Innovation of Supply Chain Collaboration Models from the Perspective of Business Ecosystems

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Abstract. In today's global economy, competition has shifted from individual firms to networks of ecosystems. This change requires supply chain collaboration to move beyond the limits of traditional linear models and embrace new forms of cooperation. This paper explores supply chain collaboration through the lens of business ecosystems. It examines the key components of ecosystems, analyzes how they drive collaboration and identifies three innovative models: platform-based, modular and value co-creation. The study also discusses the challenges of interest imbalance, data security and instability, while proposing coping strategies including dynamic benefit-sharing, secure data frameworks and strengthened cultural identity. By adopting a conceptual and analytical approach, the paper integrates insights from existing literature with ecosystem theory. The findings highlight the significance of diversity, interdependence and adaptability for modern supply chains. They provide both theoretical contributions and practical guidance for firms seeking more resilient, innovative and sustainable collaborative models. This paper provides suggestions for the development of supply chain.

Keywords: Enter key words or phrases in alphabetical order, separated by commas.

1. Introduction

Globalization and digital transformation have made supply chains increasingly complex and interconnected. They now involve multiple actors across industries and regions, creating both opportunities and risks. In this environment, collaboration among supply chain members has become essential for efficiency, resilience and long-term competitiveness. Traditional linear supply chains, once dominated by dyadic relationships between suppliers and buyers, are giving way to more networked structures that resemble business ecosystems. These ecosystems consist of firms, supporting organizations and users linked through flows of information, capital and technology.

The importance of cooperation in supply chains has been widely recognized. Agent-based simulations and mathematical models have shown how disruptions propagate across supply chains, highlighting the role of interdependence among actors [1]. However, most early studies focused on the structural aspects of supply chains, such as the number of tiers or the flow of goods [1]. They often assumed that firms would act rationally to optimize efficiency, without fully considering the possibility of opportunism or free riding. Recent research emphasizes that cooperation is a social dilemma: while individual actors may gain short-term benefits from defection, sustained collaboration is necessary for the system to function [1].

The literature on the evolution of cooperation provides useful insights for this problem. Mechanisms like reciprocity, reputation and group selection explain why cooperation can persist even under competitive conditions [1]. Applied to supply chains, these mechanisms suggest that firms coordinate because of contracts, trust, shared reputation and sanctions against defectors. Yet, most existing studies model cooperation at the level of individuals or dyadic relationships, while supply chains operate as networks of groups performing specialized tasks. This creates a gap in the literature, as group-level interactions introduce asymmetries that individual-level models cannot capture [1].

Moreover, modern supply chains are no longer linear. They take the form of complex, multi-tiered networks with loops, feedback and cross-connections [1]. These features increase both resilience and vulnerability. A single act of defection can disrupt the reputation and performance of

the entire chain. Well-known cases in the automotive industry, such as large-scale recalls caused by supplier errors, illustrate how fragile cooperation can be [1]. Despite these risks, there is still limited research on how ecosystems as a whole foster or hinder collaborative innovation in supply chains.

This study addresses this gap by analyzing supply chain collaboration from the perspective of business ecosystems. Unlike traditional models, the ecosystem view emphasizes diversity of actors, value networks and dynamic evolution. This perspective allows a deeper understanding of how collaboration is driven, how new collaborative models emerge and what challenges must be addressed.

Methodologically, this paper adopts a conceptual and analytical approach. It reviews existing studies on cooperation and supply chain networks, integrates insights from evolutionary game theory and applies them to the context of ecosystem-based supply chains. The main body of the paper is organized into three parts. Firstly, the core components of business ecosystems and their role in driving supply chain collaboration. Secondly, the innovation directions of collaborative models under the ecosystem perspective. Lastly, the key challenges and coping strategies for sustaining collaboration.

The aim of this research is to enrich the understanding of supply chain collaboration by linking it with ecosystem theory. It seeks to provide a theoretical foundation for firms to design more adaptive, innovative and resilient collaborative models.

2. The Structure of Business Ecosystems and Their Driving Role in Supply Chain Collaboration

2.1. Core Components of a Business Ecosystem

A business ecosystem indicates that enterprises do not act in isolation. They connect different stakeholders in a wider system. These stakeholders work together and affect how supply chains create and deliver value. The ecosystem consists of three essential parts, diverse actors, the value network and its ability to change over time.

At the center of the ecosystem is a core firm which often sets the rules and shapes how others work together. It may decide on standards, manage processes or control platforms. Suppliers and distributors are around the core firm. Suppliers provide materials or services, while distributors and retailers bring products to customers. The ecosystem also includes supporting organizations, for example, technology companies, banks, consulting firms and universities. They provide extra skills, funding or research that make the system more powerful. Customers also play an important role. They buy products, give feedback, participate in user communities and take part in product design. This mix of actors makes the ecosystem more open and inclusive than a traditional supply chain.

Traditional supply chains are more likely to be linear. However, ecosystems form a network. Resources such as money, information and technology move in several directions. This network allows faster communication and better coordination, which helps reduce mistakes and makes production smoother. Complementary strengths is another feature of value network. Supply chain is a division of labor where different groups have their own subtasks and collaboration among them is the key to success [1]. Each group adds what it does best and creates more value than one firm alone when these strengths combine.

A business ecosystem changes as markets, technology and society change. This ability to evolve keeps it alive. Research of supply chain collaboration indicates that punishing those who harm the value of system can promote sustainable cooperation. It also states that non-linear reward functions can boost the coexistence of different roles [1]. This reflects how supply chain maintains collaboration and adapts to external changes by improving its rules. The system also adjusts through competition in which firms that fail may leave. This process makes the ecosystem stronger over time. Moreover, change can be proactive. Core firms may start new partnerships or reorganize their networks to prepare for future challenges. Ecosystems stay flexible in this way.

2.2. The Driving Logic of Ecosystems for Supply Chain Collaboration

A business ecosystem not only connects firms but also creates forces that support supply chain collaboration. These forces come from three main aspects: demand pull, resource sharing, and capability complementarity.

Customer demand spreads rapidly across an ecosystem. Information passes through suppliers, manufacturers, and distributors without major delay. This process pushes different actors to adjust their activities in a coordinated way. In the Customer-to-Manufacturer (C2M) model, customers communicate needs directly with producers. The signal then guides procurement, production and delivery at the same time. Similarly, the EU anti-deforestation regulation requires Tanzanian coffee farmers to provide location data, processors to conduct compliance audits and exporters to submit due diligence reports. Each stage aligns its operations with the same standard [2]. As a result, products match customer preferences more closely and supply chains react with greater speed. Demand pull therefore becomes a central driver of coordination within ecosystems.

Members of an ecosystem usually share resources such as data, technology, logistics facilities, and financial services. Sharing reduces costs and lowers entry barriers for smaller firms. In the French soybean sector, cooperatives share inputs and storage to lower costs for small farmers. Agricultural institutes spread research and pest control knowledge, giving farmers access to needed support [3]. Joint research projects can also combine technical knowledge and spread risks across partners. Through resource sharing, actors move beyond individual advantages and create collective benefits. This strengthens cooperation and improves overall supply chain performance.

Each participant in the ecosystem contributes distinct capabilities. Some provide advanced production, while others specialize in design, marketing, or finance. When these capabilities are combined, strengths are reinforced. This exchange improves efficiency and encourages innovation. Capability complementarity allows supply chains to achieve outcomes that individual firms could not reach alone. In the electric vehicle battery ecosystem, firms specialize in different roles: manufacturers integrate systems, suppliers manage lithium and cobalt, and recyclers recover materials. Their strengths combine through the digital battery passport, which shares design data for recycling and traceability data for sourcing, creating effective complementarities [4].

3. Innovation Directions of Supply Chain Collaboration Models from the Perspective of Business Ecosystems

3.1. Platform-Based Collaboration Model

Digital platforms have become a central mechanism for supply chain collaboration within business ecosystems. A platform serves as a hub that integrates information, resources and services. It connects suppliers, manufacturers, distributors and customers through shared digital infrastructure. It improves visibility, coordination and efficiency across the supply chain through this method. Maersk and IBM developed TradeLens, a blockchain shipping platform that builds a shared digital system. The platform connects ports, regulators and logistics firms, aiming to break information barriers in supply chains and improve coordination among actors [5].

A platform-based model enables real-time information exchange. Data on orders, inventory and logistics can be updated and shared instantly among participants. This reduces uncertainty and avoids the delays that occur in linear supply chains. TradeLens aims for real-time data sharing to enable stakeholders can access cargo status and customs documents at the same time. It reduces delays that come from paper records and fragmented communication [5].

Platforms also integrate diverse services into one collaborative space. Beyond basic supply and demand information, platforms may provide financial support, logistics solutions and risk management tools. These services lower transaction costs and help smaller firms enter the ecosystem. The core idea of TradeLens is platform integration. Its blockchain system supports data

sharing and includes services such as tracking and document handling. By offering standard tools, it allows firms of different sizes to join global supply chains more easily [5].

A key feature of platform-based collaboration is the ability to cross organizational boundaries. Platforms create a public space where multiple actors interact under shared rules. This structure allows many participants to coordinate activities simultaneously. It is especially useful in complex industries where supply chains involve many tiers and diverse actors. TradeLens also seeks to cross organizational boundaries, trying to build an industry-wide network where shipping companies and ports work under shared rules. Although competition concerns prevented full realization, the platform still shows the value of such models for collaboration [5].

The platform model also promotes adaptability. Because data and services are centralized, participants can adjust quickly to changes in demand, technology or regulation. The platform provides a mechanism for rapid reorganization of resources when disruptions occur. This flexibility increases the resilience of the ecosystem. TradeLens has adaptive potential because its blockchain system supports real-time updates and process changes. In theory, this design helps firms respond to new regulations or disruptions, though adoption and business concerns limited its use [5].

3.2. Value Co-Creation Collaboration Model

The value co-creation model highlights the active role of customers in supply chain collaboration. In this model, customers are not only consumers but also participants in product design, production and service improvement. Their feedback and engagement provide direct input that shapes supply chain decisions.

Co-creation begins with demand identification. Customers share their preferences and expectations through online platforms, communities or surveys. Firms then use this information to design products that match customer needs more closely. This reduces mismatches between supply and demand. This logic also appears in the building materials supply chain. In the Australian sustainable housing project The Cape, buyers communicated directly with developers to demand low-energy, recyclable materials and personalized layouts. Developers adjusted designs and material lists accordingly, such as choosing recycled bricks and low-carbon timber, ensuring products matched core customer needs [6].

In production, co-creation allows firms to involve customers in testing or trial processes. Customer feedback can guide adjustments in design, quality or usability. In some cases, customers may even contribute ideas that lead to entirely new products. This interaction makes the production process more adaptive and reduces risks of failure in the market. In the Nightingale Village project, developers invited residents to test materials during construction. Feedback on insulation and flooring durability guided later design choices, which improved product quality and avoided problems of low market acceptance [6].

Co-creation also extends to the post-sale stage. Customers provide reviews, ratings and suggestions that inform service improvement and future innovation. Their continuous input forms a feedback loop that connects demand, research, production and after-sales service. This loop transforms the supply chain into a dynamic system that evolves with customer expectations.

The model is particularly suitable for industries where customer experience is central. By engaging customers as partners, firms can create stronger loyalty and achieve more sustainable growth. In housing construction, deep customer involvement from design to after-sales allows firms to meet housing needs precisely. At the same time, this feedback drives low-carbon and circular upgrades in the materials supply chain, building long-term trust between firms and customers [6].

4. Challenges and Coping Strategies in the Innovation of Supply Chain Collaboration Models

4.1. Core Challenges

While supply chain collaboration in a business ecosystem brings many benefits, it also faces important challenges. These challenges arise from differences among participants and risks linked to information exchange and the unstable nature of ecosystems.

Actors in an ecosystem often differ in size, resources, and bargaining power. Core firms usually dominate decision-making and set the rules of interaction. Smaller partners may become passive followers and gain fewer benefits. This imbalance can weaken trust and reduce willingness to collaborate. Without fair mechanisms, long-term cooperation may break down. Power imbalances also exist in algorithmic supply chains. Providers like Amazon and Microsoft gain an asymmetric advantage by controlling standards and APIs. Small developers face high switching costs, so they lack bargaining power. They must accept standard contracts and risk sudden changes or service termination [7].

Collaboration requires extensive sharing of data such as costs, production schedules and customer information. However, data exchange may expose sensitive business knowledge. Leaks or misuse of information can harm competitiveness and damage trust among partners. As digital platforms expand, the risk of cyberattacks and data abuse increases. Firms must therefore balance the need for openness with the need for protection.

Business ecosystems evolve quickly. Market fluctuations, technological disruption or strategic shifts by core firms can reshape the network. COVID-19 caused a demand drop and policy shocks in Peru, forcing squid processors to cut or halt production. The chain of fishers, intermediaries, processors and buyers was quickly reshaped. Fishers turned into nearshore fishing, while ties between intermediaries and processors broke down [4]. Partners may be replaced, and supply chain arrangements may change suddenly. This instability makes it difficult to plan long-term investments and sustain collaborative projects. Smaller firms are especially vulnerable when ecosystem structures shift. In the Philippines, informal fishers lacked resources to adjust to transport rules and were excluded from the restructured chain, which deepened network instability [8].

4.2. Coping Strategies

To address the challenges of supply chain collaboration in ecosystems, firms need strategies that promote fairness, protect data and strengthen stability. These strategies should provide mechanisms for balancing interests, ensuring secure data sharing and building long-term commitment.

A fair distribution of value is central to collaboration. Ecosystems can establish flexible benefit-sharing rules that consider resources invested, risks undertaken and contributions made by different actors. Profit distribution can be adjusted as conditions change. Some ecosystems also create development funds to support smaller partners. These measures reduce inequality and encourage participation by all members.

Data sharing must be supported by clear boundaries and strong protection tools. Firms can agree on rules for the type and scope of data to be exchanged. Sensitive information may be anonymized or masked before use. Technologies such can enhance data traceability and reduce the chance of manipulation. The framework in Real World Asset (RWA) Supply Chain for Smart Factory applies this idea through several measures. It uses Quorum and Hyperledger Besu for private transactions and stores sensitive data separately. It adopts asymmetric encryption so that only certified receivers can read messages. It also provides blockchain tools to trace and audit all operations. These measures form a system of permission control, secure transfer and traceability [9]. By combining trust and technology, ecosystems can lower risks while keeping collaboration efficient.

Stability can be improved through formal and informal mechanisms. Long-term agreements can define rights, obligations and exit conditions, which reduce uncertainty. At the same time, shared values and cultural identity can build trust beyond contracts. This logic also applies to the EU

battery supply chain. Its producer responsibility system enables efficient collaboration by combining clear rules of responsibility with a shared commitment to sustainability goals [10]. Regular ecosystem meetings, joint training and brand activities can strengthen cohesion among members. These practices increase commitment and resilience in times of change.

5. Conclusion

This paper examined supply chain collaboration from the perspective of business ecosystems. Using a conceptual and analytical approach, it outlined the core components of ecosystems, explained how these elements drive collaboration and identified three innovative directions for collaborative models: platform-based, modular and value co-creation. It further analyzed the main challenges of interest imbalance, data security and instability, and proposed strategies such as dynamic benefit-sharing, secure data frameworks and strengthened cultural identity.

The findings highlight the value of adopting an ecosystem perspective. Unlike linear models, ecosystems emphasize diversity, interdependence and continuous evolution. This perspective helps explain why collaboration emerges and how it can be sustained under dynamic conditions. The analysis also shows that collaboration is not only a matter of efficiency but also of fairness, trust and resilience. These insights contribute to both academic understanding and managerial practice, offering guidance for firms seeking to build adaptive and innovative supply chain systems.

Looking ahead, future research can expand in two directions. First, empirical studies are needed to test ecosystem-based collaboration models in different industries, particularly those facing rapid technological change and strong customer involvement. Second, methodological integration with quantitative tools like agent-based simulation or evolutionary game models may provide more precise insights into cooperation dynamics. Practically, firms should continue to invest in digital platforms, standardization and participatory mechanisms that involve customers and smaller partners more effectively.

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