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Article

The Impact of Enterprise Digital Capability on Supply Chain Digitalization—From the Perspective of Supply Chain Cooperation

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Abstract: This paper explores in depth the mechanism of enterprise digital capability effects in supply chain digital development by reconstructing the supply chain cooperation capabilities (digital diffusion capability and digital collaborative capability). We use the questionnaire data covering 272 Chinese manufacturing enterprises and apply a structural equation model to test the hypothesis. The results show that enterprise digital capability does not directly have a significant impact on supply chain digitalization, and the supply chain cooperation capabilities play mediation role between enterprise digital capability and supply chain digitalization. The results are robust due to we thoroughly consider the action boundary of enterprise capabilities, and verify the systematic requirements of supply chain digitalization and the high-order of enterprise digital capability. These provide a theoretical basis for enterprises to promote the digital transformation of supply chain through digital technology.

Keywords: supply chain cooperation; supply chain digitalization; digital capability; digital diffusion capability; digital collaborative capability

1. Introduction

Industry 4.0 is not only a technological change, but also an opportunity to seize the initiative in a new round of industrial revolution. Therefore, many enterprises have begun to reshape their development strategies in the guidance of Industry 4.0, emphasizing "cross-border" integration, and promoting the creation of fully linked ecosystems in different functional areas [1] to achieve digital development of supply chains. Obviously, digitalization has brought significant benefits to the supply chain, such as increased information availability, optimized logistics practices, real-time collection of operational data, improved inventory management efficiency, and enhanced supply chain transparency [2–4]. Through digital transformation, enterprises are able to gain more flexibility and agility in developing their supply chain management strategies, thus enabling them to create more value [5–7]. Besides, this seamless end-to-end supply chain connectivity in the digital context can put enterprise in a competitive position to more effectively through meeting the changing needs of customers [8].

Supply Chain Digitalization brings great benefits to enterprises, thus it has attracted widespread attention from scholars, and has become a vital research topic in operations management [7], while occupied a central position in the strategic planning of manufacturing enterprises [9–11]. Specifically, supply chain digitalization not only means the application of digital technology in supply chain planning, procurement, production, logistics [12], but also emphasizes the systematic use of digital technology to reshape the process and mode of enterprise supply chain management [2,13]. Therefore, the realization of supply chain digitalization not only requires enterprises to reshape their business models and strategies [14], but also requires enterprises to transform their social relations and operational networks [15]. These pose challenges for enterprises, such as the application of digital technologies, the acquisition of new knowledge and skills by enterprises [16], and the establishment

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of a "digital mindset" by enterprises [15]. To address these challenges, it is necessary for enterprises to develop capabilities such as innovation, agility, and collaborative approaches, build an organizational climate that supports digital transformation [15], as well as and restructure their management perceptions [17]. In other words, the digital transformation of supply chains requires enterprises to develop a unique set of skills and capabilities [13,18,19].

Many previous studies have indicated that dynamic capabilities contribute to the digital development of enterprises [20,21]. As a dynamic capability in the digital context [23–25], digital capability is the digital technology capability of an enterprise to respond to external technological changes [22,23]. It is conducive to enterprises digital development [26], and to improving supply chain flexibility and resilience by promoting supply chain digital transformation as well [25]. In fact, many studies have explored the mechanism of digital capability on digital transformation [19–27]. Besides, some studies have indicated that digital capability, as a high-order dynamic capability [30–32], can generally improve enterprise competitiveness and facilitate digital transformation process by reconstructing low-order dynamic capabilities and operational capabilities [32–34]).

In the context of digital economy, researchers have fully studied the mechanism of digital capability, however, most current discussions are still guided by "atomism", focusing on "single enterprise capabilities and resources - single enterprise digital transformation process and performance" logic, thus ignoring the "systematization" of digital transformation. Digital technologies have "network effect" [35,36], thus, if the digital transformation of an enterprise cannot radiate to the upstream and downstream [37] for promoting supply chain digitalization, the digital advantage of an enterprise will be greatly reduced. This underscores the importance of supply chain cooperation in digitalization. Accordingly, this study takes supply chain cooperation as the analysis logic, takes digital capability as a high-order dynamic ability, and explores the mechanism of digital capability to promote the supply chain digitalization by adjusting and reconstructing enterprises supply chain-oriented cooperation capabilities (digital diffusion capability and digital collaborative capability).

2. Literature Framework and Hypothesis Development

2.1. Digital Capability and Supply Chain Digitalization

Emerging technologies such as cloud computing, big data, artificial intelligence, and the Internet of Things are subverting and changing supply chain management methods and organizational processes [14]. Digital transformation involves a wide range of changes in the organization and supply chain, which requires a shift in organizational culture, operations, and management mindset through the integration of digital technologies, repositioning and organizing enterprise capabilities at all levels [28]. The main goal of supply chain digitalization is to develop new operational processes and innovative business models through the integration of advanced technologies and information systems [38]. As a multidimensional phenomenon, digital transformation requires various organizations in the supply chain to become proficient in the use of various emerging technologies to transform existing human-driven processes into software-driven processes [9]. As the driver of digital transformation, the effective integration of digital technology into supply chain processes is not an easy task, but a difficult "technical challenge" [39]. Therefore, in order to overcome the barriers to the use of digital technologies, enterprises need to develop a set of new skills and capabilities [13,18,19].

According to dynamic capability theory, enterprises need to constantly adjust and modify their resources and capabilities in a volatile environment to ensure continued competitiveness [40–42]. Therefore, in the context of digital transformation, enterprises need to timely adjust their resources, processes and structures according to environment requirement [28]. Although digital transformation relies on digital technology, it is difficult to drive the transformation of the enterprise and the supply chain without the appropriate skills and capabilities [39]. In fact, the development of the digital economy has made digital elements no longer scarce, and data resources are massive, replicable, and flowable, thus, digital technologies do not directly contribute to the competitive

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advantage of enterprises and supply chains [43]. It is more important for enterprise to have the capabilities to integrate, orchestrate, and reconstruct digital resources according to the needs of digital production factors and market customers. An enterprise's digital capability is manifested in the dynamic adaptability of enterprises to digital technologies [22], through which enterprises are able to effectively acquire, deploy, and leverage digital assets to drive systemic digital transformation. On the other hand, digital capability, as a dynamic capability, are characterized by the reconfiguration of organizational capabilities, which plays an important role in guiding transformational change [44]. Already, previous studies have acknowledged that enterprises digital capabilities are the core drivers of digital transformation [26,34,45]. Therefore, we propose the following hypothesis:

H1. *Enterprise digital capability has a positive effect on supply chain digitalization.*

2.2. Supply Chain Cooperation Capabilities and Supply Chain Digitalization

Supply chain digitalization is a systematic concept, which not only means that member enterprises in the supply chain use digital technology to optimize and reconstruct the operational process and structure, but also means that each member optimizes and reconstructs the process and structure of the entire supply chain through digital links [2], and take digital resources as the core input of supply chain value creation [1]. Therefore, the key to supply chain digitalization lies in the cross-organizational digital link to realize the "integration" of information systems among organizations. To achieve this "integration" of information systems, it is not possible to rely on a single enterprise, but must be a collaborative effort across the supply chain [46]. Previous studies have also emphasized that supply chain collaboration is the pillar of supply chain digitization [47,48]. Therefore, to drive the digitalization of the supply chain, enterprises must develop supply-chain-oriented collaboration capabilities. Based on the digital development context, this study proposes two kinds of collaborative capabilities for supply chain development, that is, digital diffusion capability and digital collaborative capability.

Digital diffusion capability is reflected in the willingness of an enterprise to share and transmit digital technologies and digital information [43]. It emphasizes that enterprise can selectively export digital resources and digital technologies according to supply chain digital development requirements, which focusing on making the digital development of supply chain harmonize with the digital development of enterprise. Most digital technologies and resources are not scarce or imitable [37]. Therefore, in order to maximize the benefits of digital development, enterprises should not adhere to the "monopoly" logic of "atomism", instead, they must have the capability to diffusion their products, processes, and business models supported by digital technology to drive the common development of supply chain members [49]. Enterprise with digital diffusion capability not only can enhance its influence, but also send a clear signal of its intent to collaborate with supply chain members [50]. Therefore, it is easier for enterprises to gain recognition from on-chain members when they make digital changes. In addition, it is also easier for enterprises to embed digital technology into the supply chain process, and use the "network effect" of digital technology [35–37] to promote the digital transformation of supply chain members, so as to drive the creation and reorganization of more digital elements, and finally realize the digital development of the supply chain.

Digital collaborative capability is manifested in the enterprise capability to share and coordinate information with partners through digital channels [51]. Digital collaborative capability emphasizes both the digital "output" and the "digital input". On the one hand, enterprises need to allow supply chain members have the access to digital assets; on the other hand, enterprises need to absorb other supply chain members' digital asserts, and timely adjust the organization practices and processes according the requirement of supply chain digitalization development [51]. Digital collaborative capability can help enterprises achieve "cross-border links", which can promote the collaboration and integration of digital resources in the supply chain and realize the compatibility of digital interfaces between supply chain members. As a result, it helps enterprises to promote the digital technology embedment of the entire supply chain operation process, which in turn drives the digital development of the entire supply chain. Besides, the cross-border compatibility of digital technology

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interfaces under cooperative development can also enhance the network effect of supply chain resource expansion [52], which is more conducive to the digital value creation of the supply chain, and then promotes the digital transformation of the supply chain value creation process and operational model. Based on the observations, we draw our research hypotheses as follows:

H2. *Enterprise digital diffusion capability has a positive effect on supply chain digitalization.*

H3. *Enterprise digital collaborative capability has a positive effect on supply chain digitalization.*

2.3. Digital Capability, Supply Chain Cooperation Capabilities and Supply Chain Digitalization

As a high-order dynamic capability, digital capability can play a role by reconstructing enterprise low-order dynamic capabilities or basic operational capabilities [32–34]. This study argues that supply chain cooperation is the basic requirement of supply chain competition, and the digital diffusion capability and digital collaborative capability for supply chain cooperation are also the basic collaborative operation capabilities that enterprises need to have in the context of digital economy. Therefore, with the development and improvement of digital capability, enterprises supply chain-oriented collaboration capabilities will also be reconstructed and adjusted accordingly.

Digital capability is the ability to adjust and reconstruct enterprise operational processes, structure, and business models in a timely manner in response to external technological changes [22], which can help enterprises accumulate knowledge, experience, and digital resources related to the application of digital technology [53,54]. Only with experience in the use of digital technology and digital resources can enterprise carry out digital diffusion according to the requirement of supply chain digital development. As enterprise become more proficient in the use of digital technologies and accumulate more digital resources, the needs for digital technology diffusion will also change, after all, digital technology has a "network effect" [35,36], making enterprise that is more successful in digital transformation more motivated to engage in digital diffusion activities.

Digital collaborative capability is a "two-way" link capability for supply chain cooperation [51]. Digital collaborative capability emphasizes both the "digital resource output" and "digital resource input" of the enterprise. Through the output of digital resources, enterprises can realize the collaborative value co-creation of digital resources with supply chain members; With digital resource input, enterprises need to adjust their digital resource mix based on the newly entered digital elements. This "adjustment" is reflected in the enterprise adaptability to digital technology [22,23], and is also reflected in the enterprise digital capability. Enterprise with digital capability can quickly absorb the needs of digital transformation in the collaborative process [27,55,56], and thus quickly adjust its organizational processes, structure, and technical elements. As a result, enterprises can better realize cross-border links, so as to better collaborate with on-chain members to reconstruct and innovate the value of digital resources. Based on the arguments presented above, we propose the following hypotheses:

H4. *Enterprise digital capability has a positive effect on digital diffusion capability.*

H5. *Enterprise digital capability has a positive effect on digital collaborative capability.*

Supply chain digitalization is a "systemic" concept, and the digital transformation of individual enterprises may not be generalized to the entire supply chain [57]. Unlike traditional resources, digital technologies are often not unique or imitable, and other competitors have relatively easy access to the same or similar technologies [37]. A large part of the effect of digital technologies on enterprise is manifested in supply chain synergies [58]. Accordingly, many studies have highlighted the importance of supply chain cooperation in supply chain digital transformation [47,48]. If the enterprises digital capability and digital transformation initiatives do not spillover to supply chain members, while supply chain upstream and downstream do not carry out collaborative digital reform and cultivate digital capabilities, thus the cross- organizational operation interface will not be smooth, and the benefits brought by digitalization to the enterprise will be greatly reduced. Therefore, in order to better play the advantages brought by digital technology, enterprises should actively promote the benefits of digital technology and carry out "cross-border" actions, and collaborate with partners to build the digital infrastructure of the supply chain. Therefore, we propose the following hypotheses:

 doi:10.20944/preprints202409.0560.v1

H6. *Enterprise digital diffusion capability positively moderates the relationship between digital capability and supply chain digitalization.*

H7. *Enterprise digital collaborative capability positively moderates the relationship between digital capability and supply chain digitalization.*

3. Methods

3.1. Research Design and Data Collection Method

This study collected data through self-report takes questionnaires by surveying manufacturing enterprises in China. First, the research team drew on the existing mature scales to construct the initial items of the questionnaire, and modified the content according to the suggestions of several experts. Next, we shuffled all the questionnaire items, and send the questionnaires to 15 senior managers through school's MBA program. After one-on-one feedback, we revised the questionnaire, and sent it 150 MBA students for pre-testing. According to the results of confirmatory factor analysis, we revised, adjusted and deleted some questionnaire items. The final questionnaires are collected through a professional questionnaire collection platform, and since the online platform requires the respondent to complete the questionnaire, there are no missing items in the questionnaires received. In addition, we set up "trap questions" and "verification questions" in the questionnaire to control the quality of the questionnaire data. 382 questionnaires were issued and 292 were recovered. After checking the questionnaire data one by one and deleting the obviously illogical data, 272 valid questionnaires were obtained, and the effective recovery rate was 71.20%.

Table1. Basic characteristics of samples （number of enterprises=272）.

Category	Percentage of respondents
Number of employees	
1-49 employees	0.74%
50-79 employees	1.10%
80-99 employees	1.10%
100-199 employees	6.62%
200-499 employees	29.78%
500-999 employees	27.21%
More than 1000 employees	33.46%
Asserts (CNY million)	
Less than 5	1.10%
5-10	4.41%
10-20	6.62%
20-50	19.85%
50-100	22.06%
More than 100	45.96%
Last year's sales (CNY million)	
Less than 1	1.47%
1-5	4.04%
5-10	9.93%
10-20	9.93%
20--50	16.91%
50-100	13.24%
More than 100	44.49%
Establishment period	
Less than 2 years	0.74%
3-5 years	1.47%

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6-10 years	9.93%
11-15 years	32.35%
More than 15 years	55.51%

3.2. Measurement of Constructs

The questionnaire was conducted on a Likert seven-level scale, with a numerical score from 1 to 7 indicating "strongly disagree" to "strongly agree", and "4" indicating neutral or medium level. The measurement of enterprise digital capability has five items, which refers to the research of Khin and Ho [24], including "our enterprise can acquire important digital technologies" and "our enterprise can develop innovative products/services/processes with digital technologies". The measurement of digital diffusion capability has four items, which refers to the research of Mishra et al. [43], including "our enterprise is willing to share digital technology with partners in the supply chain" and "our enterprise is able to diffusion digital elements into the supply chain in an appropriate form". The measurement for digital collaborative capability has four items, which refers to the research of Zhang and Zhu [59], Li et al. [60], including "our enterprise has built a digital cooperative management system with different supply chain partners" and "information exchange interfaces between our enterprise and supply chain partners are compatible". The measurement for supply chain digitalization has five items, which refers to the research of Liu and Chiu [12], including "our enterprise has conducted a large number of transactions with suppliers through digital technology" and "our enterprise has conducted transactions with a large proportion of customers through digital technology". Since the establishment period, scale and income of enterprises may have effect on supply chain process and structure arrangement, this study took the asset scale, sales revenue, number of employees, and years of establishment as the control variable.

4. Data Analysis and Results

4.1. Measurement Model

This study used SPSS 28.0 and MPlus 8 to test the reliability and validity of questionnaire data. Reliability is a measure of whether the results presented by the data are consistent over time [61], which can be reflected by internal consistency. Internal consistency refers to the homogeneity between all the measured items that make up a construct, and Cronbach's α is the most popular research method used in testing internal consistency [61]. Statistically, when $\alpha > 0.7$, it indicates that there is good internal consistency between the items measured by this variable. As shown in Table 2, the Cronbach's α of each variable in this study is greater than 0.84, indicating that the measurement of these variables is reliable.

Validity measures the authenticity and accuracy between the measured items and the collected data, including content validity and construct validity [61]. Content validity analysis refers to the applicability of questionnaire items to the measurement of relevant constructs [62]. Since the establishment of the scale used in this study referred to a large number of literature and sought the expert review, the measurement scale in this study has a certain content validity [63].

Construct validity reflects the degree to which a measurement tool is able to correctly measure underlying traits, including convergent and discriminant validity [64]. Convergent validity refers to the degree to which the scale relates to other measures of the same construct [65], and it can be evaluated by factor loading, Composite Reliability (CR) and Average Variance Extracted (AVE). Statistically, if the factor loading of the variable is > 0.5, it indicates that the item is valid for the explanation of the variable. At the same time, if the CR > 0.6 and the AVE > 0.5 while the AVE value less than CR, it indicates that the measurement of each variable has good convergent validity [61]. As shown in Table 2, the factor loadings in this study are greater than 0.71, CRs are greater than 0.83 and AVEs are greater than 0.5, indicating that the scale in this study has good convergent validity.

 doi:10.20944/preprints202409.0560.v1

Discriminant validity refers to the degree to which a construct is different with other constructs [66], and can be evaluated by comparing the factor's square roots of AVE with the correlation coefficient between the factor and other factors. If the square root of the AVE of each variable is greater than the correlation coefficient between the variables, it means that the variables have good discriminant validity (Fornell-Larcker criterion). As shown in Table 3, the correlation coefficients between the variables in this study are all less than the square root of AVE value, so it can be considered that the variables in this study have good discriminant validity.

Due to the high correlation coefficient between several variables in this study, we conducted a collinearity test by testing Variance Inflation Factor (VIF). The test results show that the highest VIF value is 2.659, which is much lower than the threshold of 10, indicating that there is no serious multicollinearity problem between the variables in this study.

Table 2. Convergent validity.

Construct	Items	Mean	SD	Factor Loading	Cronbach's α	CR	AVE
Digital Capability	DC1	5.91	0.911	0.851	0.915	0.916	0.686
	DC2	5.82	0.832	0.850			
	DC3	5.9	0.811	0.836			
	DC4	5.74	0.906	0.855			
	DC5	5.92	0.827	0.743			
Digital Diffusion Capability	DDC1	5.86	0.871	0.744	0.842	0.838	0.564
	DDC2	5.81	0.812	0.755			
	DDC3	5.88	0.806	0.792			
	DDC4	5.96	0.823	0.710			
Digital collaborative capability	DCC1	5.7	0.821	0.822	0.900	0.901	0.694
	DCC2	5.71	0.815	0.865			
	DCC3	5.69	0.820	0.844			
	DCC4	5.77	0.784	0.800			
Supply Chain Digitalization	SCD1	5.82	0.842	0.795	0.899	0.900	0.643
	SCD2	5.76	0.875	0.819			
	SCD3	5.81	0.861	0.816			
	SCD4	5.75	0.896	0.776			
	SCD5	5.72	0.951	0.804			

Table 3. Discriminant validity

Construct	Mean	SD	1	2	3	4	5	6	7	8
1NE	6.79	1.15	1							
2Asserts	5.95	1.23	.597***	1						
3Sales	5.54	1.65	.559***	.771***	1					
4 EP	4.40	0.79	.274***	.277***	.214***	1				
5DC	5.86	0.74	.129**	0.065	0.11*	.134**	0.828			
6DDC	5.88	0.68	.145**	0.081	0.093	.150**	.678***	0.751		
7DCC	5.72	0.71	.143**	0.046	0.016	0.111*	.719***	.728***	0.833	
8SCD	5.77	0.75	0.08	-0.016	-0.044	0.08*	.618***	.647***	.756***	0.802

Note: NE: number of employees; EP: establishment period; DC: digital capability; DDC: digital diffusion capability; DCC: digital collaborative capability; SCD: supply chain digitalization; *denotes significant at $p<0.05$, ** denotes significant at $p<0.01$, the same below; diagonals represent the square root of average variance extracted (AVE) while the other entries represent the correlations.

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4.2. Common Method Variance

We used self-report questionnaire survey for data collection in this study, thus the collected data may be affected by Common Method Variance (CMV). CMV can lead to exaggerated or underestimated relationships between study variables, resulting in statistical Type 1 or 2 errors [67]. In order to control and reduce CMV, this study have adopted procedural control measures in advance, such as anonymous response, scrambled construct measurement items, and designed reverse measurement items. In the post hoc control test, confirmatory factor analysis was used to test the hypothesis that a single factor explains all the variation. The test results showed that the fitting indexes were very unsatisfactory (χ^2=705.404, df=135, RMSEA=0.125, TLI=0.837, CFI=0.815), indicating that there was no serious common method bias in this study.

4.3. Structural Model

In this study, MPlus8.0 was used to test all the research hypotheses, and Bootstrapping was used to verify the significance of mediation effects. The overall model fit was good (χ^2=320.207, df=198, RMSEA=0.048, SRMR=0.064, TLI=0.960, CFI=0.965), so the next test can be promoted.

First, the study examined the influence of each control variable on the dependent variable. The test results show that the number of employees (b=0.014, P=0.815), sales (b=-0.098, P=0.213), total assets (b=0.001, P=0.989) and the period of establishment (b=-0.006, P=0.878) have no significant impact on supply chain digitalization. The above results confirm the analysis of this study, that is, the development of the supply chain as a whole is more dependent on the collaborative efforts of supply chain members, and the influence of a single enterprise on the supply chain may be limited.

Next, the study examined the direct effects between the variables. According to the test results, the direct effect of an enterprise digital capability (b=-0.093, P=0.663) on supply chain digitalization is not significant, so H1 is failed to be verified. Both the digital diffusion capability (b=0.281, P=0.033) and the digital collaborative capability (b=0.710, P<0.01) exert a positive and significant impact on supply chain digitalization. Therefore, H 2 and H 3 are verified, indicating that enterprises supply chain cooperation capabilities indeed exert significant and positive impact on the digital development of the supply chain. In addition, digital capability has a positive and significant impact on digital diffusion capability (b=0.803, P<0.01) and digital collaborative capability (b=0.819, P<0.01), which proves the "high-order" of digital capability, indicating that dynamic digital capability can adjust and restructure enterprise basic operation capabilities or low-order dynamic capabilities for coping with changing environment and technology. Thus H 4 and H 5 are verified.

4.4. Mediation Role of Enterprise Supply Chain Cooperation Capabilities

According to bootstrapping analysis, enterprise digital capability exerts a positive impact on supply chain digitalization by improving digital diffusion capability (b=0.226, P=0.043) and digital collaborative capability (b=0.581, P<0.01). Therefore, H 6 and H 7 are also verified. In conclusion, the total effect of enterprise digital capability on supply chain digital development through supply chain cooperation capability is 0.807 (b=0.226+0.581, P<0.05). In conclusion, the total effect of enterprise digital capability on supply chain digitalization through supply chain cooperation capabilities is 0.807 (b=0.226+0.581, P<0.05).

Table 4. Mediation results.

Path	Beta coefficients (b)	S.E.	P-Values	Significance
DC->SCD	-0.093	0.214	0.663	
DDC->SCD	0.281	0.132	0.033	**
DCC->SCD	0.710	0.120	0.000	***
DC->DDC	0.803	0.044	0.000	***

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DC->DCC	0.819	0.038	0.000	***
DC->DDC->SCD	0.226	0.112	0.043	**
DC->DCC->SCD	0.581	0.109	0.000	***

Note: DC: digital capability; DDC: digital diffusion capability; DCC: digital collaborative capability; SCD: supply chain digitalization.

5. Discussion and Conclusions

5.1. Discussion

In line with the supply chain cooperation perspective, this study constructed a theoretical model of "digital capability- enterprise supply-chain-oriented collaboration Capabilities (Digital Diffusion capability and digital collaborative capability)-supply chain digitalization", and conducted empirical analysis through 272 questionnaire data of Chinese manufacturing enterprises. The results revealed that enterprise digital capability has no direct impact on supply chain digitalization, while enterprise supply- chain-oriented collaborative capabilities play full mediation role between digital capability and supply chain digitalization. At present, some studies have explored the impact mechanism of digital capability on supply chain development, such as supply chain resilience [25,68,69], supply chain innovation [70], and sustainable supply chain performance [71]. This study proposes that, supply chain development as a "systemic" concept, a single enterprise internal capabilities and resources have limited impact on supply chain development. This begs the question of the action point of enterprise capabilities. According to the direction of capabilities, Day [72] divides enterprise capabilities into three types: inside-out capabilities, outside-in capabilities, and spanning capabilities. Inside-out capabilities are capabilities of an enterprise to meet market demand, carry out competitive challenges and take advantage of external opportunities, which is reflected in what an enterprise can "do", including financial management capabilities, cost control capabilities, human resource management capabilities. Outside-in capabilities are established by the enterprise's adaptation to the external environment, which shows the enterprise's pursuit of grasping the external demand in time. Spanning capabilities emphasize both the external information input, and the internal information output. The role of this type of capability (such as strategic development capabilities, new product development capabilities, procurement capabilities) is directed to the supply chain, emphasizing supply chain coordination. Digital capability emphasizes enterprises adaptability to external technological changes [22,23], which is an "outside-in" capability whose role is focused on the single enterprise. Therefore, there must be a link bridge between enterprise digital capability and supply chain development, and the bridge between the enterprise's inward capabilities and resources and supply chain development is the "spanning capabilities". Digital diffusion capability emphasizes the link between internal digital resources and supply chain members, and digital collaboration capability emphasizes the compatibility between internal digital resources and supply chain members, both of which are "spanning capabilities". These two "spanning capabilities" help enterprises transfer internal digital resources and knowledge to supply chain members, and also help enterprises absorb the digital knowledge and digital capabilities of supply chain members to ensure the compatibility of digital systems between enterprises and members. In this way, it is more conducive to the digital integration of supply chain logistic flow, capital flow, and commercial flow, as well as the co-creation of digital value of supply chain cooperation, thereby contributing to the digital development of the supply chain.

In addition, the research results shows that digital diffusion capability and digital collaborative capability exert direct and positive impact of supply chain digitalization. This conclusion also responds to the research on supply chain digital capabilities [13,73,74] and supply chain dynamic capabilities [25,75,76] in the context of digitalization. The above discussion of supply chain capabilities does not emphasize the role orientation of capabilities, while the results of this study show that the capabilities that can play a role in promoting supply chain development should be "spanning capabilities". therefore, our study may provide a guidance for the classification of supply chain capabilities.

 doi:10.20944/preprints202409.0560.v1

Finally, the results provide evidence of the digital capability as a high-order dynamic capability, and this result is in accord with studies confirming with enterprise digital capability can adjust and restructure enterprise operational capabilities for supply chain cooperation [32–34,77]. On the one hand, digital capability can help enterprise accumulate digital knowledge and resources, and contributes to making enterprise better perceive the demand for digital technologies and resources of supply chain cooperation, which in turn helps enterprises improve and adjust their digital diffusion capability for supply chain digital transformation. On the other hand, digital capability helps the enterprise absorb the digital knowledge and technology of the supply chain partners, thereby enhancing the compatibility of the digital interface between the enterprise and the supply chain members. This conclusion reaffirms the importance of digital capability and provides a reference for enterprises in digital transformation.

5.2. Theoretical Implications

First, this study contributes to the scientific literature in enterprise capabilities, and confirms that enterprise digital capability cannot have a direct impact on supply chain development. In the context of digital economy, many previous studies have explored the impact mechanism of digital capability on digital transformation, but most of the studies ignore capabilities' action boundary. As a high-order dynamic capability, digital capability plays a role in the enterprise adaptability to changes in the external technical environment, which is a "outside-in" capability. The findings indicate that although "inside-out" and "outside-in" capabilities will exert significant impact on enterprises performance and competitiveness, they cannot exert directly impact on supply chain performance. Therefore, future studies need to pay attention to the action boundary when exploring the mechanism of enterprise capabilities, which provides new ideas for the follow-up research of enterprise capabilities.

Second, this study enriches the literature on supply chain capabilities. In the context of digital transformation, many studies have begun to pay attention to supply chain digital capabilities and supply chain dynamic capabilities, while these studies' focus is still on single enterprise capabilities. This study proposes that the capabilities which can exert direct influence supply chain digitalization are "spanning capabilities", which provides guidance for the subsequent characterization of supply chain capabilities.

Finally, this study provides valuable insights for current research on supply chain digitalization. This study explores the mechanism of digital capabilities at the micro enterprise level to promote the digital development of supply chains, and confirms that the "outside-in" digital capability cannot exerts direct impact on supply chain digitalization. On the contrary, supply chain cooperation capabilities (digital diffusion capability and digital collaborative capability) play full mediation role between digital capability and supply chain digitalization. This study emphasizes the systematization of supply chain digitalization, and thus puts forward the matching requirements of supply chain research. In other words, this study proposes that the enable factors corresponding to supply chain digitalization should be supply chain resources and capabilities, which provides an important reference for the subsequent research on promoting supply chain digital transformation.

5.3. Practical Implications

First, enterprises should strive to cultivate digital capability. Digital capability is the dynamic capability for enterprises to cope with technological changes, and it can affect the development and reconstruction of other enterprises capabilities. Digital capability is the basic requirement for enterprises coping with technological changes. However, the cultivation of digital capability is not only the digital technology operation of enterprises for micro-operations. Instead, for developing digital capability, enterprise should have a digital baptism from the top down, such as establish digital enterprise culture, construct management models and systems adapted to digital development, cultivate cross-border collaborative thinking, introduce digital technology and talents, and focus on the accumulation of digital knowledge.

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Next, enterprises should have a supply chain development mindset and cultivate spanning capabilities. Digital technology is not scarce and inimitable, but digital technology has network effects. Therefore, in order to maximize the benefits of digital development, enterprises should be guided by the cross-border collaborative thinking of digital development, cultivate supply chain-oriented collaborative capabilities, such as such facilitating the development and utilization of supply chain collaborative information technology, building a supply chain operation platform, and promoting the exchange of digital talents among supply chain members. The construction of collaborative platform helps to smooth the circulation channels of supply chain digital flow, promote the digital integration of supply chain logistic flow, commercial flow and cash flow, so as to realize supply chain digital transformation.

Last, enterprises should establish digital governance mechanisms. Digital development requires enterprises to establish a "cross-border" collaborative mindset and share digital information and technology. Although digital technology may not be the source of enterprises sustainable competitiveness, digital information based on digital technology is the core input of enterprises digital value creation. Therefore, enterprises must establish a set of digital governance mechanisms, stratify the value of digital information, and focus on desensitizing core key data. Accordingly, enterprises should also actively use blockchain and other technologies to promote the establishment of internal "private chains" and supply chain "alliance chains" to ensure the authenticity of digital data and the security of digital data circulation.

5.4. Limitations and Avenues for Future Research

This study has several limitations. First, the research sample in this study comes from manufacturing enterprises in China, which limits the generalizability of the conclusions. On the one hand, China is a developing country with limited resources; on the other hand, most manufacturing enterprises need to invest heavily. Therefore, manufacturing enterprises in developing countries may place more emphasis on supply chain coordination due to the scarcity of resources. On the contrary, as equipped with advanced and relatively abundant resources in developed countries, enterprises resource constraints are not so serious. There hence, a single enterprise even has the capabilities to promote supply chain development. Follow-up studies could expand the scope of the study to include other sectors as well as different economies to enhance its generalizability. Second, this study highlights the role of enterprises in using high-order dynamic capability (digital capability) to develop supply chain coordination capabilities, and thus facilizing to supply chain digitalization. This study takes dynamic capability as the research starting point, and its action process is bound to be dynamic. However, the data in this study are "cross-sectional data" collected through anonymous questionnaires, and it cannot reflect the dynamic process described above. Follow-up studies can try to use "panel data", so that the above relationship pathways can be more accurately verified. Last, this study raises the question of enterprise capabilities' action boundary. Subsequent studies can further distinguish and classify enterprises "inside-out", "outside-in" and "spanning" capabilities under the background of digital transformation, which is conducive to clarifying the role of enterprises digital-related capabilities.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Figure S1: title; Table S1: title; Video S1: title.

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