Digital Transformation Path and Practice of Small and Medium-Sized Manufacturing Enterprises

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Abstract. This paper provides an in-depth discussion of the background, motivation, key paths, landing programs, and practical effects of digital transformation in small and medium-sized manufacturing enterprises (SMMEs). The challenges enterprises face, such as increased market competition and diversified customer demands, clarify the necessity and urgency of digital transformation. Through literature review and case analysis, it is analyzed that small and medium-sized manufacturing enterprises (SMMEs) need to expand their business markets, improve production efficiency, optimize management processes, and enhance market competitiveness through digital transformation. The analysis summarizes the challenges in the digital transformation process of small and medium-sized manufacturing enterprises (SMMEs). It proposes specific transformation paths and practical coping strategies to serve as valuable references for small and medium-sized manufacturing enterprises (SMMEs) that are about to be or are in the process of transformation.

Keywords: small and medium manufacturing enterprises, SMMEs, ERP, digital factory, cost reduction and efficiency improvement, digital diagnosis, production innovation and optimization

1 Introduction

In today's rapidly developing digital era, digital transformation has become a key way for global enterprises to enhance their competitiveness. As an important part of the national economy, small and medium-sized manufacturing enterprises (SMMEs) are facing unprecedented opportunities and challenges, and in to maintain competitiveness and achieve sustainable development, digital transformation has become an inevitable choice for these enterprises. Although the state and local governments have introduced a series of policies and measures to support and promote, due to the limitations faced by small and medium-sized manufacturing enterprises (SMMEs) in terms of capital, technology, talent, and other aspects, they face many challenges in the process of digital transformation. Therefore, it is particularly important to explore the digital transformation path and practice strategies suitable for small and medium-sized manufacturing enterprises (SMMEs).

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2 Status and Challenges of Digital Transformation

2.1 Facing the Status Quo and Challenges

At present, SMMEs in digital transformation present the following characteristics: Firstly, the uncertainty of the return on investment in digital transformation is high, and the enterprise is concerned about digital transformation. Enterprises are small in scale and face a shortage of capital and resources to afford expensive digital technology improvements and software system integration solution implementations; Secondly, enterprises are faced with the problem of a weak technological foundation, limited transformation of hardware equipment, and software application coverage is not high, the technological basis for digital transformation is relatively weak, there is a technical blind spot if the transformation, what technological routes are used for transformation; Thirdly, the enterprise in the digital transformation is difficult to attract and retain IT technology experts, data asset analysts and other key talents, these talents prefer professional information technology companies, resulting in the enterprise digital information system is difficult to implement and maintain the application. Fourthly, after realizing digital transformation, enterprises face challenges in data security, including the risk of data leakage and misuse, data privacy protection compliance, and weak data security protection capabilities.

2.2 Research Purpose

Combined with the current situation and the many problems faced by enterprises, this paper studies a set of SMMEs' digital transformation-specific paths and realization methodology, through the enterprise digital diagnosis, transformation program planning, technology platform selection, program implementation, and other paths, planning out the enterprise "integrated digital solutions" to break the capital, technology, talent and other bottlenecks to achieve the digital transformation of SMMEs.

3 Literature Review

Digital transformation (DT) involves leveraging digital technologies to fundamentally reshape organizational structures, processes, and value propositions. As Vial (2019) outlines, DT is a disruptive process triggered by digital technologies that urge organizations to alter value-creation pathways and manage structural changes and organizational barriers [1]. Hiningsa et al. (2018) suggest that DT involves shifts in institutional arrangements, creating new organizational forms, and reconfiguring social legitimacy within the digital ecosystem [3]. DT is not merely about technology, but rather a set of strategic renewal and transformation to recreate value at different levels in different entities [12]. The digital transformation of SMMEs is influenced by various factors [10]. Currently, one of the primary challenges for SMMEs lies in the high cost and resource requirements associated with digital transformation [6]. SMEs often lack the

financial resources and skilled personnel necessary for extensive digital adoption. Furthermore, there is a risk that employees may resist technological changes due to a lack of understanding or concerns over job security [2].

Companies should actively seize the opportunities presented by new digital technologies [4]. A crucial factor in the successful digital transformation of SMMEs is their capacity to adapt their business strategies to harness the opportunities that digital technologies present. The digital transformation strategy (DTS) emphasizes aligning IT and operational frameworks to introduce digital technologies effectively [13]. Matt et al. (2015) explain that DTS should guide firms in both initiating digital adoption and sustaining transformed processes through governance structures [9]. Meanwhile, scholars such as Kohli (2019) proposed a more hands-on model of digital transformation, i.e., attempts in the directions of human resources, technological resources, data strategy, content strategy, channel strategy, and social business strategy, and at the same time, utilizing restructured digital technology to improve the value creation model, leading to product and service innovation, business model innovation, operational efficiency, and organizational performance improvement [5].

At the same time, digital platforms play a central role in many firms' value propositions by enabling them to leverage information management [8]. Digital platforms are technologies that allow firms to homogenize, edit, and dis-tribute data on an unprecedented scale [7]. Moreover, SMMEs must focus on refining their value-creation processes to ensure competitiveness in the digital era [11]. According to research, digital business strategies (DBS) underscore the need to employ digital resources like cloud computing, IoT, and data analytics to sustain competitive advantages and streamline operational processes [1].

Through the combing of digital transformation literature, it is found that digital transformation has become a popular topic. Foreign research on enterprise transformation, and enterprise digital transformation theory is relatively early and more in-depth, in terms of background, motivation, key path, landing program and its practice effect research, etc., for China's enterprise digital transformation path research to provide a strong reference.

4 Paths and Practical Strategies for Digital Transformation

4.1 Digital Transformation Path

Develop a Clear Strategic Plan. Before the digital transformation of SMMEs, business managers should develop a clear strategic plan to define the transformation goals, core business, demand pain points, path, and timetable. Strategic planning should be in line with the overall development strategy of the enterprise, using the principle of overall planning and step-by-step implementation, to ensure that digital transformation can bring real value to the enterprise. The digital transformation process for SMMEs is shown in Figure 1.

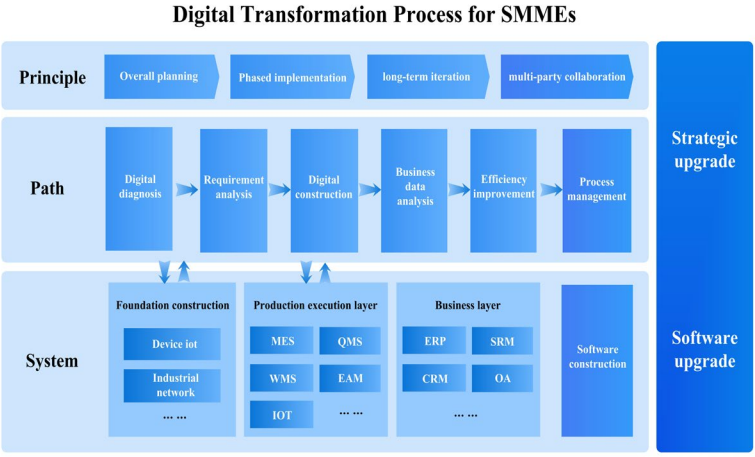

Fig. 1. Digital transformation process for SMMEs.

Choose the Right Technology Platform. SMMEs should choose the right technology platform according to their own business needs and technical strength. For example, they can combine cloud computing, big data, the Internet of Things, and other advanced technologies, while planning an "integrated" digitalization system to effectively reduce the construction cost of digital transformation and improve the enterprise's data processing and analysis capabilities and improve the enterprise's data processing and analysis capabilities . Priority should be given to the management needs of core business processes, and at the same time, attention should be paid to the scalability and compatibility of the technology to ensure that the technology platform can meet the needs of the enterprise's future development.

Optimization of Business Processes and Management Mode. SMMEs should carry out comprehensive combing and optimization of existing business processes, and the whole process to achieve a closed loop to avoid eliminating waste and bottlenecks. At the same time, they should learn from advanced management models, such as lean production, agile management, and so on, to improve the management level and operational efficiency of enterprises.

Strengthening Data Management and Application Capabilities. Data is the core element of digital transformation. Small and medium-sized manufacturing enterprises should establish a perfect data management system to ensure the accuracy, integrity, and security of data. At the same time, they should concentrate on data analysis and application capabilities, using data mining, machine learning, and other technical tools to explore the potential value of data and provide support for organizational decision-making.

Cultivate and Introduce Digital Talents. SMMEs should focus on the cultivation and introduction of digital talents. On the one hand, they can improve the digital literacy and skills of their employees through internal training and external recruitment. On the other hand, they can cooperate with universities, research institutions, and other organizations to introduce professionals with a digital background to provide talent guarantee for the digital transformation of enterprises.

Application for Policy Funding Support. The central and local governments have issued a series of policy documents, such as the Notice of the Ministry of Finance and the Ministry of Industry and Information Technology on the Pilot Work of Digital Transformation of Small and Medium-sized Enterprises (SMEs), which explicitly puts forward a policy orientation to support the digital transformation of SMEs, plans to carry out the pilot work in three batches from 2023 to 2025, and provides award funding support for the digital transformation of SMEs in the pilot cities. In addition, financial support for the digital transformation of SMEs can be provided by applying for government-guided funds and bank loans.

4.2 Digital Transformation Practice Strategy

Promote Intelligent Manufacturing. Intelligent manufacturing is an important direction for the digital transformation of SMMEs. Through the introduction of intelligent manufacturing technology, such as intelligent equipment and intelligent factories, the automation, intelligence, and collaboration of the production process can be realized. This can not only improve production efficiency and quality but also reduce production costs and resource consumption.

Building a Digital Supply Chain. The digital supply chain is an important means for SMMEs to enhance their market competitiveness. By building a digital supply chain, the transparency, collaboration, and intelligence of the supply chain can be realized. This can not only improve the responsiveness and flexibility of the supply chain but also reduce the risk and cost of the supply chain.

Innovative Product and Service Models. SMMEs should utilize digital technology to innovate product and service models. For example, they can analyze customer needs through big data to provide personalized products and services; they can expand sales channels and customer resources through the Internet platform. This can not only enhance the market competitiveness of enterprises but also increase their sources of income.

Strengthening Cooperation and Sharing. SMMEs should strengthen cooperation and sharing with other enterprises, universities, research institutions, and so on during the digital transformation process. Through cooperation and sharing, they can obtain more technical, talent, and resource support to accelerate the digital transformation process

of enterprises. At the same time, it can also promote the synergistic development of enterprises upstream and downstream of the industrial chain, resulting in the formation of an industrial ecology.

Strengthening Data Security Protection and Compliance Management. SMEs should establish sound data security management systems and processes to strengthen risk prevention of data leakage and misuse. At the same time, they should actively understand and comply with the requirements of relevant laws and regulations to ensure compliance of data processing activities. In addition, enhance employees' data security awareness and capabilities by strengthening internal training and technical support.

5 Digital Transformation Enterprise Case Results and Analysis

5.1 Successful Case Analysis

The basic information of specific digital transformation case companies is shown in Table 1.

Table 1. Digital transformation case enterprise basic situation.

Company name	Registered capital	Industry	Main products	2023 Revenue
A Intelligent Equipment Co	15 million	High-end equipment	CNC machine tool equipment	25 million
B Electrical Appliance Co	65 million	electronic information	Electronic sensors, automation controllers	43 million
C Machine Co	59 million	smart device	Intelligent packaging line equipment	165 million

Analysis of Digital Maturity Diagnosis Results of A Intelligent Equipment Co. Comprehensive evaluation of enterprise diagnosis: 31.70 points, in the stage of single coverage, the specific scores are shown in Table 2.

Table 2. Digital transformation score.

Metric	Digital infrastructure	Business application	Synergistic integration	Business model innovation	Final score
Score	38.23	28.19	23.75	6.75	31.70

Analysis of Digital Maturity Diagnosis Results of B Electrical Appliance Co. Comprehensive evaluation of enterprise diagnosis: 48.92 points, in the single coverage stage, the specific scores are shown in Table 3.

Table 3. Digital transformation score.

Metric	Digital infrastructure	Business application	Synergistic integration	Business model innovation	Final score
Score	57.20	54.69	27.23	14.76	48.92

Analysis of Digital Maturity Diagnosis Results of C Machine Co. Comprehensive evaluation of enterprise diagnosis: 44.86 points, in the stage of single coverage, the specific scores are shown in Table 4.

Table 4. Digital transformation score.

Metric	Digital infrastructure	Business application	Synergistic integration	Business model innovation	Final score
Score	51.30	39.76	32.03	35.13	44.86

5.2 Evaluation of the Effectiveness of Transformation and Upgrading

For A, B, and C three enterprises to carry out the construction of digital transformation, the implementation of the landing of the production data analysis within six months after the implementation of the quantification of digital transformation from the quality of the latitude, cost, efficiency, energy consumption, R & D and economic benefits and other dimensions of the results shown in Table 5.

Table 5. Evaluation of the effectiveness.

factor dimension	Key indicator	Enterprise A (high-end equipment)		Enterprise B (electronic information)		Enterprise C (smart devices)	
		Pre-Digital Transformation	Post-Digital Transformation	Pre-Digital Transformation	Post-Digital Transformation	Pre-Digital Transformation	Post-Digital Transformation
Quality Dimension	Qualified rate of product quality	100%	100%	99%	100%	99%	100%
cost dimension	Stagnant material ratio	1.2%	1%	0.9%	0.5%	0.8%	0.6%
	Cost-effectiveness ratio	4.38%	5%	31%	35%	6%	8%
Efficiency dimension	Total labor productivity (million yuan/person)	50.6	53	27	50	94.67	96
	Single product production efficiency (Productivity KPIs)	92	98	97	98	90	97
	Sales Margin	4.3%	6.5%	39%	45%	7%	9%

	Comprehensive equipment utilization efficiency	98%	100%	90%	95%	90%	94%
	Capacity utilization ratio	98%	100%	50%	60.5%	90%	95%
	Inventory fund turnover ratio	2	2.5	5	7	3	3.5
	On-Time delivery ratio	100%	100%	90%	100%	85%	90%
Energy Consumption Dimension	Comprehensive energy consumption of 10000 Yuan output value	0.76	0.72	0.1	0.09	0.62	0.58
	Decrease in value-added energy consumption	0%	0.2%	0%	0.7%	10%	12%
R&D Dimension	New product output ratio	10%	12%	80%	85%	17%	22%
Economic benefit	Main business growth ratio	5%	8%	0.6%	1%	12%	20%
	Enterprise value-added ratio	13%	15%	10%	13.5%	9.9%	11%
Customer' service	Customer satisfaction	90%	95%	98%	99%	89%	94%
	After-sales service response speed (hour H /incident)	24H	12H	2H	0.5H	24H	12H

6 Conclusion

6.1 Summary

SMMEs are a key way to enhance enterprise competitiveness and achieve sustainable development. In the process of digital transformation, enterprises should formulate a clear strategic plan, choose a suitable technology platform, optimize business processes and management models, strengthen data management and application capabilities, and cultivate and introduce digital talents. At the same time, they should also focus on practical strategies such as promoting smart manufacturing, building digital supply chains, innovating product and service models, and strengthening cooperation and sharing.

Through continuous exploration and practice, SMMEs can gradually overcome the challenges of digital transformation and achieve success in digital transformation. However, digital transformation is not an overnight success and requires continuous investment and effort from enterprises. SMMEs should focus on the following points in the process of digital transformation.

Continuously Focus on Technological Innovation. Technological innovation is an important driving force for digital transformation. SMMEs should continuously pay attention to the development and application of new technologies, such as artificial intelligence, blockchain, 5G, etc., and explore the application scenarios and value of new technologies in enterprises. Through technological innovation, they should continuously promote the digital transformation process of enterprises, and at the same time, combine with the enterprise budget to select suitable technology solutions.

Strengthening Organizational Management and Culture Shaping. Digital transformation is not only a change at the technical level but also a change at the organizational and cultural levels. SMMEs should strengthen organizational change, optimize organizational structure and processes, improve organizational flexibility and responsiveness, and introduce and cultivate advanced enterprise management concepts. At the same time, they should focus on culture shaping, create an open, innovative, and collaborative cultural atmosphere, and stimulate the enthusiasm and creativity of employees.

Establish a Sound Data Asset System. Data is the core resource of digital transformation. SMMEs should establish a sound data governance system, clarify the ownership, responsibility, and usage rules of data, and ensure the accuracy, integrity, and security of data. At the same time, they should focus on data integration and sharing, break data silos, and realize the optimal allocation of data resources and the development and utilization of data assets.

6.2 Future Outlook

With the continuous development and application of information technology, the digital transformation of small and medium-sized manufacturing enterprises will show a broader and deeper trend. Digital transformation will promote SMMEs to realize a more efficient, intelligent, and green production and service mode, and improve their competitiveness and sustainable development.

At the same time, digital transformation will also bring more business opportunities and innovation space for SMMEs. Through digital transformation, enterprises can expand new business areas and market space, and realize cross-border integration and innovative development. This will bring more growth momentum and development opportunities for SMMEs.

In conclusion, the digital transformation of SMMEs is a long-term and complex process that requires continuous investment and efforts from enterprises. Through continuous exploration and practice, SMMEs can gradually overcome the challenges in digital transformation, realize the success of digital transformation, and inject new vitality and momentum into the sustainable development of enterprises.

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