these previously dispersed repair-specific insights together and demonstrate their interdependence within a common analytical framework.

From this synthesis, we further propose that firms should consider repair not solely as an environmental practice, after-sales function or response to regulation, but as a strategic repair capability. Building on dynamic capability theory (Teece et al. 1997), this refers to an organisation's capacity to mobilise, integrate and reconfigure design, service, operational and relational resources to embed repair as a value-retention strategy across the product lifecycle. However, this capability is organisationally developed but ecosystem-dependent: Firms cannot realise repair outcomes independently of repair providers, consumers, supply-chain partners, policymakers, knowledge infrastructures and other supporting actors. This distinction provides the basis for the discussion that follows.

5.1 | Repair as a Strategic Organisational Capability

Much of the repair literature has approached the firm primarily through the technical characteristics of products. Studies of repairability, for example, demonstrate how industrial design decisions, disassembly, component accessibility and repairability indices influence the practical possibility of repair (Barros and Dimla 2023; Blanco-Espeleta et al. 2024). Other research has connected repair with product-service systems and value preservation (Arredondo-Soto et al. 2022). These studies establish an important technical foundation, but our

synthesis indicates that design for repairability is necessary but insufficient for developing strategic repair capability. The ability to design a repairable product does not itself ensure that repair will be economically accessible, operationally supported or integrated into the firm's value proposition. This distinction extends repair research from product-level repairability towards organisation-level capability. From a dynamic capability perspective, competitive responses to changing environments depend not simply on possessing individual resources but on organisations' capacity to integrate and reconfigure resources and competences (Teece et al. 1997). Applied to repair, our findings suggest that firms need to connect repair-oriented design with diagnostics, spare-parts provision, after-sales services, warranties, reverse flows, customer relationships, knowledge management and external repair partnerships. Repair capability is therefore multidimensional rather than exclusively technical.

This interpretation also has implications for how firms respond to the transition towards CE. Repair can be approached defensively, as a compliance activity requiring firms to satisfy minimum regulatory requirements, or more strategically, by integrating repair into broader value-retention and customer-service propositions. The latter is consistent with research demonstrating the potential of repair and related product-service strategies to preserve product value rather than relying primarily on replacement and downstream material recovery (Arredondo-Soto et al. 2022). Repair may consequently create opportunities for differentiated services, prolonged customer relationships and greater retention of product value. However, the existing repair literature provides insufficient empirical evidence to conclude that repair capability necessarily produces sustained competitive advantage. An important extension of this review is therefore to identify this as a strategic management question: Under what organisational, market and institutional conditions do strategic repair capability translate into competitive differentiation and superior value creation? The distinction is consequential for business strategy. Rather than assigning repair solely to after-sales or sustainability functions, firms seeking to develop strategic repair capability may need to coordinate decisions across product development, operations, supply chains, customer services and external partnerships. Repair consequently becomes a question of organisational configuration and capability development rather than simply technical feasibility.

5.2 | Governance and Ecosystem Coordination

The second major insight concerns the distributed nature of repair. The actor analysis identified 64 stakeholders across 15 functional categories, while showing that scholarly attention remains concentrated around consumers, manufacturers and policymakers. Supporting actors including repair providers, educators, insurers, funders, community organisations and digital knowledge infrastructures are considerably less prominent in the literature. This pattern is consistent with earlier research suggesting that repair cannot be reduced to individual consumer decisions or product characteristics. Djeunang Mezafack et al. (2022), for example, identify the need to better integrate repair shops into CE strategies, while Purkiss

et al. (2024) point towards the need for a more coordinated, system-level approach to developing the repair economy. Previous research on Repair Cafés similarly demonstrates the importance of stakeholder relationships, knowledge exchange and community infrastructures (Colombijn and Egboko 2023; Moalem and Mosgaard 2021).

Our findings extend these observations by positioning ecosystem coordination as a condition for the development and deployment of strategic repair capability. Manufacturers control important resources such as product architecture, diagnostic information and, in many cases, spare parts; professional and independent repairers contribute technical expertise and service capacity; consumers determine whether repair opportunities are taken up; policymakers establish regulatory conditions; and community and educational organisations contribute skills, repair literacy and cultural legitimacy. None of these actors independently controls all the resources required for repair.

This creates a governance problem. The central challenge is not simply whether relevant actors exist, but whether their resources, incentives and activities are sufficiently aligned. The critical and community-oriented literature provides particularly important evidence here. Research on Repair Cafés demonstrates that community initiatives can extend product lifetimes while simultaneously supporting learning, social interaction and repair culture (Colombijn and Egboko 2023), while facilitated DIY repair has been conceptualised as a process of value co-creation between users and supporting actors (Bayraktaroğlu and İdemen 2024). At the same time, critical accounts caution against overly technocratic interpretations of repair that overlook political, social and distributional dimensions (Ampe 2024; McLaren et al. 2020). Repair ecosystems should therefore not be understood simply as efficient networks for delivering repair services; they also involve questions about who controls repair knowledge and resources, who performs repair work, who bears its costs and who captures the resulting value.

These findings refine the answer to RQ2 and RQ3. The relevant issue is not merely identifying actors within repair systems but understanding the interdependencies through which repair resources and capabilities are distributed across organisational boundaries. Although previous studies identify numerous individual barriers and enablers to repair, the synthesis suggests that scalability depends less on any single intervention than on the complementarity of conditions across the repair system. Design for repair requires accessible service infrastructure; consumer willingness requires affordable and convenient repair options; repair providers require access to parts, information and skills; and regulation requires organisational and ecosystem capacity for implementation. Scaling repair should therefore be understood as a coordination problem in which technical, organisational, behavioural and institutional enablers must reinforce one another. Future governance research should consequently investigate mechanisms such as shared repair infrastructures, industry standards, knowledge-sharing arrangements, collaborative service networks and public-private-community partnerships,

while examining how power and value are distributed within these arrangements.

5.3 | Business Model and Governance Implications

The findings also contribute to discussions concerning circular business models by positioning repair as a mechanism of value retention rather than simply waste avoidance. CE frameworks have long distinguished strategies that preserve products and their embedded value from downstream approaches that recover materials after product value has been lost (Kirchherr et al. 2017; Potting et al. 2017). Repair is particularly significant within this hierarchy because it seeks to restore functionality while retaining much of the existing product structure. Empirical work similarly demonstrates the potential contribution of repair and product-service approaches to value preservation (Arredondo-Soto et al. 2022), while studies of consumer repair strategies indicate that repair decisions also have important economic consequences (Brusselaers et al. 2020). Relevant repair studies included in the review explicitly address product-service systems, value preservation and the economic consequences of consumer repair strategies.

Our review nevertheless reveals a tension between the circular logic of extending product life and conventional business models dependent on product replacement. This helps explain why improving technical repairability alone may not generate widespread repair. Firms also need mechanisms to create and capture value from longer product lifecycles. Repair services, warranties, service contracts, spare-parts provision, upgrade pathways and other product-service arrangements may therefore become important components of circular value propositions. This has a direct managerial implication. Businesses should consider whether repair can be incorporated proactively into their competitive and value-creation strategies rather than treated only as a cost or compliance requirement. Firms could, for example, integrate repairability considerations during product development, establish accessible repair and spare-parts systems, develop relationships with authorised and independent repair networks, and use repair services to maintain longer-term customer relationships. Such approaches may support differentiation around durability, service quality and lifecycle value.

The strategic opportunity, however, is likely to vary across sectors, product characteristics and customer segments; establishing the conditions under which repair-oriented business models generate both environmental and commercial value therefore remains an important empirical research priority. The actor analysis further broadens the business-model discussion by identifying actors rarely incorporated into existing models of repair. Insurers could influence repair-versus-replacement decisions; educators can contribute to technical skills and repair literacy; digital platforms can reduce information asymmetries; funders can support repair infrastructure; and community organisations can provide distributed access and knowledge. Their peripheral position in the reviewed literature suggests that current conceptualisations of circular business models may underestimate the ecosystem architecture required to make repair accessible and scalable. This represents an important extension

TABLE 4 | Future research agenda.

Research priority	Key questions
Policy effectiveness and governance	How do repair-related policies (e.g., R2R, EPR, reparability indices, subsidies) influence firm behaviour, consumer outcomes, and resource efficiency? What governance arrangements best align incentives across actors?
Repair as a strategic organisational capability	How do firms integrate repair into product design, business models, supply chains, and service systems? What capabilities differentiate compliance-driven approaches from repair-led value retention strategies?
Repair ecosystems and infrastructure	How do manufacturers, repair providers, insurers, educators, community organisations, and digital platforms interact to enable repair? What ecosystem configurations support scaling and long-term viability?
Inclusive and global repair systems	How do repair practices operate in informal economies and Global South contexts? What are the implications for labour, skills, justice, and sustainable transitions?

from firm-centric circular business models towards ecosystem-level value creation and governance.

6 | Conclusion

This study systematically reviewed 79 peer-reviewed articles to examine how repair is conceptualised and enabled within the CE. The synthesis demonstrates that repair cannot be adequately understood as an isolated technical, behavioural or regulatory intervention. Rather, repair outcomes emerge from interactions among product and organisational conditions, ecosystem actors, and the wider institutional and infrastructural environment. The findings show that repair is shaped by interactions among product design, firm practices, policy frameworks and institutional conditions. It also reveals a distributed ecosystem in which manufacturers, repair providers, users, policymakers, communities and supporting intermediaries possess complementary resources and responsibilities. The study further demonstrates that scaling repair depends on addressing interconnected barriers, including poor reparability, limited access to spare parts and information, cost and convenience constraints, insufficient user skills, replacement-oriented business models, fragmented service infrastructures, and weak coordination among ecosystem actors. Conversely, repair is enabled by repair-oriented design, accessible services and information, supportive business models and regulation, user capabilities and stronger ecosystem coordination. These conditions are mutually dependent: Addressing individual barriers in isolation is unlikely to enable repair at scale.

The principal contribution of this review is therefore to connect previously fragmented streams of repair research within an integrated conceptual framework. Building on this synthesis, we conceptualise strategic repair capability as an organisational capacity to integrate repair across product design, services, value-retention processes and external relationships. This capability is organisationally developed but ecosystem-dependent, because its effective deployment requires coordination with repair providers, consumers, supply-chain partners, policymakers,

intermediaries and supporting infrastructures. This perspective moves repair beyond its conventional treatment as an after-sales, technical or compliance activity and positions it as a potential component of circular business strategy.

For firms, developing strategic repair capability may support product-value retention, longer-term customer relationships, responsiveness to regulatory change and opportunities for competitive differentiation, although the conditions under which these benefits translate into sustained competitive advantage require further empirical investigation. The synthesis also establishes an agenda for future research as presented in Table 4. Four priorities are particularly important: examining how firms develop and deploy strategic repair capabilities and whether these generate environmental and competitive value; investigating ecosystem governance and the mechanisms through which manufacturers, independent repairers, users, communities, and underexamined intermediaries coordinate resources and responsibilities; conducting stronger ex-post evaluations of repair-related policies, including their effects on firm behaviour, repair accessibility, consumer uptake and product lifetimes; and extending repair research beyond formal systems and developed-economy contexts to examine informal repair, Global South contexts, labour, affordability and environmental justice. These priorities move the field from identifying isolated determinants of repair towards understanding the organisational capabilities and ecosystem alignment required for repair to scale.

The review nevertheless has limitations. It was restricted to English-language, peer-reviewed journal articles indexed in Scopus and therefore excludes potentially relevant evidence from grey literature, policy and industry reports, technical documentation, and non-English scholarship. Its deliberate focus on repair as a distinct CE strategy may also underrepresent adjacent value-retention practices such as maintenance, refurbishment and broader product-life-extension strategies. The proposed framework should therefore be interpreted as a synthesis of the current peer-reviewed repair literature rather than a representation of the entirety of repair practice. Addressing

these limitations while pursuing the research priorities identified above can advance understanding of how strategic repair capability, ecosystem coordination and institutional support can collectively enable repair as a scalable strategy for value retention and CE transitions.

Author Contributions

Azar MahmoudGonbadi: conceptualization, investigation, funding acquisition, writing – original draft, writing – review and editing, visualization, validation, methodology, software, formal analysis, project administration, data curation, supervision, resources. **Nadine Leder:** conceptualization, investigation, funding acquisition, validation, writing – review and editing, formal analysis, project administration, data curation, supervision, resources. **Jin Hooi Chan:** conceptualization, investigation, funding acquisition, validation, writing – review and editing, formal analysis, project administration, data curation, supervision, resources.

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Ethics Statement

Ethical approval and informed consent were not required for this study, as it is based exclusively on the analysis of published literature.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

All data analysed in this study are derived from publicly available sources.

Endnotes

¹ <https://www.scopus.com>.

² <https://www.vosviewer.com>.

³ <https://gephi.org>.

References

- Ackermann, L. 2018. "Design for Product Care: Enhancing Consumers' Repair and Maintenance Activities." *Design Journal* 21, no. 4: 543–551. <https://doi.org/10.1080/14606925.2018.1469331>.
- Amend, C., F. Revellio, I. Tenner, and S. Schaltegger. 2022. "The Potential of Modular Product Design on Repair Behavior and User Experience – Evidence From the Smartphone Industry." *Journal of Cleaner Production* 367 November 2021: 132770. <https://doi.org/10.1016/j.jclepro.2022.132770>.
- Amit, R., and P. J. H. Schoemaker. 1993. "Strategic Asset and Organizational Rent." *Strategic Management Journal* 14, no. 1: 33–46.
- Ampe, K. 2024. "Whose Circular Repair Economy Counts? Four Competing Discourses of Electronics Repair." *Resources, Conservation*

and Recycling 205, no. February: 107611. <https://doi.org/10.1016/j.resourconrec.2024.107611>.

Arias, C., J. B. Cadena Lozano, and M. A. Bello Bernal. 2024. "The Role of Value in Extending the Lifetime of Products: An Analysis of Perceived Value and Green Consumption Values on Pro-Circular Behaviors of Repair and Reuse." *Sustainability* 16, no. 4: 1567. <https://doi.org/10.3390/su16041567>.

Arredondo-Soto, K. C., A. Jiménez-Zaragoza, M. A. Miranda-Ackerman, et al. 2022. "Design and Repair Strategies Based on Product-Service System and Remanufacturing for Value Preservation." *Sustainability* 14, no. 14: 8560. <https://doi.org/10.3390/su14148560>.

Bakker, C., F. Wang, J. Huisman, and M. Den Hollander. 2014. "Products That Go Round: Exploring Product Life Extension Through Design." *Journal of Cleaner Production* 69: 10–16. <https://doi.org/10.1016/j.jclepro.2014.01.028>.

Barkhausen, R., A. Durand, Y. Y. Fong, V. Zeller, and C. Rohde. 2024. "Modeling Stock, Material and Environmental Impacts of Circular Economy Product Policies. Trade-Offs Between Early Replacement and Repair of Electric Motors." *Resources, Conservation and Recycling* 205, no. October 2023: 107600. <https://doi.org/10.1016/j.resconrec.2024.107600>.

Barros, M., and E. Dimla. 2023. "Smartphone Repairability Indexes in Practice: Linking Repair Scores to Industrial Design Features." *Journal of Industrial Ecology* 27, no. 3: 923–936. <https://doi.org/10.1111/jieec.13398>.

Bayraktaroğlu, S., and E. İdemen. 2024. "Redefining Repair as a Value Co-Creation Process for Circular Economy: Facilitated Do-It-Yourself Repair." *International Journal of Design* 18, no. 1: 1–22. <https://doi.org/10.57698/v18i1.01>.

Blanco-Espeleta, E., V. Pérez-Belis, and M. D. Bovea. 2024. "Repair Index of Energy-Related Products: Application to Capsule Coffee Machines." *Sustainable Production and Consumption* 46, no. October 2023: 146–160. <https://doi.org/10.1016/j.spc.2024.02.011>.

Bocken, N. M. P., I. De Pauw, C. Bakker, et al. 2016. "Product Design and Business Model Strategies for a Circular Economy." *Journal of Industrial and Production Engineering* 1015: 1–12. <https://doi.org/10.1080/21681015.2016.1172124>.

Börkey, P. 2024. "Individual Behaviour and Circular Economy Policies: Opportunities in Italy." www.oecdilibrary.org.

Bovea, M. D., and V. Pérez-Belis. 2018. "Identifying Design Guidelines to Meet the Circular Economy Principles: A Case Study on Electric and Electronic Equipment." *Journal of Environmental Management* 228: 483–494. <https://doi.org/10.1016/j.jenvman.2018.08.014>.

Bradley, K., and O. Persson. 2022. "Community Repair in the Circular Economy—Fixing More Than Stuff." *Local Environment* 27, no. 10–11: 1321–1337. <https://doi.org/10.1080/13549839.2022.2041580>.

Brusselsaers, J., E. Bracquene, J. Peeters, and Y. Dams. 2020. "Economic Consequences of Consumer Repair Strategies for Electrical Household Devices." *Journal of Enterprise Information Management* 33, no. 4: 747–767. <https://doi.org/10.1108/JEIM-12-2018-0283>.

Bunodiére, A., B. Hendrickx, M. Mertens, and J. Duflo. 2024. "Gear Up for Change: Unveiling 3D Printing's Potential for Appliance Repair Through Dynamic Testing of Gears." *Procedia CIRP* 122: 378–383. <https://doi.org/10.1016/j.procir.2024.01.055>.

Cainelli, G., A. D'Amato, and M. Mazzanti. 2020. "Resource Efficient Eco-Innovations for a Circular Economy: Evidence From EU Firms." *Research Policy* 49, no. 1: 103827. <https://doi.org/10.1016/j.respol.2019.103827>.

Charter, M., and S. Keiller. 2014. "Grassroots Innovation and the Circular Economy." <http://cfsd.org.uk/site-pdfs/circular-economy-and-grassroots-innovation/Survey-of-Repair-Cafes-and-Hackerspaces.pdf>.

- Cobra, R., I. T. Moroni, V. P. Rodrigues, J. M. S. Fradinho, and J. Mascarenhas. 2023. "Repair as a Circular Strategy for Increasing Resource Availability and Health System Resilience During a Crisis." *Health Policy and Technology* 12, no. 3: 100778. <https://doi.org/10.1016/j.hlpt.2023.100778>.
- Collis, D. J. 1994. "How Valuable Are Organizational Capabilities?" *Strategic Management Journal* 15: 143–152.
- Colombijn, F., and P. Egboko. 2023. "Repair Cafés in the Netherlands: Capitalist Abstinence as a Challenge to a Linear Capitalist Economy." *Vibrant Virtual Brazilian Anthropology* 20: e20911. <https://doi.org/10.1590/1809-43412023v20d911>.
- Cordella, M., F. Alfieri, and J. Sanfelix. 2019. "Analysis and Development of a Scoring System for Repair and Upgrade of Products - Final Report." <https://doi.org/10.2760/725068>.
- Cordella, M., J. Sanfelix, and F. Alfieri. 2018. "Development of an Approach for Assessing the Reparability and Upgradability of Energy-Related Products." *Procedia CIRP* 69, no. May: 888–892. <https://doi.org/10.1016/j.procir.2017.11.080>.
- Corsini, F., F. Rizzi, and M. Frey. 2017. "Extended Producer Responsibility: The Impact of Organizational Dimensions on WEEE Collection From Households." *Waste Management* 59: 23–29. <https://doi.org/10.1016/j.wasman.2016.10.046>.
- Corsini, R. R., A. Costa, S. Cannella, and J. M. Framinan. 2022. "Analysing the Impact of Production Control Policies on the Dynamics of a Two-Product Supply Chain with Capacity Constraints." *International Journal of Production Research* 61, no. 6: 1913–1937. <https://doi.org/10.1080/00207543.2022.2053224>.
- Denyer, D., and D. Tranfield. 2009. "Producing a Systematic Review." In *The SAGE Handbook of Organizational Research Methods*, 671–689. SAGE Publications Ltd. <https://doi.org/10.1080/03634528709378635>.
- Diddi, S., and R. N. Yan. 2019. "Consumer Perceptions Related to Clothing Repair and Community Mending Events: A Circular Economy Perspective." *Sustainability* 11, no. 19: 5306. <https://doi.org/10.3390/su11195306>.
- Djeunang Mezafack, R. A., M. Di Mascolo, and Z. Simeu-Abazi. 2022. "Systematic Literature Review of Repair Shops: Focus on Sustainability." *International Journal of Production Research* 60, no. 23: 7093–7112. <https://doi.org/10.1080/00207543.2021.2002965>.
- D'Urzo, M., and C. Campagnaro. 2023. "Design-Led Repair & Reuse: An Approach for an Equitable, Bottom-Up, Innovation-Driven Circular Economy." *Journal of Cleaner Production* 387 December 2022: 135724. <https://doi.org/10.1016/j.jclepro.2022.135724>.
- Edquist, C. 2009. "Systems of Innovation: Perspectives and Challenges." In *The Oxford Handbook of Innovation*. Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199286805.003.0007>.
- EMF. 2015. "Towards a Circular Economy: Business Rationale for an Accelerated Transition." Ellen MacArthur Foundation (EMF), 20.
- European Commission. 2016. "Ecodesign Requirements for Household Washing Machines and Household Washer-Dryers." 16 1 1 23.
- Fachbach, I., G. Lechner, and M. Reimann. 2022. "Drivers of the Consumers' Intention to Use Repair Services, Repair Networks and to Self-Repair." *Journal of Cleaner Production* 346, no. April 2021: 130969. <https://doi.org/10.1016/j.jclepro.2022.130969>.
- Faludi, J., R. Ritsma, and B. Flipsen. 2024. "The Total Cost of Ownership Score: Unifying Repair with Durability and Improving Objectivity, Completeness, and Scalability." *International Conference Electronics Goes Green 2024+: From Silicon to Sustainability, EGG 2024 - Proceedings*, 1 11. <https://doi.org/10.23919/EGG62010.2024.10631233>.
- Fussone, R., R. Fussone, E. Favazza, et al. 2026. "Operationalising Circular Futures: Scenario-Based Modelling of WEEE Supply Chains." *Logistics* 10, no. 8: 1–26. <https://doi.org/10.3390/logistics10080170>.
- Geels, F. W. 2001. "Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-Level Perspective and a Case-Study." 1–39.
- Geels, F. W. 2004. "From Sectoral Systems of Innovation to Socio-Technical Systems Insights About Dynamics and Change From Sociology and Institutional Theory." 33: 897–920. <https://doi.org/10.1016/j.respol.2004.01.015>.
- Geissdoerfer, M., P. Savaget, N. M. P. Bocken, and E. J. Hultink. 2017. "The Circular Economy – A New Sustainability Paradigm?" *Journal of Cleaner Production* 143: 757–768. <https://doi.org/10.1016/j.jclepro.2016.12.048>.
- Gobert, J., and R. Allais. 2021. "(IM-) Material Flow Analysis Framework Implementation On Repair And Reuse Initiatives."
- Gobert, J., R. Allais, and J. F. Deroubaix. 2021. "Repair and Reuse: Misalignments Between Stakeholders and Possible Users." *Journal of Cleaner Production* 317, no. July: 128454. <https://doi.org/10.1016/j.jclepro.2021.128454>.
- Gouveia, J. R., S. M. Pinto, S. Campos, et al. 2022. "Life Cycle Assessment and Cost Analysis of Additive Manufacturing Repair Processes in the Mold Industry." *Sustainability* 14, no. 4: 2105. <https://doi.org/10.3390/su14042105>.
- Graziano, V., and K. Trogal. 2023. "Labor Power in the Repair Shop: Circuits of Repair Between Solidarity and Poor Economy." *Capitalism Nature Socialism* 34, no. 2: 69–87. <https://doi.org/10.1080/10455752.2022.2140065>.
- Hart, C. 1998. "Doing a literature review." (p. 240).
- Hernandez, R. J., C. Miranda, and J. Goñi. 2020. "Empowering Sustainable Consumption by Giving Back to Consumers the 'Right to Repair.'" *Sustainability* 12, no. 3: 1–15. <https://doi.org/10.3390/su12030850>.
- House of Commons. 2021. "Right to Repair Regulations." House of Commons Library, (9302), 1–9. <https://researchbriefings.files.parliament.uk/documents/CBP-9302/CBP-9302.pdf>.
- Huang, Z., Q. Su, T. Liu, J. Huang, X. Wang, and S. Kaewunruen. 2024. "Full-Scale Experimental and Field Investigations Into Expansion Mechanism of Foamed Polyurethane and Its Lifting Behaviors for Repair and Maintenance of Railway Slab Track Systems." *Polymers* 16, no. 3: 404. <https://doi.org/10.3390/polym16030404>.
- Jaeger-Erben, M., V. Frick, and T. Hipp. 2021. "Why Do Users (Not) Repair Their Devices? A Study of the Predictors of Repair Practices." *Journal of Cleaner Production* 286: 125382. <https://doi.org/10.1016/j.jclepro.2020.125382>.
- Jayasiri, G., and S. Herat. 2024. "Repair and Reuse or Recycle: What Is Best for Small WEEE in Australia?"
- Jerome, A., M. Ljunggren, and M. Janssen. 2023. "Is Repair of Energy Using Products Environmentally Beneficial? The Case of High Voltage Electric Motors." *Resources, Conservation and Recycling* 196 November 2022: 107038. <https://doi.org/10.1016/j.resconrec.2023.107038>.
- Jin, C., L. Yang, and C. Zhu. 2023. "Right to Repair: Pricing, Welfare, and Environmental Implications." *Management Science* 69, no. 2: 1017–1036. <https://doi.org/10.1287/mnsc.2022.4401>.
- Karagiannopoulos, P. S., N. M. Manousakis, and C. S. Psomopoulos. 2022. "A Novel ILP Formulation for PCB Maintenance Considering Electrical Measurements and Aging Factors: A 'Right to Repair' Approach." *Energies* 15, no. 1: 183. <https://doi.org/10.3390/en15010183>.
- Karagiannopoulos, P. S., N. M. Manousakis, and C. S. Psomopoulos. 2024. "Repair and Recycling of PCBs and Their Components Based on Obsolescence Index: A Domestic Electrical Appliances Case Study." *Environmental Science and Pollution Research* 31, no. 12: 17546–17564. <https://doi.org/10.1007/s11356-022-25077-z>.

- Keulemans, G. 2023. ““Transformative Repair × ADC”: Analysis visual.”
- Kirchherr, J., D. Reike, and M. Hekkert. 2017. “Conceptualizing the Circular Economy: An Analysis of 114 Definitions.” *Resources, Conservation and Recycling* 127 September: 221–232. <https://doi.org/10.1016/j.resconrec.2017.09.005>.
- Kite, M. E., and B. E. Whitley. 2018. “Literature Reviewing.” In *Principles of Research in Behavioral Science*, 749–787. Routledge. <https://doi.org/10.4324/9781315450087-19>.
- Konietzko, J., N. Bocken, and E. J. Hultink. 2020. “Circular Ecosystem Innovation: An Initial Set of Principles.” *Journal of Cleaner Production* 253: 119942. <https://doi.org/10.1016/j.jclepro.2019.119942>.
- Korsunova, A., E. Heiskanen, and A. Vainio. 2023. “Consumer Decision-Making on Repair in a Circular Economy: A Process Model Based on Experiences Among Young Adults and Stakeholders in Finland.” *Journal of Cleaner Production* 405 October 2022: 137052. <https://doi.org/10.1016/j.jclepro.2023.137052>.
- Laitala, K., I. G. Klepp, V. Haugrønning, H. Throne-Holst, and P. Strandbakken. 2021. “Increasing Repair of Household Appliances, Mobile Phones and Clothing: Experiences From Consumers and the Repair Industry.” *Journal of Cleaner Production* 282: 125349. <https://doi.org/10.1016/j.jclepro.2020.125349>.
- Lechner, G., V. Kraßnig, and I. Güsser-Fachbach. 2024. “How Can Repair Businesses Improve Their Service? Consumer Priorities Concerning Operational Aspects of Repair Services.” *Resources, Conservation and Recycling* 204 November 2023: 107501. <https://doi.org/10.1016/j.resconrec.2024.107501>.
- Lechner, G., M. J. Wagner, A. Diaz Tena, C. Fleck, and M. Reimann. 2021. “Exploring a Regional Repair Network With a Public Funding Scheme for Customer Repairs: The ‘GRAZ repariert’-Case.” *Journal of Cleaner Production* 288: 125588. <https://doi.org/10.1016/j.jclepro.2020.125588>.
- Lifset, R., and T. Lindhqvist. 2008. “Producer Responsibility at a Turning Point?” *Journal of Industrial Ecology* 12, no. 2: 144–147. <https://doi.org/10.1111/j.1530-9290.2008.00028.x>.
- Llorente-González, L. J., and X. Vence. 2020. “How Labour-Intensive Is the Circular Economy? A Policy-Oriented Structural Analysis of the Repair, Reuse and Recycling Activities in the European Union.” *Resources, Conservation and Recycling* 162 February: 105033. <https://doi.org/10.1016/j.resconrec.2020.105033>.
- Lloveras, J., M. Pansera, and A. Smith. 2024. “On ‘The Politics of Repair Beyond Repair’: Radical Democracy and the Right to Repair Movement.” *Journal of Business Ethics* 196: 325–344. <https://doi.org/10.1007/s10551-024-05705-z>.
- Lundberg, P., A. Vainio, N. Viholainen, and A. Korsunova. 2024. “Consumers and Self-Repair: What Do They Repair, What Skills Do They Have and What Are They Willing to Learn?” *Resources, Conservation and Recycling* 206 November 2023: 107647. <https://doi.org/10.1016/j.resconrec.2024.107647>.
- Lundvall, B. Å. 2010. “Post Script: Innovation System Research – Where It Came From and Where It Might Go.” *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning* 317–350. <https://doi.org/10.7135/UPO9781843318903.016>.
- Luukkonen, R., and K. L. van den Broek. 2024. “Exploring the Drivers Behind Visiting Repair Cafés: Insights From Mental Models.” *Cleaner Production Letters* 7 August: 100070. <https://doi.org/10.1016/j.clpl.2024.100070>.
- Maguire, H., and F. Fahy. 2022. “Sew What for Sustainability? Exploring Intergenerational Attitudes and Practices to Clothing Repair in Ireland.” *Irish Geography* 55, no. 1: 1–20. <https://doi.org/10.55650/igi.v55i1.1469>.
- Mahmoudi, M., E. Mehrdad, A. Shafieizad, Z. Alsup, and M. Minary-Jolandan. 2024. “Localized Electrochemical Repair (LER) of Conductive Materials.” *Advanced Engineering Materials* 26, no. 5: 2301497. <https://doi.org/10.1002/adem.202301497>.
- MahmoumGonbadi, A., A. Genovese, and A. Sgalambro. 2021. “Closed-Loop Supply Chain Design for the Transition Towards a Circular Economy: A Systematic Literature Review of Methods, Applications and Current Gaps.” *Journal of Cleaner Production* 323 November 2020: 129101. <https://doi.org/10.1016/j.jclepro.2021.129101>.
- MahmoumGonbadi, A., A. Genovese, and A. Sgalambro. 2025. “An Optimisation Tool for Strategic Planning of Multiple Downgraded Market Levels in Circular Supply Chain Management.” *Annals of Operations Research* 364: 491–523. <https://doi.org/10.1007/s10479-025-06783-6>.
- Maitre-Ekern, E., and C. Dalhammar. 2016. “Regulating Planned Obsolescence: A Review of Legal Approaches to Increase Product Durability and Reparability in Europe.” *Review of European, Comparative & International Environmental Law* 25, no. 3: 378–394. <https://doi.org/10.1111/reel.12182>.
- Manwaring, K. 2024. ““Slowing Down the Loop”: Smart Devices and the Right to Repair.” *International Review of Law, Computers & Technology* 38, no. 3: 268–296. <https://doi.org/10.1080/13600869.2024.2324535>.
- McLaren, D., J. Niskanen, and J. Anshelm. 2020. “Reconfiguring Repair: Contested Politics and Values of Repair Challenge Instrumental Discourses Found in Circular Economies Literature.” *Resources, Conservation and Recycling: X* 8 January: 100046. <https://doi.org/10.1016/j.rcrx.2020.100046>.
- McQueen, R. H., A. Jain, L. S. McNeill, and A. Kozłowski. 2023. “The Role of Resources in Repair Practice: Engagement With Self, Paid and Unpaid Clothing Repair by Young Consumers.” *Textile Research Journal* 93, no. 3–4: 576–591. <https://doi.org/10.1177/00405175221123067>.
- McQueen, R. H., L. S. McNeill, Q. Huang, and B. Potdar. 2022. “Unpicking the Gender Gap: Examining Socio-Demographic Factors and Repair Resources in Clothing Repair Practice.” *Recycling* 7, no. 4: 1–15. <https://doi.org/10.3390/recycling7040053>.
- Moalem, R. M., and M. A. Mosgaard. 2021. “A Critical Review of the Role of Repair Cafés in a Sustainable Circular Transition.” *Sustainability* 13, no. 22: 12351. <https://doi.org/10.3390/su132212351>.
- Nagase, Y., and T. Uehara. 2024. “The Potential Impact of the New ‘Right to Repair’ Rules on Electrical and Electronic Equipment Waste: A Case Study of the UK.” *Waste Management* 182 January: 175–185. <https://doi.org/10.1016/j.wasman.2024.04.032>.
- Nazli, T. 2021. “Repair Motivation and Barriers Model: Investigating User Perspectives Related to Product Repair Towards a Circular Economy.” *Journal of Cleaner Production* 289: 125644. <https://doi.org/10.1016/j.jclepro.2020.125644>.
- Niskanen, J., and D. McLaren. 2023. “The Political Economy of Circular Economies: Lessons from Future Repair Scenario Deliberations in Sweden.” *Circular Economy and Sustainability* 3, no. 3: 1677–1701. <https://doi.org/10.1007/s43615-021-00128-8>.
- Niskanen, J., D. McLaren, and J. Anshelm. 2021. “Repair for a Broken Economy: Lessons for Circular Economy From an International Interview Study of Repairers.” *Sustainability* 13, no. 4: 1–15. <https://doi.org/10.3390/su13042316>.
- Parajuly, K., J. Green, J. Richter, et al. 2024. “Product Repair in a Circular Economy: Exploring Public Repair Behavior From a Systems Perspective.” *Journal of Industrial Ecology* 28, no. 1: 74–86. <https://doi.org/10.1111/jiec.13451>.
- Pibul, P., S. Jawjit, and S. Yimthiang. 2023. “Soil Heavy Metal Pollution From Waste Electrical and Electronic Equipment of Repair and Junk Shops in Southern Thailand and Their Ecological Risk.” *Heliyon* 9, no. 10: e20438. <https://doi.org/10.1016/j.heliyon.2023.e20438>.

- Potting, J., M. Hekkert, E. Worrell, and A. Hanemaaijer. 2017. "Circular Economy: Measuring Innovation in the Product Chain." PBL Netherlands Environmental Assessment Agency, (2544), 42.
- Priarone, P. C., G. Campatelli, A. R. Catalano, and F. Baffa. 2021. "Life-Cycle Energy and Carbon Saving Potential of Wire Arc Additive Manufacturing for the Repair of Mold Inserts." *CIRP Journal of Manufacturing Science and Technology* 35: 943–958. <https://doi.org/10.1016/j.cirpj.2021.10.007>.
- Purkiss, D., P. Pencheva, B. Munro, and M. Miodownik. 2024. "A Systems Approach to Growing the UK Electronics and Appliance Repair Economy." *Frontiers in Sustainability* 5: 1432655. <https://doi.org/10.3389/frsus.2024.1432655>.
- Ravindran, B., T. Agathocleous, B. Oswald-Tranta, E. Fauster, and M. Feuchter. 2024. "Impact Characteristics and Repair Approaches of Distinct Bio-Based Matrix Composites: A Comparative Analysis." *Journal Of Composites Science* 8, no. 4: 126. <https://doi.org/10.3390/jcs8040126>.
- Reimann, M. 2024. "The Impact of a Repair Subsidy on Repair Prices, Demand and Repair Company Profitability." *Journal of Cleaner Production* 469 June: 143102. <https://doi.org/10.1016/j.jclepro.2024.143102>.
- Rivera, J. L., and A. Lallmahomed. 2016. "Environmental Implications of Planned Obsolescence and Product Lifetime: A Literature Review." *International Journal of Sustainable Engineering* 9, no. 2: 119–129. <https://doi.org/10.1080/19397038.2015.1099757>.
- Rogers, H. A., P. Deutz, and T. B. Ramos. 2021. "Repairing the Circular Economy: Public Perception and Participant Profile of the Repair Economy in Hull, UK." *Resources, Conservation and Recycling* 168, no. October 2020: 105447. <https://doi.org/10.1016/j.resconrec.2021.105447>.
- Rogers, H. A., P. Deutz, T. B. Ramos, and A. E. G. Jonas. 2024. "Quality of Working Life in the Circular Economy: The Case of Self-Employment in the Repair Sector." *Circular Economy and Sustainability* 4, no. 2: 1613–1630. <https://doi.org/10.1007/s43615-023-00343-5>.
- Rosborough, A. D., L. Wiseman, and T. Pihljarinne. 2023. "Achieving a (Copy)right to Repair for the EU's Green Economy." *Journal of Intellectual Property Law and Practice* 18, no. 5: 344–352. <https://doi.org/10.1093/jiplp/jpad034>.
- Rudolf, S., S. Blömeke, J. F. Niemeyer, et al. 2022. "Extending the Life Cycle of EEE—Findings From a Repair Study in Germany: Repair Challenges and Recommendations for Action." *Sustainability* 14, no. 5: 2993. <https://doi.org/10.3390/su14052993>.
- Russell, J. D., and N. Z. Nasr. 2023. "Value-Retained vs. Impacts Avoided: The Differentiated Contributions of Remanufacturing, Refurbishment, Repair, and Reuse Within a Circular Economy." *Journal of Remanufacturing* 13, no. 1: 25–51. <https://doi.org/10.1007/s13243-022-00119-4>.
- Russell, J. D., S. Svensson-Hoglund, J. L. Richter, C. Dalhammar, and L. Milios. 2023. "A Matter of Timing: System Requirements for Repair and Their Temporal Dimensions." *Journal of Industrial Ecology* 27, no. 3: 845–855. <https://doi.org/10.1111/jiec.13280>.
- Sabbaghi, M., and S. Behdad. 2018. "Consumer Decisions to Repair Mobile Phones and Manufacturer Pricing Policies: The Concept of Value Leakage." *Resources, Conservation and Recycling* 133 December 2017: 101–111. <https://doi.org/10.1016/j.resconrec.2018.01.015>.
- Sandez, S., V. Ibáñez-Forés, P. Juan, and M. D. Bovea. 2024. "The Effect of Repair and Lifetime Extension on the Environmental Performance of Energy-Using Products. Application to Electric Water Kettles." *Sustainable Production and Consumption* 51 September: 445–456. <https://doi.org/10.1016/j.spc.2024.09.020>.
- Sandez, S., V. Pérez-Belis, P. Juan, and M. D. Bovea. 2023. "Do Users Have the Ability to Self-Repair Non-Complex Electrical Appliances? Design and Development of a Self-Guided Workshop with Repair Documentation in Different Formats." *Sustainable Production and Consumption* 39 February: 244–256. <https://doi.org/10.1016/j.spc.2023.05.007>.
- Sonego, M., M. E. S. Echeveste, and H. G. Debarba. 2022. "Repair of Electronic Products: Consumer Practices and Institutional Initiatives." *Sustainable Production and Consumption* 30: 556–565. <https://doi.org/10.1016/j.spc.2021.12.031>.
- Spekkink, W., M. Rödl, and M. Charter. 2022. "Repair Cafés and Precious Plastic as Translocal Networks for the Circular Economy." *Journal of Cleaner Production* 380, no. November: 135125. <https://doi.org/10.1016/j.jclepro.2022.135125>.
- Stahel, W. R. 2016. "The Circular Economy." *Nature* 531, no. 7595: 435–438. <https://doi.org/10.1038/531435a>.
- Teece, D. J., G. Pisano, and A. Shuen. 1997. "Dynamic Capabilities and Strategic Management." *Strategic Management Journal* 18: 509–533.
- Terzioğlu, N., and R. Wever. 2021. "Integrating Repair into Product Design Education: Insights on Repair, Design and Sustainability." *Sustainability* 13, no. 18: 10067. <https://doi.org/10.3390/su131810067>.
- Türkeli, S., B. Huang, A. Stasik, and R. Kemp. 2019. "Circular Economy as a Global Business Activity: Mobile Phone Repair in the Netherlands, Poland and China." *Energies* 12, no. 3: 498. <https://doi.org/10.3390/en12030498>.
- Vallet, F., B. Tyl, F. Cluzel, and C. Masclet. 2024. "A Transition Approach for Reuse and Repair of Manufactured Products." *Proceedings of the Design Society* 4: 1477–1486. <https://doi.org/10.1017/pds.2024.150>.
- van den Berge, R., L. Magnier, and R. Mugge. 2023. "Sparkling the Repair 'Can-Do' Attitude: Enhancing Users' Willingness to Repair Through Design Support in Fault Diagnostics." *International Journal of Design* 17, no. 3: 25–39. <https://doi.org/10.57698/v17i3.02>.
- van der Velden, M. 2021. "'Fixing the World One Thing at a Time': Community Repair and a Sustainable Circular Economy." *Journal of Cleaner Production* 304: 127151. <https://doi.org/10.1016/j.jclepro.2021.127151>.
- van der Velden, M., E. Maitre-Ekern, and D. K. Wanja. 2023. "The Role of Independent Repair in a Circular and Regenerative Economy." *Circular Economy and Sustainability* 4: 2981–3006. <https://doi.org/10.1007/s43615-023-00304-y>.
- Vandekerckhove, R., I. Moons, and E. Du Bois. 2021. "Introducing Repair in Sports' Consumables: Investigation of Repairability of Badminton Shuttles." *Journal of Cleaner Production* 326 October: 129229. <https://doi.org/10.1016/j.jclepro.2021.129229>.
- Vidal-Ayuso, F., A. Akhmedova, and C. Jaca. 2023. "The Circular Economy and Consumer Behaviour: Literature Review and Research Directions." *Journal of Cleaner Production* 418, no. April: 137824. <https://doi.org/10.1016/j.jclepro.2023.137824>.
- Wagner, E., E. Bracquené, and M. Jaeger-Erben. 2021. "Exploring 14 Years of Repair Records – Information Retrieval, Analysis Potential and Data Gaps to Improve Reparability." *Journal of Cleaner Production* 281: 125259. <https://doi.org/10.1016/j.jclepro.2020.125259>.
- Wehbie, M., and V. Semetey. 2022. "Characterization of End-of-Life LED Lamps: Evaluation of Reuse, Repair and Recycling Potential." *Waste Management* 141 November 2021: 202–207. <https://doi.org/10.1016/j.wasman.2022.01.037>.
- Wieser, H., and N. Tröger. 2016. "Exploring the Inner Loops of the Circular Economy: Replacement, Repair, and Reuse of Mobile Phones in Austria." *Journal of Cleaner Production* 172: 3042–3055. <https://doi.org/10.1016/j.jclepro.2017.11.106>.
- Zakharova, O., A. Glazkova, and L. Suvorova. 2023. "Online Equipment Repair Community in Russia: Searching for Environmental Discourse." *Sustainability* 15, no. 17: 1–16. <https://doi.org/10.3390/su151712990>.