Research Article

Digital Transformation of Manufacturing Enterprises: An Empirical Study on the Relationships between Digital Transformation, Boundary Spanning, and Sustainable Competitive Advantage

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This paper investigates the relationships between digital transformation, boundary spanning, and sustainable competitive advantage of manufacturing enterprises through an analysis of data from 127 manufacturing enterprises. Our main research findings are as follows. First, digital transformation has a positive impact on sustainable competitive advantage of manufacturing enterprises. Compared with the degree of transformation, technology readiness has a stronger influence on sustainable competitive advantage. Second, digital transformation has a positive impact on boundary spanning of manufacturing enterprises. Third, boundary spanning of manufacturing enterprises has a positive impact on their sustainable competitive advantage. Fourth, digital transformation affects the acquisition of sustainable competitive advantages of enterprises through boundary spanning, where the direct role of digital transformation accounts for 75% and the mediation effect of boundary spanning accounts for 25% of the total effect. Fifth, the mediation effect of boundary spanning on the relationship between digital transformation and sustainable competitive advantage is mainly realized through boundary spanning depth, while the mediation effect of boundary spanning breadth on the relationship between digital transformation and sustainable competitive advantage is insignificant. Our findings can help realize the digital transformation of manufacturing enterprises and achieve their sustainable competitive advantage.

1. Introduction

With the advance of the fifth technological revolution and the full penetration of a new generation of information technology, industrial and economic powers have put forward strategies based on the integration of information technology and manufacturing enterprises, such as "National Strategic Plan for Advanced Manufacturing Industry" and "Industry 4.0." The global manufacturing landscape is undergoing deep changes. As the world's largest manufacturing and trading country, China has made remarkable achievements in the past 40 years. In 2019, the added value of China's manufacturing industry accounted for 28.1% of the world's total. Traditional manufacturing enterprises are promoting digital transformation. For example, Lenovo launched the digital strategy of "smart China," and Huawei built a digital platform using computing, storage, and other technologies. Digitization, intelligence, and servitization have become trends for manufacturing enterprises. The COVID-19 epidemic and its continuing impact have speeded up the pace of integration of these trends. However, Chinese manufacturing enterprises still face problems such as lack of core technology, fading demographic dividend, rising cost, and overcapacity. This change is both an opportunity and a challenge to traditional manufacturing enterprises. How to use this opportunity to break the low-end lock-in of Chinese manufacturing enterprises in the global manufacturing

pattern and build new competitive advantage has become the focus when developing Chinese manufacturing industry. The Chinese government pointed out that it is necessary to "speed up to construct a manufacturing power, to develop advanced manufacturing industry, and promote the deep integration of the Internet, big data, artificial intelligence and the real economy" [1]. In June 2020, the government adopted the "guiding opinions on the integrated development of the new generation of information technology and manufacturing industry" [2]. It underlines the application and integrated development of the new generation of information technology with the manufacturing industry, to speed up the deep change of the manufacturing production mode and enterprise form, to realize the high-quality development of the manufacturing industry.

Information technology and the Internet have provided a common technological foundation for different industries and entities. However, integrating complex and cutting-edge information technology and manufacturing enterprises is a cross-border integration of technology and knowledge, which cannot be completed independently by individual enterprise. It is necessary to meet the complex and changeable needs of consumers through cross-border cooperation and innovation in an open and cooperative environment. The interaction between innovative technology and market demand has blurred the boundaries between industries, entities, and products [3]. Digital transformation is not a simple addition of the new generation of information technology to enterprises. It is an innovation that uses information processing technologies such as big data, cloud computing, and the Internet of Things to connect enterprises, consumers, suppliers, and other stakeholders with physical and mechanical units to create complex and novel products and services [4]. It highlights the integration of production factors. When the new generation of information technology spreads to enterprises, enterprises need to cross the border to seek innovative resources and realize the effective sharing of heterogeneous resources according to the market demand, to realize the cross-border innovation of original and related technologies and gain competitive advantage. Boundary spanning behavior of enterprises has a great impact on the result of digital transformation.

The existing literature has conducted in-depth research on digital transformation and boundary spanning behavior. However, the influences of boundary spanning behavior in digital transformation of manufacturing enterprises are still unclear, and there is little empirical research on it. A brief literature review shows several drawbacks in the relevant research directions. First, digital transformation research focuses on a theoretical discussion on the essential characteristics [5], antecedents [6, 7], consequences [8, 9], and value creation mechanism [10, 11] of digital transformation. The measurement of digital transformation in existing literature is not mature. Technical indicators such as Internet penetration rate, length of long-distance optical cable line, number of mobile terminals, or number of patents or technologies applied by enterprises in the field of Internet technology are mostly used for measurement [12, 13], which cannot fully describe the degree of integration between the technologies applied and value creating activities. Second, existing research on boundary spanning behavior mostly focuses on characteristics of individuals or teams in the organization, and few studies are exploring the overall characteristics of boundary spanning behavior at the organizational level. Third, most of the existing research explores the impact mechanism of digital transformation on manufacturing enterprises from internal factors such as human capital structure, organization, and innovation [6, 9] or external factors such as the value chain or network alliance [14, 15]. The research on the cross-border integration of internal and external resources in digital transformation is limited to theoretical construction.

At present, digital transformation is the inevitable trend of enterprise development, but how to effectively promote digital transformation? The implementation path is still unclear. Is the existing digital transformation of manufacturing enterprises conducive to the acquisition of competitive advantage? This has not been verified by empirical research.

Given this, this study attempts to summarize the overall characteristics of manufacturing enterprise boundary spanning behavior at the organizational level and tries to frame and verify the impact mechanism between manufacturing enterprise digital transformation, boundary spanning behavior, and sustainable competitive advantage using empirical research methods. This research measures the characteristics of enterprise digital transformation from two dimensions, namely technology readiness and transformation degree. Our findings can help manufacturing enterprises to deepen the theoretical exploration of the essence of digital transformation and boundary spanning behavior. They provide theoretical support for manufacturing enterprises to adapt to technological and market changes, and explore a more operational and effective implementation path for manufacturing enterprises in transition.

The rest of this paper is organized as follows. In Section 2, the basic concepts and measurements of digital transformation and boundary spanning behavior are introduced, and the hypotheses are put forward to build the theoretical framework. Then, the research design, data collection, analysis method, and results are presented in Sections 3 and 4, respectively. Section 5 presents the discussion of the results and the related contributions and enlightenment. Finally, Section 6 is the conclusion of this research.

2. Conceptual Framework and Hypotheses

2.1. Basic Concepts

2.1.1. Digital Transformation. The Chinese government pointed out that "we should deepen the integration of the Internet innovative achievements with all sectors of the economy and society, promote technological progress, efficiency improvements and organizational transformation, enhance the innovation and productivity of the real economy, and form a wider new form of economic and social development with the Internet as the basic infrastructure

and innovative elements" [16]. Digital transformation emphasizes the use of the new generation of information technology to achieve comprehensive transformation and upgrading of manufacturing, agriculture, energy, and other industries.

Pan and Zhao [17] defined the digital transformation of manufacturing enterprises as the phenomenon that the manufacturing industry comprehensively integrates the Internet with its development concept, production mode, business mode, and profit mode. It forms a composite economic effect by blurring the industrial boundary and promoting competition-cooperation relations in industry. It is manifested in the integrated innovation activities of manufacturing enterprises at the technical, business, and market levels. Zhao and Peng [10] define digital transformation from the perspective of value chain as "the symbiotic phenomenon of deconstruction of the real value chain and cross-chain reorganization with virtual value chain."

Based on the definition of digital transformation collected from the literature and in combination with the focus of this study, the digital transformation of manufacturing enterprises is defined as innovation process of manufacturing enterprises to adopt the new generation information technologies such as mobile Internet, cloud computing, Internet of Things, and big data; fully integrate internal and external resources; and carry out the digital, networked, and intelligent transformation of value creation activities such as production, research and development, sales, and service. The promotion of digital transformation in manufacturing enterprises mainly focuses on improving the integration level of three modernization strategies of manufacturing enterprises and developing collaborative manufacturing of the whole industrial chain. It is manifested in intelligent manufacturing characterized by smart factory, flexible production to meet users' personalized needs, networked collaborative production in all activities of the industrial chain, and service-oriented transformation for the whole process of production organization.

The empirical research related to digital transformation is not perfect yet. The measurement of this concept is constantly adjusted with the change of the penetration of information technology into the economy and society. Combining the relevant research, there are mainly three measurement methods: (1) Based on the specific technology applied by enterprises: This includes single technical indicators, such as Internet penetration [18], length of long-distance optical cable line [19], and number of mobile terminals [20], and composite indicators, such as the "information multiplier" used by Zhang [21]; that is, the two dimensions of the application of information technology and e-commerce activities are used to measure the degree of enterprise industrialization and information integration. (2) Based on the application context of information technology: This includes the use of TOE framework, which comprehensively considers technical context, organizational context, and environmental context to measure the penetration of information technology into economy and society, which is widely used in relevant empirical research on the adoption of information technology [22]. Oliveira and Martins [23] proposed, on the basis of TOE

framework, a model comprised of perceived benefits, technology and organizational readiness, and environmental and external pressure, which measures the degree of information technology integration in terms of the organization's expectation and preparation for the current technology and mode. (3) Based on the division of enterprise value creating activities involved in information technology: That is, the integration degree of information technology and enterprises is measured by testing the specific penetration and transformation degree of information technology in different value creating activities. For manufacturing enterprises, it is to measure digital transformation from the perspective of "R&D, manufacturing, marketing, sales and brand, and customer relationship maintenance" [24]. For example, Tallon [25] measured the value of information technology business from the perspective of five main processes: supplier relationship, production and operation, production and service improvement, marketing and sales support, and customer relationship. In addition, pan and Zhao [17] tested the degree of digital transformation in the three aspects of technology, business, and market from the perspective of cross-border technological innovation, business and management model innovation, and product and service innovation.

With the in-depth integration of the new generation of information technology into all activities of enterprise value creation, manufacturing enterprises are using more types of information technology. However, the technologies applied cannot fully reflect the degree of digital transformation. Therefore, this research combines the technology implication context and the transformation of organizational value creating activities to measure manufacturing enterprises' digital transformation of the industry. Technology readiness is the technical and organizational readiness for the transformation of emerging technologies and models, including the sum of human resources of enterprise technology infrastructure and information technology [26]. Technology infrastructure is the platform for adopting the new generation of information technology, and information technology human resources reflect the knowledge and skills of the organization to apply the new technology [22]. At the initial stage of the transformation of technology penetration, the organization's technical preparation for change and the organizational acceptance have a great impact on the possibility of success in digital transformation. The degree of transformation is the degree to which manufacturing enterprises use the new generation of information technology to implement transformation in all value creating activities such as R&D, manufacturing, sales, service, and organization. Manufacturing enterprises should not be limited to the technical level when they are adopting and deploying the new generation of information technology. It is necessary to promote the integration of technology and all value creating activities of enterprises and comprehensively examine the enterprise business process and organizational structure [27]. Therefore, this research draws lessons from the research results at home and abroad and comprehensively measures the degree of enterprise digital transformation by using technology readiness and degree of transformation as the two dimensions of digital transformation.

2.1.2. Boundary Spanning Behavior. Existing research on boundary spanning covers a wide range of contents with a changing focus over time. Ancona and Caldwell [28] conduct impactful empirical research on team boundary spanning behavior. They define boundary spanning as the behavior of an organization to establish relations and maintain interaction with external stakeholders to achieve its overall objectives. These externally oriented activities include managing changing customer needs, negotiating project scope, and obtaining key information sources from outside. With the development of the Internet economy, the boundaries of organization and technology are gradually blurred, and the focus of boundary spanning behavior research tends to rise from the specific behavior of "people" in the organization to more macro organizational level research. Krishnan [29] argues that boundary spanning behavior occurs at the periphery or boundary of the organization to implement all activities with partner organizations, while Catalano [30] raises boundary spanning behavior to "the behavior of the organization to reduce uncertainty or manage emergencies that may threaten the survival of the organization."

Combined with the existing literature and research objectives, this study takes the boundary spanning behavior at the organizational level as the research object. Boundary spanning behavior is defined in this study as the behavior of an organization or department to integrate different resources and capabilities, to cross different boundaries, to establish contact and management interaction with all parties in the environment, and then to create value.

Due to different levels of research objects and perspectives, there are many different standards to measure boundary spanning behavior. A brief literature review revealed that the existing measurement of boundary spanning behavior is mainly carried out from the following five perspectives: (1) Based on types of behavior in cross-border communication: Researchers need to observe the boundary spanning behavior of teams or individuals in the work context, which refines how boundary spanning behavior occurs and develops between borders. The widely accepted scale of boundary spanning behavior produced by Ancona and Caldwell [28] divides boundary spanning behavior into ambassador behavior, task coordination, scanning, and guard function. (2) Based on types of boundaries crossed: The boundary spanning behavior of the organization is measured by dividing the boundaries crossed by the flow of resources and technologies. The main boundaries include department, organization, technology, industry, and supply chain. The most representative research is Rosenkopf and Nerkar [31] studying the optical disc industry in which the axes of resources and technology divide boundary spanning behavior into four quadrants: local search, internal boundary spanning, external boundary spanning, and radical boundary spanning. (3) Based on types of resources flowing in boundary spanning behavior: The level of boundary spanning behavior is investigated by observing the different nature of resources flowing between organizational boundaries. For example, Krishnan [29] divides organizational boundary spanning behavior into knowledge

boundary spanning, social boundary spanning, and operational boundary spanning. (4) Based on the division of roles played by boundary spanners in the connection between organizations from the perspective of role theory: The most classic research is Tushman and Scanlan's [32] division of boundary spanners into gatekeepers and internal liaisons. (5) Based on the division of the scope of boundary spanning behavior and influence: It measures the number and interaction degree of external resource channels the enterprises rely on in innovation, which describes the openness of enterprises to the external environment. For example, Laursen and Salter [33] put forward the concepts of depth and breadth when studying the interaction between organizations and the external environment.

This research attempts to study the relationship between digital transformation and boundary spanning behavior at the organizational level, which has the same research level as the abovementioned fifth perspective. Therefore, this paper uses this perspective to measure boundary spanning behavior, and measures boundary spanning behavior with breadth and depth of boundary spanning. Boundary spanning breadth is the quantity of unique sources of resources in the enterprise's boundary spanning behavior, reflecting the diversity of industries and fields from which the organization obtains resources [34]; boundary spanning depth refers to the degree of absorbing information and resources from the environment [33], which is reflected in the enterprise's ability to master and integrate internal or external resources, the degree of relying on information sources to achieve innovation, and the degree of enterprise's control over resources in boundary spanning behavior [35].

2.2. Hypothesis Development

2.2.1. Digital Transformation and Sustainable Competitive Advantage. Since the 1970s, people began to pay attention to the impact of information technology on enterprise products and industrial competition. In the 1990s, information technology as a competitive weapon became a mainstream topic. Sethi and King [36] proposed that information technology can create a competitive advantage by improving efficiency, realizing differentiation and channel control. Today, efficiency and differentiation are still the sources of sustainable competitive advantage of enterprises, but the rent obtained through channel control and information asymmetry in the early stage has gradually disappeared due to the development of the Internet economy. Instead, it is realized by creating value with consumer groups and enhancing consumer stickiness. Therefore, in the Internet era, enterprises can obtain a sustainable competitive advantage by improving efficiency, realizing differentiation, and increasing customer group stickiness.

Technology readiness of digital transformation refers to the sum of enterprise technology infrastructure and human resources in the information technology field. Technology infrastructure is a platform for adopting a new generation of information technology, and human resources in the information technology field reflect the knowledge and skills of the

organization in using new technologies [22]. Enterprise infrastructure and related knowledge and skills determine the ability of enterprises to use the new generation of information technology. Organizations without strong technology infrastructure and knowledge and skills to use new technologies are relatively conservative when taking risks to adopt new technologies [23]. This means that enterprises with higher technology readiness are more inclined to promote the change of production mode with the new generation of information technology. A large number of foreign empirical studies regard technology readiness as an important factor affecting the adoption of information technology [22, 23, 37], and the adoption of information technology and its related resources are an important factor affecting the sustainable competitive advantage of enterprises under the current economic and technological background.

The degree of transformation refers to the degree to which manufacturing enterprises use the new generation of information technology to implement transformation in all value creating activities such as R&D, manufacturing, sales, service, and organization. Digital transformation reshapes the whole logic of value creation. To obtain sustainable competitive advantage in the current environment, manufacturing enterprises need to change the original logic of production and service and promote the process of digital transformation in all aspects, such as strategy, structure, and operation. The transformation degree of digital transformation in all value creating activities improves production and transaction efficiency [19] by improving the production process, promoting division of labor, improving labor productivity [38], and reducing enterprise production cost [20]; the research confirms that through digital transformation, the innovation ability of enterprises is improved and the differentiation of products and services is enhanced [39]. The digital transformation helps to increase the interaction between enterprises and consumers and enhance the stickiness of consumer groups. Strong consumer stickiness means the specificity and derivation of this consumer group. It helps enterprises occupy the market structure hole and obtain huge rents through the crowd isolation mechanism in the process of value cocreation. While the customer group adhesiveness can only be obtained through long-term cultivation, which is difficult to obtain through trading, imitation, or substitution, it will enhance and maintain the enterprise competitive advantage [40]. Therefore, the following hypotheses are proposed.

Hypothesis 1. There is a positive correlation between technology readiness of digital transformation and sustainable competitive advantage of manufacturing enterprises.

Hypothesis 2. There is a positive correlation between the transformation degree of digital transformation and the sustainable competitive advantage of manufacturing enterprises.

2.2.2. Digital Transformation and Boundary Spanning Behavior. The advancement of the digital transformation process means breaking the boundaries between departments, organizations, value chains, and even industries. It is a kind of cross-border operation. Traditional enterprises usually pay more attention to the product, while in the Internet era enterprises need to focus on relationships and connections. The process of digital transformation is a process of connecting fragmented industrial subjects and promoting integration using a new generation of information technology. Boundary spanning behavior can meet the fundamental needs of the Internet to blur boundaries and create new values. At the same time, the Internet and digitization of economic activities have led to the transformation of the way of value creation [41] from point-to-point cooperation in the value chain to value network connection between consumers and various stakeholders [42]. Industrial technology models, industrial forms, enterprise production and organization modes, business models, and market structures are undergoing drastic changes. It can be said that digital transformation has made low-cost socialized division of labor and coordination possible, provided technical support for boundary spanning behavior, and thus changed the content and nature of enterprise boundary spanning behavior.

Specifically, digital transformation affects the boundary spanning behavior of enterprises from the two aspects of technology readiness and degree of transformation.

Firstly, technology readiness is the infrastructure and relevant knowledge and skills for enterprises to adopt the new generation of information technology, which provides technical conditions for enterprises to achieve efficient collaboration across organizational and departmental boundaries. Based on the application of technologies such as Internet of Things, cloud computing, big data, and artificial intelligence, smart factory provides unprecedented technical support for information and resource interaction. Technology readiness of digital transformation provides enterprises with more technical resources and increases communication and coordination between suppliers, manufacturers, customers, scientific research institutions, and other stakeholders. Information technology, as a cross-border carrier, can promote boundary spanning behavior of enterprises [43]. The intelligent industrial network that collects, stores, and analyzes data can realize the digitization of products through the whole life cycle and establish real-time connections and interactions among products, machines, production systems, enterprises, value chains, and even different industries.

Secondly, the degree of transformation is the degree to which enterprises integrate various resources in value creating activities using the new generation of information technology, which substantially reflects the process and ability of enterprises to disintegrate their traditional boundaries and promote cross-border collaboration between enterprises. Digital transformation not only provides a low-cost way of information communication, but also breaks many traditional boundaries and changes people's understanding of the definition of boundaries: (1) Digital transformation breaks the constraints of physical time and space and has the characteristics of crossing regional and time constraints. Industrial development is no longer limited

to the unity of time and the proximity of space, and the economic time and space of value creation are gradually expanding [44]. (2) Digital transformation breaks the boundary between economic subjects, which is specifically reflected in the following: the boundary between producers and consumers is broken, and consumers participate in product design to meet personalized needs and realize value cocreation; the boundary between consumers is broken, Internet technology establishes communication channels between consumers, and consumer groups have greater market power; and organizational boundaries between producers have been broken, cross-organizational cooperation has become more and more smooth, and a large number of cross-border products and talents have emerged. Industrial and technological boundaries have been broken, technology in different fields has a trend of integration, and the time for cross industry penetration and diffusion of technology has been greatly shortened. Therefore, the following hypotheses are put forward.

Hypothesis 3. There is a positive correlation between technology readiness and boundary spanning breadth of manufacturing enterprises.

Hypothesis 4. There is a positive correlation between the degree of transformation and the boundary spanning breadth of manufacturing enterprises.

Hypothesis 5. There is a positive correlation between the technology readiness of digital transformation and the boundary spanning depth of manufacturing enterprises.

Hypothesis 6. There is a positive correlation between the degree of transformation and the boundary spanning depth of manufacturing enterprises.

2.2.3. Boundary Spanning Behavior and Sustainable Competitive Advantage. Boundary spanning behavior forms accumulated resources through the inward and outward exchange of information, knowledge, and resources across organizational boundaries. At the same time, it also realizes the dynamic circulation of resources in value networks formed by stakeholders. Boundary spanning behavior among enterprises has changed from point-to-point communication and cooperation to interactive network relations. The original competitive relationships between enterprises, or between enterprises and consumers, are transformed into a competitive and cooperative relationship. The value increment of the whole value network and the maintenance of sustainable competitive advantage can ensure that a single enterprise can obtain sustainable competitive advantage [45]. As a key organizational capability [46], boundary spanning behavior has been proved to have a positive impact on innovation [31] and performance [28] of the organization or team.

Specifically, boundary spanning behavior can help enterprises obtain sustainable competitive advantage through the following ways:

(1) Reducing uncertainty. Boundary spanning behavior helps boundary spanners convey information about the environment to the organization and reduce uncertainty [47]. Boundary spanners act as gatekeepers or filters between organizations and control the information flow in and out of the organization [32], such as social, disruptive technology, and material related technical information related to the views and expectations of competitors and other organizations. The acquisition of relevant information is conducive to reducing environmental uncertainty, which will have a positive impact on project performance or organizational competitive advantage [48].

(2) Promoting boundary spanning learning. Existing research shows that boundary spanning behavior improves the competitive advantage of organizations through individual external knowledge learning [49], knowledge sharing and transfer between departments, and knowledge absorption between organizations [48]. Luo and Li [50] research confirms that the value created by boundary spanning behavior is positively related to the breadth and richness of cross-border knowledge. Boundary spanning behavior obtains opportunities for the reallocation of cross-border resources through the complementarity of assets owned by potential partners and the potential learning from partners, to obtain the sustainable competitive advantage of the enterprise.

(3) Building relationships and obtaining connection dividends. The research confirms that the value created by cross-border cooperation is positively related to the environmental adaptability and competitiveness of enterprises [50]. In boundary spanning behavior, different cross-border relationships have different effects on inter-enterprise relationships. Interpersonal trust among boundary spanners affects interorganizational trust, while trust and dependence among alliance enterprises positively affect alliance relationships [51]. Maintaining a reasonable cross-border relationship and keeping proper relationship strength and structural strength are of great significance to the performance of enterprises' open innovation [52]. Therefore, the following hypotheses are put forward.

Hypothesis 7. There is a positive correlation between boundary spanning breadth and sustainable competitive advantage of manufacturing enterprises.

Hypothesis 8. There is a positive correlation between boundary spanning depth and sustainable competitive advantage of manufacturing enterprises.

2.2.4. The Mediating Role of Boundary Spanning Behavior on the Relationship between Digital Transformation and Sustainable Competitive Advantage. The unbounded

nature of Internet technology makes it more necessary for modern enterprises to integrate resources through effective boundary spanning behavior and create diversified products and services to meet the changing and increasingly complex needs of consumers than ever [41]. Manufacturers are facing an environment with blurred boundaries and inseparable internal and external resources [50]. For manufacturing enterprises, boundary spanning behavior has become an important way to obtain sustainable competitive advantage in the Internet era [53]. In the Internet era, the change of information acquisition and circulation mode has broken the original market structure. Through boundary spanning behavior, enterprises replace social division and market division of labor with cooperation between stakeholders, which may improve the efficiency of information flow and help enterprises obtain the synergistic effect, economy of scope, and economy of scale.

Boundary spanning behavior is a necessary starting point in the process of digital transformation of manufacturing enterprises and plays an important role in obtaining sustainable competitive advantage in an uncertain environment. Luo and Li [50] believe that boundary spanning behavior generates value by connecting irrelevant or incompatible resources. Digital transformation of manufacturing enterprises can improve interorganizational communication methods, improve communication efficiency, expand market scope and scale, reconstruct coordination mechanism, and integrate relations with stakeholders through boundary spanning behavior. With increasing exchanges and communication with suppliers, customers, scientific research institutions, and other entities, enterprises can deepen and expand cooperation with the external environment and enhance the sustainable competitive advantage of enterprises [54]. Therefore, the following hypotheses are put forward.

Hypothesis 9. Boundary spanning breadth plays a mediation role in the relationship between technology readiness, degree of transformation, and sustainable competitive advantage of manufacturing enterprises.

Hypothesis 10. Boundary spanning depth plays a mediation role in the relationship between technology readiness, degree of transformation, and sustainable competitive advantage of manufacturing enterprises.

In short, this study constructs a theoretical model of digital transformation, boundary spanning behavior, and sustainable competitive advantage of manufacturing enterprises, as shown in Figure 1.

3. Research Design and Data Processing

3.1. Sample and Data Collection. This research adopts the questionnaire survey method to test the above hypotheses and selects Chinese manufacturing enterprises as the research object. The sample consists of enterprises of different regions, sizes, industries, and ownerships. For each manufacturing enterprise, only one questionnaire was sent. In the questionnaire, respondents were asked to answer

questions about, for example, the level of their position and the number of years they had worked in the company, to make sure the respondents had a clear understanding of the enterprise strategy, to improve the effectiveness of data.

A total of 202 questionnaires were delivered from December 2019 to February 2020 through WeChat (the most widely used social media application in China) or e-mail. Among them 145 were eventually collected. After excluding invalid questionnaires such as too much missing data or too concentrated answers, 127 valid questionnaires were obtained, with an effective response rate of 87.6%. Table 1 presents the distribution characteristics of the data sample.

3.2. Measures. The measurement of research variables is based on the existing mature scales and partially adjusted to the research aims of this study. All items in this study use Likert's seven-level scoring, with 1–7 representing options from "very inconsistent" to "very consistent," respectively. Before the formal distribution of the questionnaire, the initial questionnaire was revised and polished through small-scale interviews with managers from manufacturing enterprises in Shanghai, so that the questionnaire items are easy to understand, are expressed accurately, and reflect the actual measurement problems.

3.2.1. Independent Variable: Digital Transformation. Digital transformation is measured in two dimensions: technology readiness and degree of transformation. Technology readiness is the sum of human resources of technology infrastructure and information technology application [26]. The specific scale refers to the relevant research of Zhu [26], Zhang [55], and Jain [56], which is measured by items such as the comprehensive quality of enterprise R&D personnel and the willingness to improve through technology. The scale includes four measurement items: "the company has abundant R&D funds," "the comprehensive quality of the company's R&D personnel is very high," "the company is willing to bear technical risks," and "the company often improves the existing technology or skills to meet the current demands."

Degree of transformation refers to the degree to which manufacturing enterprises use the new generation of information technology to implement transformation in various value creating activities such as R&D, manufacturing, sales, service, and organization. It is specifically reflected in the degree of network collaboration on data in R&D and manufacturing activities between enterprises in the value network, and the degree of improving enterprise R&D and production using digital transformation. According to the research of He [24] and Li [57], based on the actual research needs and interview results, the degree of transformation in different value creating activities is divided into three dimensions, namely, R&D and manufacturing, sales, and service and organization. The items of R&D and manufacturing activity include "the degree of interaction and cooperation between enterprise R&D departments, users, and upstream raw material suppliers on the platform"; "enterprises use of digital transformation to
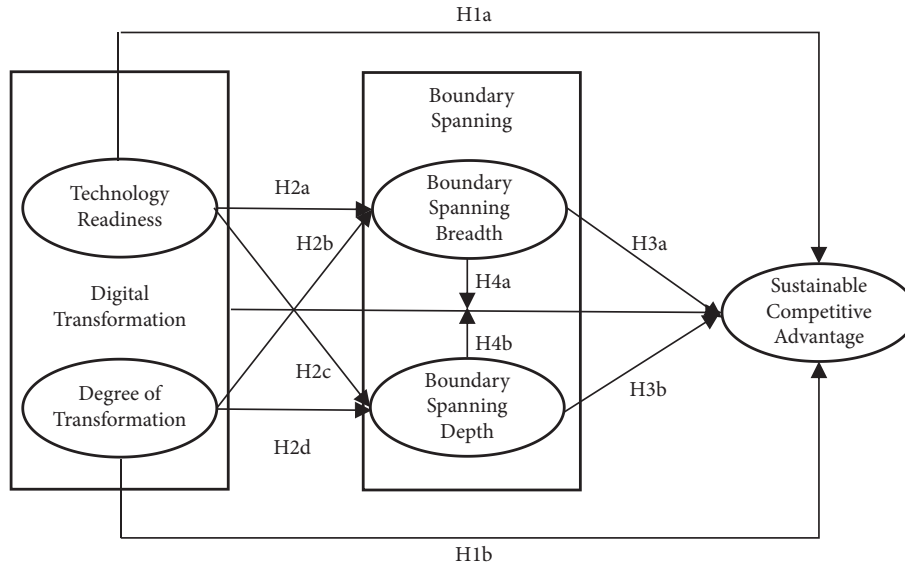
FIGURE 1: Conceptual model.

TABLE 1: Sample and population demographics.

Measure	Item	Frequency	Percentage
Ownership	State-owned enterprises	28	22
	Non-state-owned enterprises	99	78
Industry	Software, electronic, and communication equipment manufacturing	23	18.1
	Biomedicine and new materials	11	8.7
	Machinery manufacturing, chemicals, and textiles	38	29.9
	Others	55	43.3
Firm age (year)	<10	32	25.6
	10–19	39	31.2
	20–49	39	31.2
	50 or more	15	12
Number of employees	<100	40	31.49
	101–500	36	28.35
	500 or more	51	40.16
Region	Shanghai	67	52.8
	Jiangsu	26	20.5
	Others	34	26.7

improve their R&D quality"; and "enterprises use of digital transformation to improve the stability and reliability of enterprise product quality." Sales items include "establishing a self-leading e-commerce sales net," "degree of whole network channel sales," and "enterprises use of digital transformation to improve their sales revenue." The service and organization items include the following: "enterprises use digital transformation to improve the response speed to customers"; "enterprises use digital transformation to improve the service quality to customers"; and "enterprises use digital transformation to ensure smooth communication between departments and rapid allocation of resources."

3.2.2. Mediation Variable: Boundary Spanning Behavior.
Following Laursen and Salter [33] and Zahra [35], this study measures boundary spanning behavior in two dimensions based on boundary spanning breadth and boundary spanning depth.

Combining the research of Krishnan [29] and Sullivan [58], we find that boundary spanning breadth indicates the scope of enterprises boundary spanning behavior through which organizations obtain unique resources. Measuring items include the following: "the enterprise has established connections with many online user innovation communities"; "the enterprise has established connections with many competitor enterprises"; "based on the Internet platform, the enterprise has established connections with many enterprises outside the industry"; "the enterprise has established contacts with many banks, Internet financial enterprises and government departments"; and "the enterprise often sends personnel to other departments within the enterprise to understand the overall situation of the enterprise."

Based on the research of Ofstein [34] and Feng [59], this research measures the depth of boundary spanning behavior through the organization's ability to integrate internal and external resources and govern the network. The items are as

follows: "the enterprise knows the objectives and action guidelines of our participation in the innovation network"; "the enterprise has a strong ability to find, evaluate, and select partners and has various types of partners"; "the enterprise has a strong ability to develop mutual trust and mutual benefit with partners"; and "the enterprise has a strong ability to occupy the central position of the cooperation network."

3.2.3. Dependent Variable: Sustainable Competitive Advantage. Following Hwang et al. [60] and Tan et al.'s [61] research, the sustainable competitive advantage scale takes into account the enterprise's competitive situation and advantage sustainability. The scale is adjusted according to the actual research purposes. The four items are as follows: "the production and transaction costs of the enterprise have been continuously reduced compared with competitors in recent three years"; "the products of the enterprise can better meet the needs of consumers compared with competitors in recent three years"; "compared with competitors in recent three years, the enterprise's new product R&D performance is very good"; and "the enterprise's sales increased."

3.3. Nonresponse Bias and Common Method Variation. According to Armstrong and Overton [62], extrapolation methods are adopted to estimate nonresponse deviation in the questionnaire. The first 50 questionnaires received and the last 50 questionnaires received are tested, and the variance difference of the main variables in the two groups of data is observed. The results of the *t*-test show that there is no significant difference in the responses to the questions related to digital transformation, boundary spanning behavior, and sustainable competitive advantage. Therefore, it is inferred that there is no serious nonresponse deviation.

Following Podsakoff et al. [63], this research uses the single method factor approaches, to improve the effectiveness of the common method variation test. Comparing the model fitting index between the model built in the original confirmatory factor analysis and the model obtained by adding the common method factor, the change values of model fitting indexes such as RMSEA, CFI, and TLI of the two models are less than 0.03, indicating that the model has not been significantly improved after adding the common method factor. Therefore, there is no obvious common method variance in the theoretical model.

3.4. Reliability and Validity

3.4.1. Reliability Analysis. Cronbach's alpha coefficient test was conducted for each dimension of the variable, and the results showed that Cronbach's alpha coefficients of all variables were greater than 0.8, indicating that the internal consistency of each variable is high, and the questionnaire has good reliability indicators. Table 2 lists specific values.

3.4.2. Validity Test. The KMO value of each variable is greater than 0.6, and Bartlett's test passes the significance test with a significance level of 0.001, indicating that the data is suitable for factor analysis. The factor load of each variable item is greater than 0.6, indicating that each item is highly representative. The AVE of each variable is greater than 0.5, and CR is greater than 0.8, indicating that the convergence validity of each latent variable is ideal.

This study uses the method of competition model to test the discriminant validity of the questionnaire. The degree of transformation was packaged using the method recommended by Wu and Wen [64], thus forming a five-factor model. As shown in Table 3, compared with the five-factor model, the fitting indexes of other competitive models become worse, and the change value passes the chi-square test with a significant level of 0.001, indicating that the original model has good discriminant validity.

4. Analysis and Results

4.1. Descriptive Statistical Analysis of Variables. The test results of the mean, standard deviation, and Pearson correlation coefficient between variables in this study are displayed in Table 4. According to the test results, technology readiness has a significant positive correlation with boundary spanning breadth, boundary spanning depth, and sustainable competitive advantage. The degree of transformation also has a significant positive correlation with boundary spanning breadth, boundary spanning depth, and sustainable competitive advantage. There is a significant positive correlation between boundary spanning depth and sustainable competitive advantage. The correlation between each variable is significant at the level of 0.01, which is consistent with the research hypotheses of this study and provides a basis for further verification of the hypotheses.

This study controls enterprise ownership, industry category, enterprise size, and age in regression analysis. Enterprise size and age were measured using interval data, while ownership and industry categories were measured using dummy variables. Ownership was measured with a dichotomous variable, and the non-state-owned enterprise is used as the reference category. As for industry category, "other sectors" was used as the reference, and the other three categories were used as dummy variables in the regression analysis.

4.2. Hypotheses Testing

4.2.1. Results of Hierarchical Regression Analysis. According to the mediation test procedure proposed by Wen et al. [65], this study adopts hierarchical multiple regression and uses SPSS 24 software for hypotheses testing. The hierarchical regression model and analysis results are shown in Table 5. The collinearity diagnosis results reveal that the tolerance of each independent variable is greater than 0.1 and the Variable Inflation Factor (VIF) is less than 10, indicating that there is no serious collinearity problem.

As shown in Table 5, model 1, model 3, and model 5 are the basic models with control variables and take boundary spanning breadth, boundary spanning depth, and sustainable competitive advantage as dependent variables, respectively.

TABLE 2: Reliability and validity analysis of each variable.

Constructs	Items	Estimate	AVE	CR	Alpha	KMO
Technology readiness	TR 1	0.825	0.6878	0.8975	0.893	0.826 CEVA = 75.984%
	TR 2	0.721				
	TR 3	0.888				
	TR 4	0.873				
Degree of transformation	SO	0.736	0.6279	0.8347	0.839	0.625 *** CEVA = 71.176%
	SA	0.802				
	RM	0.863				
Boundary spanning breadth	BSB 1	0.788	0.5975	0.8801	0.874	0.850 *** CEVA = 66.933%
	BSB 2	0.698				
	BSB 3	0.812				
	BSB 4	0.888				
	BSB 5	0.657				
Boundary spanning depth	BSD 1	0.893	0.771	0.9308	0.929	0.815 *** CEVA = 82.799%
	BSD 2	0.894				
	BSD 3	0.888				
	BSD 4	0.836				
Sustainable competitive advantage	SCA 1	0.874	0.6518	0.8798	0.873	0.812 *** CEVA = 72.731%
	SCA 2	0.852				
	SCA 3	0.877				
	SCA 4	0.59				

Note. CEVA: cumulative explained variation rate; SO: service and organization; RM: R&D and manufacturing; SA: sales. *** means $P < 0.001$

TABLE 3: Variable validity test.

	Models	Factor	χ^2	df	IFI	TLI	RMSEA	VS	$\triangle\chi^2$	$\triangle df$
1	Five-factor model	F1, F2, F3, F4, F5	301.692	160	0.927	0.912	0.084			
2	Four-factor model 1	F1 + F2, F3, F4, F5	406.869	164	0.875	0.853	0.108	2 vs1	105.177***	4
3	Four-factor model 2	F1, F2, F3 + F4, F5	432.92	164	0.861	0.837	0.114	3 vs1	131.228***	4
4	Three-factor model 1	F1 + F2, F3 + F4, F5	536.919	167	0.809	0.78	0.133	4 vs1	235.227***	7
5	Three-factor model 2	F1, F2, F3 + F4 + F5	576.645	167	0.788	0.756	0.14	5 vs1	274.953***	7
6	Two-factor model	F1 + F2, F3 + F4 + F5	676.553	169	0.737	0.701	0.154	6 vs1	374.861***	9
7	Single-factor model	F1 + F2 + F3 + F4 + F5	747.514	170	0.701	0.662	0.164	7 vs1	445.822***	10

Note. F1: technology readiness, F2: degree of transformation, F3: boundary spanning breadth, F4: boundary spanning depth, F5: sustainable competitive advantage; "+" indicates factor consolidation; ***: $P < 0.001$.

TABLE 4: Descriptive statistics and correlation coefficient matrix.

Constructs	1	2	3	4	5	6	7	8	9	10	11
1. Enterprise ownership											
2. Software communication	−0.151										
3. Biological materials	−0.096	−0.145									
4. Mechanical chemical engineering	0.067	−0.307**	−0.201*								
5. Enterprise size	0.259**	−0.054	0.048	−0.023							
6. Enterprise age	0.258**	−0.162	−0.013	0.141	0.487**						
7. Technology readiness	−0.040	0.180*	0.106	0.081	−0.003	−0.047					
8. Degree of transformation	0.086	0.137	0.013	0.112	−0.136	−0.114	0.536**				
9. Boundary spanning breadth	0.032	0.052	0.022	0.086	−0.036	−0.141	0.635**	0.547**			
10. Boundary spanning depth	0.067	0.063	0.100	0.116	−0.051	−0.165	0.620**	0.516**	0.668**		
11. Sustainable competitive advantage	0.021	0.085	0.056	0.177*	−0.184*	-0.190*	0.659**	0.659**	0.608**	0.623**	
Mean value	0.221	0.181	0.087	0.299	3.700	23.700	5.339	5.331	5.115	5.354	5.329
Standard deviation	0.416	0.387	0.282	0.460	1.945	25.774	0.937	1.005	0.930	1.013	0.954

Note. * $P < 0.05$, ** $P < 0.01$; two-tailed tests.

Model 2 tests the relationship between technology readiness, degree of transformation, and boundary spanning breadth. The results show that technology readiness has a significant positive correlation with boundary spanning breadth ($\beta = 0.503$, $P < 0.001$). In addition, there is a significant positive correlation between the degree of transformation and boundary spanning breadth ($\beta = 0.284$, $P < 0.01$), indicating that both technology readiness and degree of transformation have a significant positive impact on boundary spanning breadth. Compared with degree of

TABLE 5: Results of hierarchical regression analysis.

	BS breadth		BS depth		Sustainable competitive advantage			
Constructs	M1	M2	M3	M4	M5	M6	M7	M8
Enterprise ownership	0.081	0.028	0.141	0.098	0.119	0.042	0.05	0.03
Software communication	0.092	−0.103	0.142	−0.038	0.175	0.094	−0.027	−0.01
Biomaterials	0.069	−0.054	0.174	0.059	0.151	0.067	0.029	0.024
Mechanical and chemical engineering	0.15	−0.01	0.216	0.07	0.274*	0.147	0.106	0.095
Enterprise size	0.039	0.061	0.023	0.038	−0.124	−0.145	−0.088	−0.101
Enterprise age	−0.187	−0.138	−0.218*	−0.175	−0.169	−0.029	−0.115	−0.071
Technology readiness		0.503***		0.489***			0.443***	0.309***
Degree of transformation		0.284**		0.228**			0.383***	0.315***
Boundary spanning breadth						0.346***		0.104
Boundary spanning depth						0.348***		0.168*
R^2	0.047	0.486	0.095	0.466	0.129	0.498	0.602	0.629
Adjusted R^2	-0.001	0.451	0.05	0.43	0.086	0.464	0.575	0.597
F value	0.983	13.929***	2.109	12.87***	2.964**	14.615***	22.271***	19.678***
ΔR^2	0.047	0.439	0.095	0.371	0.129	0.369	0.473	0.028
F variation	0.983	50.344***	2.109	40.943***	2.964**	43.301***	69.974***	4.31*

Note. Standardized coefficients are reported; $^*P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$; two-tailed tests.

transformation, the impact of technology readiness on boundary spanning breadth is greater. Hypothesis 3 and Hypothesis 4 are verified.

Model 4 tests the relationship between technology readiness, degree of transformation, and boundary spanning depth. The results show that both technology readiness ($\beta = 0.489$, $P < 0.001$) and degree of transformation ($\beta = 0.228$, $P < 0.01$) have significant positive correlations with boundary spanning depth, indicating that both technology readiness and degree of transformation have a significant positive impact on boundary spanning depth, and the impact of technology readiness on boundary spanning depth is greater compared with degree of transformation. Hypothesis 5 and Hypothesis 6 are verified.

Model 6 tests the relationship between boundary spanning breadth, boundary spanning depth, and sustainable competitive advantage. The results show that there is a significant positive correlation between boundary spanning breadth and sustainable competitive advantage ($\beta = 0.346$, $P < 0.001$), and there is also a significant positive correlation between boundary spanning depth and sustainable competitive advantage ($\beta = 0.348$, $P < 0.001$). The explanatory level of the model increased to 49.8%, an increase of 36.9% compared with model 5, indicating that both boundary spanning breadth and boundary spanning depth have a significant positive impact on sustainable competitive advantage. Hypothesis 7 and Hypothesis 8 are verified.

Model 7 tests the relationship between technology readiness, degree of transformation, and sustainable competitive advantage. The results show that both technology readiness ($\beta = 0.443$, $P < 0.001$) and degree of transformation ($\beta = 0.383$, $P < 0.001$) have a significant positive correlation with sustainable competitive advantage. After adding two independent variables, the explanatory level of model 7 increased to 60.2% ($\Delta R^2 = 43.7\%$) compared with model 5, indicating that both technology readiness and degree of transformation have a significant positive impact on the sustainable competitive advantage of enterprises. Hypotheses 1 and 2 are verified. Comparing the coefficient values of technology readiness and

degree of transformation, we can see that technology readiness has a greater impact on sustainable competitive advantage than degree of transformation.

Model 8 examines the mediation role of boundary spanning breadth and depth in the relationship between digital transformation and sustainable competitive advantage. The results show that boundary spanning depth ($\beta = 0.168, P < 0.05$) showed a significant positive correlation with sustainable competitive advantage in the mediation model. The explanatory level of model 8 was significantly improved compared with model 7 ($\Delta R^2 = 0.028$, $\Delta F = 4.31$, $P < 0.05$), in which the regression coefficient of technology readiness ($\beta = 0.309, P < 0.001$) and degree of transformation ($\beta = 0.315$, $P < 0.001$) decreased, but the significance remained unchanged, indicating that boundary spanning depth has a significant partial mediation effect on the relationship between digital transformation and sustainable competitive advantage. Hypothesis 10 is verified. However, boundary spanning breadth ($\beta = 0.104$, $P > 0.05$) has no significant influence on the relationship between digital transformation and sustainable competitive advantage, indicating that boundary spanning breadth does not have a significant partial mediation effect on the relationship between digital transformation and sustainable competitive advantage, and Hypothesis 9 has not been verified.

4.2.2. Bootstrapping Analysis and Proportion of Mediation Effect.
According to Hayes [66], the bootstrapping analysis has stronger test power on mediation relationship than the traditional testing method. Therefore, this study uses SPSS Process compiled by Hayes to further verify the mediation effect.

Model 4 in Process was used in this study to test the mediation effect of boundary spanning behavior on the relationship between digital transformation and sustainable competitive advantage under the control of enterprise ownership, industry category, and enterprise age and size, through 5,000 repeated samples and 95% confidence interval of deviation correction.

This study uses the SPSS Process to test the proportion of effect value of mediation effect, direct effect, and total effect, as well as the bootstrap confidence interval. As shown in Table 6, the upper and lower limits of bootstrap confidence interval of mediation effect, direct effect, and total effect do not contain 0, indicating that boundary spanning behavior has a mediation impact on the relationship between digital transformation and sustainable competitive advantage. Among these effects, the mediation effect (effect value = 0.203) accounts for 25% of the total effect (effect value = 0.811), and the direct effect (effect value = 0.609) accounts for 75% of the total effect.

5. Discussions and Implications

To explore the path for manufacturing enterprises to gain sustainable competitive advantage in the uncertain environment, this study focuses on digital transformation and boundary spanning behavior and empirically verifies the relationship between these two concepts and sustainable competitive advantage. This paper draws the following conclusions. First, digital transformation of manufacturing enterprises does have a significant positive impact on their sustainable competitive advantage. Second, in digital transformation of manufacturing enterprises, technology readiness has a greater impact on sustainable competitive advantage than degree of transformation. Third, the digital transformation of manufacturing enterprises has a positive impact on boundary spanning behavior. Fourth, boundary spanning behavior has a positive impact on the acquisition of sustainable competitive advantage. Fifth, boundary spanning behavior plays a significant mediation role in the relationship between digital transformation and sustainable competitive advantage. Digital transformation affects the acquisition of sustainable competitive advantage of enterprises through boundary spanning behavior, in which the direct effect of digital transformation accounts for 75%, and the mediation effect of boundary spanning behavior accounts for 25% of the total effect. Sixth, the mediation role of boundary spanning behavior in the relationship between digital transformation and sustainable competitive advantage is mainly realized through boundary spanning depth, and the mediation role of boundary spanning breadth in the relationship between digital transformation and sustainable competitive advantage is insignificant. The reason for this result may be that the wider the scope of boundary spanning behavior is, the more the enterprise resources need to be consumed. For enterprises with insufficient resources, if the scope of boundary spanning behavior is too broad, it may not be conducive to the acquisition of sustainable competitive advantage.

5.1. Theoretical Contributions. Based on the deep changes in the current economy and technology, this study measures the overall characteristics of digital transformation and boundary spanning behavior of manufacturing enterprises at the organizational level and tries to introduce boundary spanning behavior to explore the effect mechanism of digital transformation and sustainable competitive advantage, which has positive theoretical significance for promoting digital transformation and boundary spanning behavior and exploring the path of digital transformation of manufacturing enterprises. Specific theoretical contributions include the following.

First, this paper explores and deepens the research on digital transformation. Most of the existing studies measure digital transformation with the number of digital technologies adopted by enterprises [12, 13]. However, with the continuous development of digital technology and its further penetration of economic life, a more comprehensive index system needs to be used to measure the level of enterprise digital transformation. This paper attempts to measure the digital transformation of enterprises from two aspects: technology readiness and transformation degree of value creating activities. It is a theoretical attempt to measure digital transformation in a comprehensive way, which is conducive to promoting the empirical study of digital transformation.

Second, this paper enriches the theoretical perspective of boundary spanning behavior research. Given the current situation that the domestic boundary spanning behavior measurement system is relatively unitary and there is less research on boundary spanning behavior at the organizational level, based on the research of Laursen [33] and Zahra [35], this study introduces two-dimensional indicators, boundary spanning breadth and boundary spanning depth. This study measures boundary spanning behavior at the enterprise level and further explores the impact mechanism of boundary spanning behavior and digital transformation process, which may enrich the theoretical perspective of boundary spanning behavior research and make up for the lack of literature.

Third, this paper introduces boundary spanning behavior to explore the impact mechanism between manufacturing enterprises' digital transformation and sustainable competitive advantage. In the existing literature on digital transformation, more attention has been paid to the full utilization of resources inside and outside departments and organizations [14, 67]. However, most of the existing studies use case study instead of quantitative research to explore the impact of interorganizational relations. This study uses data from 127 manufacturing enterprises to verify the impact of manufacturing enterprises' boundary spanning behavior on enterprises' sustainable competitive advantage, and then it uses empirical methods to verify its mediation role in the relationship between digital transformation and sustainable competitive advantage of manufacturing enterprises. The results may provide theoretical support for manufacturing enterprises to adapt to technological and market changes and explore a more operational and effective implementation path of digital transformation.

5.2. Managerial Implications. First, manufacturing enterprises can obtain sustainable competitive advantage by promoting the process of digital transformation. Digital

TABLE 6: Bootstrapping analysis results of mediation effect and its proportion.

	Coeff	Boot SE	Boot LLCI	Boot ULCI	Proportion (%)
Mediation effect	0.203	0.092	0.029	0.389	25
Direct effect	0.609	0.113	0.389	0.835	75
Total effect	0.811	0.059	0.695	0.926	

transformation is an effective way for manufacturing enterprises to get rid of the original system and resource constraints, to improve their production and service capacity. It is also the only way to adapt to the current market situation of accelerated technology renewal and increasing uncertainty. Manufacturing enterprises need to actively adapt and invest in digital transformation to gain sustainable competitive advantage.

Second, enterprises should make full preparations for the comprehensive promotion of digital transformation by fully mobilizing the organization's acceptance of Internet technology and increasing resource investment. The results show that compared with the degree transformation, the technology readiness of manufacturing enterprises has a greater impact on the acquisition of sustainable competitive advantage. The technology readiness of manufacturing enterprises involves the application of complex technologies such as the Internet of Things and intelligent manufacturing. At the initial stage of digital transformation, there is a large demand for resource investment. Without sufficient resource preparation, it is difficult to help enterprises realize digital and intelligent transformation. As a result, enterprises may miss the opportunity to transfer and lose their competitive advantage.

Third, manufacturing enterprises may develop boundary spanning behavior during the process of digital transformation. With expanded breadth of cross-border resources and in-depth integration in cross-border cooperation, enterprises can obtain a favorable position in the value network. In the Internet era, manufacturing enterprises need to improve their position and influence in the value creation system and make better use of the new generation of information technology. Only if enterprises can adapt to the needs of intelligent production, enhance their own openness, and promote collaborative production cross borders, can they fully mobilize favorable resources in the value network and expand the boundary of enterprise capacity, thus obtaining a core position or more network power in the value network.

Fourth, the development of boundary spanning behavior helps manufacturing enterprises obtain and maintain sustainable competitive advantage. In the existing market environment, to meet and even lead consumer demands, enterprises need to integrate and absorb more favorable resources across boundaries and realize value innovation and creation through cooperative innovation and dynamic capability improvement. Cooperating with various entities in the value network, enterprises will gain more competitive advantage in the changing environment, with the transformation and upgrading of the whole value network. Cross-boundary cooperation is a scarce resource for enterprises, which cannot be obtained through purchase, and needs to be

slowly cultivated and accumulated in the long-term value creation process. Therefore, the value network established by manufacturing enterprises through boundary spanning behavior can isolate other competitors and can be more helpful for enterprises to obtain and maintain sustainable competitive advantage.

Fifth, in digital transformation, manufacturing enterprises will gain a more favorable competitive position by deepening cross-border cooperation. The digital transformation not only helps enterprises obtain sustainable competitive advantage directly, but also enhances enterprises' sustainable competitive advantage through boundary spanning behavior. The process of digital transformation undoubtedly requires the investment in infrastructure and the introduction of advanced technologies and models such as the Internet of Things. However, if technological innovation is limited to a single organization, it cannot give full play to the potential advantages of the Internet and information technology. Technological innovation needs to develop with the integration of resources across organizational and industrial boundaries. Otherwise, it may fall into repeated investment and fail to achieve a better transformation result. China's manufacturing enterprises generally have weak technological innovation ability and lack of resources, so they should avoid establishing a too broad scope of boundary spanning behavior to avoid unnecessary loss of resources. Instead, they should establish in-depth boundary spanning behavior with other enterprises to make full use of limited resources. To realize cross-border integration, enterprises need to give full play to the boundless characteristics of the new generation of information technology and establish an effective value ecosystem through in-depth integration across organizational and technological boundaries. Only when they can establish an effective value ecosystem based on consumer demand and a socialized division of labor and coordination system with consumers, suppliers, network platforms, potential partners, and even competitors, will they be able to seek more space for value creation and obtain sustainable competitive advantage in a changing environment.

5.3. Limitations and Future Research. This study attempts to sort out the ways for manufacturing enterprises to obtain sustainable competitive advantage in the changing technology and market environment, which has certain theoretical significance. However, due to the complexity of the topic, there are still several limitations that need to be gradually improved in future research. First, the study examines the mediation role of digital transformation in sustainable competitive advantage through boundary spanning behavior. However, in practice, the mechanism of

digital transformation process and sustainable competitive advantage of manufacturing enterprises is more complex than that. Are there other factors that affect the relationship between digital transformation and sustainable competitive advantage? What kind of boundary spanning behavior can help promote digital transformation and obtain sustainable competitive advantage? At present, the answer is not clear, and future research should explore relevant factors to expand and enrich the theoretical construction of digital transformation, boundary spanning behavior, and sustainable competitive advantage. Second, in terms of research design, this study measures the characteristics of digital transformation, boundary spanning behavior, and sustainable competitive advantage with a subjective score from enterprise employees. Although various methods are used to avoid the defects of subjective data in questionnaire collection and data processing, the deviation from the actual situation is inevitable. In future research, a combination of subjective and objective data can be used to improve the accuracy of the research and the reliability of the conclusion. Third, due to the limitations of time and energy, the number of samples in this study is relatively small, and the samples are mostly concentrated in the coastal areas of China. In future research, the sample size should be increased, and more random sampling methods should be adopted to enhance the reliability and applicability of the conclusion of this research.

6. Conclusion

The goal of this study is to confirm the actual impact of digital transformation on sustainable competitive advantage through empirical research methods and to explore what kind of boundary spanning behavior is conducive to the positive results of digital transformation. Based on the empirical data from 127 Chinese manufacturing enterprises, this paper explores the relationship between digital transformation, breadth and depth of boundary spanning behavior, and sustainable competitive advantage. This study is an attempt to deepen the measurement of digital transformation. It provides a more accurate measurement of the level of digital transformation, by comprehensively using the concept of technology readiness and degree of transformation of value creating activities. At the same time, the findings of this study prove that the depth rather than breadth of boundary spanning activities has a positive impact on the acquisition of sustainable competitive advantage, which provides theoretical support for the development of boundary spanning behavior.

Data Availability

The data used to support the findings of this study are available from the first author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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