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Digital transformation strategy, information technology capability and supply chain management of manufacturing enterprises: Basis for an enhanced technology innovation framework

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Abstract

Digital transformation strategy, information technology(it) capability, and supply chain management are crucial for manufacturing enterprises to thrive in the era of technological innovation. This study aimed to assess the relationships among digital information strategy, information technology (IT) capability and supply chain management as basis in developing enhanced technology framework. The paper utilized a descriptive method of research and self-made questionnaire as a data collection tool, with 406 employees from the Chinese manufacturing Industry participants. Non-parametric testing using Spearman's rank correlation coefficient is employed to test significant relationships. All analyses were conducted using SPSS version 28. The study revealed that respondents have good evaluation on the company's digital transformation strategy in terms of the digital transformation goals, digital investment, and digital technology capability level. Manufacturing companies have moderate or functional capability level in terms of IT infrastructure construction level, emerging IT technologies adoption and IT flexibility as agreed by the respondents. Respondents have good assessment of the supply chain management in terms of supply chain collaboration, supply chain security, and supply chain agility. Highly significant relationships exist between digital transformation strategy, IT capabilities, and supply chain. An enhanced technology innovation framework for Chinese manufacturing enterprises was developed.

Keywords: digital transformation strategy, IT capability, supply chain management, manufacturing industry, technology innovation

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1. Introduction

Manufacturing sector is undergoing a massive transformation driven by technological innovation. Digital Transformation Strategy, IT Capability, and Supply Chain Management are crucial for manufacturing enterprises to thrive in the era of technological innovation. The strategy identifies areas where IT capabilities can drive innovation, such as AI-powered product design or smart factory automation. Digital tools like predictive analytics and blockchain can optimize logistics, reduce waste, and ensure on-time delivery. Real-time data from the supply chain allows for better demand forecasting, which feeds back into product development and marketing strategies. By effectively leveraging these three factors, Chinese manufacturing enterprises can achieve significant advancements in product innovation, operational efficiency and supply chain resilience.

With the rapid development of globalization and information technology, Chinese manufacturing enterprises are facing unprecedented challenges and opportunities. Digital transformation has become a key strategy for enhancing corporate competitiveness and achieving sustainable development. Information technology capability is at the core of an enterprise's digital transformation, involving how enterprises utilize information technology to optimize internal processes, improve efficiency, reduce costs, and enhance innovation capabilities (Wu, 2024). As global manufacturing competition intensifies, Chinese manufacturing enterprises must enhance their global market competitiveness through digital transformation. Digital transformation is key to driving the shift of China's manufacturing industry from labor-intensive to technology intensive. Technological innovation is the fundamental driving force for enterprise development. (Miao et al., 2024).

Supply chain management, a vital component of enterprise operations, has its digitalization level directly affecting the enterprise's market response speed and customer satisfaction. Technological innovation is the driving force behind continuous development, with digital transformation offering new pathways and tools for it. The efficiency and responsiveness of the supply chain directly impact on the enterprise's market competitiveness. Domestic and foreign scholars have researched one or two variables among manufacturing enterprises' digital transformation strategies, information technology capabilities, supply chain management, and technological innovation, but existing studies have deficiencies. For example, current research focuses on constructing and analyzing theoretical models, lacking in-depth analysis and empirical research on actual cases of digital transformation in manufacturing enterprises. Different manufacturing industries face distinct problems and challenges during digital transformation, yet existing studies have not fully considered the impact of industry characteristics on digital transformation strategies. There is a lack of cross-industry comparative analysis data in existing research, making it difficult to draw universally applicable conclusions.

Corporate culture is one of the key factors influencing employees' acceptance of new technologies and processes, yet existing research overlooks the role of corporate culture in promoting digital transformation. While supply chain management is an important part of digital transformation, existing studies have not fully explored how to break information silos, achieve data sharing and integration, nor have they fully discussed how the digital economy can enhance the resilience and risk resistance of manufacturing enterprises' supply chains. Although some studies have mentioned the " stranglehold" problem of key core technologies, there is a lack of research on specific strategies and methods to break through these technological shortcomings. The digital transformation of Chinese manufacturing enterprises is a complex system engineering involving strategic planning, information technology capabilities, supply chain management, and technological innovation. Addressing these deficiencies, the researcher chose the digital transformation strategy of manufacturing

enterprises, information technology capabilities, and supply chain management: improving the technological innovation framework. This will allow for more in-depth empirical analysis, construction of a more comprehensive theoretical framework, filling the gaps in existing research, and providing strategic guidance for the digital transformation of Chinese manufacturing enterprises. This research will help enterprises identify and enhance information technology capabilities, optimize supply chain management, stimulate innovation consciousness, promote technological innovation, and offer more comprehensive guidance and suggestions for enterprises and policymakers.

Objectives of the Study - This study aimed to assess the relationships between digital information strategy, information technology (IT) capability and supply chain management as basis in developing enhanced technology framework. Specifically, it aimed to evaluate the company's digital transformation strategy in terms of the digital transformation goals, digital investment, and digital technology capability level; determined the IT capability level from the dimensions of infrastructure construction level, emerging technologies adoption and flexibility; and assessed the supply chain management situation from collaboration, security, agility. Tested the relationship between the digital transformation strategy, IT capabilities, and supply chain. It came up with enhanced technology innovation framework for Chinese manufacturing enterprises.

2. Methods

Research Design - This study used a descriptive research design, aiming to systematically record, analyze, and interpret the current status of digital transformation strategies, IT capabilities, and supply chain management in Chinese manufacturing enterprises. It also wanted to seek to explore the relationships and inter-dependencies among these variables. The choice of research design took into full account the purpose of the study, which was to assess the relationship between digital transformation strategies, IT capabilities, and supply chain management, and to provide empirical evidence for improving the technological innovation framework.

Participants of the Study - The participants of this study primarily included 406 employees from Chinese manufacturing companies, encompassing managers, IT experts, and supply chain management personnel. They possessed extensive practical experience in digital transformation strategies, IT capabilities, and supply chain management, and were able to provide valuable data and insights for this study. To ensure the authenticity and reliability of the research data, the study adopted an anonymous data collection method and protected the privacy and rights of the participants. During the data collection process, a good communication mechanism was established with the participants to ensure that they could fully understand the purpose and significance of the research and actively participate in the data collection and interview process. At the same time, strict quality control was conducted on the collected data to ensure its accuracy and reliability.

Data Gathering Instruments - The design of the data collection tools aimed to comprehensively and systematically record and analyze the digital transformation strategies, IT capability levels, and the current state of supply chain management in Chinese manufacturing companies. The questionnaire was one of the main data collection tools for this study. The design of the questionnaire included the following key sections:

Digital Transformation Strategy section: This covered the company's digital transformation goals, digital investment scale, and digital technology capabilities, aiming to assess the direction and level of investment in the company's digital transformation strategy.

IT Capability section: Starting from three dimensions—IT infrastructure construction level, adoption of emerging IT technologies, and IT flexibility—a series of questions were designed to quantitatively assess the company's IT capability level.

Supply Chain Management section: This included aspects such as supply chain collaboration, supply chain security, and supply chain agility, with question design aimed at assessing the current state of the company's supply chain management.

The data collection process involved distributing the questionnaire to selected sample companies via email or online platforms and setting a reasonable deadline for responses. The collected questionnaire and interview data were then organized, coded, and verified to ensure the accuracy and reliability of the data. Throughout the data collection process, the questionnaire and interview outlines were continuously optimized based on participant feedback and actual situations to ensure the specificity and effectiveness of the data collection tools. Additionally, a variety of data collection methods were used to complement each other, enhancing the comprehensiveness and reliability of the data. This questionnaire was subjected to content validation with the expert in the field and subjected to reliability testing to test the coherence of the items for each construct.

Table 1

Test of Reliability Result

Indicator	Cronbach Alpha	Remarks
Digital Transformation Strategy		
Digital Transformation Goals	0.789	Acceptable
Digital Investment	0.706	Acceptable
Digital Technology Level Capability	0.884	Good
IT Capability		
IT infrastructure construction level		
Emerging IT technologies Adoption	0.868	Good
IT flexibility	0.791	Acceptable
Digital Platform Building Level	0.704	Acceptable
Supply Chain Management		
Supply Chain Collaboration	0.829	Good
Supply Chain Security	0.774	Acceptable
Supply Chain Agility	0.791	Acceptable

George and Malley (2003) provide the following rules of thumb ">0.90 – Excellent, >0.80 – Good, >0.7 – Acceptable, >0.60 – Questionable, >0.50 – Poor, and <0.50 – Unacceptable"

Data Gathering Procedure - First, an extensive literature review was initially conducted, focusing on identifying key issues and concepts related to the study variables and their corresponding dimensions. By carefully analyzing existing academic research, case studies, and industry reports, a list of questions concerning attitudes and behaviors of employees in Chinese manufacturing enterprises was summarized. This step ensured that our research design was closely linked to theoretical foundations while enhancing the relevance and comprehensiveness of our survey tool. Following this, based on the key issues summarized from the literature review, a detailed questionnaire was designed. The questionnaire underwent several rounds of review and revision to ensure that the questions were clear, unbiased, and capable of effectively collecting data related to the research variables. Finally, after finalizing the version of the questionnaire, it was distributed online to employees of various Chinese manufacturing enterprises. Participants were informed that their responses would be kept confidential and used solely for academic research purposes. A reasonable deadline was set to encourage timely responses, and regular follow-ups were conducted to improve the response rate. All collected data were organized and entered a database, preparing for subsequent analysis work. This data collection process aimed to obtain high-quality data to support the accurate assessment of research hypotheses.

Ethical Considerations - Ethical considerations in this study include ensuring the confidentiality and anonymity of the respondents. Participation in the survey will be voluntary, with respondents informed about the purpose of the study and assured that their responses will be used solely for research purposes. The data will be stored securely, and only aggregate results will be reported in the study, ensuring that individual responses cannot be traced back to specific participants. These measures are crucial to uphold the ethical standards of research and ensure the integrity of the study.

Data Analysis - The data collected in this study were primarily analyzed using SPSS software version 28. Initially, descriptive statistics were used to summarize responses, providing an overview of the general trends and patterns in digital transformation strategies, IT capabilities, and the state of supply chain management among Chinese manufacturing companies. Through descriptive statistics, the study analyzed the goal setting of digital

transformation in Chinese manufacturing companies, the scale and structure of digital investments, and the level of digital technology capabilities. At the same time, a quantitative assessment was conducted on the level of IT infrastructure construction, the adoption of emerging IT technologies, and IT flexibility. Additionally, descriptive statistics were used to evaluate the state of supply chain management from three aspects: supply chain collaboration, supply chain security, and supply chain agility.

To explore the relationship between digital transformation strategies, IT capabilities, and supply chain management, Spearman's rho was used for correlation analysis. This method is suitable for non-normally distributed data and can effectively reveal the degree of correlation between variables. Through this analysis, the study aimed to reveal the impact of digital transformation strategies on the development of IT capabilities and the support of IT capabilities for the optimization and upgrading of supply chain management. Before conducting the correlation analysis, the Shapiro-Wilk test was used to check the normality of the data. The test results showed that the p-values for all variables were less than 0.05, indicating that the data set did not follow a normal distribution. Therefore, Spearman's rho was chosen as part of the non-parametric test to determine the significant relationships between variables.

By evaluating the goal setting of digital transformation, the scale and structure of digital investments, and the level of digital technology capabilities, the study understood the overall strategy and investment of Chinese manufacturing companies in digital transformation. From the dimensions of IT infrastructure construction level, the adoption of emerging IT technologies, and IT flexibility, the study quantified the IT capability level of Chinese manufacturing companies, providing data support for improving the technological innovation framework. In terms of supply chain management, the study analyzed data on supply chain collaboration, supply chain security, and supply chain agility among Chinese manufacturing companies to assess the current state and issues of supply chain management.

Through the analysis using SPSS software version 28, the study gained in-depth insights into the relationship between digital transformation strategies, IT capabilities, and supply chain management among Chinese manufacturing companies. These analytical results not only helped understand the interactions between various variables but also provided empirical support for improving the technological innovation framework. Based on these analyses, the study will further explore how to optimize the digital transformation strategies, enhance IT capability levels, and improve supply chain management strategies of Chinese manufacturing companies to achieve sustained development and competitiveness in the digital era.

3. Results and discussion

Table 2

Summary Table on Digital Transformation Strategy

Key Result Areas	Composite Mean	VI	Rank
Digital Transformation Goals	2.92	Agree	2.5
Digital Investment	2.92	Agree	2.5
Digital Technology Capability Level	3.18	Agree	1
Grand Composite Mean	3.01	Agree	

Legend:3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

Table 2 conducts a comprehensive assessment of the key result areas in the digital transformation of businesses. This study reveals an overall positive attitude among respondents towards the current digital transformation strategy, with a composite mean value of 3.01. This evaluation is significant for organizations in positioning their development direction and optimizing resource allocation in the digital process. Notably, the level of digital technology capability, with a composite mean of 3.18, ranks highest among the indicators, reflecting widespread recognition among respondents of the organization's outstanding performance in this area. This result is likely closely related to the organization's emphasis on technological innovation and continuous R&D investment in recent years. The enhancement of technological capabilities not only helps organizations

maintain an advantage in fierce market competition but also promotes the continuous development of business models and service innovation. Further analysis indicates that digital transformation significantly enhances the enterprise's technological innovation capability, achieved through increased R&D investment and improved R&D efficiency. The increase in digital technology and R&D investment is attributed to the effective operation of profit protection and cost control mechanisms. The study emphasizes that digital transformation is a key strategy for enhancing enterprise innovation capability and highlights the importance of promoting the deep integration of the digital and real economies, improving digital infrastructure, and optimizing the digital business environment. (Ji, et al., 2023).

Digital transformation goals and digital investments, with a composite mean of 2.92 each, rank second and third, respectively, both receiving an "agree" rating. This indicates that respondents recognize and approve of the organization's digital transformation goals and investment strategies, believing they contribute to the organization's long-term development and profitability. However, there is still room for improvement, and the organization may need to communicate its goals and investment plans more clearly to gain higher support. In the current research field, manufacturing enterprises have made significant progress in implementing digital transformation strategies, especially in building digital technology capabilities. However, to further enhance the effectiveness of digital transformation, it is recommended that manufacturing enterprises strengthen internal communication mechanisms, clarify transformation goals, and develop clear investment plans. Additionally, organizations should continuously pay attention to and actively address issues encountered during the transformation process to ensure the effective execution of transformation strategies. Moreover, to maintain a competitive advantage in the digital era, organizations must continue to invest in technological innovation and talent development. This not only promotes technological progress but also provides the necessary talent support for organizations to adapt to constantly changing market demands. In the digital transformation process of China's traditional manufacturing industry, Zhang (2022) proposed a series of strategies, including integrating digital transformation into the enterprise's medium and long-term development strategy, increasing the construction and investment in digital infrastructure, enhancing decision-making capabilities based on massive data, optimizing enterprise management through digital technology and platforms, advancing digital marketing and customer service innovation, creating digital intelligent manufacturing, and enhancing the innovation capability of enterprise digital transformation. Additionally, gathering and cultivating the human capital that supports enterprise digital transformation is also a key factor.

Table 3

Summary Table on IT Capability Level

Key Result Areas	Composite Mean	VI	Rank
IT Infrastructure Construction Level	3.22	Agree	1
Emerging IT Technologies Adoption	3.20	Agree	2
IT Flexibility	3.18	Agree	3
Grand Composite Mean	3.20	Agree	

Legend:3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

Table 3 shows the summary of IT Capability Level comprehensively assesses the company's IT capability level across three key result areas (KRAs): IT infrastructure construction level, adoption of emerging IT technologies, and IT flexibility. Overall, the company's IT capability level is high, with an overall composite mean of 3.20, indicating that respondents "agree" with the company's IT capabilities. This finding is significant for understanding the company's status in informatization, technological innovation, and business agility, and may have a profound impact on the company's future competitiveness and market position.

IT infrastructure construction level ranked first with the highest weighted mean of 3.22. This shows that the company's investment and construction in IT infrastructure have achieved significant results, providing solid support for the company's business operations and technological innovation. This high level of infrastructure construction may benefit from the company's emphasis on informatization construction and continuous

investment, as well as the professional capability and efficient management of the IT department. Ji (2020) pointed out that investment in IT infrastructure should not only focus on innovation to ensure support for business continuity but also operation and maintenance management should adopt standardized and proactive change strategies to enhance overall operational efficiency and risk control capabilities. The implementation of such strategies is crucial for ensuring that enterprises can maintain stable business operations and efficient risk management in the face of rapidly changing market and technological environments. A high level of IT infrastructure helps the company improve operational efficiency, reduce costs, and provides strong support for the company's exploration and application in emerging technology fields.

Secondly, the indicators ranked second and third are "Adoption of emerging IT technologies" (WM=3.20) and "IT flexibility" (WM=3.18). Both indicators received relatively high weighted means, indicating that the company performs well in technological innovation and business adaptability. The adoption of emerging IT technologies helps the company maintain technological leadership and enhance competitiveness; while the improvement in IT flexibility enables the company to quickly respond to market changes and seize development opportunities. Cong (2020) in his doctoral dissertation conducted an in-depth study on the application case of Company G, showcasing the effectiveness of the Scrum agile method in actual project management. By introducing the Scrum method to improve the management process of its software development projects, significant improvements in project efficiency were achieved, quickly meeting customer demands and ultimately enhancing its competitiveness in the market. Moreover, Shi (2023) also emphasized the role of new technologies and quick response to market demands in enterprise management innovation. He explored the development of enterprise management innovation from a management decision perspective, further confirming the importance of innovative management in enhancing enterprise competitiveness.

Although "IT flexibility" ranks the lowest among the three indicators, its weighted mean also reached the "agree" range. This indicates that there is still room for improvement in IT flexibility. To enhance IT flexibility, the company can further optimize the IT system architecture, strengthen communication and collaboration between IT and business departments, and continuously focus on the development trends of emerging technologies to better respond to market changes and business needs. Ma et al. (2024) proposed focusing on high-speed, high-energy-efficient intelligent computing hardware, which is key to driving the development of optical neural networks. Their research emphasized the importance of collaboration in driving the development of optical neural networks amid changing technology trends, which is significant for optimizing IT architecture. Furthermore, Pan et al. (2024) focused on the optimization of railway IT architecture, proposing a solution to enhance collaboration efficiency, conform to technology trends, and flexibly respond to industry changes by constructing a cloud computing platform. This solution not only could improve the operational efficiency of the railway system but also ensure that the railway system maintains its competitiveness and adaptability in the era of rapid technological development. Cheng (2019) in her research proposed that for IT enterprises to achieve healthy and stable development, they must deeply analyze market changes and accordingly optimize and integrate their marketing strategies. This optimization and integration of strategies are essential ways to respond to market dynamics, meet consumer demands, and enhance enterprise competitiveness.

Table 4

Summary Table on Supply Chain Management

Key Result Areas	Composite Mean	VI	Rank
Supply Chain Collaboration	3.18	Agree	2
Supply Chain Security	3.19	Agree	1
Supply Chain Agility	3.16	Agree	3
Grand Composite Mean	3.18	Agree	

Legend:3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

Table 4 shows the summary table for Supply Chain Management. The overall composite mean is 3.18, falling within the "agree" range, indicating that the company has achieved certain accomplishments in these key areas, yet there is still room for improvement. Studying this current state is crucial for understanding the

company's supply chain management strategies, identifying potential areas for improvement, and optimizing overall supply chain performance.

Supply chain security is the highest among the items with a 3.19 weighted mean and verbally interpreted as agree. This indicates that the company performs well in ensuring supply chain security, which may be related to the company's focus on risk management, effective safety strategies, and close cooperation with suppliers. In recent years, as global supply chains become increasingly complex and uncertain, supply chain security has become one of the key factors for business success. The company's good performance in this area helps reduce potential risks, protect the stability and reliability of the supply chain, and thereby enhance the overall competitiveness of the business. Yuan et. al.,(2021) deeply explored the key factors for successful mergers and acquisitions of cargo airlines from the perspective of the "Air Silk Road," taking the construction of the Zhengzhou-Luxembourg dual hubs as an example. Their research emphasized that strategic means such as equity acquisitions can effectively enhance the international competitiveness of airlines, thereby ensuring supply chain security in a globalized context.

Next, the indicators ranked second and third are "supply chain collaboration" and "supply chain agility," with weighted means of 3.18 and 3.16, respectively. These indicators reflect the company's capabilities in collaborating with suppliers, customers, and other partners, as well as the ability to quickly respond to market changes. Although these indicators score slightly lower than supply chain security, they are still within the "agree" range, indicating that the company has also achieved certain accomplishments in these areas. Such collaboration and agility are crucial for improving the overall efficiency, response speed, and innovation capacity of the supply chain. Song et. al.,(2021) also found that close collaboration between manufacturers and suppliers brings better economic benefits and market performance compared to not collaborating or choosing third-party research institutions for innovation activities.

This collaboration model ensures the efficiency of knowledge sharing and information flow, thus forming a virtuous cycle of innovation throughout the supply chain. However, it is worth noting that while the performance in these three key areas is within the "agree" range, it has not reached the "strongly agree" level. This indicates that there is still room for improvement in the company's supply chain management. For example, further strengthening cooperation with suppliers and customers, optimizing production plans and logistics systems, and continuously investing in new technologies and talent development can enhance the overall performance and competitiveness of the supply chain. Moreover, Lu (2023) emphasized in the study of supply chain collaboration in highway engineering projects that partner management is key to the complexity of supply chain collaboration. In this field, the introduction of new technologies and talent is seen as crucial factors, playing an important role in optimizing partner selection, motivation and coordination, and governance. Effective partner management ensures the stability of the supply chain and the smooth progress of projects. In terms of talent development, Liu et. al.,(2023) and Lu (2023) pointed out that team collaboration and communication are indispensable components of supply chain management. Talent development not only provides the necessary professional knowledge and skills for the supply chain but also promotes effective communication among team members, which is crucial for resolving problems and conflicts within the supply chain.

Table 5

Relationship Between Digital Transformation Strategy and IT Capability Level

Variables	rho	p-value	Interpretation
Digital Transformation Goals			
IT Infrastructure Construction Level	0.380**	< .001	Highly Significant
Emerging IT Technologies Adoption	0.459**	< .001	Highly Significant
IT Flexibility	0.412**	< .001	Highly Significant
Digital Investment			
IT Infrastructure Construction Level	0.380**	< .001	Highly Significant
Emerging IT Technologies Adoption	0.411**	< .001	Highly Significant
IT Flexibility	0.391**	< .001	Highly Significant

Digital Technology Capability Level			
IT Infrastructure Construction Level	0.539**	< .001	Highly Significant
Emerging IT Technologies Adoption	0.569**	< .001	Highly Significant
IT Flexibility	0.338**	< .001	Highly Significant

***. Correlation is significant at the 0.01 level*

Table 5 shows the Relationship Between Digital Transformation Strategy and IT Capability Level. Among all variables, the level of digital technology capability has the highest correlation with the level of IT infrastructure development (rho=0.539**), indicating that a strong IT infrastructure is key to the success of digital transformation. This highly significant correlation likely stems from the IT infrastructure providing a solid foundation for digital transformation, supporting the adoption of emerging technologies and the enhancement of flexibility. In recent years, with the rapid development of technologies such as cloud computing, big data, and artificial intelligence, the completeness of IT infrastructure has become a core element of enterprise digital transformation. Liu (2019) emphasized the importance of cloudification, openness, reliability, and building an efficient and elastic new infrastructure environment. Additionally, Xu (2019) pointed out the importance of building a data-centric digital economy, using IoT platforms and innovative solutions, for the digital transformation of the construction industry. Zhang et. al.,(2023) further proposed that emerging technologies, the integration of digital resources, and effective IT governance are key to enhancing enterprises' ambidextrous capabilities and promoting open innovation. Pan et al. (2024) focused on the construction of cloud computing platforms for the full-stack information and creative system, considering it a necessary condition for achieving unified management and operation to support the development of upper-layer business systems.

Secondly, the correlation between the adoption of emerging IT technologies and the level of digital technology capability is also high (rho=0.569**). This result reflects the important role of emerging technologies in driving enterprise digital transformation. Emerging technologies not only improve operational efficiency but also create new growth points and competitive advantages for enterprises. Therefore, enterprises should actively adopt these technologies to adapt to the development trends of the digital age. Zhang (2022) noted that in the field of dental implants, digital technology's three-dimensional scanning technology significantly improved treatment precision and efficiency, indicating the technology's broad application prospects in the medical field. Xue (2019) analyzed the potential of digitalization in improving medical service efficiency and environmental quality from the perspective of hospital architecture, emphasizing the importance of IT and automation technology in hospital construction. Dong et. al.,(2024) explored how digital technology can promote systematic, refined, and diversified research on urban public spaces, providing a new research path for improving the quality of human settlements. Furthermore, Yin (2019) analyzed the development trends of digital archiving resources. Despite some drawbacks, digital archive management has received industry attention, and suggestions have been made to support its sustainable development.

IT flexibility's correlation with digital transformation objectives is significant (rho=0.338**), but it is slightly lower compared to the other two indicators. This may be because IT flexibility more reflects the ability to adapt to changes rather than directly driving digital transformation. However, this does not mean that IT flexibility is unimportant. On the contrary, in a rapidly changing business environment, enterprises need to maintain the flexibility of IT systems to respond to market changes and customer needs. Yang (2020) pointed out the necessity of devising new management methods to reduce the complexity of risks in his study. Additionally, Tang (2020) pointed out that T Corporation has achieved its strategic objectives by enhancing the digital level of infrastructure, production processes, and other key areas, and by building cloud data centers, among other measures. In the fintech sector, Wang (2021) emphasized how the Agricultural Bank's R&D center accelerates the innovative application of emerging technologies around digital transformation objectives and enhances the flexibility of IT infrastructure. In the field of education, Qian et al. (2023) analyzed how the EU aims to create high-quality, inclusive digital education by investing in funding and infrastructure construction to advance its digital transformation. Dai (2024) explored the application of digital twin technology in the construction of

Internet Data Centers (IDC), showing how the technology enhances system flexibility and aids in achieving digital transformation objectives. Finally, Hu (2021) elucidated through the case study of MT Company that flexibly applying emerging technologies to optimize IT infrastructure is a key path for enterprises to achieve sustainable development goals.

Table 6, The Relationship Between Digital Transformation Strategy and Supply Chain Management. Among all variables, the correlation between digital transformation goals and supply chain collaboration is the highest (rho=0.440**), suggesting that digital transformation strategies significantly enhance the level of supply chain collaboration. This could be due to digital transformation introducing advanced technologies and tools, such as cloud computing, big data analytics, and the Internet of Things, enabling more efficient information sharing, collaborative work, and market adaptation among supply chain participants. Such enhanced collaboration helps reduce friction and waste in the supply chain, improving overall efficiency and responsiveness. Xiao (2024) explored supply chain efficiency issues, proposing optimization of network structures, selection of optimal partners, and establishment of collaboration models to reduce friction losses. Tang (2021) further emphasized the collaborative nature of work signatures, suggesting that this helps reduce friction and delays in supply chain processes, thereby enhancing overall efficiency. Practically, Wang(2023) analyzed how China Railway Materials Group optimized its digital supply chain to reduce friction and enhance collaboration and efficiency, facing global industrial chain transformation challenges and supporting domestic dual circulation. Additionally, Wang et al.(2021) studied the application of blockchain technology in timber supply chain traceability, noting that the technology enhances information transparency, reduces transaction costs and trade friction, thereby improving collaboration efficiency.

Table 6

Relationship Between Digital Transformation Strategy and Supply Chain Management

Variables	rho	p-value	Interpretation
Digital Transformation Goals			
Supply Chain Collaboration	0.440**	< .001	Highly Significant
Supply Chain Security	0.374**	< .001	Highly Significant
Supply Chain Agility	0.403**	< .001	Highly Significant
Digital Investment			
Supply Chain Collaboration	0.411**	< .001	Highly Significant
Supply Chain Security	0.387**	< .001	Highly Significant
Supply Chain Agility	0.379**	< .001	Highly Significant
Digital Technology Capability Level			
Supply Chain Collaboration	0.398**	< .001	Highly Significant
Supply Chain Security	0.416**	< .001	Highly Significant
Supply Chain Agility	0.375**	< .001	Highly Significant

***. Correlation is significant at the 0.01 level*

Ranked second and third are supply chain security and agility, respectively, with their correlations with digital transformation goals also being high (rho=0.374 and 0.403, respectively). This indicates that digital transformation strategies also contribute to enhancing the security and agility of the supply chain. By introducing advanced security technologies and risk management strategies, digital transformation can reduce security risks within the supply chain; simultaneously, by increasing the supply chain's flexibility and response speed, digital transformation enables enterprises to adapt more quickly to market changes and customer demands. In the context of globalization and rapid technological development, China's manufacturing industry faces an urgent need to enhance supply chain flexibility. Zhou et. al.,(2023) pointed out in their research that to quickly respond to market changes and adapt to technological upgrades and transformation demands, the manufacturing industry must enhance its supply chain flexibility. Similarly, the new energy vehicle industry, an important branch of manufacturing, faces similar challenges. Liu et al.(2023) proposed that new energy vehicle enterprises should enhance supply chain resilience by increasing flexibility, adaptability, and responsiveness to effectively address market and environmental changes and challenges.

Among all variables, the correlation between supply chain agility and digital transformation goals is relatively lower (rho=0.403**), but still significant. This may be because enhancing supply chain agility requires more internal transformation and innovation, not just the introduction and application of technology. However, this does not mean that supply chain agility is unimportant in digital transformation; on the contrary, it is crucial for enterprises to maintain competitiveness in a rapidly changing market environment. Zhang (2022) emphasized in his research that by transforming low-cost supply chains into profit centers, enterprises can significantly enhance their competitiveness. Further, Wei et. al.,(2021) noted that to enhance the competitiveness of China's manufacturing industry, it is necessary to strengthen supply chain system construction, technological capabilities, and talent development to effectively address the rapid changes and uncertainties of the global industry. These studies collectively highlight the core role of supply chain agility in modern enterprise development and the multifaceted measures required to achieve this goal. Bu et. al.,(2023) in their research pointed out that enterprises should achieve this goal by optimizing procurement layouts, enhancing rapid response capabilities, and strengthening security resilience. Additionally, Zhai et. al.,(2024) summarized the security challenges and status of software supply chains, analyzed four key elements to ensure supply chain security, and proposed an assessment model aimed at enhancing collaborative security in the supply chain.

Table 7

Relationship Between IT Capability Level and Supply Chain Management

Variables	rho	p-value	Interpretation
IT Infrastructure Construction Level			
Supply Chain Collaboration	0.285**	< .001	Highly Significant
Supply Chain Security	0.286**	< .001	Highly Significant
Supply Chain Agility	0.285**	< .001	Highly Significant
Emerging IT Technologies Adoption			
Supply Chain Collaboration	0.559**	< .001	Highly Significant
Supply Chain Security	0.497**	< .001	Highly Significant
Supply Chain Agility	0.495**	< .001	Highly Significant
IT Flexibility			
Supply Chain Collaboration	0.459**	< .001	Highly Significant
Supply Chain Security	0.438**	< .001	Highly Significant
Supply Chain Agility	0.469**	< .001	Highly Significant

***. Correlation is significant at the 0.01 level*

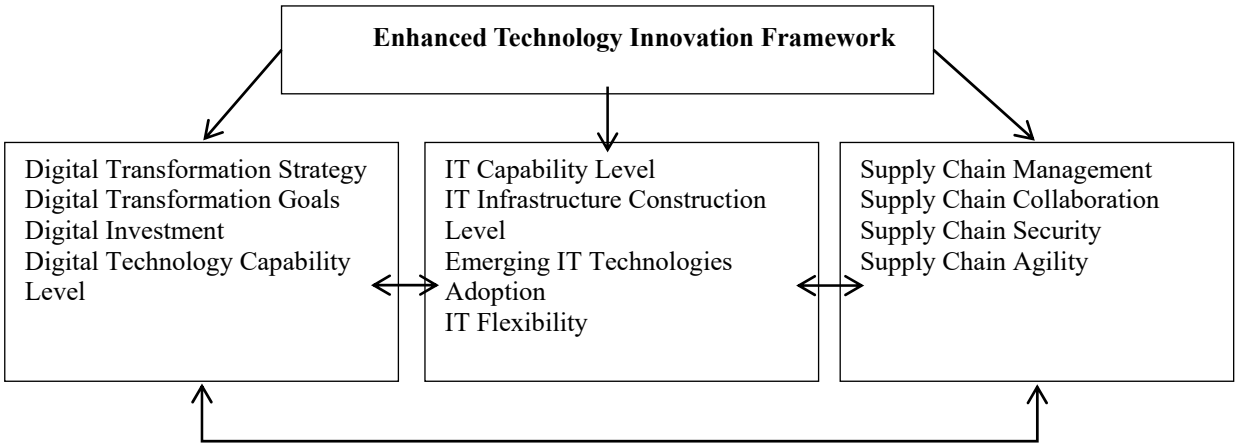
Table 7 depicts the Relationship Between IT Capability Level and Supply Chain Management. Among all variables, the adoption of emerging IT technologies has the highest correlation with different dimensions of supply chain management (rho=0.559**, 0.497, and 0.495, respectively). This finding suggests that emerging IT technologies such as Artificial Intelligence, the Internet of Things, and big data play a key role in promoting supply chain collaboration, ensuring supply chain security, and enhancing supply chain agility. The application of emerging IT technologies enables rapid transmission and sharing of information, promotes collaborative work among supply chain links, and improves response speed and decision-making efficiency. Li et al. (2021) explored the role of government incentives and regulation in promoting collaborative innovation evolution among supply chain enterprises through game theory analysis. Liu et. al.,(2019) focused on multi-supply chain collaboration technology based on cloud platforms, emphasizing the importance of emerging technologies in promoting intelligent development across industries and economic globalization, and noted that enterprises need to expand markets and seek cooperation for mutual benefits. Additionally, Liang (2021) demonstrated how emerging technologies significantly promote the collaborative effects of specific industries, such as the feed industry, using e-commerce as an example.

Following closely are IT flexibility and the level of IT infrastructure construction, which also have high correlations with supply chain management. IT flexibility means that enterprises can quickly adapt to technology and market changes, which is crucial for maintaining the stability and agility of the supply chain. A strong IT infrastructure is the foundation for efficient operation of the supply chain, providing a stable and reliable environment for data transfer, storage, and processing. Quan(2024) emphasized the importance of a

self-controllable operating system in the financial industry's journey towards innovation and creativity, which not only ensures the security of IT infrastructure but also supports the stability of the supply chain. Meanwhile, Li et al. (2023) delved into the challenges faced by IT infrastructure in supply chain operations and discussed how to explore solutions through the application of the TCO (Total Cost of Ownership) model and new technologies to enhance the resilience and efficiency of the supply chain.

Relatively speaking, the correlation between the level of IT infrastructure construction and supply chain management is slightly lower (rho=0.285). This might be because the construction of IT infrastructure focuses more on the construction of hardware and network levels, while supply chain management emphasizes the optimization of processes and collaboration. However, this does not mean that IT infrastructure is unimportant; on the contrary, it is the foundation for efficient operation of supply chain management. Zhuang et al. (2021) emphasized the supporting role of high-performance IT infrastructure in digital new infrastructure, pointing out that technological innovation is key to enhancing computing power in data centers. Furthermore, Pan et al. (2024) proposed a cloud computing platform based on a full-stack innovation and creation system, which can effectively support the efficient operation of the supply chain by unifying management and operation of IT infrastructure, significant for the digital transformation of key industries such as railways. IT capabilities have shown a significant impact on enhancing supply chain capabilities. While traditional IT capability dimensions are more mature, emerging technology capabilities are still in the early stages of development, mainly focusing on research into big data analytics capabilities.

Through the summary of IT capabilities and emerging technology capabilities, it is not difficult to find that whether it is traditional IT capabilities or emerging technology capabilities, scholars usually believe that in addition to tangible resources such as technological infrastructure, intangible resources such as enterprise management capabilities and relationship capabilities are also indispensable; moreover, different emerging technologies are not substitutes for each other, and a good collaboration relationship can compensate for the shortcomings of a single technology. (Gong, 2022) Peng (2022) proposed that this integration must closely align with customer needs to achieve efficient operation of the supply chain. Guo (2020) further emphasized that enterprises need to keenly adapt to IT technology changes, drive the digital transformation of the supply chain, and strengthen internal and external cooperation to respond to market fluctuations. Furthermore, the application of Internet of Things (IoT) technology has shown great potential in enhancing the level of supply chain services. Gu (2020) explored the application of IoT technology in tank container asset tracking and management, demonstrating how to achieve full process monitoring and management through automatic identification and information sharing platforms, thereby improving service efficiency and quality.



In this study, the researcher constructed a framework aimed at integrating the digital transformation strategy, IT capabilities, and supply chain management of Chinese manufacturing enterprises. The purpose of this framework is to provide a solid foundation for these enterprises to improve their technological innovation

framework and to drive sustainable development and enhanced competitiveness in the digital age.

The framework is structured around three core elements: digital transformation strategy, IT capabilities, and supply chain management. Firstly, it involves a thorough assessment of the enterprise's digital transformation strategy, which includes clarifying the transformation objectives, analyzing the scale and structure of digital investments, and evaluating the level of digital technology capabilities. Secondly, it comprehensively tests the enterprise's IT capability level from three dimensions: IT infrastructure construction, adoption of emerging IT technologies, and IT flexibility. Lastly, it assesses the state of supply chain management from the aspects of supply chain collaboration, supply chain security, and supply chain agility. Through this framework, the researcher analyzes the intrinsic connections between the digital transformation strategy, IT capabilities, and supply chain management. The core objective of the study is to reveal how the direction and investments of the digital transformation strategy shape the development of IT capabilities and how IT capabilities in turn feed back into the effectiveness of supply chain management. By identifying key areas for improvement and optimization, enterprises can formulate more effective technology development strategies, thereby enhancing overall operational efficiency and market responsiveness. This framework will first conduct an in-depth assessment of the digital transformation strategy of Chinese manufacturing enterprises, clarifying the transformation goals, analyzing the scale and structure of digital investments, and evaluating the digital technology capabilities. The digital transformation strategy is a key component of the overall corporate strategy, determining the enterprise's positioning and path forward in the wave of digitalization.

In the assessment of IT capabilities, the framework will comprehensively consider the level of IT infrastructure construction, the situation of emerging IT technology adoption, and IT flexibility. These three dimensions collectively form the cornerstone of enterprise IT capabilities, which are decisive factors for the successful implementation of digital transformation. The assessment of supply chain management will focus on three aspects: supply chain collaboration, supply chain security, and supply chain agility. Through a comprehensive assessment of these three key elements, the framework will further analyze their interactions. Specifically, it will explore how the digital transformation strategy impacts the building and enhancement of IT capabilities and how IT capabilities support the optimization and upgrading of supply chain management. Based on these analyses, recommendations for improving the technological innovation framework will be proposed, providing theoretical foundations and practical guidance for the digital transformation of enterprises.

4. Conclusions and recommendations

Based on the findings of this study, the following conclusions drawn: The respondents moderately agreed on the digital transformation strategy adopted by the manufacturing companies. The respondents moderately agreed on the functional capability of manufacturing companies. The respondents moderately agreed on the supply chain management practices. There is highly significant between digital transformation strategy, IT capability and supply chain management. Enhanced technology framework was developed.

Chinese manufacturing enterprises may establish a dedicated digital transformation strategy department responsible for assessing, adopting, and integrating the latest digital technologies and tools to promote innovation and optimization in project management practices. Chinese manufacturing enterprises may enhance the level of IT capabilities, enterprises may invest in training programs for IT skills and emerging technologies, especially in areas such as IT infrastructure construction, adoption of emerging IT technologies, and IT flexibility. Given the importance of supply chain management in digital transformation, the human resource department of these Chinese manufacturing enterprises may provide specialized training for supply chain teams, focusing on supply chain collaboration, security, and agility. The proposed framework to enhanced technology innovation may be adopted by the manufacturing chines companies. Other factors that may affect technology innovation can be used on the future studies to be conducted like employee innovation behavior , IT investment and business performance.

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