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Digital Transformation Empowers SME Supply Chain Management: A Study on the Path and Mechanism for Enhancing Competitiveness

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Abstract

Against the backdrop of the rapid evolution of the digital economy and the continuous restructuring of the global supply chain, SMEs have become important carriers of industrial chain resilience and regional economic vitality. However, due to limited resources and weak digital application foundations, they generally face prominent problems in supply chain management, such as insufficient information collection, low data transmission efficiency, imperfect logistics collaboration mechanisms, and delayed risk warnings, which in turn restrict the overall operational efficiency and market competitiveness of enterprises. How to leverage digitalization to achieve efficient collaboration and intelligent upgrading of the supply chain system has become an important issue that urgently needs to be addressed. Based on this, this paper takes SMEs as the research object, systematically sorts out their key pain points in the supply chain operation process, and explores the role mechanism of digital transformation from three core dimensions: information processing, business execution, and risk management. The study suggests that SMEs can follow a three-stage path to digital transformation : The first stage involves strengthening information infrastructure by building digital management systems and improving data collection terminals to enhance internal operational transparency and information visualization. The second stage promotes data sharing and process collaboration across the supply chain by connecting data interfaces with suppliers and customers, optimizing inventory and order management, and achieving dynamic resource allocation and efficient business flow integration. The third stage introduces intelligent algorithms and digital decision-making tools to proactively identify demand fluctuations, logistical bottlenecks, and supply risks, thereby improving the responsiveness and flexibility of the supply chain system. The study further points out that digital transformation not only helps SMEs reduce operating costs and improve resource allocation efficiency in the short term, but more importantly, it significantly enhances their resilience in the face of uncertainties in the medium to long term, providing strong support for their steady development in a complex competitive landscape.

Keywords

Digital Transformation; Supply Chain Management; SMEs; Competitiveness Enhancement; Supply Chain Resilience.

1. Introduction

Against the backdrop of rapid development of the digital economy and accelerated restructuring of the global supply chain, SMEs play a vital role in my country's economic system.[1] However, they are relatively weak in terms of technological foundation, management capabilities, and resource acquisition,[2] particularly in supply chain management,[3] where

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issues such as information asymmetry, low collaboration efficiency, and weak risk resilience are particularly prominent.[4] These structural contradictions are further amplified under conditions of rising external uncertainty and intensified market competition, hindering the sustainable development and competitiveness enhancement of SMEs. Existing research indicates that digital transformation is becoming an important force driving organizational change and capability restructuring in enterprises, and is one of the key pathways for enterprises to embed themselves in the new round of industrial revolution and value chain reorganization (Qi Yudong, 2020). With the continuous maturation and application of technologies such as big data, cloud computing, the Internet of Things, and artificial intelligence, digital transformation provides new directions for SMEs to optimize their supply chain management.[5] On the one hand, at the internal level of enterprises, digital technologies can reshape the ways in which information is collected, processed, and transmitted, improving the long-standing phenomenon of "information silos" and enhancing the timeliness and accuracy of decision-making. Related research emphasizes that the understanding and acceptance of digital transformation by employees and management is a crucial prerequisite for enterprises to drive organizational change and upgrade information systems (Gferer et al., 2022; Lu et al., 2023).[6] On the other hand, at the external collaboration level of the supply chain, digital technologies help improve cross-organizational information sharing and process collaboration, enabling enterprises to integrate resources on a larger scale, reduce transaction costs, and thus enhance their ability to cope with complex environments. From a supply chain perspective, digitalization is not only used to improve internal operational efficiency but is also gradually becoming an important tool for reconstructing the structure and operating mechanisms of the supply chain.[7] Existing research shows that supply chain digitalization can significantly improve the collaborative performance of procurement, inventory, and logistics by increasing data availability and visibility, thereby enhancing the resilience and recovery capabilities of the supply chain (Hallikas et al., 2021; Zouri et al., 2021). For small and medium-sized enterprises with relatively limited resources, how to rationally select digital solutions, promote transformation in stages, and achieve substantial improvements in key areas such as information flow, logistics, and capital flow under realistic constraints is a question with significant theoretical and practical value.[8]

Based on this, this paper takes SMEs as the research object and discusses the core question from the perspective of supply chain management: "How can digital transformation alleviate the prominent contradictions in the supply chain management of SMEs, and through what paths can it promote the improvement of enterprise competitiveness?" After reviewing the main bottlenecks in SME supply chain management, the paper analyzes the mechanisms by which digital technologies play a role in information processing, process optimization, and risk management.[9] It further proposes feasible paths for SMEs to promote digital transformation in stages and discusses the impact of digital transformation on enterprise competitiveness from three dimensions: operational efficiency, market responsiveness, and organizational resilience. The aim is to provide a reference for SMEs to choose digital paths under limited resources and to provide theoretical support and practical insights for relevant policy formulation.[10]

2. The Prominent Contradictions in Supply Chain Management for SMEs

2.1. Weak Information Processing Capabilities and Data Silos

Compared to large enterprises, SMEs invest significantly less in information systems, often relying on fragmented financial software and simple inventory management systems, lacking a unified data platform and standardized data management mechanisms. This hinders smooth information flow between procurement, production, inventory, and sales processes, with inter-departmental information transmission relying on manual aggregation and offline

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communication, resulting in widespread data lag and distortion. Existing research indicates that a crucial prerequisite for digital transformation is that enterprises possess basic information infrastructure and data processing capabilities; otherwise, the synergistic effects of technology cannot be fully realized (Qi Yudong, 2020; Zhang Yongshen et al., 2023). Against this backdrop, the "information silo" problem is prominent in SMEs, affecting not only the timeliness and accuracy of internal operational decisions but also weakening their ability to participate in supply chain collaboration .

2.2. Inadequate Logistics Collaboration System and Low Execution Efficiency

In supply chain operations, logistics is a crucial link connecting upstream suppliers and downstream customers. Due to a lack of digital tools, many SMEs still rely primarily on experience-based management in areas such as warehousing, transportation scheduling, and delivery tracking. This lack of visualized process monitoring and data-driven performance evaluation mechanisms leads to problems such as irrational inventory structures, low turnover rates, and unstable delivery cycles. Research shows that digitalization can significantly improve the transparency and coordination of logistics processes, thereby improving overall supply chain performance (Halikas et al., 2021). However, in reality, SMEs are often constrained by funding and technology in building logistics collaboration systems, making it difficult to construct digital systems at the same level as large enterprises. This further amplifies their disadvantaged position in the supply chain division of labor.

2.3. Insufficient Stability of the Capital Chain and Limited Risk Tolerance

Small and medium-sized enterprises (SMEs) generally face problems such as low credit ratings, insufficient collateral, and limited financing channels. Banks and financial institutions have limited risk appetite towards them, and traditional lending models are insufficient to effectively meet their operating capital needs. Under these circumstances, enterprises often face cash flow pressure when purchasing raw materials, expanding production capacity, or coping with demand fluctuations. Tightening payment terms from upstream suppliers or delayed payments from downstream suppliers can easily lead to cash flow problems or even a break in the supply chain . Existing research indicates that innovation in supply chain finance in a digital environment can alleviate the financing constraints of SMEs to some extent, but this is contingent on enterprises possessing a relatively complete foundation of transaction data and operational records (Dou et al., 2024). Currently, many SMEs have not yet formed stable data assets that financial institutions can identify and assess, placing them in a passive position of "high risk and low bargaining power" within the supply chain system .

3. The Mechanism by which Digital Transformation Improves Supply Chain Management

3.1. Digitalization Improves the Efficiency of Information Collection, Sharing and Decision-making

Digital technologies, through system integration and data platform construction, help bridge the gaps between various business modules within SMEs, enabling the collection and integration of data across the entire process from orders, procurement, and production to sales and service. Related research indicates that digital indicators built upon annual reports, business records, and online transaction data can effectively reflect the degree of transformation in a company's technology application and management practices (Chen Nan et al., 2024). At the supply chain management level, digitalization improves the timeliness and accuracy of information collection, reducing deviations from manual input and transmission. Furthermore, by enhancing data sharing, it provides more reliable decision-making support for demand forecasting, production planning, and inventory control. For SMEs with limited

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resources, leveraging cloud platforms and other methods to acquire information system capabilities at a lower cost is a crucial means of improving their management level .

3.2. Digitalization Promotes Supply Chain Process Optimization and Operational Efficiency Improvement

At the process optimization level, digital tools can be embedded in key links such as warehousing, transportation, and order fulfillment, providing support for enterprises to achieve standardized operations, visualized processes, and quantifiable performance. Dold and Speck (2021) emphasized that although there are complexities and "paradoxes" in the digital production environment, process efficiency can be significantly improved by rationally allocating technological and organizational resources. Domestic research has also found that data-driven process reengineering can effectively improve the total factor productivity and operational quality of enterprises (Qiu Zixun and Zhou Yahong, 2023; Song Wei et al., 2024). For SMEs, by introducing barcode or RFID management, transportation tracking systems, and electronic order management systems, they can gradually achieve inventory structure optimization, faster turnover, and optimized transportation routes, reducing logistics costs and improving supply chain execution efficiency. At the same time, process visualization also provides a basis for performance evaluation and continuous improvement. Enterprises can analyze the operational efficiency and error rate of different positions and links based on system data, identify weak links in management, and formulate more targeted improvement measures. Through a closed loop of "data-analysis-improvement," SMEs have the opportunity to continuously optimize their processes without significantly increasing their investment in manpower and equipment, thereby steadily improving the overall operational efficiency of their supply chain.

3.3. Digitalization Enhances the Ability to Identify and Respond to Supply Chain Risks

In a context of increasing external uncertainty and frequent supply chain shocks , enterprises are increasingly demanding higher capabilities in risk identification and emergency response. Research by Feng Gengzhong et al. (2024) indicates that networked monitoring, production traceability, and precise allocation enabled by the Internet of Things (IoT) and data platforms can help improve the resilience of supply chains during pandemics. Digitalization can identify abnormal fluctuations and potential risks through real-time monitoring of data such as orders, inventory, logistics status, and market prices, and guide enterprises to adjust their procurement, production, and inventory strategies early through early warning mechanisms. For SMEs with relatively weak risk resistance, building a digitally-based risk management mechanism can not only reduce losses from supply disruptions and inventory backlogs but also, to some extent, enhance their bargaining power and cooperation stability in supply chain negotiations . From a risk management perspective, digitalization enables enterprises to integrate previously scattered "local information" across different business segments into an analyzable "global view." For example, when the system detects that the supply cycle of a key raw material is continuously lengthening and the purchase price is fluctuating significantly, the company can promptly initiate an evaluation of alternative suppliers or adjust its product structure; when sales data shows a sudden increase that is inconsistent with past patterns, the company can combine inventory and production capacity to determine whether it is a short-term promotional effect or a substantial change in demand structure, and formulate different response strategies accordingly.

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4. Feasible Pathways for Digital Transformation of SMEs

4.1. Restructuring of Basic Digital System Construction and Management Processes

For SMEs with relatively limited resources and technological foundations, the first step in digital transformation should be to strengthen their internal information infrastructure. At this stage, companies do not need to configure complex and expensive systems from the outset. Instead, they should prioritize introducing basic information systems with broad coverage and ease of use, focusing on core business areas such as procurement, inventory, production, sales, and finance. This ensures that key business data is "recorded, searchable, and traceable." Based on this, existing business processes should be systematically reviewed to identify problems such as excessive manual steps, lengthy approval chains, and repetitive information entry. The processes should then be appropriately restructured in conjunction with system functions to make data flow paths clearer and responsibilities more rationally defined. This process not only reduces the reliance on individual experience in internal "human-based" management but also gradually forms a data-driven management model, laying a solid institutional and technological foundation for subsequent supply chain collaboration and intelligent upgrades.

4.2. Supply Chain Collaboration Platform Applications and Cross-organizational Information Integration

Once the internal foundation is relatively stable, SMEs can further promote digital collaboration around upstream and downstream relationships in the supply chain. On the one hand, they can leverage industry platforms, e-commerce platforms, or third-party supply chain service platforms to share information such as orders, inventory, and delivery plans online with suppliers and customers, reducing the time lag and information distortion caused by traditional communication methods such as telephone and email. On the other hand, by accumulating transaction records, performance data, and settlement data on the platform, it helps to form identifiable and usable "digital credit," providing support for securing more favorable procurement terms and more flexible payment arrangements . As the level of collaboration increases, enterprises can learn about changes in upstream supply and adjustments in downstream demand earlier, and more rationally arrange production plans and inventory layout, reducing the risks of "blindly stockpiling" and "passive shutdowns." For SMEs, the key at this stage is to choose a platform type that matches their business and gradually accumulate data assets and collaborative governance experience through cooperation.

4.3. Intelligent Technology Embedding and Supply Chain Optimization and Upgrading

Once enterprises have accumulated sufficient data and management experience in basic information systems and supply chain collaboration, they can selectively introduce intelligent tools to further optimize supply chain management. One type is analytical tools for demand forecasting and inventory control. These tools comprehensively analyze historical sales data, seasonal patterns, and promotional rhythms to help enterprises develop more forward-looking production and replenishment plans, reducing fluctuations caused by the "bullwhip effect." Another type is optimization solutions for production scheduling and logistics dispatching. Based on factors such as capacity constraints, delivery deadlines, and transportation conditions, these solutions provide enterprises with production scheduling suggestions and delivery route recommendations, improving resource utilization efficiency. In this process, SMEs do not need to fully implement intelligent applications. Instead, they should conduct pilot programs focusing on a few key bottleneck areas, gradually validating and amplifying the management benefits of digitalization while ensuring cost control. As the pilot scope expands and employees'

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digital literacy improves, enterprises can further integrate intelligent analytics into daily operational decisions, supporting the construction of a refined and flexible supply chain system .

5. The Intrinsic Logic of Digital Transformation Driving Enterprise Competitiveness Enhancement

5.1. Improved Operational Efficiency and Resource Allocation Capabilities

Digital transformation is first and foremost reflected in the continuous improvement of operational efficiency. On the one hand, through the construction of basic information systems and process restructuring, enterprises have reduced a significant amount of repetitive data entry and manual statistical work in order processing, production planning, and inventory management. Information flow between departments is smoother, error rates have decreased significantly, and business response speed has improved. On the other hand, with the help of supply chain collaboration platforms and some intelligent tools, enterprises can more accurately grasp the rhythm of customer demand and upstream supply capacity, optimize the pace of raw material procurement and capacity arrangement, and avoid the situation of "overload during busy periods and idle capacity during off-peak periods." As data is integrated across different business modules, resource allocation gradually shifts from "experience-driven" to "data-driven," production organization becomes more refined, and cost structures become clearer, releasing space for enterprises to further reduce costs and increase efficiency. Overall, digitalization enhances the "efficiency frontier" of enterprises under given resource constraints, thus forming an important foundation for competitive advantage.

5.2. Strengthening Market Responsiveness and Customer Service Capabilities

In a market environment characterized by rapidly changing demand structures and the emergence of numerous competitors, a company's ability to promptly identify demand shifts and quickly adjust its product supply and service methods is increasingly becoming a decisive factor in the competitive landscape. Digital supply chains provide SMEs with more real-time sales and inventory information, enabling them to continuously monitor sales trends across different channels and products at a lower cost, thereby allowing for more timely adjustments to production structures and optimization of inventory combinations. In terms of customer service, the application of online order management systems, logistics tracking, and after-sales feedback modules allows companies to provide customers with a more transparent and predictable service experience, reducing complaints and disputes caused by information asymmetry. Simultaneously, the long-term accumulation of customer interaction data helps companies more accurately identify key customer groups and their preferences, providing a basis for subsequent product improvements and service innovations. Through improved market responsiveness and optimized service experiences, SMEs can gradually develop a differentiated advantage in a highly competitive environment characterized by product homogeneity.

5.3. Enhanced Organizational Resilience and Sustainable Development Capabilities

In an environment of frequent external shocks and intensified demand fluctuations, corporate competition is no longer a single-stage "efficiency contest," but rather a test of whether businesses can maintain basic operations and achieve recovery and regeneration amidst multiple shocks. Digital transformation provides SMEs with new tools and means to enhance organizational resilience. On the one hand, through real-time data monitoring of key nodes such as supply, production, inventory, and channel sales, companies can detect abnormal changes earlier and take timely adjustment measures to keep risks within an acceptable range. On the other hand, historical data archives based on digital records help companies review their

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response strategies and effects under different scenarios, summarizing a set of iterative and replicable "crisis response experiences." Based on this, the accumulation of knowledge, standardization of processes, and restructuring of capabilities within enterprises exhibit dynamic evolutionary characteristics, moving beyond reliance solely on the experience of individual managers or key personnel, and gradually forming an organizational-level learning and adaptation mechanism. In the long run, this resilience supported by digitalization will become a crucial guarantee for the continued survival and upgrading of SMEs in an uncertain environment.

6. Conclusion and Policy Recommendations

6.1. Main Research Conclusion

This paper, from the perspective of supply chain management, examines the real challenges faced by SMEs in the digital economy. It outlines the role of digital transformation in information processing, process optimization, and risk management, and constructs a relatively clear analytical framework accordingly. Overall, the problems of weak information infrastructure, insufficient logistics coordination, and fragile cash flow in SME supply chain management share certain commonalities and structural characteristics. These shortcomings, when combined, often leave enterprises in a passive position to cope with demand fluctuations and external shocks. Digital transformation cannot solve all problems once and for all, but it shows a clear direction in alleviating the aforementioned contradictions. By introducing basic information systems and data platforms, enterprises can gradually streamline internal business processes, improving data lag and information silos. Furthermore, embedding digital tools into key nodes such as procurement, warehousing, transportation, and order fulfillment helps promote the standardization and visualization of business processes, improving the overall efficiency of the supply chain. With real-time monitoring and early warning mechanisms, enterprises can identify risks such as supply disruptions and abnormal demand more promptly, and their adjustment space is correspondingly expanded. The three-stage path proposed in this paper reflects the gradual nature of SMEs' digital transformation under realistic constraints. Digitalization has not only improved operational efficiency and resource allocation, but has also reshaped, to some extent, a company's market responsiveness and organizational resilience, enabling it to thrive in a more uncertain environment. These changes constitute the inherent logic behind how digital transformation drives the competitiveness of SMEs.

6.2. Recommendations for Promoting Digital Transformation of SMEs

From the perspective of the enterprise itself, digital transformation is first and foremost a long-term, stable endeavor. Before initiating related work, SMEs need to accurately assess their existing business processes and management pain points, clarifying whether to prioritize addressing internal management chaos and information fragmentation, or to first explore supply chain collaboration and customer service. Only by focusing on a few key scenarios can they avoid resource dilution and a transformation that appears impressive but is ultimately unrealistic. At the implementation level, SMEs are advised to view the construction of basic information systems as a foundational task, rather than simply a technology procurement. When selecting systems, they should not pursue the most comprehensive functionality, but rather focus on the degree of matching with their own business, the ease of use for employees, and future expansion potential. During the gradual rollout of the system, processes should be adjusted appropriately to ensure that the system's logic aligns with management logic, rather than having employees working according to old processes while passively entering data into the system. Furthermore, if digital transformation remains solely from the perspective of the technology department and a few managers, it will be difficult to truly change the way the enterprise operates. Management needs to proactively incorporate data and system outputs

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into daily decision-making processes, demonstrating their commitment to digitalization through concrete actions. Frontline employees, on the other hand, need to gradually develop usage habits through training and practice, making working within the system the default option rather than an additional burden. Meanwhile, SMEs can consciously leverage external service providers, industry platforms, and peer networks to reduce trial-and-error costs in technology solution selection and project implementation, compensating for their own shortcomings in professional capabilities through leveraging external resources .

6.3. Policy Recommendations for Promoting the Digital Development of SMEs

From a broader perspective, the effectiveness of digital transformation for SMEs largely depends on whether the external environment provides sufficient support and space. On the one hand, policies can more clearly incorporate SME digitalization into industrial and regional development plans, reducing the financial burden on enterprises for information system construction, process improvement, and talent training through fiscal subsidies, tax and fee reductions, and special loans. Simultaneously, building public digital service platforms at the regional or industry level can provide SMEs with relatively standardized and cost-effective supply chain collaboration, data analysis, and online transaction tools, making affordable and understandable solutions truly accessible. On the other hand, creating a standardized, secure, and predictably stable digital application environment is equally crucial. As the importance of data in production and operation continues to increase, SMEs' concerns about data security, privacy protection, and platform rules are also growing. If relevant institutional arrangements are not clear enough, enterprises will inevitably have reservations when using digital tools. By improving data usage standards, clarifying responsibility boundaries, and strengthening the supervision of the digital service market, the legitimate rights and interests of SMEs can be protected while enhancing their confidence in participating in digital transformation. In general, proactive exploration within SMEs and the improvement of external institutional and service systems are two sides of the same coin. Digital transformation can only truly transform from a slogan into a sustainable practice when enterprises are willing to try and make adjustments, and when the external environment can provide the necessary resources and institutional guarantees. Only then can the potential of digital technology to empower supply chain management be fully unleashed .

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