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RESEARCH ARTICLE

A Configurational Analysis on How Industrial Internet Platforms Empower the Digital Reconstruction Performance of Value Chain in Participatory Manufacturing Enterprises*

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Abstract

The digital reconstruction of value chain plays an important role in achieving the goal of moving up the value chain in participatory manufacturing enterprises (PMEs). This study aims to investigate the configuration path for the realization of the digital reconstruction performance of value chain in PMEs. Taking 122 PMEs embedded in the Haier COSMOPlat ecosystem as research objects, we change the traditional research perspective and use fuzzy-set qualitative comparative analysis to explore how technology resources, information resources, relationship resources, and digital services provided by industrial internet platform empowerment synergistically affect the digital reconstruction performance of enterprise value chain. This study obtains two groups of high (non-high) performance, namely, product-driven and service-driven; and relationship-trapped and information-trapped. The results show that the impact of industrial internet platform empowerment on the digital reconstruction performance of value chain exhibits equifinality across PMEs at different levels and stages of development.

Keywords participatory manufacturing enterprises (PMEs); industrial internet platform; empowerment; digital reconstruction performance of value chain; fuzzy-set qualitative comparative analysis (fsQCA)

1 Introduction

Since 2018, deglobalization has emerged. Stabilizing corporate value chains while advancing to higher value chain segments poses a significant challenge for manufacturing enterprises. The digital reconstruction of value chain offers a dual-path mechanism: Adaptive reconstruction strengthens operational stability and risk resilience, while innovative digital technology deployment drives industrial upgrading and digital transformation (Kano, 2018; Reinartz et al., 2019). This process enables manufacturing enterprises to navigate external uncertainties by leveraging emerging digital technologies to reengineer value chain activities. Accordingly, the digital reconstruction of value chain has emerged as a critical strategy

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for manufacturers confronting developmental bottlenecks (Zhang, 2017). On the one hand, many enterprises lack sufficient resources and capabilities to independently pursue the digital reconstruction of value chain, thus seeking to integrate into digital platforms to access external empowerment resources and services. On the other hand, platforms built by a few large enterprises often struggle to attract sufficient numbers of participating enterprises to generate the network effects essential to platform success. Consequently, embedding manufacturing enterprises into industrial internet platforms developed by third-party digital enterprises has become a new paradigm for joint construction and value co-creation.

Industrial internet platforms have proven instrumental in promoting the high-end development of manufacturing enterprises (Chen et al., 2022; Li et al., 2023). Leading industrial platforms, including GE Predix, Cisco Jasper, Haier COSMOPlat, and SANY Rootcloud, enable participatory manufacturing enterprises (PMEs) with resources such as information (Chen, 2014) and technology (Miller, 2004), facilitating their digital transformation and high-end development. The empowerments manifest in the following aspects: providing manufacturing enterprises with technological resources encompassing advanced digital hardware/software equipment and digital knowledge (Miller, 2004); offering information resources such as collaborative workflow progress across the value chain and consumer preferences/market demand from the client end (Chen, 2014; Huo et al., 2021); granting access to relational resources including upstream/downstream suppliers, service providers, and customers (Morgan et al., 2006); and delivering digital services such as data governance, remote operation and maintenance, and digital finance (Crozet & Milet, 2017). Notably, current scholarship emphasizes empowering entities while marginalizing the empowered participants, particularly PMEs. This lack of attention to empowered participants implies an assumption that platform participants passively accept their role (Li et al., 2023; Senyo et al., 2019), overlooking their autonomy and agency as independent entities. It presumes they can only receive empowerment from the platform core enterprises (Ma et al., 2020; Sun et al., 2022). Such a perspective hampers the achievement of supply-demand balance. There is a pressing need to focus on the genuine needs of enabling objects to realize value co-creation between both parties (Lusch & Nambisan, 2015).

In light of this, this study centers on how empowered participants autonomously select and configure resources offered by empowering entities. It focuses on how various combinations of empowerment variables provided by industrial internet platforms influence the digital reconstruction performance of value chain among embedded PMEs. To address this question, data from 122 manufacturing enterprises embedded in the Haier COSMOPlat platform are analyzed using the fuzzy-set qualitative comparative analysis (fsQCA; Zhang & Du, 2019). This study investigates how the configurational alignment of multivariate factors as antecedent conditions influences the digital reconstruction performance of value chain in PMEs. The findings provide theoretical and practical insights to guide such enterprises in scientifically selecting and acquiring resources or services offered by industrial internet platforms. The research framework is illustrated in Figure 1.

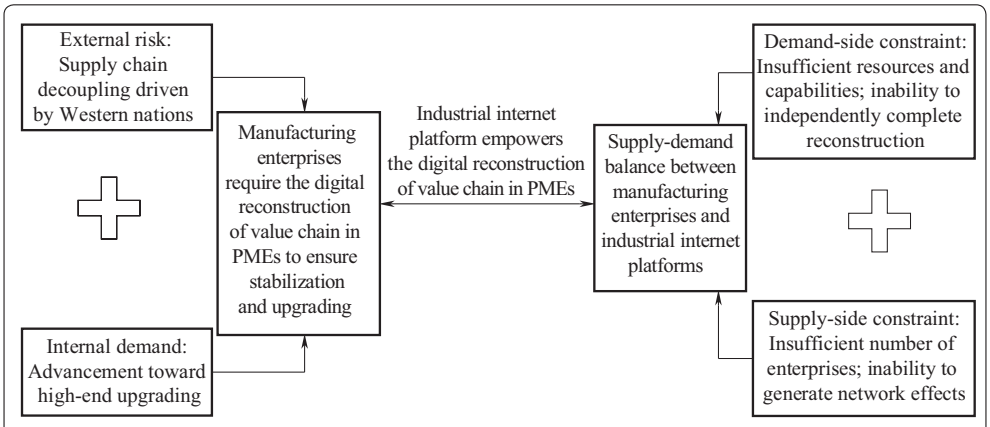

Figure 1 Research Framework

2 Theoretical Foundation and Model Development

2.1 Value Chain and the Digital Reconstruction of Enterprise Value Chain

The value chain concept holds that an enterprise's value creation stems from a series of relatively independent yet functionally interconnected business activities, consisting of primary and support activities. These collectively form the enterprise's value chain. To maintain the stability of the value chain system and facilitate enterprises' ascent toward higher value-added positions, value chain reconstruction has become a routine form of adaptive innovation and transformation (Liu & Ling, 2020; Xu & Wang, 2015). Given that the enterprise value chain constitutes the core unit of digital reconstruction (Senyo et al., 2019), this study specifically examines reconstruction behaviors and innovation-driven transformations occurring at the value chain level.

Amidst the rise of digital technologies and the emergence of the digital economy, traditional approaches to value chain reconstruction increasingly fall short of evolving market demands. Digital technologies, with their speed and agility, introduce both fresh technological support and new challenges for value chain reconstruction (Li, 2020; Reinartz et al., 2019). In the current research, the term "digital reconstruction" often refers to the process and outcomes by which enterprises employ digital technologies, methods, or tools to drive adaptive innovation in business models (Li, 2020), organizational structures, and management systems (Yeow et al., 2018). Building on this, this study defines the digital reconstruction of enterprise value chain as the process whereby enterprises, operating in uncertain digital environments, pursue competitive advantage and value chain upgrading by leveraging digital technologies, methods, or tools to enact adaptive innovations across value chain activities, thus reshaping the organizational structures of digital value creation (He et al., 2023). This process encompasses not only technological transformation but also business and organizational transformations (Zhang, 2017). Through the integrated application of digital technologies across value chain activities, enterprises evolve from interpersonal trust to digital trust and from isolated innovations in individual links to diversified innovations spanning the broader ecosystem. In terms of its fundamental purpose, digital value chain restructuring represents

a strategic choice through which enterprises proactively adapt their value creation activities by leveraging digital technologies and tools to respond to external environmental disruptions (Kane et al., 2015). This transformation serves to reshape value organization patterns in the digital era (Reinartz et al., 2019), primarily manifested in two dimensions: digital value augmentation within value chain segments and the expansion/extension of value chain relational boundaries (Senyo et al., 2019).

2.2 Industrial Internet Platform Empowerment

Industrial internet platform empowerment represents a comprehensive digital transformation process wherein next-generation technologies enable the complete digitization and modeling of industrial scenario resources. This technological infrastructure facilitates three critical functions: the integration of fragmented data assets, the optimization of heterogeneous resources, and the strategic reconstruction of operational processes (Sirmon et al., 2011). This process enables platforms and client enterprises to develop personalized data capabilities that unlock the latent value of data (Chen et al., 2022). Such empowerment unfolds across three hierarchical levels. At the business level, industrial resources are digitized, rendering both production processes and accumulated production experience into digital forms (Fernández-Rovira et al., 2021). At the enterprise level, organizational structures are digitally reengineered, establishing data-driven, multidimensional linkages that form hive-like networks and enhance enterprises' agility in navigating uncertain markets (Chen et al., 2022). And at the ecosystem level, empowerment elevates enterprise value chains by improving production and operational capabilities, fostering a balance between mass customization and large-scale production, and ultimately driving the upgrading of the entire industrial value chain (Li et al., 2023).

Manufacturing enterprises should fundamentally reshape their value creation mechanisms, reposition themselves along the value chain, and pursue high-end upgrading as a core objective in competitions (Huo et al., 2021; Liu & Ling, 2020), while simultaneously addressing the urgent need for digital technology and service support (Li et al., 2023; Yeow et al., 2018). However, restrained by the limited internal resources (Sirmon et al., 2011), manufacturing enterprises rely on selectively acquiring empowerment from industrial internet platforms to facilitate the digital reconstruction of value chain and achieve their strategic upgrading goals. Existing research mainly conceptualizes industrial internet platform empowerment across four dimensions: technology resources, information resources, relationship resources, and digital services (Chen et al., 2020).

2.3 Conceptualization and Variable Selection

The digital reconstruction performance of value chain measures the comprehensive organizational benefits achieved through the strategic application of digital technologies, methods, or tools to reinvent value chain processes, ultimately transforming the fundamental architecture of digital value creation (Dong & Sun, 2022).

Technology resources include the hardware tools, software systems, and process expertise

upon which enterprises rely to create value (Miller, 2004; Silverman, 1999). PMEs can access advanced digital hardware, intelligent software systems, and leading process capabilities via industrial internet platforms. When synergistically combined with other value chain production factors, these digital resources catalyze innovative value creation paradigms (Wang et al., 2024), driving three transformational outcomes: the digital reconstruction of value chains, enhanced operational efficiency, and significant overall cost decrease.

Information resources consist of the diverse sets of digital information required and utilized in the value creation process, including operational data, customer demands, market trends, and partner information (Chen, 2014; Huo et al., 2021). Through industrial internet platforms, PMEs gain access to real-time operational data, enabling adjustments in production scheduling, the optimization of manufacturing processes, and the development of digital products or services aligned with evolving customer demands. Platform-mediated information sharing among value chain partners enables precise coordination in digital reconstruction initiatives, resulting in enhanced supply chain synchronization and improved organizational agility in responding to market dynamics (Chen et al., 2020).

Relationship resources refer to the network of stakeholders with which enterprises engage, including suppliers, service providers, cross-sector innovation partners, and customers (Morgan et al., 2006). Industrial internet platforms serve as interactive ecosystems for value chain participants. By embedding within these platforms, PMEs can rapidly match supply and demand with suitable partners, ensuring accurate material supply and after-sales services. Such platforms also foster loosely coupled partnerships, enabling enterprises to expand business boundaries and integrate cross-sector capabilities for scenario-based value co-creation.

Digital services involve the suite of diversified offerings provided to client enterprises via the application of digital tools, methods, or models (Crozet & Milet, 2017). PMEs can leverage digital services offered by industrial internet platforms, including data governance, remote maintenance, and digital finance (Paiola & Gebauer, 2020), thereby promoting value chain stability. By collecting and analyzing operational data across value chain stages, platforms optimize process models (Li et al., 2023), continuously strengthening enterprises' efficiency, cost, and quality advantages. Digital financial services further serve to mitigate unexpected risks that arise during the course of digital reconstruction, enhancing strategic flexibility (Crozet & Milet, 2017; Wang et al., 2024).

2.4 Model Development

The digital reconstruction performance of value chain in manufacturing enterprises is driven by the interplay of multiple factors. However, constrained by methodological limitations, extant research has failed to comprehensively explain how industrial internet platforms' four core resource dimensions—technological, informational, relational, and service-based—interact through configurational mechanisms to collectively determine PMEs' digital reconstruction performance. In practice, such enterprises selectively combine and adopt various resources provided by industrial internet platforms according to their individual contexts and development needs, jointly influencing performance outcomes in the digital

reconstruction of value chain. Based on this, the research framework of configuration analysis presented in Figure 2 is developed.

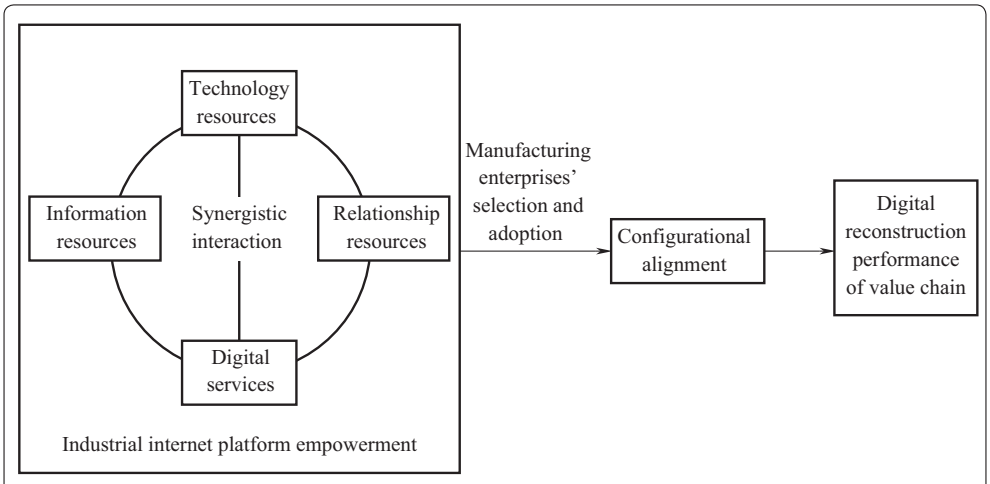

Figure 2 Research Framework for Configurational Analysis

3 Research Design

3.1 Selection of Research Methods

This study employs the fsQCA method to examine how industrial internet platform empowerment affects PMEs' digital reconstruction performance of value chain (Wu et al., 2023). The choice of fsQCA is informed by several key considerations:

(1) *Uniqueness of the research question.* PMEs always combine various technologies, information, relationship resources, and digital services offered by industrial internet platforms based on their individual circumstances and development needs in pursuit of enhanced the digital reconstruction performance of value chain. As a methodological complement to traditional symmetric analyses, fsQCA addresses three aspects of causal complexity: inherent data asymmetries, interdependencies among antecedent conditions, and equifinal causal pathways to outcomes. This capability to uncover context-dependent configurations (Zhang & Du, 2019) suits this study's objectives of identifying PMEs' heterogeneous resource orchestration patterns.

(2) *Limitations of extant methods.* Traditional regression analysis focuses on the net effect of single variables, while case studies—bounded by their limited rationality—often lack empirical validation and quantification of empowerment pathways, diminishing their generalizability (Sun et al., 2022). The fsQCA method is particularly well-suited to address issues of concurrent causality, enabling researchers to uncover the synergistic effects among antecedent factors better (Zhang & Du, 2019) and more effectively explain the impact of industrial internet platform empowerment on the digital reconstruction performance of value chain of participating manufacturing enterprises.

(3) *Methodological suitability.* Given that technology resources, information resources, relationship resources, digital services, and the digital reconstruction performance of value

chain exhibit degrees of set membership that cannot be fully captured by binary coding ("0" or "1"), fsQCA is applied (Zhang & Du, 2019). This allows for an in-depth examination of how different combinations of these resources affect the performance, while identifying equifinal pathways leading to both high and non-high performances and clarifying the mechanisms behind their formation.

3.2 Questionnaire Design

The questionnaire design for this study is as follows.

3.2.1 Design Procedure

Following the five-step questionnaire design framework widely recommended by established scholars, along with their operational guidelines and optimization advice, the questionnaire design ensured methodological rigor.

First, we focused on the impact of industrial internet platform empowerment on PMEs' digital reconstruction performance of value chain, identifying core variable metrics and adapting relevant measurement items to form the initial draft. Second, we engaged domain experts in enterprise management to comprehensively evaluate all measurement items, assessing wording appropriateness, categorical logic, and potential omissions in context-specific indicators, resulting in a revised second version. Third, we invited three industry professionals with relevant expertise to conduct in-depth discussions, refining items through iterative review, including pruning redundancy, enhancing terminological clarity, and verifying contextual alignment, yielding a third optimized version. Fourth, we then conducted pilot testing with 21 PMEs' managers to identify comprehension barriers, assess response patterns, and fine-tune question flow, producing a fourth finalized draft. Fifth, only after completing three rigorous revision cycles and verifying scientific validity did we proceed with large-scale formal survey distribution, ensuring the instrument's robustness for examining the configurational effects of platform empowerment on digital reconstruction outcomes. This rigorous process culminated in the finalized comprehensive questionnaire encompassing all study variables (see Table 1).

3.2.2 Bias Control Methods

The questionnaire design incorporated multiple safeguards to ensure data reliability. (1) All variable-related questions focused on the surveyed enterprises' activities within the latest three years or ongoing initiatives, minimizing recall bias. (2) Respondents were required to engage in their organization's value chain digital reconstruction process, ensuring first-hand knowledge of industrial internet platform adoption and transformation outcomes. (3) To reduce translation errors, we employed back-translation procedures and pilot-tested questionnaire phrasing to eliminate ambiguous item wording. (4) The survey explicitly stated its academic purpose and promised to share aggregated results as feedback to enhance participant engagement.

Table 1 Measurement Items and Tests for Reliability and Validity (N = 122)

Variable	Measurement items	Measurement scale source	Cronbach's α	CR	AVE
Digital reconstruction performance of value chain	The enterprise extensively applies digital technologies and tools across its value chain to enhance value creation activities and upgrade methods and tools used in these stages. The enterprise has improved operational efficiency across value chain stages. The enterprise has reduced operating costs across value chain stages. The enterprise has improved output quality across value chain stages. The enterprise has activated or enhanced the value chain to strengthen resilience, enabling it to withstand uncertainties. The enterprise has activated or enhanced the value chain to strengthen agility, enabling rapid response to changes. The enterprise has developed new digital products or services.	(Watabaji et al., 2016)	0.982	0.983	0.982
Technology resources	The enterprise has acquired digital hardware equipment or upgraded existing hardware through the industrial internet platform. The enterprise has obtained software operating systems via the industrial internet platform. The enterprise has accessed advanced industrial knowledge and expertise through the industrial internet platform. The enterprise is applying specialized technologies provided by the industrial internet platform.	(Silverman, 1999)	0.985	0.987	0.950
Information resources	The enterprise obtains real-time operational management information via the industrial internet platform. The enterprise acquires market trend information via the industrial internet platform. The enterprise captures customer demand information via the industrial internet platform. The enterprise accesses dynamic partner information via the industrial internet platform.	(Huo et al., 2021)	0.968	0.969	0.885
Relationship resources	The enterprise establishes dynamic supplier relationships via the industrial internet platform. The enterprise builds dynamic service provider relationships via the industrial internet platform. The enterprise co-creates value with cross-border innovation partners via the industrial internet platform. The enterprise maintains close customer relationships via the industrial internet platform.	(Morgan et al., 2006)	0.967	0.968	0.883
Digital services	The enterprise receives data governance services from the industrial internet platform. The enterprise receives remote operation and maintenance services from the industrial internet platform. The enterprise receives digital financial services from the industrial internet platform.	(Crozet & Milet, 2017)	0.954	0.956	0.879

3.3 Data Collection and Sample Selection

Data for this study were collected through the collaborative network of Haier COSMOPlat by administering questionnaires to PMEs embedded within the platform. These enterprises engage in the digital reconstruction of value chain by selecting and adopting combinations of technology resources, information resources, relationship resources, and digital services offered by the platform, making them typical cases for analysis. They also serve as representative examples of Chinese manufacturing enterprises pursuing high-end value chain upgrading. The sampled enterprises span diverse industries and founding periods, providing substantial heterogeneity for empirical investigation.

During data collection, efforts were made to capture a wide range of resource combination scenarios. After identifying target PMEs, contact information was obtained via Haier COSMOPlat, and questionnaires were distributed through the Wenjuanxing platform (an online survey tool widely used in China). Multiple communication channels, including telephone, email, and WeChat (a dominant messaging and social media application in China), were kept open throughout the process to promptly address any questions from respondents. A total of 180 questionnaires were distributed, of which 147 were returned. Following screening and elimination of invalid responses, 122 valid questionnaires were retained for analysis. The sample characteristics are summarized in Table 2.

3.4 Variable Measurement and Testing

The outcome variable in this study was the digital reconstruction performance of value chain, while the condition variables comprised technology resources, information resources, relationship resources, and digital services. All variables were measured using a unified five-point Likert scale, where respondents rated each item from 1 (“strongly disagree”) to 5 (“strongly agree”), based on the extent to which each statement applied to their enterprise.

Following established practices in fsQCA research, reliability and validity tests were conducted using SPSS. The results for Cronbach’s α, composite reliability (CR), and average variance extracted (AVE) are shown in Table 1. All Cronbach’s α coefficients exceeded 0.7, indicating strong internal consistency. Similarly, CR values for all constructs surpassed 0.7, confirming sound composite reliability. The Kaiser-Meyer-Olkin (KMO) statistic reached 0.891 (approaching 0.9), and Bartlett’s test of sphericity was highly significant ($p < 0.001$), satisfying the prerequisites for factor analysis. Additionally, all AVE values exceeded the 0.5 threshold, demonstrating acceptable convergent validity.

3.5 Variable Calibration

The direct calibration method was employed to transform both condition and outcome variables in this study. Utilizing the Calibrate function in fsQCA 3.0, original variable measurements were converted into fuzzy membership scores ranging from 0 to 1. Following established calibration conventions, three thresholds were specified—full non-membership, crossover point, and full membership—based on sample means and quartile distributions. To avoid potential distortion in QCA results, cases with membership scores of exactly 0.5 were adjusted to 0.501. The specific calibration anchors for each variable are shown in Table 3.

Table 2 Basic Characteristics of Sample Enterprises (N = 122)

Attribute	Category	n	Percentage (%)	Attribute	Category	n	Percentage (%)
Industry	Home appliance manufacturing	27	22.13	Enterprise age (years)	< 5	11	9.02
	Textile and apparel manufacturing	22	18.03		5–10	19	15.57
	Steel manufacturing	11	9.02		11–20	25	20.49
	Equipment manufacturing	15	12.30		21–30	38	31.15
	Automotive manufacturing	7	5.74		31–40	21	17.21
	Food processing and manufacturing	13	10.66		> 40	8	6.56
	Materials processing and manufacturing	9	7.38	Value chain digital reconstruction stage	Initial digital reconstruction at certain value chain stages	21	17.21
	Furniture manufacturing	12	9.84				
	Electronics manufacturing	6	4.92				
Enterprise size (employees)	⩽ 50	12	9.84		Partial digital reconstruction of value chain	47	38.52
	51–200	15	12.30				
	201–500	28	22.95				
	501–1,000	37	30.33		Major digital reconstruction of value chain	42	34.43
	1,001–1,500	17	13.93				
	> 1,500	13	10.66				
Annual operating revenue (10,000 yuan)	⩽ 500	19	15.57		Full digital reconstruction of value chain with significant results	12	9.84
	501–1,000	36	29.51				
	1,001–2,000	48	39.34				
	> 2,000	19	15.57				

Note. Following the industrial classification standards of the National Bureau of Statistics of China and based on the research context, enterprises with annual operating revenue of 20 million yuan or above are defined as large-scale PMEs, while those with revenue below 20 million yuan are classified as small and medium-sized PMEs.

Table 3 Calibration Anchors for Variables (*N* = 122)

Variable	Calibration anchors		
	Full non-membership	Crossover point	Full membership
Technology resources	1.50	3.00	4.50
Information resources	1.75	3.25	4.75
Relationship resources	1.75	3.25	4.75
Digital services	1.67	3.17	4.67
Digital reconstruction performance of value chain	2.00	3.43	4.86

4 Configurational Analysis and Research Results

4.1 Necessary Condition Analysis

The objective of necessary condition analysis is to determine whether any single antecedent serves as a prerequisite for the outcome variable. As indicated in Table 4, none of the individual antecedent conditions exhibit consistency levels exceeding 0.9. Hence, no single antecedent condition constitutes a necessary condition for high digital reconstruction performance of value chain in PMEs (Zhang & Du, 2019).

Table 4 Necessary Condition Analysis (*N* = 122)

Antecedent condition variable	Outcome variables			
	High digital reconstruction performance of value chain		Non-high digital reconstruction performance of value chain	
	Consistency	Coverage	Consistency	Coverage
Technology resources	0.469	0.803	0.321	0.295
Absence of technology resources	0.588	0.616	0.786	0.443
Information resources	0.496	0.678	0.546	0.401
Absence of information resources	0.562	0.697	0.562	0.374
Relationship resources	0.498	0.673	0.557	0.405
Absence of relationship resources	0.560	0.702	0.551	0.371
Digital services	0.526	0.854	0.275	0.240
Absence of digital services	0.532	0.577	0.833	0.485

4.2 Configuration Analysis

Using fsQCA 3.0 software, this study constructs a truth table to identify configurations of factors influencing the digital reconstruction performance of value chain among PMEs. In line with established analytical protocols in the literature (Zhang & Du, 2019), the frequency threshold is set at 2, the consistency threshold at 0.8, and the proportional reduction in inconsistency (PRI) threshold at 0.7. The standard analysis yields complex, parsimonious, and intermediate solutions.

The effects of various combinations of technology resources, information resources, relationship resources, and digital services—actively selected and adopted by PMEs—remain uncertain. No preset specifications are made in fsQCA regarding whether conditions are present or absent. Consistent with prevailing academic practice, this study adopts the widely applied intermediate solution. Conditions appearing in both the parsimonious and intermediate solutions are designated as core conditions, while those appearing exclusively in the intermediate solution are classified as peripheral conditions. The detailed results of the configuration analysis are presented in Table 5.

Table 5 Configuration Analysis of High and Non-High Digital Reconstruction Performances of Value Chain (N = 122)

Category	Outcome variable			
	High digital reconstruction performance configuration of value chain		Non-high digital reconstruction performance configuration of value chain	
	H1	H2	NH1	NH2
Technology resources	●			⊗
Information resources	•	●	⊗	●
Relationship resources		●	●	⊗
Digital services	●	•	⊗	
Raw coverage	0.379	0.387	0.482	0.381
Unique coverage	0.337	0.045	0.083	0.282
Consistency	0.917	0.862	0.854	0.902
Overall coverage	0.724		0.764	
Overall consistency	0.896		0.862	

Note. ● = core condition present; ⊗ = core condition absent; • = peripheral condition present; ⊗ = peripheral condition absent. "blank" indicates conditions that are indifferent to the outcome.

The configuration analysis identifies two antecedent conditions associated with high digital reconstruction performance of value chain, labeled H1 and H2, with consistency scores of 0.917 and 0.862, respectively. The overall solution consistency stands at 0.896, exceeding the established threshold. Coverage statistics indicate that both configurations offer substantial explanatory power, jointly accounting for approximately 72% of the high performance cases. Similarly, two configurations associated with non-high performance—NH1 and NH2—are identified, with an overall solution consistency of 0.862, meeting the preset criterion.

4.2.1 Configuration Analysis of Antecedents for High Digital Reconstruction Performance of Value Chain in Manufacturing Enterprises

Small and medium-sized start-ups—product-driven configuration (H1). Configuration H1 (Technology Resources ∗ Information Resources ∗ Digital Services) reveals that, regardless of whether relationship resources are adopted, small and medium-sized PMEs

achieve high digital reconstruction performance of value chain when they primarily leverage technology resources and digital services from the industrial internet platform, with information resources serving as supplemental support. These enterprises typically generate less than 20 million yuan in annual revenue, operate for fewer than 20 years, employ around 1,000 staff, and have successfully implemented the digital reconstruction across most value chain stages. Generally, in their formative or early growth phases, these small and medium-sized PMEs operate within focused business niches and face constraints in technology, talent, and capital, with simplified relationship networks. Confronted by critical technological deficiencies, they lack the internal capacity to independently execute the digital reconstruction of value chain. By adopting technological empowerment from the industrial internet platform, these enterprises integrate advanced technologies into their value creation processes, achieving digital regeneration and optimization in efficiency, cost, and quality. Digital services further enable small and medium-sized PMEs to capitalize on digital dividends, accessing data governance, remote maintenance, and digital financial services at low cost, thereby bolstering value chain resilience. Although these small and medium-sized PMEs obtain market and customer information via the platform, their rigid business models and singular value propositions limit sensitivity to external signals, relegating information resources to a supporting role. Moreover, since these small and medium-sized PMEs operate within a relatively simple cooperative network confined to limited geographical areas (Zhang & Du, 2019), such a structure is more conducive to sustaining stable, efficient, and low-cost operations within their existing business domains. In reality, most small and medium-sized PMEs lack strong incentives to expand relational resources or diversify their business fields. Consequently, relational resources do not play a significant role in enabling these enterprises to achieve high digital reconstruction performance of value chain.

Large and mature enterprises—service-driven configuration (H2). Configuration H2 (Information Resources ∗ Relationship Resources ∗ Digital Services) demonstrates that large, mature manufacturing enterprises achieve high digital reconstruction performance of value chain when they prioritize information and relationship resources from the industrial internet platform, with digital services providing auxiliary support—regardless of technology resource acquisition. These enterprises typically report annual revenues exceeding 20 million yuan, operate for over 30 years, employ more than 1,500 people, and have comprehensively implemented the digital reconstruction across their value chains. Occupying advanced growth or mature stages, these enterprises operate diversified businesses with abundant technological, human, and financial resources and maintain complex relational networks. Possessing advanced industrial machinery and intelligent systems, they have little need to acquire additional technology resources via the platform. Instead, they employ platform-based digital services to support process optimization. Data governance helps refine production workflows (Liu & Ling, 2020), enhancing quality, cutting costs, and increasing efficiency. Remote maintenance and digital finance services mitigate disruption risks, further strengthening value chain resilience. Critically, these enterprises rely heavily on information and relationship resources. Real-time customer and market insights, gathered through platform-based community interactions, guide adaptive operations and secure customized or large-scale

orders, boosting output. Shared process data enhances inter-organizational coordination and agility. Given their diversified operations, these enterprises also require dynamic partnerships across suppliers, service providers, logistics, industry bodies, and clients. The platform's ecosystem facilitates timely, high-quality resource fulfillment while enabling cross-sector collaborations that drive digital value creation and open new arenas for product and service innovation, thereby advancing value chain reconstruction.

4.2.2 Configuration Analysis of Antecedents for Non-High Digital Reconstruction Performance of Value Chain in Manufacturing Enterprises

Large and mature enterprises—relationship-trapped configuration (NH1). Configuration NH1 (Absence of Information Resources ∗ Relationship Resources ∗ Absence of Digital Services) suggests that when large-scale PMEs focus exclusively on obtaining relationship resources through the industrial internet platform—while neglecting information resources and forgoing digital services—they fail to achieve high levels of the digital reconstruction performance of value chain. PMEs under NH1 typically generate annual revenues exceeding 40 million yuan, have been in operation for more than 40 years, employ over 1,500 staff, and have implemented the digital reconstruction in only a few parts of their value chains. In practice, some large enterprises embed themselves in platform ecosystems, seeking to expand relational networks with potential customers, suppliers, and service providers, thus building self-centric value chain ecosystems. Having reached the limits of scalable industry growth, these enterprises lack distinct competitive advantages and fail to adapt their business models to evolving customer needs, market conditions, or partner insights. Consequently, they face challenges such as low value-added operations, inventory backlogs, and limited innovation in digital products and services. While an expanding relationship network may yield occasional incremental business gains, it is insufficient to offset the structural weaknesses or unlock the full potential of the value chain ecosystem.

Small and medium-sized start-ups—information trapped configuration (NH2). Configuration NH2 (Absence of Technology Resources ∗ Information Resources ∗ Absence of Relationship Resources) demonstrates that small and medium-sized PMEs that prioritize acquiring information resources through the industrial internet platform while neglecting both relationship and technology resources likewise fail to achieve high digital reconstruction performance of value chain. Enterprises under NH2 typically generate annual revenues below 15 million yuan, operate for approximately 10 years, employ 200 to 1,000 staff, and have achieved the digital reconstruction only within limited portions of their value chains. In practice, many such small and medium-sized PMEs join industrial internet platform ecosystems to capture real-time insights into customer demand, market trends, and partner activities, hoping to capitalize on emerging opportunities. However, limited in scale, these small and medium-sized PMEs often fail to establish relationship networks with matching suppliers, service providers, industry institutions, and financial partners through the platform. Simultaneously, they overlook the technological empowerment available on the platform. As a result, their digital value creation capabilities remain underdeveloped, with insufficient improvements in efficiency, cost, or quality, and they have yet to establish distinctive

competitive strengths. Consequently, these small and medium-sized PMEs struggle to capitalize on fleeting opportunities within the platform ecosystem, resulting in underwhelming digital reconstruction outcomes of value chain.

Based on the foregoing analysis, the following propositions are advanced:

Proposition 1: For small and medium-sized PMEs, acquiring technology resources and digital services through industrial internet platforms, while simultaneously enhancing their digital value creation capabilities and using information resources to optimize value chain decisions, enables them to achieve high digital reconstruction performance of value chain. In contrast, enterprises that focus exclusively on acquiring information resources while neglecting technology resources and digital services are likely to exhibit non-high digital reconstruction performance.

Proposition 2: For large-scale PMEs, securing information and relationship resources from industrial internet platforms, supplemented by digital services that support value chain operations, facilitates high digital reconstruction performance of value chain. Conversely, enterprises that prioritize relationship resources alone, without adapting their business domains or models in response to information resources, risk falling into non-high digital reconstruction performance of value chain.

4.3 Robustness Test

In fsQCA studies, threshold settings possess inherent flexibility, which may influence the analytical outcomes; therefore, robustness tests are essential. This study evaluates robustness by adjusting both the frequency and consistency thresholds (Zhang & Du, 2019). When the frequency threshold is raised to 3, the resulting configurations remain largely stable; similarly, when the consistency threshold is increased to 0.85, the configurations remain essentially unchanged. While minor variations are observed in the overall consistency and coverage metrics following these adjustments, the results remain broadly aligned with the original findings, thereby confirming the robustness of the analysis.

5 Conclusion

This study adopts fsQCA to examine how varying combinations of technology resources, information resources, relationship resources, and digital services provided by industrial internet platforms jointly affect the digital reconstruction performance of value chain in PMEs. This approach offers a comprehensive perspective on the research question.

Focusing on PMEs embedded within industrial internet platforms—which pursue value chain upgrading through digital transformation—this study finds that for small and medium-sized PMEs, high digital reconstruction performance is achieved when they prioritize acquiring technology resources and digital services, supplemented by information resources, regardless of whether relationship resources are utilized. Conversely, small and medium-sized PMEs that rely exclusively on information resources and neglect both relationship resources and technology support tend to experience suboptimal performance. For larger-scale PMEs, similarly, high performance results when enterprises emphasize

information and relationship resources, supported by digital services, irrespective of whether they access platform-provided technology resources. However, over-reliance on relationship resources while disregarding information resources and digital services leads to diminished performance.

This study provides a systematic and integrated analysis of how industrial internet platform empowerment shapes the digital reconstruction performance of value chain in PMEs. While prior research has acknowledged the importance of platform empowerment (Chen et al., 2020), rigorous large-sample empirical evidence remains limited. This study makes three primary contributions. First, it reframes the research perspective by focusing on the empowered enterprises themselves, recognizing their autonomy in selecting and utilizing empowerment resources. Existing studies have largely emphasized the platform providers' viewpoint (Wang et al., 2024), with insufficient attention to the empowered enterprises' agency. This study conceptualizes platform empowerment as an external driver, where enterprises actively choose resources based on their development stage and strategic needs, which are crucial determinants of reconstruction performance. Second, it offers a holistic analysis of how multiple empowerment resources interact. Prior research often isolated the effects of individual variables, such as technology, information, relationships, or digital services, without considering their combined influence. The necessary condition analysis demonstrates that no single factor is indispensable; overemphasis on any one resource fails to capture the complexity of performance outcomes. Third, it identifies four distinct empowerment configurations: two leading to high performance and two resulting in underperformance, thereby clarifying the intricate causal mechanisms linking platform empowerment to the digital reconstruction of value chain.

This study argues that PMEs demonstrate heterogeneous demands for the resources and services offered by industrial internet platform empowerment, reflecting temporal and spatial variations in enterprise needs. First, for small and medium-sized start-ups within the platform ecosystem, an overemphasis on technological empowerment in pursuit of superior digital reconstruction performance of value chain can lead to an information trap. In the absence of adequate preparation, information overload fails to translate into meaningful productivity gains. Conversely, for mature large enterprises that have long cultivated stable stakeholder networks within specialized domains, there is a proclivity for path dependence on relationship resources. This relationship trap fosters a diminished sensitivity to and acceptance of new technologies, similarly constraining performance in digital reconstruction. Second, these divergent trajectories reflect fundamentally different organizing logics for achieving high digital reconstruction performance of value chain—namely, a shift from goods-dominant to service-dominant logic (Lusch & Nambisan, 2015). This distinction not only shapes enterprises' perceptions of relationship resources but also suggests a strategic evolution: Early-stage enterprises should focus on product innovation and market capture, while mature ones should transition toward collaborative interaction and value co-creation within the value chain ecosystem. This progression echoes the Confucian philosophy articulated by Mencius: "When poor, attend to your own virtue in solitude; when advanced to dignity, strive to make all virtuous in the kingdom" (Legge, 1895b). Third, both start-ups and mature enterprises exhibit a common path dependence: reinforcing previously successful strategies

while overlooking the pursuit of a second growth curve, ultimately forfeiting the resources and capabilities necessary for sustained expansion. According to *Master Zuo's Commentary on Spring and Autumn Annals* (one of China's earliest narrative historical records), "As a man begins, so shall he end" (Legge, 1895a). Enterprises must therefore have the courage to break free from their comfort zones and actively engage with the diverse resources available through industrial internet platform empowerment to achieve meaningful digital reconstruction of value chain.

The managerial insights generated by this study serve two key functions. First, they offer a crucial reference point for PMEs embedded within the Haier COSMOPlat industrial internet platform as they navigate resource selection and pursue the digital reconstruction of value chain. Second, they provide a broader framework for enterprises embedded in other industrial internet platforms seeking to advance up their value chains, helping these enterprises to identify and acquire appropriate empowerment resources.

To examine how industrial internet platform empowerment affects the digital reconstruction performance of value chain, this study utilized a questionnaire-based survey to collect empirical data. Respondents accurately reported how PMEs selected and adopted platform-provided empowerment resources, allowing this study to capture short-term performance outcomes following digital reconstruction. However, based on prior observations of enterprise growth trajectories, it is recognized that the digital reconstruction performance of value chain is likely to evolve over time. Consequently, future research could, first, continue to explore how industrial internet platforms promote manufacturing digital transformation from the empowered enterprise's perspective and, second, undertake longitudinal studies that track the development of empowered enterprises over time. Such time-series analyses would offer a more objective evaluation of the long-term effects of platform empowerment on the digital reconstruction performance of value chain.

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