Research on the Collaborative Mechanisms and Value Restructuring Pathways of Smart Logistics Industrial Chains Empowered by the Digital Economy

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Abstract: In the context of the digital economy, data, algorithms, and computing power are profoundly reshaping the collaborative patterns and value creation mechanisms of the logistics industry chain. Focusing on the smart logistics industry chain, this study aims to explore the intrinsic logic and pathways of collaborative mechanism optimization and value chain restructuring under digital empowerment. By systematically reviewing relevant literature and constructing an integrated analytical framework of "digital empowerment, collaborative mechanism optimization, value chain restructuring, and enterprise competitiveness enhancement," the paper examines three core collaborative mechanisms—platform collaboration, data collaboration, and technology collaboration—and analyzes the evolutionary characteristics and differentiated models of full-chain, multi-actor cooperation in smart logistics. The results show that digital empowerment not only breaks information silos and improves resource flow and operational coordination efficiency across the industry chain but also extends service boundaries, fosters innovation in value co-creation models, and enhances user experience, thereby facilitating the transformation of logistics enterprises from traditional service providers to data-driven, value co-creation platforms. The study concludes that collaborative mechanism optimization and value chain restructuring constitute a dynamically coupled process in which digital technologies continuously drive value chain innovation through strengthened collaboration, ultimately generating competitive advantages. Smart logistics enterprises should regard digital empowerment as a strategic resource and build a fully integrated development model centered on data-driven operations, intelligent collaboration, and value co-creation to adapt to the complex and evolving market and supply chain ecosystems.

Keywords: Digital Economy; Smart Logistics; Industrial Chain Collaboration; Value Chain Restructuring; Digital Empowerment

1. Introduction

With the rapid development of the digital economy, data, algorithms, and computing power have gradually become key elements reshaping enterprise production and operation methods, driving industries toward intelligent and digital transformation. As a critical hub connecting production and consumption, the digital transformation of logistics not only concerns the efficiency improvement and cost optimization of logistics enterprises themselves but also directly affects the coordination level and response capacity of the entire supply chain [1]. In this context, smart logistics has emerged as an essential path to enhance industrial chain flexibility, coordination, and value creation capabilities.

By deeply integrating technologies such as the Internet of Things, artificial intelligence, big data, and blockchain, smart logistics has realized full-chain information transparency, intelligent decision-making, and operational automation. This effectively alleviates traditional logistics issues such as information asymmetry, low coordination efficiency, and resource misallocation [2]. However, as the complexity of industrial chain collaboration increases, smart logistics still faces numerous challenges in achieving multi-entity, high-frequency, and full-chain collaboration, including persistent data silos, incomplete upstream and downstream collaboration mechanisms, and singular modes of value creation.

In the digital economy environment, smart logistics is not merely a tool for internal process optimization but has evolved into a crucial platform for connecting upstream and downstream enterprises and driving value chain reconstruction. The collaboration of the smart logistics industrial chain extends beyond information sharing and operational collaboration in logistics processes, reaching into areas such as demand forecasting, inventory optimization, and customer experience management across the entire supply chain, forming a full-chain, multi-level collaboration system [3]. Furthermore, in the process of value chain reconstruction, smart logistics enterprises have transitioned from "logistics service providers" to "value co-creation partners" through platform-based operations and intelligent data analytics, driving profound transformations in service models and value creation methods.

Therefore, this paper focuses on the collaborative mechanisms and value reconstruction paths of the smart logistics industrial chain empowered by the digital economy. It aims to address two core research questions: how does the digital economy drive the optimization of smart logistics industrial chain collaboration mechanisms, and how can smart logistics enterprises enhance their competitiveness through value chain reconstruction? A systematic analytical framework is constructed to reveal the internal logic of smart logistics industrial chain collaboration and value reconstruction under digital empowerment, striving to provide theoretical support and practical pathways for the digital transformation and upgrading of smart logistics enterprises.

2. Literature Review

2.1 The Concept and Evolution of Digital Economy and Smart Logistics

The digital economy is characterized by the pervasive integration of data, digital technologies, and intelligent systems into various industrial processes, reshaping production factors and value creation mechanisms. In this context, data is no longer a byproduct of operations but has become a critical production factor alongside labor and capital [4]. Smart logistics, as an extension of digital transformation in the logistics sector, embodies the deep integration of information flows, material flows, and financial flows through technologies such as IoT, AI, big data analytics, and automation systems [5]. The evolution of smart logistics signifies a transition from traditional logistics models, which focus on physical transportation efficiency, towards a holistic, data-driven ecosystem emphasizing real-time visibility, predictive analytics, and dynamic coordination across supply chains [1].

2.2 Research Status of Industrial Chain Collaboration in Smart Logistics

Current studies on supply chain collaboration emphasize the importance of information sharing, synchronized operations, and strategic partnerships to enhance supply chain resilience and responsiveness. Within the domain of smart logistics, collaboration extends beyond mere operational alignment; it involves real-time data interaction, shared decision-making processes, and platform-based coordination frameworks that facilitate flexible responses to market dynamics [6]. Existing research has explored various collaboration models, including platform-based coordination that centralizes data and resources, data-driven collaboration that leverages analytics for joint optimization, and ecosystem-based collaboration where multiple stakeholders co-create value through digital interfaces.

However, several challenges persist in practical applications. Data silos among enterprises hinder seamless information flow, limiting the effectiveness of collaborative decision-making. Moreover, discrepancies in digital infrastructure capabilities across upstream and downstream partners often lead to fragmented collaboration processes. While theoretical models highlight the potential benefits of industrial chain integration, empirical studies frequently reveal gaps between collaborative intentions and actual implementation outcomes, particularly in scenarios requiring high-frequency, multi-party coordination.

2.3 Research on Value Chain Restructuring Driven by Digital Technologies

The concept of value chain restructuring in the digital economy emphasizes shifting from traditional product-centered value creation to

service-oriented and experience-driven models [7]. Digital technologies enable enterprises to extend their value propositions beyond logistics services, offering data analytics, supply chain consulting, and customized solutions that enhance client engagement and operational agility [8]. Theories such as the value co-creation model and dynamic capability theory provide a foundation for understanding how firms leverage digital tools to reconfigure their value chains in response to changing market demands [9].

In the smart logistics domain, value chain restructuring increasingly manifests as the continuous extension of service boundaries, with logistics enterprises evolving from traditional transport providers into integrated solution providers [10,11]. This transformation is driven by the extensive application of intelligent technologies, which enable capabilities such as real-time monitoring, demand forecasting, and flexible scheduling [12]. Such advancements align with the service-dominant logic perspective, wherein logistics firms shift from offering isolated operational functions toward co-creating value through comprehensive, data-driven solutions. However, existing research within the smart logistics context remains insufficient in examining the interlinked relationship between industrial chain collaboration mechanisms and value chain restructuring pathways. Most studies tend to treat collaboration and value chain restructuring as separate analytical dimensions, overlooking the dynamic interaction and mutual reinforcement between the two processes.

This paper addresses this research gap by constructing an integrated analytical framework that links digital empowerment, collaborative mechanism optimization, and value chain restructuring within the smart logistics industrial chain, providing a systematic perspective on how enterprises achieve coordinated development and value innovation in a digital economy environment.

3. Theoretical Analysis

3.1 Digital Empowerment and Evolution of Collaboration Mechanisms in Smart Logistics

Under the digital economy, the collaborative mechanisms of smart logistics industrial chains are evolving from linear coordination models to dynamic, platform-based ecosystems. Traditional supply chain collaboration focuses on bilateral information exchange and process synchronization, which often results in rigid structures incapable of responding to rapid market fluctuations. In contrast, digital empowerment fosters an ecosystem-oriented approach where multiple stakeholders, including logistics providers, manufacturers, retailers, and consumers, are interconnected through intelligent platforms.

Platform collaboration enables resource aggregation, real-time visibility, and flexible matchmaking of supply and demand across the entire chain. Data collaboration, driven by real-time analytics and AI algorithms, transforms static data exchanges into dynamic, predictive insights, allowing enterprises to preemptively adjust operations in response to fluctuating demand patterns and external disruptions. Technology collaboration, encompassing IoT, blockchain, and automation technologies, ensures the seamless integration of physical and digital processes, enhancing overall supply chain agility and resilience.

Moreover, the evolution of collaboration mechanisms is characterized by a shift from enterprise-centered coordination to ecosystem-wide orchestration. Enterprises are no longer isolated entities but active participants in value networks, where collaboration efficiency is determined by the degree of digital interconnectivity and data interoperability among all nodes within the chain.

3.2 Pathways of Value Chain Restructuring in Smart Logistics

The restructuring of the smart logistics industrial chain is a strategic process that extends beyond operational improvements to encompass business model innovation and value proposition redefinition. Firstly, logistics enterprises are extending their service boundaries from transportation and warehousing to integrated logistics solutions, including demand forecasting, inventory optimization, and supply chain consulting. This extension is facilitated by data-driven insights that enable precise customization of services according to client needs.

Secondly, value co-creation models are reshaped through collaborative innovation ecosystems, where logistics enterprises, suppliers, and

customers jointly participate in service design, process optimization, and product innovation. This co-creation not only enhances service differentiation but also fosters long-term partnerships that strengthen the competitive position of logistics enterprises.

Thirdly, digital empowerment enables smart logistics enterprises to transition from cost-driven strategies to value-driven strategies, emphasizing customer experience enhancement. Personalized services, such as dynamic delivery scheduling, real-time tracking, and customized logistics solutions, significantly improve customer satisfaction and loyalty, thereby unlocking new avenues for value creation on the demand side.

3.3 Differentiated Collaborative Models for Platform-Based and Manufacturing-Linked Smart Logistics Enterprises

It is important to recognize that the collaborative mechanisms and value chain restructuring pathways differ across various types of smart logistics enterprises. For platform-based logistics enterprises, collaboration primarily revolves around the orchestration of multi-sided markets, where the enterprise acts as an intermediary facilitating transactions, data flows, and service coordination among a diverse set of participants. Their value chain restructuring focuses on enhancing platform efficiency, expanding service ecosystems, and leveraging network effects to achieve scale advantages.

In contrast, manufacturing-linked logistics enterprises emphasize vertical integration within specific supply chains. Their collaborative models prioritize deep coordination with upstream suppliers and downstream distributors to ensure seamless production-logistics alignment. value chain restructuring for these enterprises often involves embedding logistics capabilities within manufacturing processes, enabling real-time production scheduling, just-in-time delivery, and flexible supply chain reconfiguration in response to market demands.

This differentiation underscores the necessity for tailored strategies in collaborative mechanism optimization and value chain restructuring, aligned with enterprise-specific positioning and resource endowments.

3.4 The Dynamic Evolution of the "Digital Empowerment, Collaboration Optimization, and Value Chain Restructuring" Framework

The proposed analytical framework of "digital empowerment, collaborative mechanism optimization, value chain restructuring, and enterprise competitiveness enhancement" is not a static model but a dynamic process that evolves alongside technological advancements and market environment changes. In the initial phase, digital technologies act as enablers of basic data visibility and process automation, laying the groundwork for preliminary collaboration improvements. As digital maturity increases, enterprises move towards real-time, data-driven coordination and intelligent decision-making, which significantly enhances collaboration efficiency and enables deeper value chain integration.

Furthermore, value chain restructuring evolves from operational efficiency enhancement to strategic innovation. Enterprises progressively shift their focus from cost optimization to service innovation, developing new business models such as platform-based logistics ecosystems, shared logistics services, and data monetization strategies. This evolution is cyclical and iterative, with each stage of collaborative mechanism enhancement feeding into new rounds of value chain restructuring and driving continuous competitiveness improvement.

This dynamic interaction also underscores the importance of enterprise agility and digital adaptability. Organizations that can rapidly align their structures, resource configurations, and technological capabilities with evolving collaboration models and value creation logics are better positioned to sustain competitive advantages in the digital economy landscape.

3.5 Strategic Implications for Smart Logistics Enterprises

The analysis indicates that smart logistics enterprises must adopt a holistic approach to digital empowerment, treating platform collaboration, data collaboration, and technology collaboration as an integrated strategic imperative rather than isolated initiatives. Enterprises should prioritize the development of open digital platforms that facilitate multi-party collaboration, invest in advanced data analytics capabilities to derive actionable insights, and continuously explore emerging technologies to enhance process intelligence and supply chain flexibility.

Additionally, enterprises need to cultivate

organizational agility by fostering a culture of digital innovation, building cross-functional collaboration teams, and establishing adaptive governance structures that can respond swiftly to environmental changes. By doing so, smart logistics enterprises can effectively navigate the complexities of collaborative mechanism optimization and value chain restructuring, thereby achieving sustainable growth and long-term competitiveness in the digital economy era.

4. Conclusion and Prospects

This paper systematically examines the collaborative mechanisms and value chain restructuring pathways of the smart logistics industrial chain empowered by the digital economy. Focusing on platform collaboration, data collaboration, and technology collaboration as three core mechanisms, it analyzes how digital technologies reshape collaboration patterns among upstream and downstream enterprises, breaking through information silos to achieve efficient resource circulation and operational coordination. Furthermore, the study explores the intrinsic pathways of value chain restructuring from three dimensions: service boundary extension, innovation of value co-creation models, and optimization of user experiences, uncovering the key logic and mechanisms by which logistics enterprises transform from "operational entities" to "service-oriented" and "data-driven" enterprises in a digital economy environment.

Building upon these insights, this paper constructs a systematic theoretical analytical framework of "digital empowerment — collaborative mechanism optimization — value chain restructuring — enterprise competitiveness enhancement." The framework reveals how digital technologies, through the optimization of collaborative mechanisms, drive dynamic value chain restructuring and continuously enhance enterprise competitiveness. The findings indicate that industrial chain collaboration and value chain restructuring are not isolated processes but constitute an integrated system that evolves dynamically. The optimization of collaborative mechanisms under digital empowerment lays the foundation for value chain restructuring, which in turn promotes continuous improvement in collaboration efficiency and quality.

With the advancement of emerging technologies such as Artificial Intelligence of Things (AIoT) and digital twins, the pathways of industrial chain collaboration and value chain restructuring in smart logistics will become increasingly intelligent and dynamically adaptive. Enterprises must not only enhance their data analytics and intelligent decision-making capabilities at the technical level but also undergo flexible transformations in organizational structures and collaboration models to cope with the complexities of evolving market demands and supply chain environments. Therefore, smart logistics enterprises should regard digital empowerment as a strategic resource, building a full-chain, integrated development model centered on "data-driven, intelligent collaboration, and value co-creation" to secure a competitive edge in future markets.

Despite the theoretical contributions and analytical frameworks developed in this study, limitations remain, particularly in terms of research scope and the lack of large-scale empirical data support. Future research should aim to broaden the diversity of industry samples and adopt dynamic empirical validation methods. By leveraging big data analytics, simulation modeling, and case tracking approaches, further investigations can explore the heterogeneity and adaptability of collaborative and value chain restructuring pathways across different types of smart logistics enterprises, thereby enhancing the practical applicability and generalization value of the research findings.

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