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Where Coordination Sits: Reverse Logistics Configurations in Remanufacturing Systems

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Abstract:

Remanufacturing is central to circular economy strategies, yet its scalability is often limited by reverse logistics rather than production. This study reframes remanufacturing as a reverse logistics coordination design problem, examining how interdependent activities are organised and governed across dispersed actors, locations, and uncertain return streams. From a system-level perspective, it develops three analytical frameworks. A coordination load mapping framework makes coordination work explicit by tracing information processing, decision coupling, and exception handling across activities and actors. A configuration–governance–digital fit framework explains how governance arrangements and digital tools interact with logistics configurations to redistribute coordination burdens. A return-flow feasibility and impact framework clarifies when reverse flows remain operationally and economically viable under uncertainty, spatial dispersion, and cross-border frictions, and which cost, lead-time, and environmental trade-offs are plausible. Together, these frameworks enable comparative analysis and advance a coordination-centred view of remanufacturing scalability.

Keywords: Reverse logistics; Remanufacturing; Closed-loop supply chain; Product returns; Logistics network design; First-

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mile/last-mile logistics; Supply chain visibility; Coordination mechanisms.

Problem

Remanufacturing relies on reverse logistics systems that enable the collection of used products from dispersed points of use and their reintegration into industrial operations. Operations management research has firmly established reverse logistics as a core infrastructural element of closed-loop supply chains, shaping the feasibility and performance of remanufacturing activities (Govindan et al., 2023; Kazancoglu et al., 2024). however, much of this literature has treated reverse logistics primarily as a technical network to be optimised, offering limited insight into how such systems are organised, coordinated, and governed in practice, and how these organisational features determine which return flows are feasible at scale.

In industrial remanufacturing contexts, reverse logistics is characterised by substantial uncertainty in return volumes, timing, quality, and spatial dispersion. Empirical studies document fragmented collection arrangements, first- and last-mile inefficiencies, and significant coordination burdens across multiple organisations and locations (Abbey et al., 2023; Hazen et al., 2023; Wang et al., 2023). As remanufacturing systems expand across regions and organisational boundaries, coordination demands rise and shift across collection, transport, processing, and cross-border interfaces. These dynamics raise fundamental questions about how reverse logistics systems are configured and governed as they scale amid uncertainty, and about how coordination burdens accumulate, shift, and become binding constraints.

At the same time, digital technologies—including analytics, IoT, digital platforms, and AI—are widely promoted as enablers of coordination in reverse logistics, primarily by improving information visibility and integration among dispersed actors. Yet empirical evidence suggests that digital investments frequently fail to deliver the expected improvements in logistics coordination or circular performance (Kristoffersen et al., 2021; Chirumalla et al., 2025). This persistent gap points to a deeper problem: digital tools do not operate independently of the organisational structures within which reverse logistics is embedded. Their effects depend on how reverse flows are structured, how coordination responsibilities are allocated, and how decision rights are governed across actors—that is, on the degree of “fit” between configuration, governance, and digital tools.

Taken together, these observations suggest that the central challenge in remanufacturing is not merely technological or operational, but organisational. The key problem concerns how reverse logistics systems can be configured and governed under conditions of uncertainty and dispersion, so that coordination remains effective as remanufacturing scales, digital technologies support—rather than complicate—system performance, and return flows remain feasible and deliver measurable operational and environmental impact.

Current understanding

Research in operations and logistics consistently recognises reverse logistics as a necessary infrastructure for remanufacturing and closed-loop supply chains, supporting environmental objectives and, in some cases, economic performance (Reike et al., 2018; Govindan et al., 2023; Kazancoglu et al., 2024). Empirical studies document the potential of repair, remanufacturing, and recycling to improve resource efficiency and reduce waste when reverse logistics systems function effectively (Kazancoglu et al., 2021; Sonar et al., 2024). In parallel, a growing literature highlights the promise of digital technologies to enhance information visibility and decision-making in reverse supply chains (Perey et al., 2018; Kristoffersen et al., 2021).

At the same time, recent studies increasingly suggest that reverse logistics performance depends less on the adoption of individual practices or technologies and more on how reverse flows are organised and coordinated across dispersed actors, locations, and return streams (Gligor et al., 2019; Hazen et al., 2020; Wang et al., 2023). Reverse logistics for remanufacturing is marked by pronounced uncertainty in return volumes, timing, and product condition, as well as significant first- and last-mile challenges, creating interdependencies across collection, transport, and processing activities (Zhang et al., 2024). These interdependencies make coordination central to system performance, particularly as remanufacturing operations grow in scale and complexity—yet the literature rarely specifies how coordination demands can be mapped, compared, or diagnosed across alternative configurations.

Despite this recognition, much of the literature continues to approach reverse logistics through optimisation models, network design, or practice-based perspectives. Review studies show that remanufacturing is often treated as a functional node within an abstracted logistics system, rather than as an organised socio-technical arrangement involving governance, decision rights, and coordination across organisational boundaries (Zhang et al., 2022). While this body of work provides valuable insights into efficiency, cost trade-offs, and uncertainty management, it offers limited system-level understanding. It does not show how reverse logistics activities are configured and governed as remanufacturing expands to include more actors and institutional interfaces. It also does not explain how this expansion alters the distribution and intensity of coordination work.

Similarly, research linking reverse logistics to the circular economy frequently emphasises enabling technologies, firm-level practices, or sectoral applications, while offering fragmented accounts of inter-organisational relationships and governance mechanisms (Biancolin et al., 2023). As a result, questions about how alternative reverse logistics configurations reshape coordination demands—and how these configurations condition the effects of digital technologies on operational outcomes such as cost, service, and environmental performance—remain underexplored, particularly under conditions of uncertainty and spatial dispersion (Julianelli et al., 2020; Wang et al., 2023). Further, existing studies seldom treat “return-flow feasibility” as an explicit system constraint—i.e., when coordination burdens and frictions make certain returns economically or operationally non-viable even if technically recoverable.

Research Gap

This study addresses these gaps by developing three integrative analytical frameworks for reverse logistics in industrial remanufacturing. First, we develop a coordination load mapping framework that makes coordination demands explicit and comparable across alternative reverse logistics configurations by tracing where information processing, decision coupling, and exception handling are concentrated across activities and actors. Second, we develop a configuration–governance–digital fit framework that explains when digital tools reduce (rather than amplify) coordination burdens, depending on the alignment of information architectures, decision rights, and governance mechanisms with the underlying logistics configuration. Third, we develop a return-flow feasibility and impact framework that clarifies when reverse flows remain operationally and economically feasible under uncertainty, dispersion, and cross-border frictions—and what performance and environmental impacts are plausible under different coordination and fit conditions. Together, these frameworks reframe reverse logistics as a coordination design problem that shapes the scalability of remanufacturing systems under uncertainty.

Research Questions

RQ1. (Coordination load mapping): How do alternative reverse logistics configurations redistribute coordination load—i.e., information processing, decision coupling, and exception handling—across activities and actors within industrial remanufacturing systems?

RQ2 (Return-flow feasibility and impact): Under return uncertainty, spatial dispersion, and cross-border frictions, when does the redistribution of coordination load make specific return flows feasible (or infeasible), and what operational and environmental impacts follow from those feasibility conditions?
RQ3 (Configuration–governance–digital fit): How do governance arrangements and digital tools align (or misalign) with reverse logistics configurations to reduce, relocate, or amplify coordination load as remanufacturing systems scale?

Research design

This study will adopt a system-level, theory-informed comparative research design grounded in coordination theory to examine reverse logistics for remanufacturing as a set of interdependent activities, the performance of which depends on how coordination demands are structured and allocated across actors and locations. Reverse logistics configurations will be conceptualised as alternative ways of organising material and information flows across key activities, including first-mile collection, transport, processing, and cross-border interfaces, and compared using the three proposed analytical frameworks.

The research will draw on secondary data sources, including academic literature, industry and consultancy reports, and validated datasets from international organisations. These sources will be used to identify recurring reverse logistics configurations, map material and information flows, and characterise governance arrangements and the roles assigned to digital tools in remanufacturing systems. Rather than estimating causal effects or measuring realised firm-level performance, the study will pursue a comparative and configurational analysis to develop system-level explanations of how coordination demands are redistributed under conditions of return uncertainty, spatial dispersion, and cross-border frictions and how these redistributions condition feasibility and impact.

Comparative and scenario-based analyses will be used to examine how alternative coordination structures affect costs, lead times, and environmental performance. These implications will be examined through a reasoned comparison of different configurations. The analysis will draw on documented process characteristics, cost structures, and reported operational challenges in the literature, rather than on statistical inference. Governance arrangements and digital tools will be studied as structural complements to reverse logistics configurations. Attention will be given to how they enable or constrain coordination and visibility, depending on how coordination responsibilities are distributed within the logistics network, with specific attention to misfit patterns (e.g., visibility without decision rights; decision rights without reliable visibility).

Overall, the proposed research design is intended to support the development of system-level theory. It clarifies how different reverse logistics configurations shape coordination challenges and operational trade-offs in dispersed, uncertain remanufacturing systems. The study aims to offer conceptual insights to operations management research on coordination, configuration, and governance. It also provides a foundation for future empirical work that could examine these dynamics in specific organisational settings by offering framework-based diagnostics that can be operationalised in primary data studies.

Expected Findings

This study is expected to show that remanufacturing system performance and scalability depend less on individual practices or digital technologies. Instead, they hinge on how reverse logistics configurations shift coordination demands across dispersed actors and activities. The key is whether that coordination shifts keep return flows within feasible operational and economic bounds. The analysis is expected to reveal systematic trade-offs in coordination between centralised and distributed configurations, particularly under return uncertainty, spatial dispersion, and cross-border frictions. Centralised setups are expected to focus coordination in upstream planning and cross-border interfaces, potentially benefiting from scale efficiencies and standardisation, but also increasing first-mile challenges and coordination at key nodes. Distributed configurations are expected to reduce collection distances and first-mile inefficiencies, but shift coordination demands to local information processing, governance complexity, and inter-organisational alignment.

The study is expected to clarify how governance arrangements and digital tools influence trade-offs. It is not expected to resolve them outright. Scenario-based analyses will show that information-sharing mechanisms, visibility tools, and decision-support systems only mitigate coordination challenges when they align with the appropriate decision rights and governance structures. Digital tools do not replace coordination work. Instead, they enable the redistribution of coordination tasks. Sometimes this is productive, reducing the need for exception handling. Sometimes it is counterproductive, creating additional coordination interfaces and data reconciliation work. The study also aims to identify how different reverse logistics configurations shape costs, lead times, and environmental trade-offs in remanufacturing-oriented systems. Insights will be organised into analytical frameworks. This will clarify the interaction among coordination demands, governance arrangements, and digital tools across reverse logistics systems. It will not imply a universally optimal configuration but will specify feasibility "frontiers" beyond which certain return flows are unlikely to be viable under given frictions.

Contribution

This study is expected to contribute to the operations management and reverse logistics literature by reframing remanufacturing as a system-level coordination design problem, rather than primarily a production, technology, or firm-level practice issue. By integrating coordination theory with research on reverse logistics and closed-loop supply chains, the study aims to explain how alternative logistics configurations redistribute coordination demands across first-mile collection, transport, processing, and cross-border interfaces, and how these redistributions are linked to distinct operational trade-offs under conditions of uncertainty and geographic dispersion through three transferable analytical frameworks.

Conceptually, the study aims to advance research by moving beyond practice- and technology-centric accounts. It seeks a configuration-based explanation of reverse logistics performance and scalability. Empirically, the study synthesises evidence from academic and practitioner sources. It maps material and information flows and compares coordination trade-offs across configurations. Thus, the study responds to calls for more system-level explanations of operational performance in circular and remanufacturing contexts. It clarifies when coordination, rather than capacity or technology, becomes a binding constraint on remanufacturing at scale. These insights are organized into integrative analytical frameworks that support comparative reasoning by: (1) enabling coordination load mapping across configurations, (2) diagnosing configuration–governance–digital fit and misfit, and (3) specifying return-flow feasibility and impact under different frictions.

Practical implications

The study is also expected to inform managerial decisions on digitalisation in reverse logistics. Rather than treating digital tools as universal solutions, the findings are expected to show that analytics, visibility platforms, and decision-support systems are most effective when used to address specific coordination needs arising from configuration choices. These tools work best when paired with governance mechanisms that assign decision rights to where relevant information is generated and validated. For policymakers, the study is also expected to highlight the importance of reducing regulatory, informational, and infrastructural frictions. Reducing these frictions helps lower coordination costs in reverse flows. This supports the scalable implementation of remanufacturing systems and expands the set of feasible return flows in practice.

Participation Mode

In-person.

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