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SUPPLY CHAIN DIGITAL TRANSFORMATION TO INFLUENCE THE COMPETITIVE ADVANTAGES OF ENTERPRISES IN MANUFACTURING INDUSTRY IN CHINA

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Abstract

Based on the previous research results, this dissertation takes the supply chain digital transformation of manufacturing enterprises as the starting point, and focuses on the impact and path of the supply chain digital transformation on the competitive advantage of manufacturing enterprises in an uncertain environment, striving to answer: Firstly, why should manufacturing enterprises carry out supply chain digital transformation? How does the supply chain digital transformation affect the competitive advantage? Secondly, what role do supply chain dynamic capabilities play in the process of supply chain digital transformation? Thirdly, how does environmental uncertainty affect the relationship between supply chain digital transformation, supply chain dynamic capabilities, and competitive advantage?

Keywords: Digital Transformation of the Supply Chain, Environmental Uncertainty, Supply Chain Dynamic Capability, Competitive Advantages of Enterprises, Manufacturing Industry.

1. INTRODUCTION

Amidst the backdrop of digitization, conventional industrial companies have adopted and established a new trend called digital transformation. From 17.98 trillion yuan in 2012 to 27.6 trillion yuan in 2020, China's manufacturing industry's added value grew, and its share of the global manufacturing sector expanded by over 8%. The State Council's most recent "14th Five Year Plan" for the growth of the digital economy makes it abundantly evident that by 2025, China's digital economy would go through a phase of complete expansion, with the added value of its core businesses contributing 10% of the country's GDP. Currently, there is a national push to advance industrial digitalization and digital industrialization. In certain parts of China, the percentage of critical linkages in industrial businesses larger than the designated size is predicted to reach 65% by 2025.

Even nevertheless, there are still important problems with business digital transformation that cannot be disregarded. For instance, despite their enormous size and solid basis, conventional manufacturing companies nevertheless struggle with issues including an unjust industrial structure, a shortage of skilled labor, and a lackluster capacity for independent innovation. An important area of research in supply chain management has always been how to increase an organization's competitive edge. Investigating ways to improve manufacturing companies' competitive edge in the context of digital transformation is very useful study.

Within the macroeconomic context, China's manufacturing sector is among the most significant, serving as the foundation of the national economy and contributing significantly to

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its development. In order to better adapt to the expansion and transformation of the new pattern of the global economy, China led the way in introducing the "Made in China 2025" plan as early as 2015. The plan calls for China to join the ranks of manufacturing powers by 2025, move up to the middle level by 2035, and take the top spot by 2050. At that point, China's conventional manufacturing companies began to gradually modernize and transition to digital platforms. The article "On deepening a new generation of information technology and manufacturing integration development guidance" made clear that current manufacturing enterprises face new challenges as well as great opportunities in order to steer large and small manufacturing enterprises toward the road of independent innovation, to integrate a new generation of information technology and manufacturing, and to leave the path of manufacturing enterprises with Chinese characteristics. In China's 14th Five-Year Plan and the Outline of 2035 Vision Goals, the digital transformation of manufacturing businesses is highlighted as a crucial tool to increase their efficiency and quality. This is advantageous for strengthening the base, ensuring the safety and security of supply chains and industry, and successfully controlling major risks and outside shocks.

2. LITERATURE REVIEW

2.1 Digital Transformation of Supply Chain and Competitive Advantage of Enterprises

Nowadays the competition pattern is in sharp contrast to the stable and predictable traditional competition pattern in the 20th century, and enterprises strive to survive in an increasingly dynamic and hostile environment.Some scholars have found through research that the digital transformation of the supply chain of manufacturing enterprises has a positive impact on the economic benefits of enterprises. Neubert et al. (2017) believe that the digital transformation of the supply chain of manufacturing enterprises will reduce the crisis and risks in the process of enterprise internationalization, and maximize the compression of internationalization costs, so as to accelerate the entry of enterprises into the international market.

Sundaram et al. (2020) believe that the digital transformation of the supply chain of manufacturing enterprises will further promote business innovation, enhance customers' consumption experience, and ultimately enhance the competitive advantage of enterprises. Kwon et al. (2014) have proved through empirical research that the application of advanced digital technology in the supply chain, especially big data technology, can improve the quality of data management and effectively enhance the market competitiveness. Sharma, Joshi and Ellis et al. (2020) have found that the introduction of big data, Internet of Things and other intelligent technologies in the supply chain will have a positive impact on the improvement of product quality. Tapscott et al. (2023) pointed out that digital supply chains collect and store large amounts of data, which are the valuable experience of enterprises. Through the analysis of long-term data, enterprises can effectively improve their supply chain performance. Nowadays digital supply chain is still in its infancy. After preliminary exploration, some enterprises and scholars have found that the digital transformation of supply chain of manufacturing enterprises will bring beneficial effects to enterprises in economic, environment, society and other aspects.

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2.2 Digital Transformation of Supply Chain and Dynamic Capability of Supply Chain

Manufacturing enterprises are increasingly integrating supply chain management with advanced digital technology, which has gradually changed the dynamic supply chain capability of enterprises. According to Chen et al. (2018), the digital transformation of the supply chain encourages the integration of businesses and industries. Businesses can obtain more industry information to fully prepare for various risks posed by the environment of intense competition, as well as to exchange information more frequently with competitors in the same industry and upstream and downstream of the supply chain. According to Wu Fei et al. (2021), digital transformation can assist businesses in better managing large amounts of non-standardized data in the upstream and downstream supply chains by coding and storing it as visual data, which will increase information usage. According to Jacobi and Brenner (2018), businesses can better identify unforeseen developments in a changing business environment and implement management changes by transforming their supply chains digitally. Hanelt (2021) believes that an organization's digital transformation can strike a balance between innovation and integration, highlighting the fact that digital transformation can bring new ideas to strategy and supply chain management in addition to altering how things are manufactured (integration). Iansiti and Lakhani (2020) think that in the manufacturing enterprise supply chain using artificial intelligence (AI) technology, will bring customers new dynamic experience, and ultimately affect their behavior and expectations, and as customer demand become more and more demanding, which in turn will stimulate enterprises to seek to change, looking for different ways to meet customer demand, but also improve enterprise's supply chain innovation ability. Through empirical research, Kwak et al. (2018) have demonstrated how the introduction of digital technologies, such as big data analysis, has enhanced businesses' capacity to gather and process data rapidly, which has a beneficial effect on the supply chain's capacity for innovation. Generally speaking, research to date has indicated that manufacturing enterprises have a positive impact on the digital transformation of their supply chains.

2.3 Supply Chain Dynamic Capability and Competitive Advantage of Enterprises

In this era of increasingly fierce competition and frequent unexpected changes in the external environment, enterprises with competitive advantage are likely to survive. Gao Junshan (2018) points out, supply chain learning and absorption ability exists in all aspects of enterprise supply chain management, directly determines the development of the enterprise strength, innovation ability and sustainable competitive advantage. According to Lee (2022), supply chain innovation is not just internal to the company; it also involves interacting with upstream suppliers and downstream customers to forge new cooperative relationships that strengthen the supply chain's overall competitive advantage. Sinayi (2018) also develop supply chain innovation capabilities in sustainable supply chains, which helps to meet consumers' demand for green products, and plays a crucial role in improving the profit of the entire supply chain and consumer consumption experience. Therefore, with the rapid development of economic globalization, the competition between enterprises in the world is gradually transformed into the competition between supply chain. Academia and industry are beginning to realize the integration and optimization of supply chain is of great significance.

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2.4 The Regulatory Role of Environmental Hostility

According to the resource base theory, the enterprise access to resources greatly affect the competitive advantage, when the enterprise to obtain resources, the environmental hostility is low, on the other hand, environmental hostility is high. Zeng Guojun (2018) discusses the relationship between environmental hostility and the dynamic ability of enterprise supply chain, et al. They believe that environmental hostility is the antecedent variable that affects the dynamic ability of supply chain. Chen Zhijun et al. (2015) believe that environmental hostility will promote enterprise performance through the dynamic ability of the supply chain.With the rapid development of economic globalization, environmental uncertainty is inevitable for enterprises, which brings challenges to their operation. If enterprises want to improve their competitive advantage in an uncertain environment, they should look for opportunities in this challenge.

3. METHODOLOGY

This thesis mainly studies the relationship between the digital transformation of supply chain, the dynamic ability of supply chain and the environmental uncertainty and the competitive advantage of manufacturing enterprises. Preliminary literature search found that domestic materials related to digital transformation of supply chain, supply chain dynamic capacity, environmental uncertainty and competitive advantages of manufacturing enterprises can hardly be obtained from existing resources. Therefore, the quality of the questionnaire itself is the central element of the efficient implementation of this method. This research refers to the existing research results, and designs the questionnaire around the research questions of this research. The questionnaire will be distributed and collected through online electronic questionnaires from April 2024 to May 2024. The collected questionnaires are screened according to the following criteria:

(1) Delete missing questions;

(2) Improper filling, such as selecting the same score or deleting the score in an obvious way.

(3) Short questionnaire answers will be deleted.

Four variables and eleven dimensions were used in the relationship model proposed in this study. In terms of sample size, by summarizing various literature and the experience, it can be concluded that the structural equation models require at least approximately 220 sample company representatives. The sample of this study includes the top management or their representatives for the organization. The population of this study is 589 company representatives. A 5% acceptable deviation can generate at least one sample size, which is sufficient for data analysis. However, respondents received less attention by sending questionnaires to collect data, resulting in a relatively low response rate. Therefore, the 220 samples used in this study were considered sufficient, exceeding the minimum sample size required for structural equation modeling (SEM) analysis.

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The basic personal information of the sample is shown in Table 1.

Table 1: Basic Information of Respondents (n=220)

Name	Option	Frequency	Percentage
Enterprise establishment years	10 or less	27	12.27
	10~15	42	19.09
	15~20	90	40.91
	20 and above	61	27.73
Number of enterprise employees	Less than 300	28	12.72
	300~2000	74	33.64
	2000~5000	86	39.09
	More than 5000	32	14.55
Nature of the enterprise	State-owned enterprise	53	24.09
	Private enterprise	82	37.27
	Joint enterprise	59	26.82
	Wholly foreign-owned enterprise	26	11.82
Main market distribution of enterprise products	International market	81	36.8
	Domestic market	94	42.73
	Domestic market and international market	45	20.47
total		220	100

4. RESULTS

4.1 Reliability and Validity Analysis

Table 2: Reliability and Validity Analysis of Variables

Variables	Items	Factor Loading	Cronbach Alpha	CR	AVE
CA	CA30	0.790	0.943	0.950	0.595
	CA31	0.800			
	CA32	0.770			
	CA33	0.755			
	CA34	0.747			
	CA35	0.760			
	CA36	0.797			
	CA37	0.779			
	CA38	0.777			
	CA39	0.763			
	CA40	0.748			
	CA41	0.778			
	CA42	0.762			
DT	DT1	0.793	0.912	0.928	0.618
	DT2	0.801			
	DT3	0.758			
	DT4	0.782			
	DT5	0.788			
	DT6	0.795			
	DT7	0.776			
	DT8	0.791			

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Variables	Items	Factor Loading	Cronbach Alpha	CR	AVE
EU	EU22	0.837	0.945	0.954	0.721
	EU23	0.836			
	EU24	0.839			
	EU25	0.862			
	EU26	0.858			
	EU27	0.862			
	EU28	0.852			
	EU29	0.850			
SC	SC10	0.777	0.945	0.951	0.601
	SC11	0.750			
	SC12	0.783			
	SC13	0.782			
	SC14	0.764			
	SC15	0.784			
	SC16	0.768			
	SC17	0.783			
	SC18	0.773			
	SC19	0.776			
	SC20	0.782			
	SC21	0.784			
	SC9	0.765			

The factor load of each question item in this dimension reflects the measurement relationship of each question item to this factor, which is greater than 0.7, indicating that the measurement relationship of the model is good. As shown in Table 2, it can be seen from the above table that the load of each item on its factor is greater than 0.7, indicating that each item in the questionnaire data has a good measurement relationship with the embodiment.

Analysis of cronbach Alpha: from the point of view of the measurement standard, the larger the coefficient, the more reliable the questionnaire is, and vice versa. Its value fluctuates between 0 and 1. If the coefficient is higher than 0.9, it indicates that the reliability of the questionnaire is high, indicating that the questionnaire data is very reliable; The reliability coefficient is between 0.7 and 0.9, indicating that the reliability of the questionnaire is good; If the reliability coefficient is between 0.6 and 0.7, it indicates that the questionnaire can be accepted; otherwise, if it is less than 0.6, it indicates that the reliability effect is poor, and it is necessary to adjust the questionnaire title or recollect data to ensure the reliability of the questionnaire. The table above shows that the reliability values of all variables are above 0.7, indicating that the reliability of the survey data is high.

If the AVE values in the model are greater than 0.5, it shows that the model has good reliability and convergence validity.

As shown in Table 2, the AVE values corresponding to all factors are greater than 0.5, and the CR values are higher than 0.7, which means that the analysis data has good aggregation validity.

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Table 3: HTMT Analysis of Variable Discriminant Validity

	CA	DT	EU	SC
CA				
DT	0.531			
EU	0.363	0.439		
SC	0.512	0.482	0.430	

HTMT criterion is the ratio of inter trait correlation and intra trait correlation. It is the ratio of the mean value of index correlation between different facets to the mean value of index correlation between the same facet. The value of HTMT below 0.85 indicates that the discriminant validity of each variable is good. The HTMT values in the above table are all below 0.85, indicating that these four variables have good discriminant validity.

4.2 Common Method Biases Test

The working principle of harman's one factor test is to load all measured variables onto a common factor and check whether this single factor explains most of the variability in the data. Generally, if the variability of a single factor interpretation is less than 40%, it is considered that there is no serious common method bias. The variability explained by a single factor in this study is 36.492%, far below the threshold of 40%.

4.3 Direct Path Analysis

In this study, the structural equation model was constructed using SmartPLS 3.0 as shown in Figure 1 and the path coefficients were tested. The results are shown in Table 4. Original sample (O) is the path coefficient, reflecting the influence of independent variables on dependent variables. Standard deviation (STDEV) is standard error. T Statistics (|O/STDEV|) is a statistic, which is greater than 1.96, indicating that this path is significantly established. When the statistic is greater than 1.96, the corresponding P value is less than 0.05, which also means that the path is significant.

The path coefficient of DT→CA is 0.282, and the P value is 0.000<0.05, indicating that the positive effect of DT on CA is significant at the significant level of 99%.

The path coefficient of DT→SC is 0.394, and the P value is 0.000<0.05, indicating that the positive effect of DT on SC is significant at the significant level of 99%.

The path coefficient of SC→CA was 0.377, P value was 0.000<0.05, indicating that the positive effect of SC on CA was significant at the significant level of 99%.

Verification of regulatory effect: construct the interaction term (product term) of independent variable and regulatory variable to regress the dependent variable. If the interaction item is significant, it means that the regulation is established, and if the interaction item is positive, it means that it is positive regulation.

The P value of EU × DT→SC is 0.000 < 0.05, which indicates that the regulation effect of EU on DT→SC path is tenable, and the coefficient is 0.140, which indicates that the positive effect of DT→SC is gradually strengthened with the increase of regulation variables.

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The P value of EU × SC→CA is 0.000 < 0.05, indicating that the regulation effect of EU on SC→CA is tenable, and the coefficient is 0.138, indicating that the positive effect of SC →CA is gradually strengthened with the enhancement of the regulation variable.

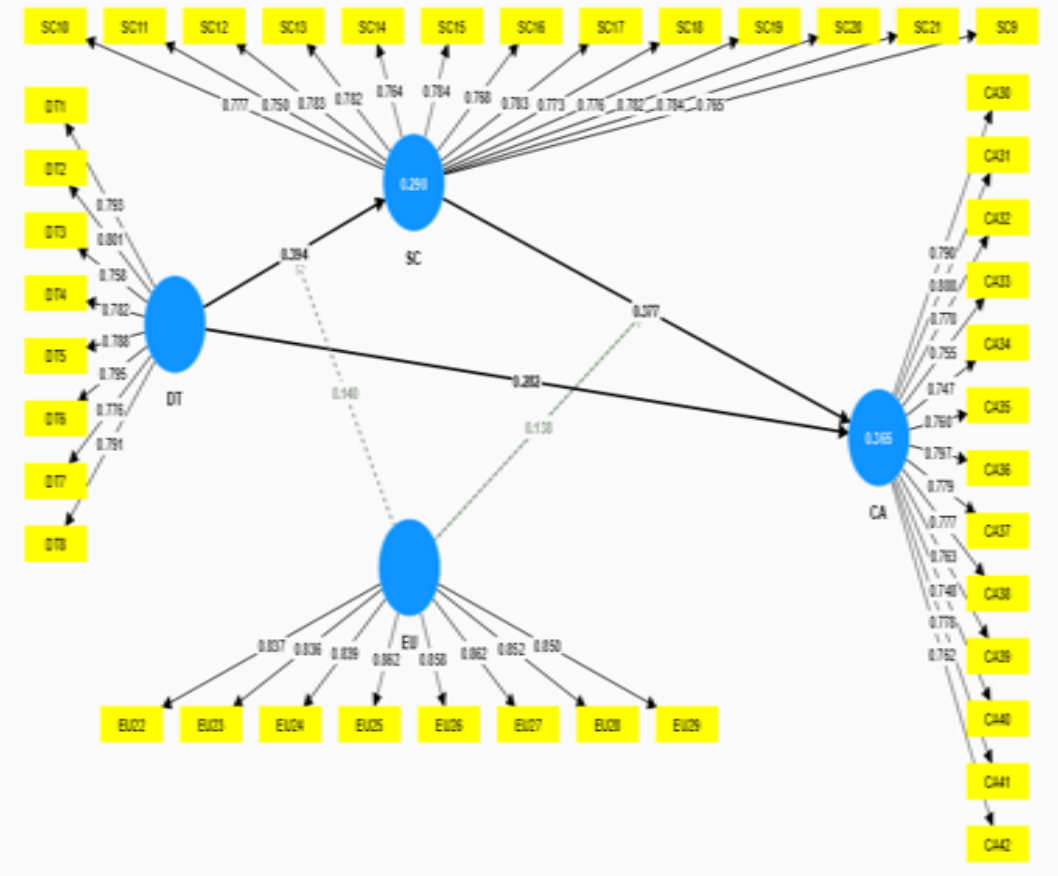

Figure 1: Structural Equation Model in SmartPLS 3

Table 4: Direct Path Coefficients

No.	Path	Original Sample(O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P-value
H1	DT → CA	0.282	0.281	0.068	4.132	0.000
H2	DT→ SC	0.394	0.395	0.057	6.938	0.000
H3	SC → CA	0.377	0.378	0.061	6.143	0.000
H4	EU × DT → SC	0.140	0.141	0.038	3.653	0.000
H5	EU × SC → CA	0.138	0.137	0.032	4.267	0.000

4.4 Mediation Effect in the Research Model

The results of the mediation effect analysis in this study are shown in Table 5. For the path of "DT→SC→CA", the mediation effect is estimated to be 0.090. The bias corrected 95% CI for this effect ranged from 0.059 to 0.133, excluding zero. The corresponding P value was 0.008, which was also statistically significant.

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Table 5: Mediation Effect

No.	Path	Original sample (O)	Bias-corrected 95%CI		P-value
			2.5%	97.50%	
H6	DT → SC → CA	0.090	0.059	0.133	0.000

4.5 Hypotheses Test

Table 6: Hypotheses Test Results

No.	Hypothesis	Results
H1	DT → CA	Supported
H2	DT → SC	Supported
H3	SC → CA	Supported
H4	EU × DT → SC	Supported
H5	EU × SC → CA	Supported
H6	DT → SC → CA	Supported

As shown in Table 6, six hypotheses were proposed and all supported by tests.

5. CONCLUSIONS

(1) The digital transformation has had a profound impact on the supply chain, further impacting the competitive advantage of enterprises.

Firstly, digital transformation enhances the transparency and visibility of the supply chain. By monitoring and analyzing supply chain data in real-time, enterprises can more accurately grasp the operation of the supply chain, identify potential problems in a timely manner, and take corresponding measures, thereby reducing operational risks.

Secondly, digital transformation has improved the efficiency of the supply chain. By utilizing advanced technologies such as big data and artificial intelligence, enterprises can optimize various aspects of the supply chain, such as procurement, production, logistics, etc., reducing waste and lowering costs. At the same time, through in-depth analysis of supply chain data, enterprises can also achieve more accurate market and demand forecasts, thereby formulating more scientific production plans and market strategies.

Finally, digital transformation helps enterprises innovate their supply chain models. For example, by applying blockchain technology, enterprises can build a more secure and transparent supply chain system; by applying IoT technology, enterprises can achieve real-time monitoring and intelligent scheduling of various links in the supply chain. These innovative supply chain models can bring differentiated competitive advantages to enterprises, enhance market share and profitability.

(2) In the process of digital transformation in the supply chain, dynamic capabilities play a crucial role.

Firstly, dynamic capabilities help businesses better cope with the challenges brought about by digital transformation. Digital transformation often involves multiple aspects such as technological updates, business process restructuring, and organizational culture

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transformation, which may bring certain pressure and risks to enterprises. Enterprises with dynamic capabilities can quickly adapt to these changes, fully utilize the opportunities brought by digital transformation, and reduce potential risks.

Secondly, dynamic capabilities can enhance the competitiveness of enterprises in digital transformation. By continuously adjusting and optimizing supply chain strategies and operations, enterprises can maintain the flexibility and agility of their supply chains, quickly respond to market changes and customer demands. This rapid response capability is one of the important sources for enterprises to gain competitive advantage.

Finally, dynamic capabilities help businesses achieve sustained innovation in digital transformation. Enterprises with dynamic capabilities can continuously explore new supply chain models and technological applications, promoting continuous improvement and innovation in the supply chain. This innovative spirit is crucial for enterprises to maintain a leading position and achieve sustainable development.

(3) Environmental uncertainty, as an external factor, has a significant impact on the supply chain operation and competitive advantage of enterprises.

Firstly, the uncertainty of the environment may come from changes in market demand, adjustments to policies and regulations, technological progress, and other aspects. These uncertain factors require enterprises to have flexibility and adaptability to cope with various challenges and opportunities.

Secondly, the digital transformation of the supply chain is one of the important means for enterprises to cope with environmental uncertainty. Through digital transformation, enterprises can improve the transparency and visibility of their supply chains, optimize their efficiency and costs, innovate their operational models, and thereby enhance their competitiveness in the market.

Finally, environmental uncertainty not only means threats and risks, but also contains the development opportunities in the era of digital economy. In an uncertain environment, enterprises will be more actively involved in resource input to foster valuable and competitive dynamic capabilities, so as to reduce the impact of external environment changes.

In summary, there is a close relationship between the digital transformation of the supply chain and the competitive advantage of enterprises, and the dynamic capabilities of the supply chain are an important bridge and driving force to achieve this relationship.

Enterprises should attach importance to the digital transformation of the supply chain and the cultivation of dynamic capabilities to cope with the constantly changing market environment, and to obtain and maintain competitive advantages.

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