Fostering Stakeholder Collaboration to Embrace Circular Economy Principles for a Sustainable Industry

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Abstract

Industries face intensifying pressure to minimise waste, decarbonise operations, and embed regenerative practices, yet the adoption of circular economy principles remains fragmented due to misaligned incentives and weak coordination across value chains. This study aims to explain how multi-stakeholder collaboration can accelerate CE adoption at industry level by proposing an integrative conceptual framework. Using a structured review of peer-reviewed English-language scholarship, the study synthesises insights from governance, ecosystem orchestration, and digital-traceability perspectives. The analysis identifies five collaboration levers: shared governance and accountability, interoperable data and traceability, incentive alignment, capacity building for small and medium enterprises, and cross-sector platforms that facilitate experimentation and scaling. The proposed model links antecedents, collaboration mechanisms, and outcomes, highlighting collaboration quality as the decisive determinant of industrial circularity. The framework offers scholars, managers, and policymakers a pathway for designing collaborative architectures that mainstream CE practices and foster sustainable industry.

Keywords: Circular economy (CE); Multi-stakeholder collaboration; Industry-level governance; Extended Producer Responsibility (EPR); Digital product passports and traceability; Industrial symbiosis.

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1. Introduction

The circular economy (CE) has moved from a niche sustainability idea to a mainstream strategic agenda for industry, reframing production–consumption systems around regeneration, resource efficiency, and value retention rather than linear take–make–waste logics. Yet even as definitions proliferate, recent syntheses emphasize the need to translate conceptual agreement into actionable, cross-firm collaboration that can deliver measurable outcomes at scale (Kirchherr, 2023).

Industrial transitions toward circularity are inherently multi-actor. They depend on coordination across supply chains (e.g., design, sourcing, manufacturing, logistics), across ecosystems (e.g., eco-industrial parks and industrial symbiosis), and with public and civic actors. Evidence shows that where collaboration structures are absent or weak, circular strategies stall despite technical feasibility (Oughton et al., 2022; Zhang & Seuring, 2024). However, the literature remains fragmented regarding which governance mechanisms – platforms, standards, and incentives – most effectively align heterogeneous stakeholders toward shared circular objectives.

This conceptual paper develops an integrative argument for fostering stakeholder collaboration as the keystone for embracing CE principles across industry. Specifically, it (i) synthesizes insights on networked/ collaborative governance and circular supply chains, (ii) articulates propositions about the governance levers (e.g., data transparency, accountability regimes, incentive alignment) that enable joint value creation from circularity, and (iii) outlines a conceptual model that connects these levers to expected industrial, environmental, and social outcomes. To ground the argument, we draw on emerging evidence that digital traceability and interoperable information infrastructures can reduce transaction costs and enable coordination in reverse flows and secondary markets (Rejeb et al., 2023; Zhang & Seuring, 2024).

Collaborative governance research increasingly identifies conditions under which cross-sector partnerships catalyze green transitions, but links to circular manufacturing and supply-chain practice remain under-specified (Nielsen, 2024; Torfing, 2024). By integrating these literatures with current CE governance and measurement work, this paper contributes a configurable set of collaboration mechanisms that can be theorized and empirically tested in future research.

For managers, regulators, and ecosystem orchestrators, the framework clarifies how to operationalize collaboration: (1) shared data regimes (e.g., Digital Product Passports) to improve material provenance, repairability, and end-of-life decisions; (2) accountability and incentive alignment through policy instruments (e.g., extended producer responsibility) that mobilize co-investment and role clarity across value chains; and (3) platforms for joint experimentation (e.g., industrial symbiosis and circular hubs) that convert local complementarities into system-level circular outcomes. Recent studies illustrate how such levers help firms and regions progress from isolated pilots to embedded circular operations (Mensah, Owusu, Boateng, & Asare, 2025; Leclerc, 2024; Oughton et al., 2022; Dennison, 2024; Fobbe, 2023).

2. Literature Review

2.1 Key Concepts and Definitions

The circular economy (CE) increasingly denotes a system-level transition that organises production and consumption around value retention rather than linear "take–make–waste" logics. Contemporary syntheses characterise CE as a multi-dimensional umbrella concept – encompassing design for durability and repair, product–service systems, secondary materials markets, and regenerative resource cycles – whose boundaries have broadened as scholarship has matured. A recent analysis of 221 definitions documents both consolidation around resource-value retention and continued differentiation across disciplines, underscoring the need to translate conceptual breadth into operational clarity for firms and industries (Kirchherr, 2023).

Against this backdrop, reviews of reviews show that CE is best understood as an ecosystemic transformation requiring coordination among firms, governments, and civil society to align goals, standards, and data for circular practices at scale. Hossain and colleagues' umbrella review synthesising 167 review articles concludes that definitional ambiguity persists but that convergence is emerging on CE as a *systemic* reconfiguration of value creation and capture across supply chains, with governance and collaboration repeatedly highlighted as enabling conditions (Hossain et al., 2024).

Building on this systemic view, the notion of the "circular ecosystem" articulates the networked character of CE transitions. Here, diverse actors co-create circular value through shared rules, incentives, and information infrastructures that enable resource loops to be slowed (through longevity and repair), closed (through reuse and recycling), and narrowed (through efficiency). Pietrulla's (2022) review crystallises the term by mapping the constituent actors and coordination mechanisms, while Aryee et al. (2025) outline research directions that foreground governance, data, and business-model interdependencies in ecosystem formation and scaling. Together, these contributions emphasise that circularity is less an aggregate of firm-level practices than a property that *emerges* from orchestrated interaction among interdependent stakeholders across an industrial system (Pietrulla, 2022; Aryee et al., 2025).

Within industrial practice, **industrial symbiosis** remains a cornerstone concept for operationalising circularity. It refers to the purposeful exchange of materials, energy, water, and by-products among colocated or networked firms under enabling institutional arrangements. The latest comprehensive review establishes industrial symbiosis as a proven pathway to higher resource productivity and reduced environmental burdens, provided supportive governance, information-sharing, and economic incentives are in place (Neves et al., 2020). As industries expand beyond single-plant optimisations toward ecosystem-wide circular strategies, such symbiotic exchanges illustrate how coordination capabilities and shared infrastructures become foundational to CE outcomes.

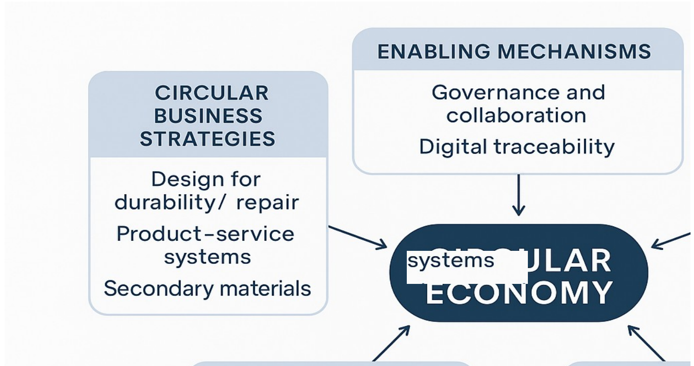

Figure 1. Key concepts in circular industry ecosystems

Figure 1 is a concept map showing CE at the centre linked to: (a) circular business strategies (design for durability/repair, product–service systems, secondary materials), (b) enabling mechanisms (governance and collaboration, digital traceability, standards), (c) ecosystem structures (clusters, industrial symbiosis, platforms), and (d) system outcomes (resource productivity, emissions reduction, resilience). Arrows indicate how enabling mechanisms coordinate strategies across ecosystem structures to yield outcomes.

2.2 Theoretical lenses and models

Collaboration for circular economy (CE) implementation is best understood through a governance perspective that recognises the complexity of coordinating heterogeneous, interdependent actors. Comparative work across sixteen national settings shows that effective CE transitions rarely rely on hierarchical control alone; instead, they blend public authority with networked forms of steering that enable joint priority-setting, shared standards, and iterative problem-solving across value chains (Cramer, 2022). This "dual mode" of steering resonates with transition management and public administration insights, suggesting that policy sets enabling conditions while networks of firms, municipalities, and civil actors co-create the operational rules that make circular flows viable at scale (Cramer, 2022).

Building on this, polycentric governance theory specifies how multiple decision centres emerge and interact to govern privately owned resources that must circulate across firm boundaries. In an inductive, multi-country study, Patala et al. (2022) show that polycentric arrangements develop through collective action among businesses, public agencies, and societal actors, with each centre authorised to make and enforce rules that address local coordination problems while remaining loosely coupled to broader system goals. Such arrangements appear particularly suited to CE because they accommodate context variety (sectoral, technological, and regional), reduce free-riding through locally credible accountability, and enable experimentation with rule designs for residual resource mobilisation and secondary markets (Patala et al., 2022).

A complementary lens centres on ecosystems and resource orchestration. Because no single firm controls the assets, information, and capabilities required to retain value across lifecycles, "ecosystem orchestrators" must configure partners, align incentives, and sequence joint investments to realise circular offerings. Multi-case evidence elaborates how focal actors articulate a circular value proposition, assign roles across manufacturing, service, and recovery partners, and deploy orchestration mechanisms, such as boundary resources, shared metrics, and dispute-resolution routines – to stabilise collaboration (de Vasconcelos Gomes et al., 2023). Related work grounded in resource orchestration theory shows that supply-chain traceability and transparency function as mutually reinforcing capability bundles that lower coordination costs and unlock competitive advantage – capabilities that are foundational for CE collaboration because they enable credible quality, provenance, and end-of-life decisions (Malik et al., 2021). Extending this stream, Jensen et al. (2024) provide an ecosystem orchestration framework for Digital Product Passports (DPPs), identifying stage-specific practices (initiation, momentum building, control, and self-renewal) that help partners convert regulatory compliance into shared value creation.

Socio-technical transition theory offers a third, system-level lens. Bibliometric synthesis on the multi-level perspective (MLP) indicates that CE transitions unfold through interactions among niche innovations (e.g., repair-ready design, product-service systems), sectoral regimes (dominant production and market structures), and landscape pressures (regulatory, cultural, macroeconomic) (Wang et al., 2022). Collaboration matters in this view because it aligns institutions, technologies, and business models across levels – for example, by coordinating standards that allow niche circular solutions to interoperate with regime infrastructures, or by forming coalitions that translate landscape pressures (like carbon targets) into feasible industry rules. Evidence from organisational research on institutional logics further suggests that firms' circular capabilities co-evolve with often competing logics (cost efficiency versus stewardship), and that navigating these tensions requires relational capabilities and forums that support joint sense-making and rule adaptation (Rovanto, 2024).

Taken together, these lenses converge on a theoretically coherent account of how collaboration enables CE. Governance perspectives explain *who* sets and enforces the rules for circular flows and *how* accountability is maintained across distributed actors; ecosystem orchestration clarifies *how* partners are configured and capabilities combined to deliver circular value propositions; and the socio-technical perspective situates collaboration in a dynamic system, explaining *why* cross-level alignment is necessary to move from pilot projects to industry-wide circular outcomes. Cross-fertilising these perspectives yields a set of propositions that can be tested empirically: for instance, that polycentric governance quality positively influences the effectiveness of orchestration mechanisms, and that both are mediated by information capabilities (traceability/transparency) in producing circular performance at the ecosystem level (Cramer, 2022; Patala et al., 2022; de Vasconcelos Gomes et al., 2023; Malik et al., 2021; Jensen et al., 2024; Wang et al., 2022; Rovanto, 2024).

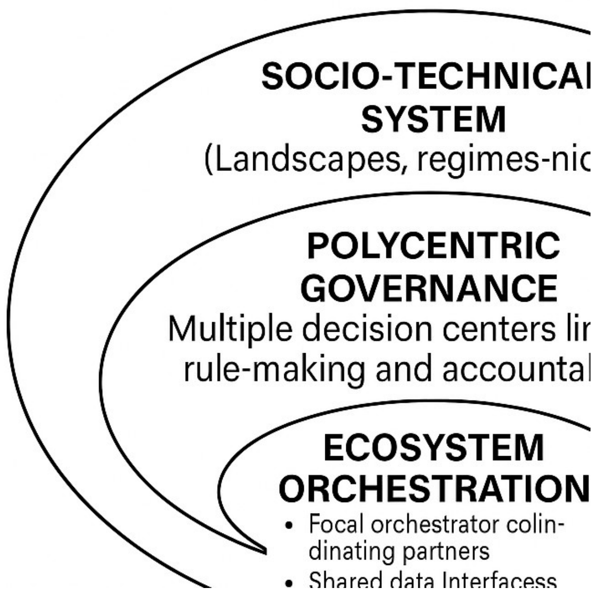

Figure 2. Theoretical lenses for industry-level circular collaboration

Figure 2 is a layered diagram with three concentric frames. Outer frame: socio-technical system (landscape–regime–niche). Middle frame: polycentric governance (multiple decision centres linked by rule-making and accountability ties). Inner frame: ecosystem orchestration (focal orchestrator coordinating partners, shared data interfaces, and investment sequencing). Arrows depict how governance quality enables orchestration, while data/traceability capabilities mediate both toward circular outcomes.

2.3 Empirical review

Recent empirical studies converge on the view that stakeholder collaboration is the decisive mechanism translating circular economy (CE) aspirations into measurable outcomes, while also revealing the contingencies that shape success across sectors. In the textile and fashion domain, multiple case studies in Italy's regenerated-wool district demonstrate that "circular supply chain orchestration" helps firms overcome adoption barriers by assigning clear partner roles, formalizing interaction routines, and aligning incentives around repair, reuse, and fiber recovery (Saccani et al., 2023). Complementing these findings, a longitudinal field study of a sustainability-led fashion company shows how orchestrators phase collaboration (initiation, expansion, consolidation) and deploy boundary resources (shared metrics, dispute-resolution routines) to sustain momentum in multi-actor projects (Ermini et al., 2024). Single-firm ecosystem evidence from a Swedish fashion retailer identifies three orchestration capability clusters – managing circular offerings, managing circular activities, and partnering – that underpin cross-firm coordination for textile take-back and remanufacturing (Sandberg, 2023). Together, these studies depict orchestration as a relational capability set that enables circular business models to function at scale.

Manufacturing studies broaden the lens beyond fashion. A multi-country investigation of "circular stakeholder engagement practices" finds that structured engagement with suppliers, customers, and civic actors predicts the depth and persistence of CE implementation in plants, highlighting the importance of forums, joint target-setting, and feedback channels (Fobbe et al., 2023). Empirical work on performance management further shows that credible collaboration is reinforced by shared measurement: a system-dynamics-informed performance measurement system for circular supply chains integrates circularity, economic, environmental, and social metrics and is designed to surface trade-offs that can otherwise derail partnerships (Vegter et al., 2023).

Evidence on information infrastructures indicates that collaboration quality increasingly hinges on data. A multiple-case study in mechatronics specifies the life-cycle data needed by Digital Product Passports (DPPs) to support decisions about maintenance, reuse, and end-of-life options, operationalizing how shared data reduces uncertainty and enables coordinated reverse flows (Jensen et al., 2023). A structured review of 82 DPP use cases then maps where DPPs add value – traceability, compliance, secondary material markets – and where gaps remain, such as end-of-life quality assessment (Zhang & Seuring, 2024). These findings suggest that DPPs can convert regulatory pressure into collective action when governance and orchestration are in place.

Policy-coupled collaboration mechanisms show mixed but instructive effects. In an effect evaluation of circular public procurement (CPP) tenders in the Netherlands, two-thirds of tenders with circular criteria did not yield reduced impacts, underscoring that criteria alone are insufficient without implementation monitoring and inventory systems that track circular flows (Zijp et al., 2022). A detailed CPP implementation case in a public furniture context confirms that centralized governance, follow-up systems, and contract designs that accommodate reuse and remanufacturing are pivotal for outcomes (Lingegård & von Oelreich, 2023). For end-of-life responsibilities, an empirical study of an e-waste extended producer responsibility (EPR) program in Canada finds that municipal participation hinges on clarity of roles, cost sharing, and trust in producer responsibility organizations – governance factors that condition collaborative effectiveness (Leclerc & Badami, 2024).

Industrial symbiosis (IS) provides ecosystem-level evidence that collaboration can reconfigure material and energy exchanges. Case studies in Brazilian forest-based clusters show how thermoelectric plants using forestry residues act as anchors for symbiotic exchanges, catalyzing reuse and recovery practices among proximate firms (Simioni et al., 2024). Yet, cross-country analyses caution that IS diffusion is constrained by information asymmetries, weak inter-firm cooperation, and limited infrastructure readiness – barriers that empirical work prioritizes for managerial and policy action in apparel manufacturing (Hossain et al., 2024). Overall, the empirical record indicates that collaboration yields circular outcomes when three conditions co-occur: orchestrators specify roles and incentives; governance allocates responsibilities and accountability; and shared data systems (often via DPP-like infrastructures) reduce uncertainty and enable coordinated reverse flows.

2.4 Relationships among concepts in CE collaboration

Across the concepts surfaced in the uploaded manuscript – stakeholder management, extended producer responsibility (EPR), industrial symbiosis, and data-rich tools such as Digital Product Passports (DPPs) and blockchain – the central relationship is that governance and orchestration only translate into circular outcomes when they are coupled with robust information capabilities. In circular ecosystems, rules and roles coordinate expectations, but high-friction information environments still impede secondary markets, reverse logistics, and quality assurance. Empirical syntheses and umbrella reviews therefore increasingly characterise *information transparency* as the mediating capability that converts collaborative intent into credible action and measurable circular performance (Aryee et al., 2025; Hossain et al., 2024).

DPPs operationalise this mediation by standardising product-level data (composition, provenance, repairability, use history, and end-of-life options) so that heterogeneous partners can make aligned decisions about maintenance, reuse, remanufacture, and recycling. Multiple reviews and case studies show that DPPs reduce information asymmetries, enable accountability, and coordinate reverse flows, thereby linking stakeholder governance with day-to-day supply-chain orchestration (Jensen et al., 2023; Zhang & Seuring, 2024; Psarommatis et al., 2024). Technological frameworks emphasise that DPPs work best when embedded in interoperable data spaces and middleware that allow secure sharing across organisational boundaries (Voulgaridis et al., 2024), while implementation reviews underscore the need for common semantics and lifecycle-data completeness (Lopes & Barata, 2024; Rumetshofer et al., 2023). At the capability level, traceability and transparency form mutually reinforcing "bundles" that lower coordination costs and support competitive advantage – precisely the capabilities required to make cross-firm circular collaboration viable (Malik et al., 2021). Blockchain can further strengthen these relationships by providing tamper-evident audit trails for high-value or safety-critical loops, but value is contingent on governance choices about data access, standards, and incentives (Rejeb et al., 2023).

Policy levers align incentives with these information architectures. EPR allocates end-of-life responsibilities and financing across producers, retailers, municipalities, and recyclers; when combined with traceability (e.g., DPP-linked reporting), EPR clarifies roles, improves cost-sharing legitimacy, and supports market formation for secondary materials (Tumu et al., 2023; Leclerc & Badami, 2024). Circular public procurement (CPP) similarly hard-wires circular criteria and data requirements into purchasing, but evaluations show that criteria alone are insufficient without monitoring systems and inventory data that verify circular flows – again reinforcing the centrality of information capabilities to make governance effective (Zijp et al., 2022). In short, *governance sets the rules, information proves compliance, and orchestration delivers the operations*.

Industrial symbiosis illustrates how these relationships manifest at ecosystem scale. Symbiotic exchanges – by-product and energy cascading among proximate or networked firms – depend on shared information about material quality, timing, and risk, as well as enabling institutional arrangements and platforms (Neves et al., 2020; Henriques et al., 2021). When DPP-style traceability and CPP/EPR-driven incentives are present, symbiosis scales beyond ad hoc transactions toward stable, contractible exchanges, closing loops and increasing resource productivity. Thus, stakeholder collaboration in CE is best viewed as a *triadic* relationship: governance instruments (EPR/CPP) and orchestration capabilities (roles, routines, investment sequencing) are necessary but not sufficient; interoperable information infrastructures (DPP/traceability, potentially blockchain-enabled) are the connective tissue that binds them into reliable, scalable circular outcomes (Zhang & Seuring, 2024; Malik et al., 2021; Rejeb et al., 2023).

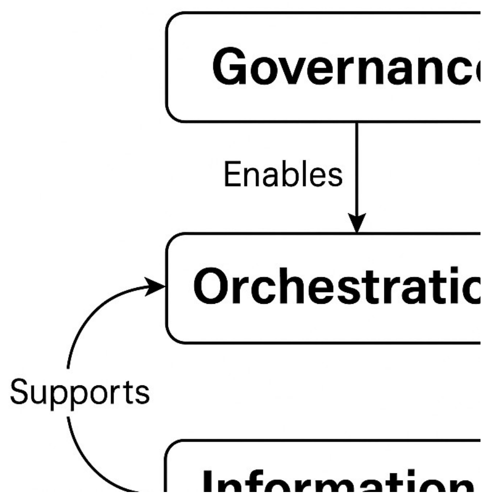

Figure 3. Interplay of governance, information, and orchestration in circular ecosystems

*Figure 3 is a systems diagram showing: Left – **Governance levers** (EPR, CPP, standards) feeding into Center – **Information capabilities** (DPP, traceability, shared data spaces, optional blockchain) which mediate and enable Right – **Orchestration mechanisms** (roles, routines, partner configuration). Downstream arrows lead to **Circular outcomes** (reuse/remanufacture rates, secondary material uptake, emissions reduction, resilience). Feedback loops return performance data to governance for rule refinement and to orchestration for process improvement.*

2.5 Proposed conceptual model

This paper proposes an industry-level model that explains how external pressures translate into circular outcomes through collaboration. The model links three building blocks – **antecedents → collaboration mechanisms → outcomes** – and specifies information-rich coordination as the core mediating logic. Antecedents are exogenous drivers that trigger collaboration; collaboration mechanisms are the governance, orchestration, and data practices that enable joint action; and outcomes are the measurable industrial, environmental, and resilience benefits associated with circular economy (CE) performance. The model is grounded in recent comparative governance and ecosystem research showing that CE transitions succeed where public policy creates enabling conditions while multi-actor networks co-produce operational rules (Cramer, 2022; Patala et al., 2022). It also draws on empirical studies that unpack how orchestrators configure partners, align incentives, and stabilise collective action over time (Ermini et al., 2024; Saccani et al., 2023), and on emerging evidence that digital infrastructures such as Digital Product Passports (DPPs) provide the informational backbone required to coordinate reverse flows and secondary markets (Zhang & Seuring, 2024; Jensen et al., 2024).

Antecedents comprise regulatory mandates (e.g., extended producer responsibility), public procurement standards, market signals for low-footprint products, and institutional pressures arising from reputational and compliance logics. These forces create shared problem recognition and lower collective-action thresholds, but they do not on their own deliver circularity. Comparative analyses show that countries and sectors with similar regulatory intent achieve different results depending on how those pressures are translated into collaborative rules and shared infrastructures (Cramer, 2022). In our model, antecedents thus activate collaboration mechanisms rather than directly producing outcomes.

Collaboration mechanisms operate through three intertwined channels. First, **collaborative governance** establishes rule systems – roles, responsibilities, decision rights, dispute-resolution routines, and accountability – that fit local coordination problems while remaining connected to system goals. Polycentric governance theory explains why multiple, semi-autonomous decision centres (firms, municipalities, producer-responsibility organisations, civic actors) are well-suited to govern privately owned resources that must circulate across organisational boundaries (Patala et al., 2022). Second, **ecosystem orchestration** concerns how focal actors configure partners, align incentives, and sequence co-investments so that circular value propositions (repair, reuse, remanufacture, high-quality recycling) can be delivered reliably. Recent field studies detail stage-specific orchestration practices and boundary resources – shared metrics, joint roadmaps, and monitoring routines – that sustain momentum and curb opportunism in multi-actor settings (Ermini et al., 2024; Saccani et al., 2023). Third, **information capabilities** – traceability and transparency – form the connective tissue that links governance to orchestration. DPPs and interoperable data spaces standardise product and process information (composition, provenance, repairability, use history, and end-of-life options), reducing uncertainty, enabling credible accountability, and coordinating reverse logistics (Zhang & Seuring, 2024; Jensen et al., 2024). Resource-orchestration research further shows that traceability and transparency function as mutually reinforcing capability bundles that lower coordination costs – precisely the capabilities needed to make cross-firm circular collaboration viable (Malik et al., 2021).

Outcomes in the model are expressed as improvements in circular performance (e.g., higher rates of reuse, repair, remanufacture, and secondary-material uptake), environmental impacts (life-cycle emissions and waste reduction), and **ecosystem resilience** (diversified reverse networks, reduced exposure to virgin-material shocks). Because outcomes are multi-dimensional, robust measurement systems are required to surface trade-offs and verify progress; recent work on circular metrics and performance dashboards provides templates for shared measurement that can be embedded in governance and orchestration routines (Saidani et al., 2024; Vegter et al., 2023).

The model includes two cross-cutting **contingencies**. First, **data quality and interoperability** moderate the effects of governance and orchestration on outcomes: even well-designed rules and partnerships underperform when product-life-cycle data are incomplete or siloed (Jensen et al., 2024; Zhang & Seuring, 2024). Second, **institutional logics** – cost-efficiency versus stewardship – shape partners' willingness to invest in circular capabilities, implying that relationship-building and sense-making forums are necessary complements to technical solutions (Rovanto, 2024). Together, these contingencies clarify why similar policies or partnerships yield uneven outcomes across sectors and regions.

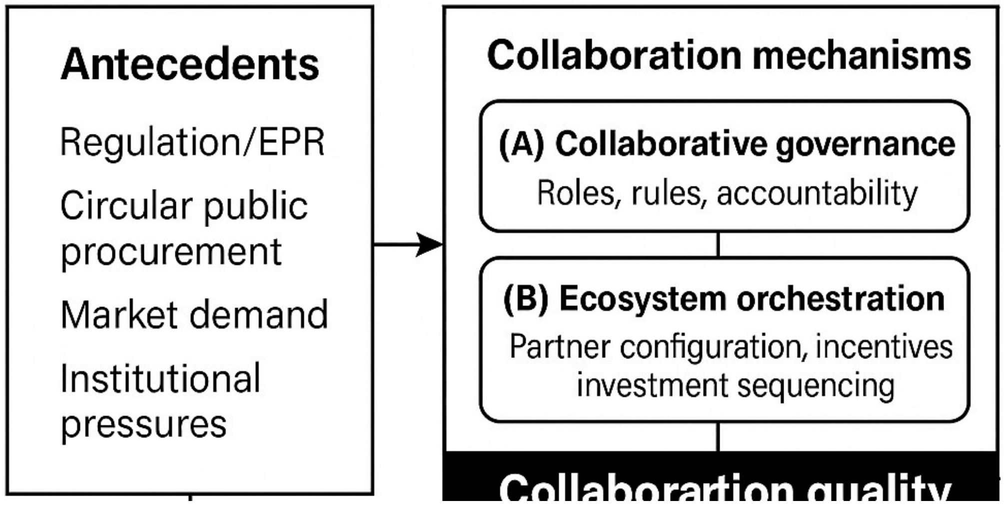

Figure 4. Stakeholder-collaboration model for industry-level circular outcomes

Figure 4 is the proposed conceptual model – a path diagram: left panel Antecedents (regulation/EPR, circular public procurement, market demand, institutional pressures) feed into a central panel Collaboration mechanisms with three stacked modules – (A) Collaborative governance (roles, rules, accountability), (B) Ecosystem orchestration (partner configuration, incentives, investment sequencing), (C) Information capabilities (traceability, transparency, DPP/data spaces). A bold mediating band labelled Collaboration quality spans A–C. Arrows lead to the right panel Outcomes (circular performance, environmental impact reduction, ecosystem resilience). Dashed arrows from Data quality & interoperability and Institutional logics enter the mechanism–outcome link as moderators. Measurement icons loop outcomes back to governance to indicate learning and rule refinement.

2.6 Gaps warranting this study

Despite rapid advances, the scholarship remains fragmented across governance, orchestration, and digital-traceability streams, with few integrative models that specify how rules, roles, and data jointly convert external pressures into circular outcomes. Umbrella and ecosystem reviews emphasise CE's systemic nature but call for stronger theorisation of the collaborative mechanisms that link stakeholder governance to operational coordination across value chains. This signals a persisting conceptual gap: the field still lacks a unifying account that interlocks collaborative governance, ecosystem orchestration, and information capabilities into a single, testable framework. (Hossain et al., 2024; Aryee et al., 2025).

Operationalisation gaps mirror the conceptual ones. Studies routinely invoke "collaboration quality" yet offer limited validated constructs for the rule clarity, role alignment, accountability routines, and data completeness that make collaboration effective in practice. Comparative governance evidence suggests that similar policies yield different results depending on how networks translate mandates into shared rules and infrastructures, but empirical instruments to measure those translation processes remain sparse – especially at industry level. This points to a need for construct development and multi-actor measurement protocols that can capture collaboration mechanisms across contexts. (Cramer, 2022; Patala et al., 2022).

A third gap concerns information infrastructures. Digital Product Passports (DPPs) are widely proposed to reduce information asymmetries, yet research documents unresolved issues around lifecycle data scope, interoperability, and the translation of compliance datasets into decisions about repair, reuse, remanufacture, and high-quality recycling. Reviews of DPP use cases highlight weak coverage of end-of-life quality assessment and heterogeneous data standards; case research on DPP data needs similarly underscores that decision-useful information remains incomplete and siloed. The field therefore requires robust data semantics, cross-platform interoperability, and protocols for verifying secondary-material quality at scale. (Zhang & Seuring, 2024; Jensen et al., 2023).

Fourth, evidence on policy–collaboration couplings is mixed. Circular public procurement often embeds circular criteria but does not consistently deliver environmental impact reductions without monitoring systems and inventory data that verify circular flows, suggesting that governance levers must be coupled to traceability and performance-measurement architectures to become effective. This underscores a design gap at the policy–data interface and motivates quasi-experimental and longitudinal studies that can isolate causal effects of different collaboration designs. (Zijp et al., 2022).

Finally, measurement and comparability remain underdeveloped. Expert consensus highlights the need for next-generation, decision-relevant CE metrics that are interoperable across sectors and tie directly to collaborative actions and outcomes; until then, studies struggle to benchmark ecosystem-level progress or adjudicate among alternative collaboration designs. Together, these gaps justify the model advanced in this paper and its accompanying propositions, which integrate governance, orchestration, and information capabilities while foregrounding measurement as an enabling substrate for collaboration at scale. (Saidani et al., 2024).

3. METHODOLOGY

A structured, integrative review with systematic elements was employed to ensure transparency, coverage, and reproducibility. Reporting followed the PRISMA 2020 guidance and its search-reporting extension PRISMA-S, both adapted to a conceptual – rather than meta-analytic – synthesis of collaboration mechanisms for the circular economy (CE) at industry level (Page et al., 2021; Rethlefsen et al., 2021). The review corpus was defined as English-language, peer-reviewed journal articles published between 1 January 2020 and 11 September 2025, reflecting the rapid evolution of CE governance, ecosystem orchestration, and digital traceability. Eligibility further required a registered DOI to ensure persistent identification and verifiability (Page et al., 2021).

Literature was retrieved from Scopus, Web of Science Core Collection, ScienceDirect, Wiley Online Library, Taylor & Francis Online, Emerald Insight, SpringerLink, IEEE Xplore, and ACM Digital Library, thereby capturing research in management, operations, sustainability, and information systems. To mitigate database bias and enhance recall, the database searches were complemented with forward–backward citation chasing of seed papers and authors (Rethlefsen et al., 2021; Donthu et al., 2021). Iteratively refined Boolean strings combined CE terms with collaboration, governance, ecosystem, and data-infrastructure constructs, for example:

("circular economy" OR "industrial symbiosis" OR "circular supply chain" OR "product-service system") AND ("collaborative governance" OR polycentric OR "stakeholder collaboration" OR orchestrat* OR ecosystem) AND (traceab* OR "digital product passport" OR "extended producer responsibility" OR "circular public procurement"). Truncation and proximity operators were adapted to the conventions of each database.

Articles were included if they (i) explicitly addressed industry-level or supply-chain collaboration for CE, (ii) examined governance instruments (e.g., EPR, circular procurement), ecosystem orchestration, or information capabilities (e.g., DPP/traceability), and (iii) reported sufficient methodological detail for appraisal. Exclusions applied to non-English materials, items published before 2020, non-peer-reviewed outputs (policy briefs, theses, editorials), conference papers lacking full-journal versions, and publications without a DOI (Kraus et al., 2020; Paul et al., 2021). A two-stage screening process (titles/abstracts, followed by full text) was applied against the eligibility criteria. Discrepancies were resolved by re-checking against the protocol and revisiting conceptual fit.

For each included study, bibliographic details, contextual characteristics (sector, geography), research design, theoretical lens, collaboration mechanisms (governance, orchestration, information), policy levers (EPR/CPP), outcome measures (circular performance, environmental impacts, resilience), and key findings were extracted. A concept-centric matrix was developed to retain conceptual fidelity while enabling cross-study synthesis, with codes harmonised iteratively across domains (Kraus et al., 2020; Paul et al., 2021). Design-sensitive quality assessment was undertaken to account for the diversity of included studies. Criteria emphasised conceptual clarity, construct validity, methodological transparency, and alignment between evidence and claims. For empirical studies, additional considerations included sampling adequacy, robustness of measurement (e.g., traceability/CE metrics), and credibility of analysis. Conceptual contributions were appraised for coherence, boundary conditions, and theoretical advancement (Kraus et al., 2020; Page et al., 2021).

Findings were integrated through a narrative, concept-centric synthesis, supported by light bibliometric profiling (e.g., outlets, methods, and theory clusters) to contextualise thematic patterns and reveal gaps. The coding outputs informed the conceptual model and the propositions.

4. Analysis And Discussion Of Findings

Critical examination of literature

The body of literature on the circular economy (CE) highlights that achieving circularity requires more than firm-level innovation; it is a systemic transition that depends on collaboration across diverse stakeholders. This transition is conceptualised through different lenses, each contributing distinct emphases. Governance-oriented studies stress the significance of designing rule systems and accountability mechanisms that enable coordination among heterogeneous actors. Comparative analyses demonstrate that polycentric governance – where multiple decision centres such as firms, municipalities, and civil organisations co-produce and enforce rules – provides flexibility and legitimacy, particularly in addressing local resource challenges while linking them to wider system goals (Cramer, 2022; Patala et al., 2022). These insights underscore governance as a structural foundation for aligning incentives and responsibilities across value chains.

In parallel, ecosystem perspectives focus on orchestration, showing that the effective implementation of circular strategies hinges on how partners, incentives, and capabilities are configured. Multi-case investigations illustrate how ecosystem orchestrators create and sustain collaboration through role allocation, incentive alignment, and investment sequencing (de Vasconcelos Gomes et al., 2023). Further, orchestration studies reveal the importance of boundary resources such as shared metrics and dispute-resolution routines, which help sustain momentum in complex multi-actor initiatives (Ermini et al., 2024). This strand of literature thus conceptualises collaboration as an ongoing relational capability that transforms abstract governance rules into practical outcomes.

The socio-technical transitions perspective situates CE adoption within multi-level dynamics, linking niche innovations, sectoral regimes, and macro-level landscapes. Bibliometric analyses confirm that CE progress often depends on the ability of coalitions to align institutions, technologies, and business models across these levels (Wang et al., 2022). Organisational studies extend this view by showing that firms' circular capabilities evolve within competing institutional logics, such as cost efficiency and stewardship. Reconciling these logics requires platforms and forums where actors can engage in joint sense-making and adaptation, emphasising the cultural and institutional dimensions of collaboration (Rovanto, 2024).

Empirical findings reinforce and extend these theoretical claims. Case studies in fashion and manufacturing highlight that stakeholder engagement practices and orchestration routines are critical in overcoming barriers to CE adoption (Saccani et al., 2023; Fobbe et al., 2023). Digital Product Passports (DPPs) are increasingly recognised as tools for addressing information asymmetries, yet research consistently identifies lifecycle-data gaps and interoperability challenges that undermine their potential (Jensen et al., 2023; Zhang & Seuring, 2024). Policy instruments such as Extended Producer Responsibility (EPR) and circular public procurement (CPP) provide enabling conditions, but studies note they require integration with robust monitoring systems and traceability infrastructures to be effective (Leclerc & Badami, 2024; Zijp et al., 2022).

Collectively, the literature confirms that collaboration is indispensable for CE transitions, but fragmentation persists across governance, orchestration, and information systems research. This lack of integration leaves unanswered questions about how these mechanisms interact, under what contingencies they succeed, and how they can be measured and compared across contexts. The critical insight emerging from the literature is that collaboration quality – defined by coherent governance, effective orchestration, and mature information infrastructures – remains the pivotal determinant of circular outcomes.

Proposition development

Building on the synthesis, several conceptual propositions emerge:

- *Proposition 1*: The quality of collaborative governance (clarity of roles, accountability routines, and inclusiveness of decision-making) positively influences the effectiveness of CE outcomes at industry level.
- *Proposition 2*: Ecosystem orchestration capabilities – partner configuration, incentive alignment, and investment sequencing – mediate the relationship between collaborative governance and industrial circular performance.
- *Proposition 3*: Information capabilities (traceability, transparency, and DPP-enabled interoperability) strengthen the governance–orchestration linkage, serving as a mediating mechanism that converts rules and roles into operational coordination.
- *Proposition 4*: Policy levers such as EPR and CPP enhance collaboration effectiveness when coupled with information infrastructures that allow monitoring and verification of compliance.

- *Proposition 5*: Institutional logics (efficiency versus stewardship) and data quality moderate the relationship between collaboration mechanisms and outcomes, influencing the degree to which governance and orchestration deliver circular performance.

Integration of ideas: When integrated, the insights indicate that collaboration in CE ecosystems is a multi-layered construct. Governance provides the institutional scaffolding, orchestration delivers the relational and operational coordination, and information capabilities ensure transparency and accountability. Together, these mechanisms form a triadic system in which none is sufficient alone. Governance without data lacks credibility; orchestration without governance lacks legitimacy; and data without orchestration lacks practical uptake. The reviewed literature thus supports a holistic model where collaboration quality – defined by the alignment of governance, orchestration, and information – emerges as the central determinant of industry-wide CE outcomes (Cramer, 2022; Patala et al., 2022; Saccani et al., 2023; Jensen et al., 2023; Zhang & Seuring, 2024).

5. Implications for Theory and Practice

The insights generated in this study carry important implications for scholarship, management practice, and policy. From a theoretical perspective, the synthesis clarifies that collaboration in circular economy ecosystems cannot be examined in isolation through governance, orchestration, or information capabilities alone. Each mechanism is necessary but not sufficient, and their interaction defines the quality of collaboration. By integrating these perspectives into a unified model, the paper advances conceptual clarity and establishes a foundation for proposition testing. This contributes to ongoing debates about how cross-sector partnerships drive systemic transitions and provides a framework that future empirical research can operationalise and measure.

For management practice, the findings highlight the practical pathways through which firms and industry actors can convert collaborative intent into circular outcomes. Managers are encouraged to invest not only in technology or design innovation but also in the relational and institutional capabilities that make cross-firm collaboration viable. Establishing shared rules, building trusted orchestration platforms, and adopting interoperable traceability systems emerge as essential levers for embedding circularity in supply chains. Firms that develop these capacities are likely to secure competitive advantage through enhanced resource efficiency, resilience against material shocks, and access to new circular markets.

At the policy level, the framework demonstrates that instruments such as extended producer responsibility and circular public procurement are most effective when coupled with transparent monitoring systems and interoperable data infrastructures. Policymakers can therefore strengthen collaboration by mandating information-sharing, funding industry-wide traceability platforms, and designing incentives that reward verified circular performance rather than symbolic compliance. The integration of governance levers with digital infrastructures ensures accountability, supports secondary material markets, and lowers risks for actors engaging in joint investments.

Together, these implications underline that achieving a sustainable industry requires aligning theory, practice, and policy through collaborative architectures. For scholars, the proposed model offers a platform to refine constructs and test relationships. For practitioners, it offers actionable insights into the operationalisation of collaboration. For policymakers, it suggests design principles for coupling regulation with enabling infrastructures. The overarching message is that collaboration quality – defined by the alignment of governance, orchestration, and information – remains the decisive determinant of progress toward circular economy outcomes.

6. Conclusion

This paper has examined how fostering stakeholder collaboration can accelerate the adoption of circular economy principles and drive the transition toward sustainable industry. The review and analysis demonstrate that while technological innovation and policy incentives are important, they are insufficient on their own. The decisive factor lies in the quality of collaboration, which is shaped by the interplay of governance mechanisms, ecosystem orchestration capabilities, and information infrastructures. By integrating these perspectives, the paper advances a conceptual model that explains how external pressures are converted into tangible circular outcomes through well-designed collaborative arrangements.

The theoretical contribution of the study lies in synthesising fragmented strands of literature into a unified framework that positions collaboration quality as the central determinant of circular performance. Governance ensures legitimacy and accountability, orchestration enables relational and operational coordination, and information capabilities reduce uncertainty by providing transparency and traceability. Together, these mechanisms illustrate that industry-wide circularity is an emergent property of coordinated interaction rather than the sum of individual firm-level practices.

At the same time, this research acknowledges certain limitations. As a conceptual paper, the arguments developed rely on existing literature rather than new empirical evidence, making them subject to the biases of prior research and the scope of studies included. Furthermore, the framework does not yet provide validated measures for collaboration quality, nor does it capture contextual variations across sectors, geographies, or regulatory regimes. These constraints highlight the need for empirical testing and refinement.

Future research should therefore focus on operationalising the constructs proposed here and subjecting them to empirical examination. Quantitative studies could develop and validate metrics for collaboration quality, while case-based and longitudinal designs could illuminate how governance, orchestration, and information capabilities evolve and interact over time. Comparative analyses across industries and regions would also provide insight into the conditions under which collaboration is most effective. Such work would not only test the propositions generated by this paper but also extend them into practical guidance for firms and policymakers seeking to embed circularity in industrial ecosystems.

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