Journal of Innovation and Development
ISSN: 2958-4752 | Vol. 12, No. 1, 2025

Research on the Impact of Supply Chain Digital Transformation on Corporate Performance - Empirical Results from Manufacturing Enterprises in Guangdong Province

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Abstract: This paper focuses on small and medium-sized manufacturing enterprises (SMEs) in Guangdong Province of China, aiming to clarify the profound impact of their supply chain digital transformation strategies on corporate performance. Based on theories such as supply chain management and the learning curve, a conceptual model of supply chain digitization for SMEs is constructed. Using 300 questionnaire surveys from Guangdong's SMEs as research samples, the study examines the relationship between supply chain digitization and corporate performance. The results show: (1) The implementation level of corporate digital transformation and performance is independent of enterprise profile variables; (2) The digitalization levels of the supply chain in procurement, manufacturing, inventory management, demand planning, warehousing, transportation, and customer service are significantly correlated with the performance levels of selected manufacturing enterprises; (3) The impact of supply chain digitalization implementation on corporate performance ranks in the order of customer service, procurement, transportation, demand planning, inventory management, manufacturing, and warehousing. Finally, based on the research results, policy recommendations are proposed to promote the implementation of supply chain digitalization, including customer service, digital technology, and human capital.

Keywords: Digitalization; Supply Chain Management; Corporate Performance.

1. Introduction

SMEs not only make important contributions to the national economy, tax revenue, and employment but also play a key role in promoting innovation and social and economic transformation, serving as an indispensable force in the economic and social governance system[1]. However, these enterprises generally face numerous challenges in the context of global digital transformation, such as information asymmetry, homogeneous competition, financing difficulties, uncertain demand planning, and insufficient customer satisfaction, which restrict their sustainable development potential. Supply chain digitization provides a new solution for SMEs to address challenges and tackle bottlenecks in the digital economy. The 2024 Government Work Report proposed deepening the special action of digitizing SMEs to promote their specialized, refined, characteristic, and innovative development[2]. At the same time, the State Council officially promulgated the Action Plan for Digital Transformation of Manufacturing Industry, proposing to increase support for the digital transformation of (SMEs), integrate it with large-scale equipment renewal and technological transformation projects, improve the construction of public service platforms, and explore the formation of a long-term mechanism to promote the digital transformation of SMEs.

Regarding the research on the relationship between supply chain digitization and the performance of SMEs, some scholars have pointed out that the essence of digitization is a means to enhance enterprise competitiveness in the changing digital economy[3]. Fitzgerald et al. (2014) emphasized that enterprise digitization can use new digital technologies such as social media, mobile technology, analytics, or embedded devices to achieve significant business process reforms and promote SMEs to achieve digital strategic transformation [4]. Cheng Wenxian et al. (2021) found that the digital economy significantly promotes the improvement of China's industrial green total factor productivity[5]. In recent years, domestic scholars' research on digital transformation has increasingly focused on the micro level, believing that enterprise digital transformation is an important means to comprehensively drive efficiency improvement, restructure business models and value networks, and stimulate innovation efficiency with a focus on discussing the performance of digital transformation in the internal development of enterprises. Enterprise digitization will affect production costs and operational efficiency, significantly reduce information asymmetry among internal stakeholders, improve enterprise internal control levels, and enhance manufacturing enterprises' performance.

In summary, digital technology and enterprise digitization are crucial to enterprise performance, and existing literature generally confirms the positive impact of supply chain digitization on the manufacturing industry. However, research on digitization of SMEs is still scarce, and there is particularly a lack of empirical analysis on the impact of supply chain digitization on SME performance. This study expands in the following two aspects to fill research gaps: The first is to use the “learning curve” theoretical method to quantify the implementation of supply chain digitization and incorporate it into the research framework of SMEs performance, enriching existing research in the field of supply chain innovation. The second is to have important significance for different audiences, including academia, stakeholders, and practitioners.

2. Methods and Materials

2.1. Theoretical Analysis

In 1961, Professor Forrester of the Massachusetts Institute of Technology first proposed the "supply chain" concept while studying the optimization of dynamic relationships between upstream and downstream industries[6]. Subsequently, in 1982, Oliver, Webber, and others first proposed the concept of supply chain management, defining it as integrated logistics management, a management tool to effectively reduce inventory occupation levels[7]. After the 1990s, due to changing market environments and intensified commercial competition, academia and industry gradually realized the importance of collaborative cooperation among enterprises at supply chain nodes, and the concept of supply chain management also underwent fundamental changes. Bolstorff et al. proposed the Supply Chain Operations Reference (SCOR) model, defining the supply chain as five processes: planning, procurement, manufacturing, transportation, and returns, aiming to achieve the integration of internal and external enterprise processes and information through applications such as enterprise resource planning (ERP) and business process reengineering (BPR)[8]. The application of this model has greatly promoted the development of supply chain management.

The digitization of supply chains for SMEs must first be based on supply chain management theory, fully considering the roles and statuses of various components in supply chain management and complying with the dynamic laws of supply chain operations; second, it must expand supply chain management theory, using new technologies and management ideas to promote the transformation of supply chain management toward digitization; finally, due to differences in value distribution across supply chain links (downstream customer service has the highest value increment, while intermediate processing and assembly links have the least), the value distribution of digitized manufacturing supply chains typically exhibits a “smile curve” pattern. Based on the above theories and existing research results, this paper takes seven elements: procurement, inventory management, warehousing, logistics transportation, demand planning, and customer service as input variables, and four performance indicators: finance, learning and growth, internal business processes, and customer satisfaction as output results, proposing a theoretical analysis framework of a “semi-smile” curve for supply chain digitization in SMEs (Figure 1).

As shown in Figure 1, supply chain digitization of selected enterprises will improve business processes such as procurement, production, and demand planning, thereby enhancing corporate performance, specifically: (1) Digital transformation can improve enterprise financial status through procurement, manufacturing, demand management, warehousing, transportation, inventory, and other links, achieving enterprise financial increment △P1. (2) Digital transformation can effectively improve enterprise learning and growth in procurement, manufacturing, demand management, warehousing, transportation, inventory, and other links by optimizing data collection and analysis, enhancing employee skills, and promoting departmental collaboration, increasing enterprise learning and growth △P2. (3) Digital transformation can improve internal business processes through data-driven, automated processes, and intelligent decision-making in procurement, manufacturing, demand management, warehousing, transportation, inventory, and other links. For example, real-time monitoring of supplier performance and big data analysis of market price trends help better grasp procurement timing, improving enterprise internal business process efficiency increment △P3. (4) Digital transformation can enhance customer satisfaction in product quality, delivery speed, product customization, service quality, etc., through optimizations in procurement, manufacturing, demand management, warehousing, transportation, inventory, and other links. For example, digitized manufacturing becomes more flexible and intelligent, quickly meeting customers' personalized customization needs and shortening delivery times, thereby increasing customer satisfaction increment △P4.

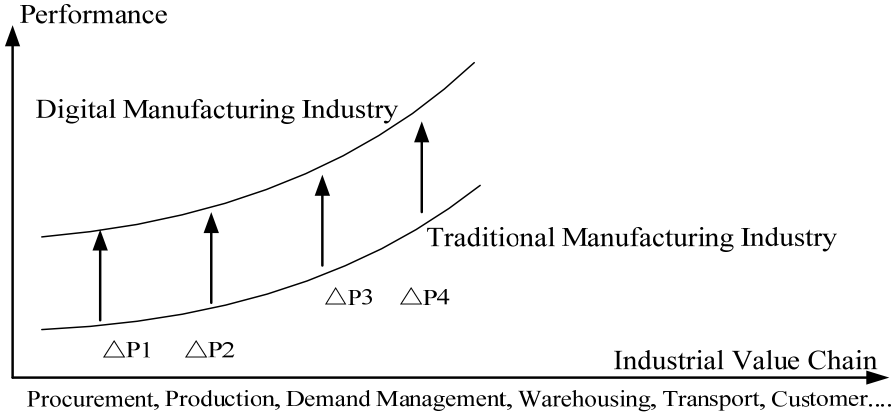

Figure 1. Theoretical Analysis Framework

2.2. Research Hypotheses

Due to the penetration and application of digital technologies in SMEs, production, organization, and management efficiency can be improved, new competitive and cooperative relationships can be established, and qualitative changes in intelligent manufacturing can be triggered. Therefore, enterprise profile variables are often regarded as key factors influencing enterprise strategic decisions. Some scholars believe that large enterprises are more likely to advance digital transformation due to resource endowment advantages, while SMEs may lag in digitization due to resource constraints[9]. However, other studies suggest that under the accelerating penetration of the digital economy, external competitive pressures and policy guidance may prompt enterprises of varying scales and ownership types to adopt consistent digital strategies[10]. Additionally,

enterprise profile grouping variables, as important attributes of enterprises (such as enterprise type, scale, age, etc.), are often considered key factors influencing strategic choices and resource allocation. Conversely, some scholars have found that in highly marketized economies, the differentiated impact of enterprise type on performance may be weakened by competition mechanisms. For example, Liu Wei et al., based on an empirical study of listed manufacturing companies in China, found that after controlling for enterprise scale and technological investment, the direct impact of ownership type on enterprise performance was not significant[11]. However, some scholars note that the effects of digital transformation may exhibit heterogeneity due to differences in internal and external enterprise environments. For example, in SMEs with weak technological foundations or poor organizational adaptability, digital transformation may lead to insignificant performance improvements due to high cost investments and mismatched short-term benefits[12]. Based on the above theories and analyses, this paper proposes the following research hypotheses:

H1: There are no significant differences in the implementation level of enterprise digital transformation across enterprise profile variable groups.

H2: There are no significant differences in enterprise performance levels across enterprise profile variable groups.

H3: There is no significant relationship between the implementation level of supply chain process digital transformation and the performance levels of selected SMEs.

2.3. Research Sample and Data Collection

The Guangdong-Hong Kong-Macao Greater Bay Area Development Plan Outline clearly states that the Greater Bay Area and Guangdong Province should actively promote the digital transformation of manufacturing industries. Therefore, this survey uses the 2022 Edition of SME Digitalization Level Evaluation Indicators promulgated by the Ministry of Industry and Information Technology to conduct online self-evaluations of the digitalization level of SMEs in Guangdong Province and selects representative enterprises such as Guangzhou International Precision Industry Company for in-depth questionnaire surveys. The survey includes 58 SMEs across 9 cities in Guangdong Province and involves 300 managers, employees, and customers for analysis.

To collect data on the digital transformation and corporate performance of SMEs, a modified questionnaire adapted from Li Yue's doctoral thesis Research on the Impact of Data Strategy on Dual Digital Transformation of Enterprises was used[13]. This questionnaire was proven highly suitable for the current study and includes the following components: The first part covers basic background information of participants and selected enterprises, including age, gender, education level, job position, business type, operational years, number of employees, and enterprise revenue. The second part evaluates the implementation level of digitization in procurement, manufacturing, inventory management, demand planning, warehousing, transportation, and customer service. The third part assesses enterprise performance in four aspects: finance, customers, internal processes, and learning and growth. The fourth part collects participants' issues and challenges in digital transformation implementation and solicits open-ended suggestions. To eliminate the influence of extreme values, variables were winsorized at the 1% level.Statistical results show that in terms of gender, there are 147 males (49% of the total sample) and 153 females (51%). In age distribution, the 31-40 age group is the largest, with 120 people (40%). As most respondents are enterprise employees, the largest educational background is undergraduate degree, with 150 people (50%) and 117 people (39%). Overall, the sample is comprehensive and representative of the research objects, meeting research requirements.

2.4. Variable Explanation/Description

As shown in Table 1, the explanatory and dependent variables were operationalized based on data availability and transparency, with all items measured on a 4-point Likert scale.

Table 1. Scales for Explanatory and Dependent Variables

Average Range	Implementation Level	Performance Level
3.25-4.00	Very High	Very High
2.50-3.24	High	High
1.75-2.49	Moderate	Moderate
1.00-1.74	Low	Low

The explanatory variable is enterprise digital transformation (DT). Considering that the manufacturing industry is in a rising period of industrial digitization and digital industrialization, with many enterprises having low digitalization levels and significant imbalances and inadequacies in development among enterprises, the final measurement dimensions of this variable, combined with the theoretical review of supply chain digitization, include seven aspects: value chain digital procurement (PD), production (MPD), demand planning (DPD), inventory management (IMD), transportation (TD), warehousing (WD), and customer service (CSD), totaling 56 items. Due to space limitations, all items are not listed here.

The dependent variable in this study is enterprise performance (EP). Considering that the manufacturing industry is currently in a rapid development stage, but financial revenue indicators of some SMEs in Guangdong Province are uneven and not optimistic, this scale incorporates the perspectives of Zhang Jide et al. (2024), covering financial revenue (FD), customer satisfaction (CS), learning and growth (L&G), and internal business process (IBP) indicators, totaling 32 items. Due to space limitations, all items are not listed here.

Based on previous research experience, this paper selects enterprise nature, enterprise revenue, number of employees, and operational years as control variables and virtualizes them to improve the accuracy of research conclusions. 1 represents sole proprietorship, 2 represents joint venture, and 3 represents cooperative enterprise. Enterprises in operation for less than 5 years are represented by 1, those established for 6-10 years are represented by 2, and those established for more than 11 years are represented by 3. Enterprises with fewer than 20 employees are represented by 1, 21-300 employees by 2, 301-500 employees by 3, and 501-1000 employees by 4. Enterprise revenue is measured by capital amount, with 1 representing micro enterprises with revenue below 3 million yuan, 2 representing small enterprises with 3-20 million yuan, and 3 representing medium enterprises with over 20-400 million yuan.

3. Results and Discussions

3.1. Descriptive Statistics

IBP (internal business processes), CS (customer satisfaction), and FD (financial revenue), with values of 3.11, 3.08, 3.01, and 2.98, respectively, indicating that different manufacturing enterprises' performances were evaluated as "high". The mean value of DT (digital transformation) is 3.13, with measurement dimensions including value chain PD (procurement), MPD (production), DPD (demand planning), IMD (inventory management), TD (transportation), WD (warehousing), and CSD (customer service), with a maximum of 3.19, minimum of 3.01, and standard deviation of 0.631, indicating significant heterogeneity in digitalization levels among SMEs, with supply chain implementation levels evaluated as "High".

This paper uses SPSS 26.0 software to test the proposed research hypotheses and the conceptual model of the impact of supply chain digitization on enterprise performance.

3.2. Testing the Effect of Enterprise Participant Variable Groups on the Implementation Level of Digital Transformation

According to enterprise variable groups (enterprise type, enterprise age, number of employees, and enterprise revenue), the relationship between enterprise participants and the implementation level of supply chain digitization is tested as shown in Table 2. The calculated probability $P > 0.05$, indicating that enterprise participants have no significant differential impact on the implementation level of digital transformation, so Hypothesis H1 is accepted.

Table 2. Effect of Enterprise Variable Groups on Supply Chain Transformation Implementation

Variable	Control Variables				Decision at α =0.05
	Enterprise Type	Enterprise Age	Number of Employees	Enterprise Revenue	
PD	0.325(.127)	0.065(2.434)	0.737(.423)	0.489(.716)	Accept H1
MPD	0.863(.148)	0.742(.415)	0.332(1.142)	0.396(.928)	Accept H1
IMD	0.573(.558)	0.857(.255)	0.161(1.730)	0.411(.893)	Accept H1
DPD	0.481(.968)	0.224(1.136)	0.218(1.136)	0.440(.536)	Accept H1
WD	0.381(.968)	0.115(1.995)	0.542(.719)	0.464(.769)	Accept H1
TD	0.756(.281)	0.444(.895)	0.229(1.449)	0.933(.069)	Accept H1
CSD	0.402(.941)	0.152(1.775)	0.855(.259)	0.937(.066)	Accept H1

As shown in Table 2, the P-values for enterprise type (0.325, 0.863, 0.573, 0.481, 0.381, 0.756, 0.402) are all greater than 0.05, indicating that enterprise type has no significant impact on the evaluation of digital transformation implementation levels. The probability values for enterprise age (0.065, 0.742, 0.857, 0.224, 0.115, 0.444, 0.152) are also greater than 0.05, suggesting that enterprise age does not significantly differ in evaluating the implementation level of digital transformation. The P-values for the number of employees (0.737, 0.332, 0.161, 0.218, 0.542, 0.229, 0.855) are greater than 0.05, meaning the number of employees has no differential impact on evaluating digital transformation implementation. The probability values for enterprise revenue (0.489, 0.396, 0.411, 0.440, 0.464, 0.933, 0.937) are all greater than 0.05, indicating that regardless of revenue scale, participants' evaluations of digital transformation implementation levels remain unchanged.

3.3. Effect of Enterprise Participant Variable Groups on the Performance Levels of SMEs

As shown in Table 3, the probability P-values for enterprise type (0.143, 0.407, 0.396, 0.944) are greater than 0.05, indicating that regardless of enterprise type, participants' evaluations of performance levels do not vary. The probability P-values for enterprise age (0.060, 0.142, 0.055, 0.476) are greater than 0.05, suggesting that operational years are not factors influencing differential evaluations of enterprise performance levels by participants. The probability values for the number of employees (0.987, 0.872, 0.705, 0.436) are greater than 0.05, indicating that there are no significant differences in performance levels (financial, customer, learning and growth, internal processes) among selected SMEs when grouped by employee count. The probability values for enterprise revenue (0.907, 0.923, 0.659, 0.818) are greater than 0.05, suggesting that enterprise revenue scale is not a factor influencing participants' evaluations of enterprise performance levels.

Table 3. Hypothesis Test Results for Enterprise Variable Groups and Corporate Performance

Variable	Control Variables				Decision at α=0.05
	Enterprise Type	Enterprise Age	Number of Employees	Enterprise Revenue	
FD	0.143 (1.96)	0.060 (2.501)	0.987 (.0.046)	0.907 (.097)	Accept H2
CS	0.407 (.902)	0.142 (1.829)	0.872 (.235)	0.923 (.080)	Accept H2
L&G	0.396 (.928)	0.055 (2.557)	0.705 (.468)	0.659 (.417)	Accept H2
IBP	0.944 (.057)	0.476 (0.833)	0.436 (0.911)	0.818 (.200)	Accept H2

3.4. Testing the Relationship Between Supply Chain Digitalization Implementation Level and Enterprise Performance Level

Data in Table 4 show that the probability P-values for the seven variables (procurement, production, demand planning, inventory management, transportation, warehousing, and customer service) are all less than 0.05, so the hypothesis H3 is rejected, indicating a significant relationship between the implementation level of supply chain process digital transformation and the performance levels of selected SMEs in finance, customer satisfaction, learning and growth, and internal business processes. This means that a higher implementation level of supply chain digitization leads to higher performance in financial, customer, learning and growth, and internal business process aspects.

Additionally, sorted by descending r-values, the impact on financial performance ranks as follows: customer service (CSD, 0.933), procurement (PD, 0.467), transportation (TD, 0.251), demand planning (DPD, 0.197), inventory management (IMD, 0.185), manufacturing (MPD, 0.183), and warehousing (WD, 0.166).

Table 4. Significant Relationship Between Digital Transformation Level and Performance Level

Impact Degree	Dependent Variable							
	FD		CS		L&G		IBP	
	r	p-value	r	p-value	r	p-value	r	p-value
PD	0.467	0.000	0.493	0.000	0.509	0.000	0.480	0.000
MPD	0.183	0.001	0.209	0.000	0.288	0.000	0.292	0.000
IMD	0.185	0.001	0.212	0.000	0.305	0.000	0.301	0.000
DPD	0.197	0.001	0.247	0.000	0.285	0.000	0.197	0.000
WD	0.166	0.004	0.203	0.000	0.250	0.000	0.225	0.000
TD	0.251	0.000	0.259	0.000	0.307	0.000	0.281	0.000
CSD	0.933	0.000	0.999	0.000	0.394	0.000	0.254	0.000

4. Conclusions and Policy Implications

4.1. Main Conclusions

Based on theories such as supply chain management and learning curves, this paper constructs a “semi-smile” conceptual model of supply chain digitization, taking seven elements-procurement supply, inventory management, warehousing, logistics transportation, demand planning, and customer service-as input variables and four performance indicators-finance, learning and growth, internal business processes, and customer satisfaction-as output variables. The study uses 300 questionnaire surveys from SMEs in Guangdong Province as research samples to explore the relationship between supply chain digitization and the performance of SMEs. The results show: (1) The implementation level of supply chain digitization and performance are independent of SMEs profile variable groups (enterprise type, age, number of employees, and capital scale); (2) The digital transformation levels of supply chain in procurement, manufacturing, inventory management, demand planning, warehousing, transportation, and customer service are significantly correlated with the performance levels of selected SMEs, and a higher implementation level of digital transformation leads to higher enterprise performance; (3) The impact of supply chain digitization implementation on enterprise performance ranks as follows: customer service (0.933), procurement (0.467), transportation (0.251), demand planning (0.197), inventory management (0.185), manufacturing (0.183), and warehousing (0.166).

4.2. Policy Implications

At its core, digital supply chains must deliver intelligent, personalized services through a three-pronged strategy: Supply-side innovation requires cultivating specialized digital service providers to develop “small, fast, lightweight, precise” solutions while strengthening data security frameworks and establishing digital feedback platforms for enhanced customer experience. Concurrently, talent development demands building multi-level digital capabilities-supported by government-facilitated third-party certification programs like “Digital Management Specialist”-to foster versatile professionals with triple-domain expertise thereby addressing SMEs' technical skill gaps. Crucially, enterprise success hinges on leadership engagement: decision-makers must drive digital investment, deploy integrated IoT and big data-enabled supply chain platforms for real-time information sharing and precision servicing, while advancing supportive policies to cultivate an ecosystem conducive to intelligent transformation and digital advancement. This holistic approach synergizes innovation, human capital, and strategic direction to elevate supply chain value.

Acknowledgements

This research was supported by Guangdong Philosophy and Social Sciences “Research on the Mechanism and Countermeasures of Digital and Green Integration Development of Manufacturing Supply Chain”(2024XL032).

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