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Management Recommendations for Inter-organizational Knowledge Sharing Driven by Digital Innovation: A Practical Analysis Based on COSMOPlat

Lili Wang *

School of Economics and Management, Southwest Petroleum University, Chengdu 610500, China
* **Corresponding author**: (Email: wanglili002024@163.com)

Abstract: Against the backdrop of the deep integration of the digital economy and the manufacturing sector, traditional inter-organizational knowledge sharing generally faces persistent pain points, including high trust costs, low circulation efficiency, and the difficulty of balancing security and openness. Industrial internet platforms offer a brand-new pathway to address these dilemmas. Taking Haier's COSMOPlat as the empirical case, this paper systematically analyzes the architectural support, governance logic and practical system through which digital innovation enables inter-organizational knowledge sharing. The research demonstrates that COSMOPlat builds a digital foundation for knowledge circulation via a four-layer structure comprising the resource layer, platform layer, application layer and business model layer. It adopts modular governance featuring "closed core modules and open peripheral modules" to strike a balance between security control and ecological openness, and ultimately establishes a four-in-one inter-organizational knowledge sharing system integrating resources, technology, data and capabilities. This system upgrades knowledge flow from one-way transmission to multi-directional co-creation, and from linear delivery to dynamic iteration. Building on the practical logic and existing limitations, this paper puts forward management suggestions from four dimensions: technical architecture, governance mechanism, knowledge operation and ecological collaboration, so as to provide practical reference for manufacturing enterprises to improve inter-organizational knowledge sharing mechanisms based on industrial internet platforms.

Keywords: Digital innovation, Inter-organizational knowledge sharing, Industrial internet platform, Modular governance.

1. Introduction

The iterative popularization of digital technologies continues to reshape the production modes, collaboration logic and value creation systems of the manufacturing industry, and industrial internet platforms have emerged as the core carrier for industrial digital and intelligent upgrading. As a critical production factor for the high-quality development of manufacturing, the efficient flow and collaborative reuse of knowledge across organizations, industries and regions is not only an important prerequisite for industrial chain collaborative innovation, but also a core path for the traditional manufacturing industry to break through growth bottlenecks and achieve transformation and upgrading [1].

Existing studies have yielded rich findings on the influencing factors, governance mechanisms and value effects of inter-organizational knowledge sharing. However, most traditional knowledge transfer theories are grounded in a linear transfer perspective, presupposing one-way knowledge flow from the advantaged party to the recipient and focusing on factors such as trust building, transfer willingness and absorptive capacity. Such frameworks are poorly adapted to the new features of knowledge in digital ecosystems: multi-directional interaction, dynamic iteration and symbiotic evolution [2]. Digital technological innovations represented by blockchain and distributed cloud platforms systematically reshape the underlying logic of knowledge creation, storage, circulation and iteration by reconstructing industrial collaboration architectures, iterating governance models and expanding ecological boundaries, thus providing new solutions to mitigate the key challenges in traditional inter-organizational knowledge sharing, including insufficient trust, low collaboration efficiency and high risk of knowledge leakage [3].

Scholarly work has been conducted from three perspectives: technical architecture empowerment [4], governance mechanism design [5] and knowledge operation modes [6]. Nevertheless, few studies treat these three dimensions as an organic whole to systematically reveal the collaborative mechanism of digital innovation-driven inter-organizational knowledge sharing in industrial internet scenarios. Meanwhile, in-depth empirical analyses of domestic industrial internet platforms remain insufficient, limiting the practical guidance for manufacturing enterprises. Against this background, this paper addresses two core research questions. The first is through what pathways and mechanisms digital innovation enables inter-organizational knowledge sharing in industrial internet scenarios. The second is how to balance the tension between open knowledge sharing and security control through architectural design and governance arrangements to build a sustainable knowledge sharing ecosystem.

In this paper, digital innovation refers to the systematic reconstruction of industrial collaboration in terms of technical architecture, governance models and value creation modes, supported by digital technologies such as the Internet of Things, big data and cloud computing [4]. Inter-organizational knowledge sharing refers to multi-directional knowledge flow, reuse and co-creation activities among multiple actors—including upstream and downstream industrial chain enterprises, platform operators and users—centered on resources, technology, data and capabilities [6].

Drawing on the practice of Haier COSMOPlat, this paper systematically unpacks the technical architecture, governance mechanisms and knowledge systems through which digital innovation enables inter-organizational knowledge sharing, sorts out multi-level practical outcomes, and formulates systematic management recommendations. It aims to enrich theoretical interpretations of knowledge collaboration in digital scenarios and provide practical reference for domestic manufacturing enterprises to build safe and efficient inter-organizational knowledge sharing ecosystems.

2. Practical Foundation of Inter-organizational Knowledge Sharing on COSMOPlat

COSMOPlat is an industrial internet platform developed by Haier Group based on over 30 years of accumulated manufacturing practice. Its core breakthrough lies in subverting the traditional paradigm of standardized mass production, reconstructing the value interaction between enterprises and users, and driving the manufacturing industry to shift from enterprise-led mass production to user demand-driven personalized mass customization [7]. Traditional industrial production modes center on standardized assembly-line operations, with production decisions dominated unilaterally by enterprises. Users sit at the end of the value chain, facing lengthy demand transmission chains and lagged feedback, while knowledge circulation is confined within enterprises or linear supply chains [8].

In contrast to traditional modes, COSMOPlat centers on user value co-creation and builds an open, symbiotic community-based ecosystem. It enables users to transform from product consumers to full-process participants, deeply engaging in all value chain links: product definition, R&D and design, manufacturing, and experience iteration. Accordingly, knowledge sources expand from inside the enterprise to all ecological actors [9]. Guided by the core philosophy of "co-evolution and value-added sharing", the platform establishes mechanisms for full user participation and advances industrial logic from "enterprise production with passive user acceptance" to "user traction with enterprise flexible intelligent manufacturing", laying a value foundation for inter-organizational knowledge sharing [10].

This development model has driven Haier's transformation from a traditional product manufacturer to a digital ecological enabler, and shifted enterprises from closed linear value chains to open networked value ecosystems. The platform integrates resources from diverse actors—manufacturing enterprises, upstream and downstream suppliers, end users, maker teams and more—to form a value community characterized by multi-directional interaction, complementary strengths and collaborative symbiosis. It also opens digital tools, industrial software and intelligent manufacturing solutions to small and medium-sized manufacturing enterprises, continuously releasing the spillover effects of industrial knowledge and supporting overall cost reduction, efficiency improvement and innovation upgrading across the industrial chain [11]. COSMOPlat's comprehensive exploration in platform architecture, governance models and knowledge practice provides a typical empirical sample for unpacking the internal mechanisms of digital innovation-driven inter-organizational knowledge sharing.

3. Practical Logic of Inter-organizational Knowledge Sharing on COSMOPlat

From the perspective of the platform's internal operating logic, the core of COSMOPlat's inter-organizational knowledge sharing is to systematically address the pain points of traditional knowledge sharing through digital innovation across three dimensions: technology, institution and content. The four-layer digital architecture provides a technical base for knowledge circulation, solving the problems of low efficiency and high access thresholds. Modular governance provides institutional guarantees for knowledge sharing, addressing the balance between openness and security. The full-dimensional knowledge system provides content carriers for value realization, enabling full-chain coverage of knowledge from resources to capabilities. The three dimensions work in coordination to form a complete inter-organizational knowledge sharing operation system.

3.1. Four-layer Business Architecture: Technical Foundation for Digital Knowledge Sharing

COSMOPlat constructs a four-layer three-dimensional business architecture—resource layer, platform layer, application layer, business model layer—forming an empowerment system that aligns technology, scenarios and objectives, and providing solid digital support for inter-organizational knowledge sharing.

First, the resource layer serves as the basic support layer. It integrates full-chain resources including industrial hardware, industrial software, business processes and industrial services to build a standardized shared resource pool. Its core value for knowledge sharing lies in standardizing and pooling fragmented resources such as production equipment, capacity and warehousing distributed across enterprises, codifying and explicating fragmented resource-based knowledge, breaking down resource barriers and information silos in traditional enterprises, and providing fundamental factor guarantees for cross-organizational knowledge circulation [2].

Second, the platform layer acts as the core hub. It integrates digital technologies such as the Internet of Things, big data, cloud computing and artificial intelligence to build a distributed microservice cloud platform, realizing the softwareization of industrial technology and digitization of business processes, and opening up core tools such as industrial models, algorithm components and cloud services. Its core value for knowledge sharing lies in enabling intelligent matching of knowledge supply and demand based on the digital technology base, greatly reducing knowledge search and docking costs, improving the efficiency and accuracy of cross-organizational knowledge circulation, and providing core technical support for cross-organizational technical collaboration and knowledge flow [4].

Third, the application layer is the scenario implementation layer. It is equipped with multiple lightweight SaaS applications covering production control, supply chain management, warehousing and logistics, and collaborative office work. Its core value for knowledge sharing lies in transforming complex manufacturing and management knowledge into plug-and-play scenario-based tools, significantly lowering the threshold for SMEs to absorb and apply knowledge, expanding the coverage of knowledge sharing, and enhancing the inclusiveness of knowledge implementation [12].

Fourth, the business model layer functions as the top-level traction layer. It standardizes and systematizes the mature user-driven mass customization model from the home appliance industry for cross-industry replication and promotion. Its core value for knowledge sharing lies in clarifying the innovation orientation of knowledge sharing, promoting the migration and replication of proven mature business models and management experience from a single industry to multiple industries, amplifying the economies of scope of knowledge sharing, and driving cross-organizational collaboration from passive participation to active co-creation [7].

3.2. Modular Governance: Institutional Guarantee for Balancing Openness and Security

COSMOPlat innovatively adopts a modular governance model of "closed core modules and open peripheral modules", which effectively resolves the contradiction between open collaboration and security control in inter-organizational knowledge sharing and achieves a dynamic balance between ecological development and risk prevention. This is embodied in three operating mechanisms [5].

First, the hierarchical knowledge control mechanism. Differentiated control is applied to core and peripheral modules. Closed control is imposed on strategic knowledge modules such as core intelligent manufacturing algorithms, key process models and underlying core technologies. Intellectual property protection and core authority control safeguard the platform’s core competitiveness, ensure the security of core knowledge assets, and provide a stable trust foundation for ecological collaboration. Peripheral knowledge components—such as scenario-based service modules, general adaptation modules and differentiated product modules—are fully opened up to widely engage heterogeneous actors including suppliers, independent engineers, SMEs and end users in ecological co-construction, fully activating external knowledge resources and innovation vitality [13].

Second, the boundary and accountability mechanism. It clarifies knowledge usage rights and contribution benefits for different actors, including platform operators, resident enterprises, users and third-party service providers. It not only delimits the protection boundaries of core knowledge to prevent knowledge leakage and improper use, but also reserves sufficient space for free flow and combinatorial innovation of peripheral knowledge, achieving the governance effect of "controlling the core while invigorating the periphery" [5].

Third, the dual-platform collaboration mechanism. Relying on the inward-oriented open innovation of the HOPE (Haier Open Partnership Ecosystem) platform, global external technical resources and innovative knowledge are introduced to continuously inject external knowledge increments into the platform. Through the outward-oriented capability output of COSMOPlat, accumulated manufacturing capabilities and solutions are empowered to external parties. Modular governance provides rule support for the cross-platform circulation and transformation of the two types of knowledge, forming a virtuous knowledge cycle of "external knowledge introduction – internal digestion and precipitation – external output and empowerment – feedback iteration and upgrading" [14].

3.3. Full-dimensional Knowledge System: Value Carrier for Multi-level Knowledge Sharing

COSMOPlat has formed a knowledge sharing system covering four dimensions: resources, technology, data and capabilities, which precisely matches the knowledge collaboration needs of the entire manufacturing chain. The four types of knowledge present a hierarchical progression from explicit to tacit, and from basic to advanced, supporting each other and continuously appreciating in value during circulation [6].

Resource-based and data-based knowledge are explicit knowledge that can be directly circulated and reused across organizations via the platform. Specifically, resource-based knowledge covers industrial resource information such as production equipment, production capacity, warehousing and supply chains, which enables cross-enterprise sharing of idle resources through intelligent scheduling and improves the resource allocation efficiency of the industrial chain. Data-based knowledge covers multi-source data including user demands, equipment operation, production control and market feedback; it circulates across organizations under compliant and controllable premises, providing data support for enterprises to optimize production, iterate products and adjust supply chains [13].

Technology-based and capability-based knowledge are tacit knowledge that requires standardized packaging and scenario-based application to realize transformation and sharing. Technology-based knowledge covers core technical resources such as industrial mechanism models, lean production parameters and intelligent R&D tools, and it realizes collaborative reuse of technical knowledge through carriers such as innovation spaces and engineering marketplaces, so as to support cross-organizational joint R&D and technological iteration. Capability-based knowledge covers mature experience in lean management, production optimization and supply chain collaboration, which is condensed into standardized intelligent manufacturing solutions and transformed into reusable digital service capabilities, greatly improving the implementation efficiency and adaptability of cross-organizational knowledge collaboration [15].

The four types of knowledge are not isolated; instead, they form a dynamic cycle within the platform ecosystem. Data resources provide a realistic basis for technological iteration, and technical capabilities, once condensed into standardized solutions, further enrich the resource pool. Ultimately, knowledge continuously appreciates and iteratively upgrades in cross-organizational circulation [11].

Overall, the four-layer architecture addresses the "technical accessibility" of knowledge sharing and provides a digital carrier for the implementation of modular governance and the operation of the knowledge system. Modular governance addresses the "institutional feasibility" and provides institutional guarantees for the realization of architectural functions and the delimitation of knowledge boundaries. The full-dimensional knowledge system addresses "value realizability", and the data and experience accumulated through its operation will in turn optimize architectural functions and governance rules. The three support each other and iterate dynamically, jointly underpinning COSMOPlat’s cross-organizational and cross-industry knowledge sharing ecosystem [4].

4. Practical Effects and Limitations

4.1. Practical Effects of Inter-organizational Knowledge Sharing

Relying on the aforementioned architecture, governance and knowledge system, COSMOPlat has implemented the inter-organizational knowledge sharing model across enterprise, industry and cross-border scenarios, effectively alleviating problems such as knowledge silos, low collaboration efficiency and rigid models in traditional manufacturing, and achieving remarkable practical results.

4.1.1. Micro-level: Empowering Digital and Flexible Transformation of Manufacturing Enterprises

At the enterprise micro level, the platform leverages the ecological knowledge collaboration system to help traditional manufacturing enterprises complete digital and flexible transformation. Taking Qingdao Ruihua Group as an example, COSMOPlat built a digital sharing platform, opened up data links among multiple actors in the industrial chain, and coordinated the operation of multiple systems. It encapsulated mature flexible production management knowledge into digital tools to directly empower the enterprise, realizing efficient cross-link and cross-organizational circulation of production, sales and supply chain knowledge, and helping the enterprise implement the "small-batch, fast-response" flexible production model. After the transformation, the enterprise's production cycle was significantly shortened, management efficiency markedly improved, and order scale and product added value increased simultaneously, successfully achieving strategic upgrading from traditional OEM production to flexible intelligent customization [12]. This process confirms the core logic of the knowledge-based view: the acquisition and reuse of external knowledge is the core path for enhancing enterprises' dynamic capabilities.

4.1.2. Meso-level: Promoting Collaborative Upgrading of the Industrial Chain

At the industry meso level, the platform promotes collaborative upgrading of the entire industrial chain based on an industry-university-research-application integrated knowledge network. Addressing pain points in the tire industry—such as overcapacity, slow technological iteration and single service modes—COSMOPlat collaborated with Double Star Group, universities, financial institutions and other actors to co-build an industry industrial internet platform and a tire internet smart cloud system. Supported by platform-layer technical empowerment and modular governance rules, it realized cross-organizational circulation and reuse of technology, R&D, data and financial knowledge, driving Double Star Group's transformation from traditional manufacturing to "manufacturing + services" [8].

At present, this knowledge collaboration model has been widely applied to 15 major manufacturing industries including home appliances, automobiles and chemicals, effectively promoting the overall upgrading of industrial chains across multiple sectors. This reflects the economies of scope effect of knowledge spillover in platform ecosystems and validates the leading role of leading enterprises in driving industrial innovation [11].

4.1.3. Cross-border Scenario Level: Realizing Cross-domain Reuse of Industrial Knowledge

At the cross-border scenario level, the platform realizes cross-domain migration and reuse of industrial digital knowledge, expanding the application boundaries of inter-organizational knowledge sharing. In the Sanxingdui Cultural Heritage Digitalization Project, COSMOPlat collaborated with archaeological institutions, technology enterprises and cultural entities to integrate industrial technical knowledge—such as digital twin and SLAM scanning—with professional archaeological knowledge. It built a cross-organizational collaboration system, completed high-precision digital archiving of the site efficiently, and advanced archaeological work from experience-driven to data-driven. The standardized knowledge accumulated from the project, including digital modeling, data management and scenario adaptation, can be reused in the field of digital cultural communication. This reflects the transferability of standardized knowledge and expands the application boundaries of industrial knowledge sharing [11].

4.2. Boundaries and Limitations in Practice

Nevertheless, this model still has certain boundaries and limitations in its implementation and promotion. First, SMEs vary greatly in digital foundation. Some enterprises have weak digital capabilities and insufficient knowledge absorptive capacity, making it difficult for them to fully absorb the high-level technical and management knowledge output by the platform, leading to stratified effects of knowledge sharing. Second, cross-industry knowledge migration entails adaptation costs. When general solutions are implemented in segmented industry scenarios, a certain degree of customized adjustment is still required, and knowledge reuse efficiency declines as industry span increases. Third, intellectual property definition and benefit distribution rules under multi-actor collaboration still need continuous optimization, and the value quantification and benefit matching mechanism for knowledge contributions requires further improvement [16].

The above practical effects and limitations provide a realistic basis for extracting general management recommendations for inter-organizational knowledge sharing in the manufacturing industry.

5. Management Recommendations for Digital Innovation-driven Inter-organizational Knowledge Sharing

In response to the aforementioned practical limitations and drawing on COSMOPlat's practical logic, this paper puts forward systematic management recommendations from four dimensions—technical architecture, governance mechanism, knowledge operation and ecological collaboration—to provide practical guidance for manufacturing enterprises to build an efficient, safe and sustainable inter-organizational knowledge sharing mechanism.

5.1. Technical Architecture: Building a Layered Digital Foundation to Lower Knowledge Sharing Thresholds

Against the background of SMEs' weak digital foundation and insufficient knowledge absorptive capacity, building a layered digital architecture to reduce the thresholds for knowledge access and application is the fundamental prerequisite for inter-organizational knowledge sharing.

Enterprises can follow the four-layer architecture logic of "resource layer – platform layer – application layer – model layer" to advance digital construction from bottom to top. At the bottom layer, efforts should be made to promote the standardization and pooling of industrial resources, break down information silos, and realize the codified precipitation of knowledge. At the middle layer, a unified technical base should be built to realize intelligent matching of knowledge supply and demand via big data and artificial intelligence, so as to improve circulation efficiency. At the application layer, lightweight and scenario-based SaaS tools should be developed to transform complex knowledge into easy-to-use functions and lower the threshold for SMEs to absorb and apply knowledge. At the top layer, replicable business models should be condensed to promote cross-industry migration and reuse of mature knowledge. Through the layered architecture, full-chain digital support for knowledge—from precipitation and circulation to reuse—can be realized.

5.2. Governance Mechanism: Implementing Modular Hierarchical Governance and Establishing Value-added Sharing Incentives

To address unclear intellectual property boundaries and the difficulty of balancing openness and security, modular hierarchical governance and value-added sharing mechanisms are core guarantees.

On the one hand, implement a modular hierarchical control strategy. Strictly protect core knowledge assets such as core technologies, key processes and confidential data, with clear usage rights and boundaries; fully open up peripheral knowledge such as general technologies, scenario experience and standard solutions, and encourage multi-actor co-creation, so as to achieve "controllable core and invigorated periphery". On the other hand, establish a value-added sharing mechanism that aligns knowledge contribution with benefits. Clarify the value distribution rules of knowledge sharing to ensure that knowledge contributors receive reasonable returns, and continuously stimulate the endogenous motivation of all parties to participate in sharing. Meanwhile, build a digital trust system based on the platform's data traceability capability to reduce trust costs and breach risks in cross-organizational collaboration.

5.3. Knowledge Operation: Building a Full-cycle Knowledge System and Promoting Productized Knowledge Output

To tackle the high adaptation costs and low reuse efficiency of cross-industry knowledge, full-cycle knowledge management and productized knowledge output are key pathways.

First, build a hierarchical knowledge sharing system covering resources, technology, data and capabilities, and match differentiated circulation carriers and sharing rules for knowledge of different attributes to achieve precise knowledge reuse. Second, promote the explicitation of tacit knowledge and the productization of explicit knowledge. Extract and encapsulate scattered management experience, technical solutions and collaboration models into replicable, callable digital products and solutions, reducing the adaptation costs of knowledge reuse. Finally, build a positive cycle mechanism of "knowledge creation – standardized packaging – cross-organizational reuse – feedback-driven iteration", and continuously iterate knowledge content based on multi-actor feedback to realize continuous appreciation of knowledge assets.

5.4. Ecological Collaboration: Strengthening Leading Enterprises' Role and Building a Diversified Symbiotic Network

The long-term operation of inter-organizational knowledge sharing depends on a multi-level collaboration system with clear hierarchy and sufficient motivation.

First, strengthen the ecological leading role of leading enterprises. Industry leading enterprises should take the lead in building sharing platforms, output mature manufacturing experience, technical capabilities and management paradigms, and undertake functions such as ecological rule formulation, resource integration and direction guidance, providing core traction for industrial chain knowledge sharing. Second, improve industrial chain collaboration mechanisms. Take digital platforms as links to connect production, supply and sales actors across the chain, unify collaboration standards and cooperation logic, drive all actors to shift from passive participation to active co-creation, and build a collaborative network featuring complementary knowledge, shared benefits and shared risks. Third, enrich cross-organizational collaboration scenarios. Through in-depth collaboration forms such as joint R&D, project co-construction and solution implementation, accelerate the transmission and transformation of tacit knowledge, and strengthen collaborative tacit understanding and cognitive alignment among organizations.

6. Conclusion and Outlook

6.1. Research Conclusions

Taking the COSMOPlat industrial internet platform as the analytical sample, this paper systematically dissects the practical modes and internal mechanisms through which digital innovation drives inter-organizational knowledge sharing in the manufacturing sector. The findings demonstrate that the four-layer digital business architecture provides the technological underpinning for inter-organizational knowledge sharing, the modular governance mechanism strikes a dynamic balance between knowledge security and ecological openness, and the multi-dimensional knowledge system underpins collaborative innovation across the industrial chain. The synergistic interplay of these three elements constitutes a complete empowerment paradigm of digital innovation.

The theoretical contributions of this study are mainly reflected in two aspects. First, it breaks through the analytical perspective of traditional linear knowledge transfer, constructs a three-in-one analytical framework of "technical architecture – governance mechanism – knowledge system" for inter-organizational knowledge sharing on industrial internet platforms, and expands theoretical interpretations of knowledge collaboration in digital scenarios. Second, it reveals the collaborative logic of two-way knowledge flow—inward and outward—in open innovation, providing empirical evidence for the knowledge cycle mechanism in platform ecosystems.

In practice, the practical framework of "layered architecture – hierarchical governance – full-cycle operation – ecological collaboration" extracted in this paper can provide a feasible reference path for manufacturing enterprises to build inter-organizational knowledge sharing systems based on industrial internet platforms, and also offer local practical reference for knowledge collaboration in the process of industrial digital transformation.

6.2. Research Outlook

This study mainly focuses on industrial internet platforms led by leading manufacturing enterprises, and the industry applicability of relevant conclusions still has room for expansion. Future research can be deepened in two directions. The first is to combine practices from more industries and more types of platforms to extract common laws and differentiated characteristics of knowledge sharing in different contexts, so as to enhance the generality of conclusions. The second is to further explore risk control, benefit distribution and intellectual property protection mechanisms in inter-organizational knowledge sharing, improve the integrity of the theoretical system, and provide more comprehensive guidance for industrial practice.

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