Front. Bus. Res. China, 2026, 20(1): 102–128
DOI 10.3868/s070-021-026-0005-3

CASE STUDY

The Impact Mechanism of Differentiated Data Endowments on Digital Servitization of Manufacturing Enterprises: Based on the Longitudinal Case Study of SANY Group*

XIE Xiaomeng[a], ZHU Xiumei[b]

Abstract

In the digital economy era, the operating logic of manufacturing enterprises has changed from product-driven to service-driven, and digital servitization has become an important realization path of the service-driven logic. To gain insight into the emerging phenomenon of digital servitization, this paper selects SANY Group as the case company to analyze the connotation and composition of digital servitization and reveal the impact mechanism of differentiated data endowments on digital servitization of manufacturing enterprises. This paper finds the following: (1) The digital servitization of a manufacturing enterprise usually goes through three stages: product + service, product × service, and product-service integration, which are also known as digital extended services, digital customized services, and digital ecosystem services; (2) differentiated data endowments that are mainly based on product data, user data, and platform data constitute the key driving factor for the digital servitization of manufacturing enterprises; (3) data affordance behaviors, which mainly include data-pipeline affordance behaviors, data-insight affordance behaviors, and data-governance affordance behaviors, offer the key path for differentiated data endowments to influence the digital servitization of manufacturing enterprises. This paper deconstructs the digital servitization modes and constructs a theoretical model that describes the transmission among differentiated data endowments, data affordance behaviors, and digital servitization. It offers new perspectives and pathways for research on digital servitization, as well as valuable managerial insights for Chinese manufacturing enterprises seeking to overcome growth limitations and expand their value creation space through digital servitization innovation.

Keywords digital servitization; differentiated data endowments; data-pipeline affordance behaviors; data-insight affordance behaviors; data-governance affordance behaviors

* This paper is translated from *南开管理评论* [Nankai Business Review], 2025, (9), 16–27.

[a] School of Business and Management, Jilin University, Changchun 130012, China

[b] School of Management, Guangdong University of Technology, Guangzhou 510520, China

1 Introduction

Digital servitization refers to the integration of products, services, and software systems by enterprises to provide customers with personalized, intelligent, and systematic digital service solutions. Through innovation in digital services, a leading and inclusive digital product-service system can be formed for the transformation from product-driven logic to service-driven logic. Digital servitization provides new value growth points for manufacturing enterprises (Shen et al., 2023; Sjödin et al., 2021). It provides customers with personalized intelligent product-service combinations, which can better meet diverse user needs for digital services and constitute an important source of competitive advantages for manufacturing enterprises (Ferreira & Fernandes, 2017). It prompts more entities to join the service systems, boosting multi-scenario innovation, multi-industry integration, and multi-business-form prosperity in the manufacturing sector. The *14th Five-Year Development Plan for Intelligent Manufacturing*[1] encourages manufacturing enterprises to try and create new business models and forms by working together with internet platforms, such as collaborative manufacturing, large-scale personalized customization, and remote operation and maintenance (O&M) services. It also emphasizes the significant role of digital servitization in promoting the development of the manufacturing industry. For manufacturing enterprises, the most important task now is to explore the models and implementation paths of digital servitization based on local contexts and experience accumulated in practices from representative cases.

Data factors, as a new production factor, play a significant role in promoting innovation in service-oriented manufacturing models, raising efficiency, and expanding markets. Data factors create more value through various means, such as process support, integration of software and hardware, and product reconstruction, exerting a significant impact on the digital servitization of manufacturing enterprises (Zhang et al., 2024). The immediate value of data factors can meet user needs, improve user experience, and promote innovative interaction between enterprises and users (Cao et al., 2023; Xie et al., 2023). The potential value of data factors is an important source of an enterprise's long-term competitive advantage. Existing research emphasizes the significance of data factors in digital servitization but neglects the intelligent services and differentiated solutions provided by differentiated data endowments.

The *Three-Year Action Plan (2024–2026) for "Data Factors ×"*[2] points out the following problems existing in our practice: low-quality data supplies, unsmooth circulation mechanisms, and insufficient release of application potential. It calls for multi-scenario application and multi-subject reuse of data, and the cultivation of new products and services based on data factors. In reality, many manufacturing enterprises are unable to cope with the rapidly changing demands in the digital age, and problems such as data silos prevent raw data from being transformed into data resources. Data affordance behaviors

[1] The corresponding Chinese title is "十四五" 智能制造发展规划.

[2] The corresponding Chinese title is "数据要素 ×" 三年行动计划.

serve as crucial intermediate processes through which data factors provide users with action potentials. Moreover, they represent key pathways through which differentiated data endowments drive digital servitization (Dincelli & Yayla, 2022). Therefore, it is imperative to identify the data affordance behaviors that can activate differentiated data endowments, thereby opening the "black box" of how differentiated data endowments influence manufacturing enterprises' digital servitization.

Overall, although certain research achievements have been made in digital servitization in recent years, there are still the following research gaps. Firstly, the current research has not clearly answered what digital-servitization mode manufacturing enterprises have, which restricts the progress of relevant theoretical research (Li et al., 2023). Secondly, from the perspective of the relationship between products and services, digital servitization has undergone a complex process—from the reliance of services on products, to the organic integration of products and services, and finally to services encompassing products. Unfortunately, none of the existing research has described the digital servitization of manufacturing enterprises from germination to maturity. Thirdly, from the perspective of the mechanism of data-driven digital servitization, it is necessary to combine the logic of data affordance with the logic of service innovation to explore what types of data affordance behaviors can transform differentiated data endowments into digital servitization modes for manufacturing enterprises. To bridge the above-mentioned research gaps, this paper conducts a longitudinal case study on SANY Group Co., Ltd. (hereinafter "SANY Group") to explore the mechanism through which differentiated data endowments influence the digital servitization of manufacturing enterprises via data affordance behaviors. This paper aims to answer the following questions: What are the modes of digital servitization? Through what data affordance behaviors do differentiated data endowments influence the digital servitization of enterprises?

2 Literature Review

2.1 Research on Digital Servitization

Existing studies usually define digital servitization from three perspectives: the embedding and the coupling perspectives, the perspective of business model innovation, and the perspective of service transformation. Definitions made from the embedding perspective usually hold that digital servitization is the expansion of digitalization in the field of servitization (Jiang & Jin, 2022; Soellner et al., 2024). Studies adopting the coupling perspective argue that digital servitization is not merely a combination of digitalization and servitization; rather, it entails a fundamental shift in value creation logic and a comprehensive transformation of incumbent manufacturers' strategies, business models, and operational processes (Kohtamäki et al., 2022). From the perspective of business model innovation, digital servitization is defined as a business model integrating intelligent solutions, including products, services, software, etc. (Pan et al., 2023), offering new ways to capture and create service value (Gebauer et al., 2020;

Zhang et al., 2022). From the perspective of service transformation, digital servitization is guided by organizational changes and business restructuring and driven by digital technology: Many manufacturers shift from mainly providing products to offering intelligent solutions composed of products, services, and software and achieve a transformation from traditional services to digital services, which reflects the shift from product-driven logic to service-driven logic (Favoretto et al., 2022; Jiang et al., 2023; Smania et al., 2022).

Existing research mainly explores digital servitization from the following perspectives: product and service perspective, user perspective, and platform perspective. From a product-service perspective, digital servitization entails innovations in digital technologies related to products, which improve service processes and create additional service value during product usage: This is how additional services for a product are formed (Coreynen et al., 2020). From the user perspective, user needs constitute an important factor for enterprises to identify new business opportunities, meet demand, and create new value for users, which underpins the success of digital servitization. Based on user needs, users and enterprises can jointly create service value (Hasselblatt et al., 2018). From the platform perspective, platformization deepens the industrial embedding of a platform and helps an enterprise to achieve the advancement from product-driven logic to service-driven logic (Zhang et al., 2023). A platform ecosystem offers leading enterprises and complementary enterprises opportunities and scenarios to integrate their product and service portfolios, enriching the ways of value creation and reconfiguring the flow of value (Jiao et al., 2023; Yi & Liang, 2023).

2.2 Digital Servitization Driven by Data Factors

Data factors are an important driving factor for the emergence of new digital services and play a crucial role in the process of digital servitization (Gebauer et al., 2021). Firstly, integrated data is an important source of service innovation. For instance, mobile customer behavior data and product status data can be utilized for predictive analysis that underpins the provision of real-time online services to customers (Ardolino et al., 2018; Lim et al., 2018). Secondly, the degree and timeliness of data openness and sharing affect the effectiveness of digital servitization: Enterprises need to continuously offer new service solutions through data analysis and intelligent decision-making (Ritter & Pederson, 2020). Thirdly, data enhances the connectivity among products, services, and software systems, facilitating the transition from the product-oriented logic to the service-oriented logic (Kohtamäki et al., 2022). Fourthly, data is a key source of information for enterprises to effectively respond to customer demands (Chirumalla et al., 2023). The effective utilization of customer data is an important method to offer differentiated products and services. With an increase in the amount of customer data, an enterprise will see increasingly great customer value and create new service value by leveraging the aggregated data.

2.3 Digital Technology Affordance Theory and Data Affordance Behaviors

Affordance theory is originally a psychological theory discussing the possibility that a material object provides to an actor. With the emergence of digital technology, scholars apply the theory to the digital sector, proposing the affordance theory of digital technology to describe the affordance generated by the interaction between digital technology and its users. According to the specific types of the involved digital technology, the affordance can be further classified into big data affordance, artificial intelligence affordances, etc. (Deluca et al., 2021; Trocin et al., 2021; Tronvoll et al., 2020). The affordance theory of digital technology explains how digital technology is embedded in products or services, how it generates digital functions, and how technology users understand and implement the changes in the functions and use value of the products or services, which are realized by the embedding of digital technology (Chirumalla et al., 2023).

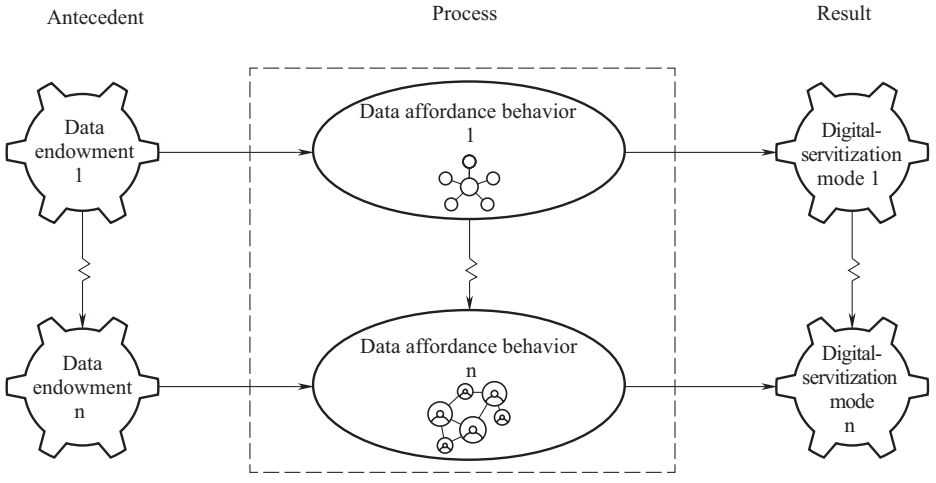
According to the affordance theory of digital technology, data affordance behaviors serve as indispensable paths to unlock the value of data. Firstly, big data analysis capabilities formed based on data factors give an enterprise the ability to identify customer needs or explore new opportunities (Chirumalla et al., 2023). Secondly, data factors blur the boundaries of enterprises, expand communication channels between them, enable enterprises to better obtain and effectively utilize data from different sources, and promote value co-creation among multiple entities based on data sharing and complementarity (Cui et al., 2024). Existing research has not fully revealed the micro-processes of data affordance behaviors. There is an urgent need to distill a research framework for data affordance behaviors based on local practice in China and expand and enrich the application scenarios of data affordance.

2.4 Literature Review and Research Framework

Overall, the existing research has the following deficiencies. (1) Prior studies have not sufficiently deconstructed digital servitization, often adopting a single analytical perspective and employing overly broad categorizations. (2) Differentiated data endowments decide whether digital services can efficiently meet customer demands, but their influence mechanism on digital servitization remains unclear. (3) Data affordance behaviors help explain the utilization efficiency and effectiveness of different enterprises' data endowments and represent a critical pathway through which differentiated data endowments catalyze digital servitization. This pathway likewise warrants further in-depth investigation. This paper, based on the affordance theory of digital technology and the framework of "antecedent–process–result," initially constructs a basic research framework "differentiated data endowments–data affordance behaviors–digital-servitization modes" (see Figure 1). This paper responds to the demand for the exploration into how data integration from different participants achieves more advanced integration functions (Dalenogare et al., 2022; Nambisan, 2017). It also explains how manufacturing enterprises activate

differentiated data endowments, carry out data affordance behaviors, and thereby promote the evolution of digital-servitization modes.

Figure 1
Basic Research Framework



3 Research Design

Digital servitization is an emerging management phenomenon that requires direct observation of enterprises and explorations into how they carry out digital servitization, which suggests suitability for the method of case study (Eisenhardt & Graebner, 2007). The emerging management phenomenon has multiple causes and is related to the genetic traits of enterprises, which are difficult to replicate. This shows that case study is a more appropriate research method (Gioia, 2013). Therefore, this paper adopts a constructive single-case study approach to explore how enterprises promote digital servitization with differentiated data endowments.

3.1 Case Selection

This paper selects the case study subject with the theoretical sampling method. Based on the principles of typicality, representativeness, and applicability for case selection, SANY Group is chosen as the sample for this single-case study. (1) Regarding typicality, SANY Group has consistently seized the opportunities of the digital technology revolution by innovating its digital products, services, and solutions. This ongoing innovation has injected new impetus into the development of the manufacturing industry in China and globally. (2) As to applicability, the development of SANY Group has remarkable characteristics of digital service innovation. The Group has created a brand-new service paradigm to empower customers with digital tools, which ensures large-scale provision of digital services

and explores replicable innovative service paths, such as internal incubation and external empowerment. (3) Regarding representativeness, SANY Group is representative in the construction of data infrastructure. Internally, it has released a white paper on data security. Externally, it has participated in the formulation of the national digital twin standards and released the excavator index. These efforts have generated a considerable response at both the industry and national levels.

3.2 Data Collection

The multi-source data of this paper include primary data obtained through semi-structured interviews and participatory observations; archival data from annual reports of listed companies, research reports, and corporate publications; and publicly published literature data. The credibility and richness of the data are ensured. As shown in Table 1, corporate publications serve to supplement and corroborate the interview materials, thereby establishing a triangulation with the interview data.

3.3 Case Analysis

(1) Based on the case analysis data, the milestone events of SANY Group are identified, and the digital servitization process is divided into three stages: product + service, product × service, and product-service integration. The key events during the development process are shown in Figure 2. The stage of product + service features the physical combination and intelligent upgrade of products and services. In the stage of product × service, products and services interact to generate new products and services. The stage of product-service integration basically refers to the business model known as "products as services and services as products." In this dynamic environment, SANY Group integrates data with its operations management and service systems, aligning top-down digital service strategies with bottom-up digital service practices to generate different modes of digital servitization. This provides a suitable sample for exploring the mechanism through which differentiated data endowments influence the digital servitization of manufacturing enterprises.

(2) In the coding analysis stage, unified thematic cognition, iterative correction, and back-to-back coding approaches are adopted to reduce the homologous bias caused by a single subjective cognition. In addition, to further enhance the reliability and validity of the research results, this paper uses the information follow-up method to revalidate the data and adopts intra-group discussion and expert evaluation suggestions to eliminate differences (Ulaga & Reinartz, 2011). The research team conducted multiple visits to SANY Group for data collection and exchange, and supplemented and verified the original data to ensure the model's credibility. The coding results are presented in Figure 3.

Table 1

Representative Data Sources for the Case Study of SANY Group

Data source	Channel and target		Interviewee	Time	Transcribed text (unit: 10,000 characters)	Interview content	Code
In-depth interview	The Group	2020	President of SANY Group; President of SANY Incubator	1.5h	1.37	The "globalization, digital intelligence, and low-carbonization" strategy of SANY Group; the digital servitization process and key nodes of SANY Group; the development mode of SANY Incubator, etc.	Y_1
		2021	Chief engineers and department directors of SANY Group; General managers, project managers, and operation specialists of SANY Incubator	4.3h	4.06	The application of product and service data of SANY Group, the digital service plan of SANY Group, the construction and operation of internal platforms of SANY Group, the construction of the mass innovation incubation platform of SANY Incubator, etc.	Y_2
		2022	Deputy director of the Intelligent Manufacturing Headquarters of SANY Group	2.5h	2.36	The achievements of SANY Group in intelligent manufacturing, the relationship between intelligent manufacturing and data usage, and the planned layout of intelligent manufacturing, etc.	Y_3
		2023	Vice president of SANY Group; Public relations director of SANY Group	1.5h	1.25	The "globalization, digital intelligence, and low-carbonization" strategy of SANY Group; the service innovation plan of SANY Group; SANY Group's efforts to empower the development of overseas services, etc.	Y_4
		Field investigation	Visits to SANY Changsha Industrial Park and SANY Mass Innovation Incubation Industrial Park and on-site introductions and presentations, etc.				Y_5

(*To be continued*)

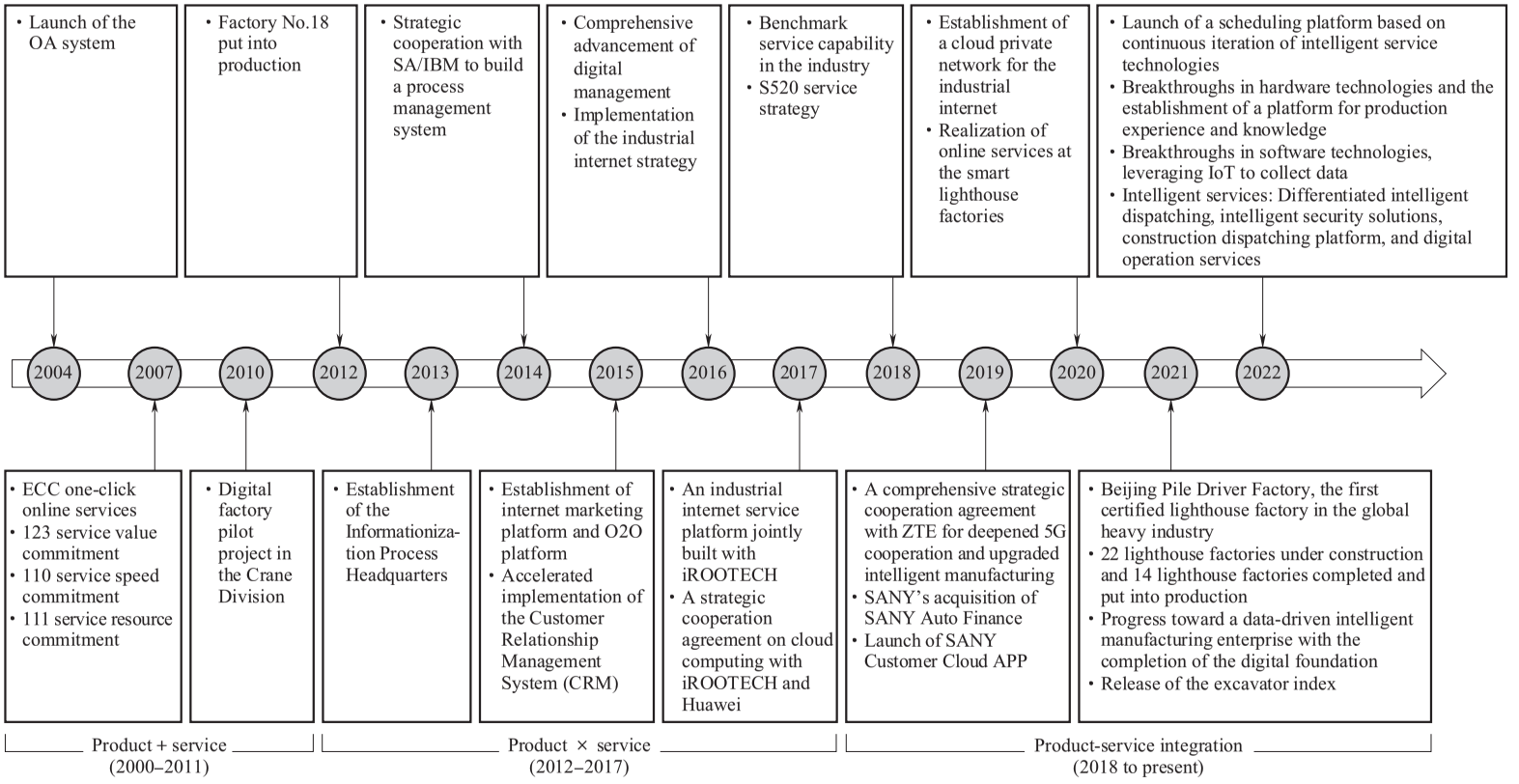
(*Continued*)

Data source	Channel and target		Interviewee	Time	Transcribed text (unit: 10,000 characters)	Interview content	Code
In-depth interview	Partner enterprises	2020	General manager of Changsha Youli Electric Drive System Co., Ltd.; General manager of Hunan Xijie Heavy Industry Co., Ltd.; General manager of Changsha Xidima Technology Co., Ltd.; General manager of Hunan Siborui Intelligent Equipment Co., Ltd.	4.5h	5.89	The motivation for cooperation between the partner enterprises and SANY Group, and the products and services jointly created by SANY Group and the partner enterprises, etc.	H_1
		2021	General manager and senior brand director of iROOTECH	2h	1.83	Products and services of the industrial internet platform jointly built by SANY Group and iROOTECH	H_2
		2023	Senior vice president of iROOTECH	2.5h	2.05	Digital solutions provided by the industrial internet platform jointly built by SANY Group and iROOTECH	H_3
Archival data	Corporate publications		Thematic publications of SANY Group (2015–2024)	35 issues	141.96	The digitalization, electrification, and internationalization of SANY Group and phased achievements	E_1
	Conferences and speeches		39 reports, including keynote speeches at conferences and reports from academic research workshops on innovation and entrepreneurship				E_2
	Corporate reports		Annual reports, quarterly reports, prospectuses, WeChat official account releases (2010–2023)				E_3
Publicly available literature	33 Chinese and English articles, 7 cases from the management case library, and 97 financial news reports, government reports, and media reports						W_1

Note. The duration of each interview is measured in hours, and the counting unit for transcribed texts is 10,000 characters. Y represents primary data of SANY Group. H represents primary data of partner enterprises. E represents archival data. W represents publicly available literature data.

Figure 2

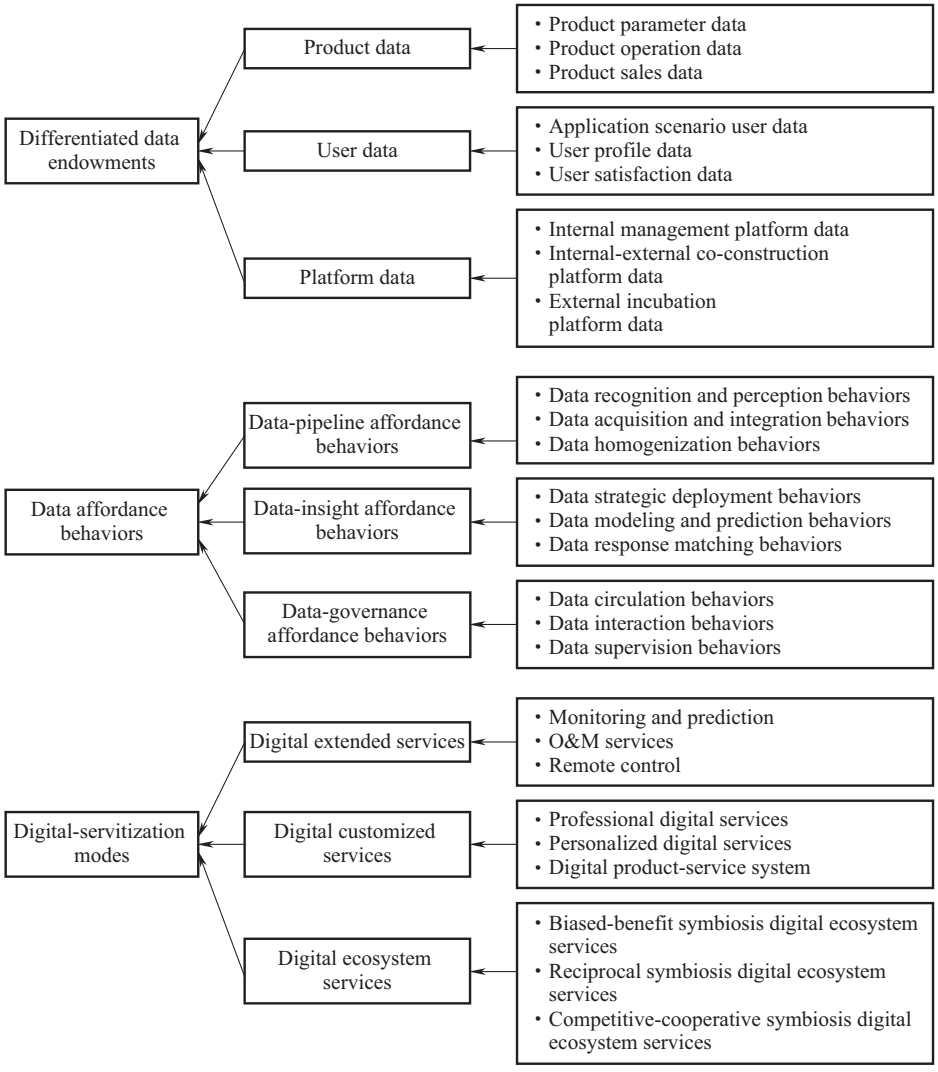
Digital Servitization of SANY Group and the Milestone Events



Note. Information compiled by the authors.

Figure 3

Coding Structure



4 Case Discovery

4.1 Product + Service: Digital Extended Services Driven by Product Data

In the stage of product + service, digital servitization is actualized through digital extended services. In this stage, product data is the major driving force of the digital extended services, and data-pipeline affordance behaviors serve as the key intermediate path between the two. This forms the following architecture: product data–data-pipeline affordance behaviors–digital extended services (due to space limitations, representative evidence is available upon request).

4.1.1 Product Data

In the early stage of data construction, SANY Group has to transform product data into value-added services. Product data mainly includes product parameter data, product operation data, and product sales data. Firstly, product parameter data is taken as the fundamental indicator for digital extended services. Based on the long-tail effect of customer demands, enterprises create mechanical product parameters. Based on the industrial big data it has collected, SANY Group matches each process with its optimal parameters and optimizes the production rhythm. Secondly, product operation data is regarded as a barometer for digital extended services. The data application center of SANY Group has collected all the data of the asset map, including business data, Internet of Vehicles data, etc. The business system data covers core business areas such as sales and logistics. Product sales data serves as a decision-making indicator for measuring the effectiveness of existing products and digital extended services.

4.1.2 Data-Pipeline Affordance Behaviors

Product data is the main data source in the stage of product + service. SANY Group enables real-time extraction, processing, and storage of product data through data-pipeline affordance behaviors (Zhu et al., 2023), promoting the integration of product data through data analysis applications. Data-pipeline affordance behaviors entail a process of automatically capturing, storing, and aggregating data based on intelligent technology (Zhu et al., 2023). Such behaviors include data identification and perception behaviors, data acquisition and integration behaviors, and data homogenization behaviors. Data identification and perception behaviors are the automatic capture, access, and storage of data through intelligent technologies (Effah et al., 2021). SANY Group has basically achieved equipment interconnection by installing multiple sensors on excavators and other equipment. Data acquisition and integration behaviors involve multi-channel integration and initial cleaning and accumulation of data (Cao et al., 2023). SANY Group, in collaboration with China Telecom and ZTE, has built a 5G digital factory in SANY Changshu Industrial Park, realizing the interconnection and interoperability of equipment within the factory and establishing a unified data foundation. This helps it eliminate data silos and significantly enhance the production efficiency of its affiliated enterprises. Data homogenization behaviors involve the use of digital technology to uniformly process various forms of data related to tasks, which cleans, deconstructs, and reconstructs large-scale data (Muchenje & Seppanen, 2023). SANY Group has established a unified data interface and built a full-process data-structure coding system to achieve data identification and invocation.

4.1.3 Effect Result: Digital Extended Services

The key to digital servitization lies in eliminating redundant data and activating unstructured data to create extended value of digital services (Dalenogare et al., 2023). The core functions

of the digital extended services are monitoring and prediction, O&M services, and remote control. Monitoring and prediction refer to the ability of an enterprise to grasp real-time information on the location and status of its products and carry out preventive maintenance (Ardolino et al., 2018). O&M services are an important business form for manufacturing enterprises to create value for customers and gain competitive advantages (Zhang et al., 2020). Remote control is a usage method of remotely operating products based on embedded software (Chirumalla et al., 2023). SANY uses sensors to obtain product data and monitor the data of C-end equipment in real time, achieving multiple service functions such as equipment interconnection and working condition query. SANY AR online experts can remotely control cameras to perform AR intelligent scanning and exert functions such as database retrieval and remote access, thereby providing digital extended services such as real-time monitoring and prediction, online O&M, and remote control.

4.1.4 Product Data–Data-Pipeline Affordance Behaviors–Digital Extended Services

In the stage known as product + service, product data promotes data-pipeline affordance behaviors, thereby facilitating digital extended services. Firstly, through model training, historical and real-time product operation data help enterprises conduct predictive analysis that underpins the resource scheduling for O&M services. Secondly, remotely obtained product operation and parameter data at a low cost increases the flexibility of digital extended services. Thirdly, sales data can be utilized for the arrangement of digital marketing channels. Data-pipeline affordance behaviors can play a role in data identification, integration, and standardization, providing enterprises with a more comprehensive source of innovative information (Matarazzo et al., 2021).

Based on the above, this paper puts forward the following proposition.

Proposition 1: In the stage known as product + service, digital servitization is mainly realized in digital extended services, which consist of three digital-service forms, namely monitoring and prediction, O&M, and remote control. Product data is a key driving factor for digital extended services. Through data-pipeline affordance behaviors, product data can facilitate the formation of digital extended services.

4.2 Product × Service: Digital Customized Services Driven by User Data

The stage named product × service mainly involves three second-level themes: user data, data-insight affordance behaviors, and digital customized services. In this stage, digital servitization is mainly realized through digital customized services. User data serves as the main driving factor for digital customized services, and data-insight affordance behaviors provide the key intermediate path between the two. This forms such an architecture: user data–data-insight affordance behaviors–digital customized services (due to space limitations, representative evidence is available upon request).

4.2.1 User Data

User data serves as the foundation for value co-creation between users and enterprises, mainly including application scenario data, user profile data, and user satisfaction data. Application scenario data is the data generated by users during the process of using products, which is used for process optimization, quality analysis, and the development of new application scenarios. User profile data reflects specific user information, which is used to gain insights into user needs. SANY Group collects user profile data with data mining technology and organically integrates user profile data, machine operation data, and user operation data to implement more precise services. User satisfaction data refers to the results of quantitative evaluations of user experiences. SANY Group provides users with an app that allows them to directly provide feedback. Through an online survey platform, it scientifically and accurately collects user satisfaction data and is the first in the industry to conduct a full-sample survey on user needs.

4.2.2 Data-Insight Affordance Behaviors

User data is an important source for enterprises to adapt in a timely manner to market changes, adjust innovation strategies, and verify innovation effectiveness (Wu et al., 2023). In the stage known as "product × service," user data can inspire data-insight affordance behaviors. Through these behaviors, enterprises can deeply integrate user data with digital service businesses and make strategic deployments. Data-insight affordance behaviors encompass data strategic deployment, data modeling and prediction, and data response matching. Data strategic deployment behaviors refer to the formulation of data strategies and the determination of goals and tasks for data analysis and utilization. SANY Group utilizes data to improve its management efficiency and implements a strategy of operationalizing all data and conducting all business operations online. Data modeling and prediction behaviors involve training a data model to achieve optimal fit for analysis and prediction purposes. SANY Group has established a unified data interface, a data middle platform, and data coding rules, building a complete data chain and a data warehouse. Using 5G high-definition sensors, the Group can generate one million 3D data coordinates per second, providing real-time in-depth scenario information and three-dimensional models. Data response matching behavior refers to the ability to interpret and match user data, which helps manufacturing enterprises conduct risk assessments of their current product and service portfolios (Ulaga & Reinartz, 2011) and deploy new portfolios. SANY Group leverages business data analysis to guide its decision-making and strategic formulation, carry out business management activities such as goal decomposition and plan prediction, and coordinate the allocation of enterprise resources.

4.2.3 Effect Result: Digital Customized Services

To better meet customer needs and form a customized digital service mode, SANY Group

acquires, analyzes, and utilizes user data through data research, pain point analysis, and software design. The mode known as digital customized services mainly involves three dimensions: professional digital services, personalized digital services, and digital product-service systems. Specialized digital services are services dedicated to specific industries. The equipment operation data of SANY Group is not only applied in scenarios such as equipment inspection and maintenance, but also in the insurance and financial industries. Personalized digital services are digital services provided for specific targets. SANY Group designs a virtual safety diagnosis system for unmanned road rollers based on the actual scenario requirements of customers, providing a guarantee for electronic fences and successful anti-collision in cluster operations. The entire construction process can be subject to quality monitoring through a tailor-made satellite navigation system and wireless communication system. A digital product-service system is a system based on the interconnection and interoperability of digital products, services, and software. SANY Intelligent Mining creates a digital mine to achieve the interconnection of all things, offering an integrated solution covering human resources, machines, materials, methods, and environment.

4.2.4 User Data, Data-Insight Affordance Behaviors, and Digital Customized Services

In the stage known as product × service, user data promotes data-insight affordance behaviors, thereby facilitating the mode of digital customized services.

User profile data provides user characteristics, helping enterprises capture market demands and customize user services. User application scenario data provides scenario sources for personalized and customized services, enabling enterprises to adjust their product and service innovation strategies in real time. User feedback data shortens the cycle of product and service innovation, which reduces innovation costs and enables rapid verification of market feedback effects (Wu et al., 2023). Data-insight affordance behaviors integrate internal and external data with enterprise businesses, providing support for the development of digital customized services.

Based on the above, this paper puts forward the following proposition.

Proposition 2: In the stage named product × service, digital servitization is mainly manifested in digital customized services, which include professional digital services, personalized digital services, and digital product-service systems. User data is a key driving factor for digital customized services. Through data-insight affordance behaviors, user data can promote the formation of digital customized services.

4.3 Product-Service Integration: Digital Ecosystem Services Driven by Platform Data

In the stage of product-service integration, digital servitization is mainly manifested in digital ecosystem services. Platform data drives the mode of the digital ecosystem services, and data-governance affordance behaviors provide the key path between the two. Therefore, the architecture

is described as platform data–data-governance affordance behaviors–digital ecosystem services (due to space limitations, representative evidence is available upon request).

4.3.1 Platform Data

In the stage of product-service integration, SANY Group fully interacts with its users and gradually expands its business and functions. It further transcends organizational boundaries and upgrades its data partnership into a data community, entering a stage of product-service integration mainly based on platform data. With an increase in the types of data collected, the collaborative value of the data is raised, and high-quality data-driven decisions are ensured (Cao et al., 2023). With platforms that coordinate enterprises, open supply chains, financial chains, and service chains are developed, which give rise to new products, new services, and cross-border integration solutions. The sources of its platform data include the internal management platform, the internal-external co-construction platform, and the external incubation platform. The internal management platform is a data platform that supports internal manufacturing operations, Internet of Things (IoT) management, and logistics management within the enterprise. It is the core of the enterprise's internal control. The internal and external co-construction platform is a data platform jointly built by different enterprises. SANY Group collaborates with its digital intelligence supplier iROOTECH in building an industrial internet platform. Utilizing iROOTECH's data analysis and processing capabilities, it provides digital service solutions that enhance the collaborative efficiency of the entire industrial chain. The external incubation platform is a data platform supported by core enterprises and utilized by non-core enterprises. SANY Incubator is the external incubation platform of SANY Group. It integrates multiple services such as human resources and public technologies to support the development of startup enterprises. The platform data from the three sources helps the Group to build a mode of digital ecosystem services. Built through inter-organizational data integration, ecosystem data networks generate a multiplier effect by exponentially amplifying the service improvement capabilities of interconnected enterprises.

4.3.2 Data-Governance Affordance Behaviors

In the stage of product-service integration, inter-enterprise collaboration increases, making the platform data the dominant factor. Enterprises need data-governance affordance behaviors to enhance cross-organizational trust and collaboration and support the trading and circulation of platform data. Data-governance affordance behaviors include data circulation behaviors, data interaction behaviors, and data supervision behaviors. Firstly, data circulation behaviors convert data into tradable assets. SANY Group has two main forms of platform data circulation: data mortgage and data index. SANY Incubator provides data processing services for incubated enterprises, achieving efficient collaboration between online data transactions and offline services. It charges service fees for long-term platform data processing to obtain long-term subscription-based service income. Data mortgage uses data as evidence to obtain

financing or leasing. Take the New Transport Capacity Leasing Service Platform created by ROOTCHAIN for the UNe Electric Driving System as an example. By integrating the "Root Chain" trusted evidence storage service, the enterprise realizes the transparency of equipment status with reliable data and can mortgage its business data and asset data to financial institutions to obtain loan credits. This changes financial services through technological means. Secondly, data interaction behaviors that are related to the interaction among data, technology, and human beings usually involve two aspects: human digital interaction and digital intelligence interaction. The former refers to the process by which people perceive and learn from actionable datasets. The latter is based on data's enhancement of the efficiency and capability of intelligence and on intelligent technologies' enhancement of data quality. SANY Group and iROOTECH have jointly developed a cloud platform for public benefits that collects data about the Group's departmental quotas, auxiliary material quotas, process optimization, etc. The battery operation data of the UNe Electric Driving System, an enterprise incubated by SANY Incubator, can provide the government with information on electric vehicle violations for the construction of smart cities. Thirdly, data supervision behaviors serve as a key measure that ensures the smooth transmission of online data interaction and resists security threats (Zhang et al., 2024). SANY Group's release of the *SANY Group Data Governance White Paper (1.0)*[3] on its internal OA system, marking that the Group's digital and intelligent transformation has moved from an exploratory stage described as "feeling its way forward" to a new stage where it summarizes and accumulates its own experience. The data governance activities of the Group will be focused on the equipment manufacturing sector and implemented in core businesses and crucial projects such as those related to R&D and manufacturing. This way, the value of data will be enhanced, and a solid foundation for digital and intelligent transformation will be laid.

4.3.3 Effect Result: Digital Ecosystem Services

During the stage of product-service integration, SANY Group forms a mode named digital ecosystem services. When the Group enters the deep-water zone of digital transformation, this digital-ecosystem service mode is a major change. This mode relies on data sets from multiple systems and various interfaces, as well as efficient data distribution. It needs platform data as its carrier and requires a shift from individual operations to collaborative ones, promoting enterprises to innovate their original products and services through multi-subject interaction. This gives rise to cross-border provision of products, services, and solutions and provides continuous impetus for the upgrade of digital servitization. This mode mainly includes three dimensions: biased-benefit symbiosis digital ecosystem services, reciprocal symbiosis digital ecosystem services, and competitive-cooperative symbiosis digital ecosystem services. Biased-benefit symbiosis digital ecosystem services refer to the comprehensive solutions offered to a wide range of industrial fields and cross-industry enterprises through SANY

[3] The corresponding Chinese title is 三一集团数据治理白皮书 (1.0).

Group's main platform, through which other enterprises experience enhancements in their operations and unidirectionally absorb value. Reciprocal symbiosis digital ecosystem services refer to the collection of products and services generated by the interaction between SANY Group, the platform owner, and the platform enterprises in the digital service platform ecosystem. Both sides interact in terms of value and jointly create new value. In the digital ecosystem of reciprocal symbiosis digital ecosystem services, SANY Group offers digital infrastructure support services to the platform enterprises, and the platform enterprises provide the Group and other customers with specialized and characteristic digital services. Thus, a mutually beneficial and symbiotic digital ecosystem service relationship and digital ecosystem service system with complementary advantages are formed. The symbiosis encompasses both cooperation and competition, referring to an organization providing alternative solutions by targeting somewhat overlapping market segments (Jiao et al., 2023). Competitive-cooperative symbiosis digital ecosystem services refer to the collection of digital ecosystem services generated by the interaction between SANY Group's service ecosystem and other service ecosystems. SANY Incubator has carried out digital IoT transformation on the equipment of its incubated enterprises, enabling them to integrate into the ecosystem of construction machinery as upstream and downstream entities of the main industry and achieve data flow integration. Relying on SANY Incubator, the upstream and downstream enterprises form an ecological relationship. The data flows of the ecological partners blend with one another, causing fundamental changes in products, services, and solutions and creating a new way to capture the value of new symbiotic services.

4.3.4 Platform Data, Data-Governance Affordance Behaviors, and Digital Ecosystem Services

In the stage of product-service integration, platform data promotes digital ecosystem services through data-governance affordance behaviors. Firstly, data from the internal management platform reflects the potential problems in the usage process of products and services, which can help enterprises continuously iterate service innovations and provide corresponding service solutions. Secondly, data from the external incubation platform can help core enterprises grasp the market trends of their products and services. Thirdly, data from the internal-external co-construction platform can generate a superimposed effect on market demand, enabling partners to collaboratively improve products and services. Data-governance affordance behaviors provide new business models for mutual assistance within the ecosystem, lowering the threshold for creating new products or services and promoting the formation of a digital ecosystem service mode.

Based on the above, this paper puts forward the following proposition.

Proposition 3: In the stage of product-service integration, digital servitization is mainly realized through digital ecosystem services, involving biased-benefit symbiosis digital services, reciprocal symbiosis digital services, and competitive-cooperative symbiosis digital services. For digital ecosystem services, platform data is a key driving factor. Platform data, through data-governance affordance behaviors, can promote the formation of digital ecosystem services.

5 Case Discussion

5.1 Theoretical Model

With the rise of the service economy, the competitiveness of a manufacturing enterprise is based on not only its products but also its services that are its new value growth point (Liu et al., 2010). There exists a mutual influence and co-evolution relationship between differentiated data endowments and digital servitization. Product data, user data, and platform data are crucial driving factors for the digital servitization of an enterprise: Based on the results of differentiated data analyses, an enterprise can establish corresponding intelligent decision-making systems, integrate data sources at different levels, and provide corresponding digital service solutions, which promotes the formation and evolution of digital servitization (Schiavone et al., 2022). With its current data endowment advantages, a manufacturing enterprise resorts to data affordance behaviors and reconfigures its resources based on these behaviors to penetrate or create new service markets and promote the transformation toward digital servitization (Coreynen et al., 2020). In this process, the first digital-servitization mode foreshadows the second one, which underpins the third one. This intertemporal transformation of the modes continuously drives the cycle of digital servitization: "accumulation–advancement–upgrade" of digital service. Based on the temporal analysis of SANY Group's digital servitization and the in-depth exploration and theoretical derivation of digital-servitization practices, this paper analyzes the dimensional composition of differentiated data endowments, data affordance behaviors, and digital servitization and, on this basis, constructs a model to illustrate differentiated data endowments' impact on the digital servitization of a manufacturing enterprise, as shown in Figure 4.

5.2 The Spatio-Temporal Evolution Path of Digital Servitization

Through the temporal analysis of the cases in the different stages mentioned above, it can be seen that the three models, i.e., the digital extended service, digital customized service, and digital ecosystem service, evolve in terms of time and space. The temporal perspective emphasizes the sequence in which events occur (Cloutier & Langley, 2017; Teece, 2007). The spatial perspective emphasizes the changes in the spatial-potential relationship of the event subject in a complex network (Hou et al., 2011). Furthermore, as time and space evolve toward higher dimensions, there are also changes in physical space scenarios that aggregate resources as the key carriers for different participants to jointly create value (Yi & Liang, 2023). The changes in application scenarios are also an important dimension for the iteration and evolution of the digital-servitization mode. From a temporal perspective, different digital-servitization modes will be formed in the stage of product + service, that of product × service, and that of product-service integration. Spatially, there are changes in the spatial-potential relationship among a single subject, the enterprise-user dual relationship, and the multiple relationships within the service ecosystem. With changes in the spatial-potential relationship of time and space, the application scenarios of the digital-servitization mode constantly evolve, and their complexity gradually increases. Based on the proposition that

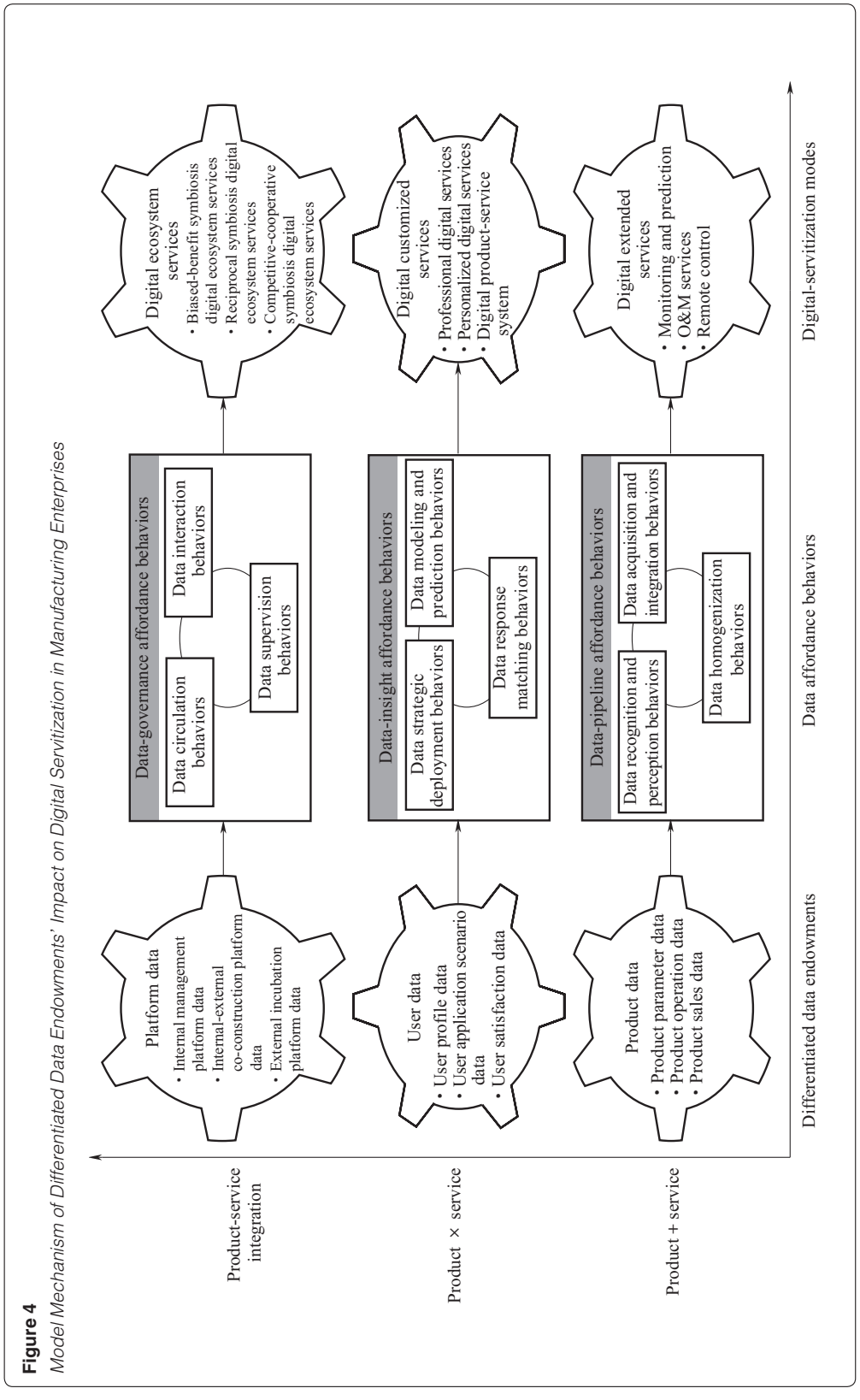


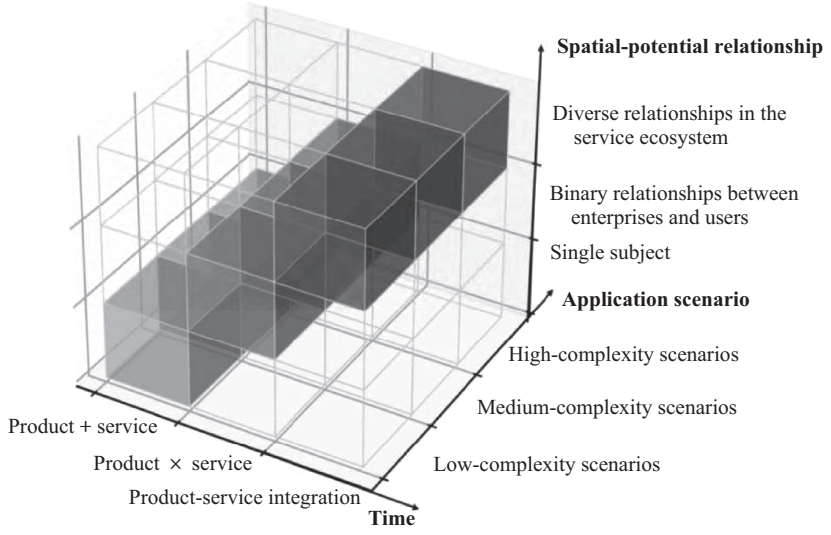
Figure 4

Model Mechanism of Differentiated Data Endowments' Impact on Digital Servitization in Manufacturing Enterprises

academic research shall adopt a global perspective that integrates time and space (Wang & Zhang, 2022), this paper three-dimensionally depicts the spatio-temporal evolution path of the digital-servitization mode from the perspectives of time, spatial-potential relationship, and application scenarios, as shown in Figure 5.

Figure 5

The Spatio-Temporal Evolution Path of the Digital-Servitization Modes



Note. The three-color shades, from light to dark, respectively represent three modes, namely digital extended services, digital customized services, and digital ecosystem services.

5.3 The Intertemporal Impact of Differentiated Data Endowments on the Digital-Servitization Modes

Over the stages of product + service, product × service, and product-service integration, a mutually reinforcing and upwardly spiraling dynamic evolution emerges. During the stage of product + service, product data promotes data-pipeline affordance behaviors and acquires new value through digital extended services, laying a foundation for the accumulation of user data. By extending the functions of existing products or services, the performance of the products or services can be enhanced, which brings about better user experiences, strengthened interaction between enterprises and users, and further increased volume and quality of user data for manufacturing enterprises. In the stage of product × service, user data promotes data-insight affordance behaviors, serving as a key link in building platform data. Firstly, data strategic deployment behaviors create a standardized environment on which the circulation of platform data is premised. Secondly, the digital product-service systems integrate different data sources, actualize interconnection and interoperability among digital service businesses, and further expand the scope of data partnerships. This transforms user data into multi-subject data and promotes the accumulation of platform data. During the stage of product-service

integration, platform data promotes data integration and sharing through data-governance affordance behaviors, enhancing data relevance and further improving the quality and value of data (Zhang et al., 2024). This makes it possible to better utilize various types of data and enhance the comprehensive value of differentiated data factors.

6 Research Contributions and Future Prospects

6.1 Theoretical Contributions

(1) This paper, through a vertical case analysis of SANY Group, innovatively divides digital servitization into the following modes: digital extended services, digital customized services, and digital ecosystem services. From a spatio-temporal perspective, it provides three-dimensional depiction of the evolution paths, spatial-potential relationship, and application scenarios of the digital servitization modes in the three stages, i.e., product + service, product × service, and product-service integration. Compared with existing studies, this paper, based on the local context of China, offers an explorative deconstruction of the constituent dimensions of digital servitization and lays a theoretical foundation for the subsequent development of research scales.

(2) This paper refines the types of data endowments and reveals the dynamic impact of differentiated data endowments on digital servitization. It makes up for the deficiency in the existing research on the driving forces of digital servitization and provides a new perspective for relevant studies. Data serves as the foundation for manufacturers to reconfigure and allocate resources and seize opportunities to innovate digital services (Chirumalla et al., 2023). Data factors are bridge-type elements that connect other production factors, bringing about qualitative changes in traditional production factors and giving rise to new production capabilities, innovative models, and business opportunities (Xie et al., 2023). Despite existing research emphasizing the significance of data for digital servitization, the action mechanisms through which differentiated data endowments enhance digital servitization—and their dynamic evolution—remain unexplored. This paper reveals that differentiated data endowments exert heterogeneous effects on digital servitization modes and can drive the continuous evolution of digital servitization.

(3) This paper reveals how data affordance behaviors serve as a path between differentiated data endowments and digital servitization. Through a mechanism model with differentiated data endowments–data affordance behaviors–digital servitization as the main line, it illustrates the internal mechanism of differentiated data endowments' impact on digital servitization, providing a new path for research on digital servitization. Besides, this paper extends the affordance theory from the perspective of data affordance, broadening its application boundaries within the digital-servitization context. It proposes the concept and the constituent dimensions of data affordance behaviors, laying a theoretical foundation for the development of research scales for data affordance behaviors. From the perspective of the interaction between data objects and data users, this paper enriches the research on data affordance and

provides a reference or research paradigm for relevant research on other application scenarios.

6.2 Practical Implications

(1) This paper innovatively proposes the mode of digital extended service, that of digital customized services, and that of digital ecosystem services, which provides a manufacturing enterprise with a handle for the planning and design of its digital servitization and management inspirations for its dynamical control of the digital-servitization process. In this paper, digital extended services are further divided into monitoring and prediction, O&M services, and remote control; digital customized services, into professional digital services, personalized digital services, and digital product-service systems; digital ecosystem services, into biased-benefit symbiosis digital ecosystem services, reciprocal symbiosis digital ecosystem services, and competitive-cooperative symbiosis digital ecosystem services. That is, the digital servitization of a manufacturing enterprise shall be carried out step by step, and different digital-servitization modes shall be implemented at different, mutually influenced development stages. When building a mode of digital extended services, the focus should be on product/equipment maintenance services and the synergy between products and services. When building a mode of digital customized services, the focus should be on flexibility, agility, and strategic foresight. When building a mode of digital ecosystem services, the focus should be on breaking through structural boundaries, constructing a digital-service value network among multiple actors, and highlighting connectivity and growth strategically.

(2) This paper finds that differentiated data endowments have different impacts on digital servitization modes. Specifically, product data can better promote digital extended services; user data, the digital customized services; and platform data, the digital ecosystem services. This paper provides management insights for enterprises to unlock the potential of different types of data at various stages of their digital servitization. In the stage of product + service, efforts shall be exerted to establish synergy between the data department and the business department, strengthen the application of product data, and promote innovation in digital extended services. In the stage of product × service, solid customer relationships should be established, and the acquisition and utilization of user data should be strengthened, which promotes innovation in digital customized services. In the stage of product-service integration, platform data can be utilized to introduce influential partners, gathering upstream and downstream participants of the industrial chain to form a broader collaboration. Through the data network, the construction of the value network can be driven to achieve value co-creation and value acquisition among the participants of the value network, promoting the establishment of a digital service ecosystem.

(3) This paper finds that data affordance behaviors bridge differentiated data endowments with digital servitization. This provides management insights for manufacturing enterprises' differentiated data affordance behaviors. In different stages of digital servitization, an enterprise's affordance behaviors need to be highly consistent with the characteristics of the

stages to fully activate the value of differentiated data endowments. In the stage of product + service, data-pipeline affordance behaviors are needed, including data identification and perception, data acquisition and integration, and data homogenization behaviors. In this stage, a manufacturing enterprise needs concerted efforts to eliminate data silos and build data pipeline facilities that help to obtain, store, and aggregate data. In the stage of product × service, data-insight affordance behaviors are needed, such as data strategic deployment, data modeling and prediction, and data response matching behaviors. A manufacturing enterprise has to do well in the following aspects in this stage: enhancing the matching degree between its user data and business operations, establishing data partnerships, and improving data insights. In the stage of product-service integration, data-governance affordance behaviors are needed, which are composed of data circulation, data interaction, and data supervision behaviors. A manufacturing enterprise shall aim to build a data community in this stage. It must pay attention to the security and standardization of its platform data and strengthen its data governance behaviors.

6.3 Limitations and Prospects

Firstly, this paper conducts an exploratory study on digital servitization and proposes its constituent dimensions, and future research can be focused on the development of research scales for digital servitization, which will promote quantitative research on digital servitization. Research on digital servitization is still in its infancy. Due to the constraints caused by the immature quantitative methods, existing research mainly takes qualitative methods instead of in-depth empirical research methods. The mechanism of enterprises' digital servitization still needs to be discussed from multiple perspectives and through various methods in the future. Secondly, digital servitization is a process undergoing dynamic changes, and constant attention needs to be paid to its changes in the future. This paper mainly focuses on the antecedent role of differentiated data endowments, and other key driving factors need to be explored in the future. Besides, as this paper mainly focuses on manufacturing enterprises, its results may not be universally applicable to cases in other industries. Given the differences in the digital servitization of different industries, it is necessary to explore its mechanism in other industries. Thirdly, the digital servitization may vary depending on the size of an enterprise. Small and medium-sized enterprises can grasp new business opportunities through agile responses, and large enterprises have more resources to innovate their business models (Raddats et al., 2022). This paper focuses on a large manufacturing enterprise, and the digital servitization of a small or medium-sized enterprise can be explored in the future (Raddats et al., 2022).

Acknowledgments This paper is supported by the National Natural Science Foundation of China (No. 72572045); the major project of the National Natural Science Foundation of China (No. 72091315); and the Guangzhou Philosophy and Social Sciences Development "14th Five-Year Plan" Project (No. 2025GZYB34).

References

Ardolino, M., Rapaccini, M., Saccani, N., & Gaiardelli, P. (2018). The role of digital technologies for the service transformation of industrial companies. *International Journal of Production Research*, *56*(6), 2116–2132.

Cao, Y., Li, X., Hu, H. L., Wan, G. Y., & Wang, S. Y. (2023). 数字化如何推动制造企业绿色转型——资源编排理论视角下的探索性案例研究 [How does digitalization drive the green transformation of manufacturing enterprises: An exploratory case study from the perspective of resource orchestration theory]. *管理世界* [Journal of Management World], (3), 96–113.

Chirumalla, K., Leoni, L., & Oghazi, P. (2023). Moving from servitization to digital servitization: Identifying the required dynamic capabilities and related microfoundations to facilitate the transition. *Journal of Business Research*, *158*, 113668.

Cloutier, C., & Langley, A. (2017). Negotiating the moral aspects of purpose in single and cross-sectoral collaborations. *Journal of Business Ethics*, *141*(1), 103–131.

Coreynen, W., Vanderstraeten, J., van Witteloostuijn, A., Cannaerts, N., Loots, E., & Slabbinck, H. (2020). What drives product-service integration? An abductive study of decision-makers' motives and value strategies. *Journal of Business Research*, *117*, 189–200.

Cui, M., Qian, J. F., & Wang, Z. L. (2024). 持续用户生成内容的实现机制: 可供性–实现视角下Bilibili案例研究 [Actualization mechanism of sustainable user-generated content: A case study of Bilibili based on affordance actualization theory]. *南开管理评论* [Nankai Business Review], (1), 40–52.

Dalenogare, L., Le Dain, M., Benitez, G., Ayala, N., & Frank, A. (2022). Multichannel digital service delivery and service ecosystems: The role of data integration within smart product-service systems. *Technological Forecasting and Social Change*, *183*, 121894.

Dalenogare, L., Le Dain, M., Ayala, N., Pezzotta, G., & Frank, A. (2023). Building digital servitization ecosystems: An analysis of inter-firm collaboration types and social exchange mechanisms among actors. *Technovation*, *124*, 102756.

Deluca, P., Coulton, S., Alam, M., Boniface, S., Cohen, D., Donoghue, K., Gilvarry, E., Kaner, E., Maconochie, I., McArdle, P., McGovern, R., Newbury-Birch, D., Patton, R., Pellatt-Higgins, T., Phillips, C., Phillips, T., Pockett, R., Russell, I., Strang, J., & Drummond, C. (2021). Brief interventions to prevent excessive alcohol use in adolescents at low-risk presenting to emergency departments: Three-arm, randomised trial of effectiveness and cost-effectiveness. *International Journal of Drug Policy*, *93*, 103–113.

Dincelli, E., & Yayla, A. (2022). Immersive virtual reality in the age of the metaverse: A hybrid-narrative review based on the technology affordance perspective. *Journal of Strategic Information Systems*, *31*(2), 101717.

Effah, J., Amankwah-Sarfo, F., & Boateng, R. (2021). Affordances and constraints processes of smart service systems: Insights from the case of seaport security in Ghana. *International Journal of Information Management*, *58*, 102204.

Eisenhardt, K., & Graebner, M. (2007). Theory Building from Cases: Opportunities and Challenges. *Academy of Management Journal*, *50*(1), 25–32.

Favoretto, C., Mendes, G., Filho, M., Oliveira, M., & Ganga, G. (2022). Digital transformation of business model in manufacturing companies: Challenges and research agenda. *Journal of Business & Industrial Marketing*, *37*(4), 748–767.

Ferreira, J., & Fernandes, C. (2017). Resources and capabilities' effects on firm performance: What are they? *Journal of Knowledge Management*, *21*(5), 1202–1217.

Gebauer, H., Arzt A., Kohtamäki M., Lamprecht, C., Parida, V., Witell, L., & Wortmann, F. (2020). How to convert digital offerings into revenue enhancement—Conceptualizing business model dynamics through explorative case studies. *Industrial Marketing Management*, *91*, 429–441.

Gebauer, H., Paiola, M., Saccani, N., & Rapaccini, M. (2021). Digital servitization: Crossing the perspectives of digitization and servitization. *Industrial Marketing Management*, *93*, 382–388.

Gioia, D., Patvardhan, S., Hamilton, A., & Corley, K. (2013). Organizational identity formation and change. *The Academy of Management Annals*, *7*(1), 123–193.

Hasselblatt, M., Huikkola, T., Kohtamäki, M., & Nickell, D. (2018). Modeling manufacturer's capabilities for the Internet of Things. *Journal of Business and Industrial Marketing*, *33*(6), 822–836.

Hou, J., Lu, Q., Shi, Y. J, & Rong, K. (2011). 基于组织生态学的企业成长演化: 有关变异和生存因素的案例研究 [Enterprise growth and evolution based on organizational ecology: A case study on variation and survival factors]. *管理世界* [Journal of Management World], (12), 116–130.

Jiang, X. J., & Jin, J. (2022). 数字技术提升经济效率: 服务分工、产业协同和数实孪生[Digital technology promotes economic efficiency: Labor division of service, industrial synergy and digital-real twins]. *管理世界* [Journal of Management World], (12), 9–26.

Jiang, Z. S., Wang, J. X., & Li, J. H. (2023). 制造商依托数字技术推进跨越式服务化转型的过程: 基于诺力股份的案例研究 [The process of manufacturers' leapfrog servitization transformation based on digital technology: A case study of Noblelift]. *管理工程学报* [Journal of Industrial Engineering and Engineering Management], (3), 212–223.

Jiao, H., Zhang, R., & Yang, J. F. (2023). 数字经济情境下企业战略选择与数字平台生态系统构建——基于共演视角的案例研究 [Corporate strategic choices and digital platform-based ecosystem building in the context of the digital economy: A case study from the co-evolution perspective]. *管理世界* [Journal of Management World], (12), 201–229.

Kohtamäki, M., Rabetino, R., Parida, V., Sjädin, D., & Henneberg, S. (2022). Managing digital servitization toward smart solutions: Framing the connections between technologies, business models, and ecosystems. *Industrial Marketing Management*, *105*, 253–267.

Li, Z., Xie, W., Wang, Z., Wang, Y., & Huang, D. (2023). Antecedent configurations and performance of business models of intelligent manufacturing enterprises. *Technological Forecasting and Social Change*, *193*, 122550.

Lim, C., Kim, K., Kim, M., & Heo, J. (2018). From data to value: A nine-factor framework for data-based value creation in information-intensive services. *International Journal of Information Management*, *39*, 121–135.

Liu, L. Q., Lei, H., & Tan, L. W. (2010). 从商品主导逻辑到服务主导逻辑——以苹果公司为例 [From commodity dominant logic to service dominant logic—A case of Apple Co. Ltd.]. *中国工业经济* [China Industrial Economics], (9), 57–66.

Matarazzo, M., Penco, L., Profumo, G., & Quaglia, R. (2021). Digital transformation and customer value creation in Made in Italy SMEs: A dynamic capabilities perspective. *Journal of Business Research*, *123*, 642–656.

Muchenje, G., & Seppanen, M. (2023). Unpacking task-technology fit to explore the business value of big data analytics. *International Journal of Information Management*, *69*, 102619.

Nambisan, S. (2017). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. *Entrepreneurship Theory and Practice*, *41*(6), 1029–1055.

Pan, R. R., Luo, J. Q., & Yang, Z. (2023). 数字技术赋能制造企业服务化转型：理论分析与展望[Digital technology empowers servitization transformation of manufacturing enterprises: Theoretical analysis and prospect]. *系统工程理论与实践* [Systems Engineering—Theory & Practice], (11), 3110–3128.

Raddats, C., Naik, P., & Bigdeli, A. (2022). Creating value in servitization through digital service innovations. *Industrial Marketing Management*, *104*, 1–13.

Ritter, T., & Pederson, C. (2020). Analyzing the impact of the coronavirus crisis on business models. *Industrial Marketing Management*, *88*, 214–224.

Schiavone, F., Leone, D., Caporuscio, A., & Lan, S. (2022). Digital servitization and new sustainable configurations of manufacturing systems. *Technological Forecasting and Social Change*, *176*, 121441.

Shen, L., Sun, W., & Parida, V. (2023). Consolidating digital servitization research: A systematic review, integrative framework, and future research directions. *Technological Forecasting and Social Change*, *191*, 122478.

Sjödin, D., Parida, V., Palmié, M., & Wincent, J. (2021). How AI capabilities enable business model innovation: Scaling AI through co-evolutionary processes and feedback loops. *Journal of Business Research*, *134*, 574–587.

Smania, G., Mendes, G., Lizarelli, F., & Favoretto, C. (2022). Service Innovation in medical device manufacturers: Does the digitalization matter? *Journal of Business & Industrial Marketing*, *37*(3), 578–593.

Soellner, S., Helm, R., Klee, P., & Endres, H. (2024). Industrial service innovation: Exploring the transformation process to digital servitization in industrial goods companies. *Industrial Marketing Management*, *117*, 288–303.

Teece, D. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319–1350.

Trocin, C., Hovland, I., Mikalef, P., & Dremel, C. (2021). How artificial intelligence affords digital innovation: A cross-case analysis of Scandinavian companies. *Technological Forecasting and Social Change*, *173*, 121081.

Tronvoll, B., Sklyar, A., Sörhammar, D., & Kowalkowski, C. (2020). Transformational shifts through digital servitization. *Industrial Marketing Management*, *89*, 293–305.

Ulaga, W., & Reinartz, W. (2011). Hybrid offerings: How manufacturing firms combine goods and services successfully. *Journal of Marketing*, *75*(6), 5–23.

Wang, F. B., & Zhang, X. (2022). 用纵向案例研究讲好中国故事: 过程研究范式、过程理论化与中西对话前景 [Telling Chinese stories well with longitudinal case studies: Process study paradigm, process theorization, and the prospects of Sino-Western dialogue]. *管理世界* [Journal of Management World], (6), 191–213.

Wu, X. L., Xiao, J. H., & Wu, J. (2023). 当创意遇到智能: 人与AI协同的产品创新案例研究 [When creativity meets intelligence: A case study of human-AI collaboration in product innovation]. *管理世界* [Journal of Management World], (5), 112–127.

Xie, K., Zhang, Y., & Wu, Y. (2023). 数据要素如何产生即时价值: 企业与用户互动视角 [How data elements generate instant value: An interactive perspective between enterprises and users]. *中国工业经济* [China Industrial Economics], (11), 137–154.

Yi, S. H., & Liang, W. (2023). 传统商业企业如何创新转型——服务主导逻辑的价值共创平台网络构建 [How do the traditional commercial enterprises innovate and transform—The construction of the value co-creation platform network from the perspective of service-dominant logic]. *中国工业经济* [China Industrial Economics], (1), 171–188.

Zhang, C., Hao, L. Y., & Shan, Y. (2023). 服务主导逻辑下B2B电商平台企业生态优势构建机制——基于华采找鱼的探索性案例研究 [The ecosystem-specific advantage construction mechanism of B2B e-commerce platform companies under the service dominant logic: An exploratory case study based on Huacai Fishery Platform]. *南开管理评论* [Nankai Business Review], (3), 28–41.

Zhang, R. J., Chen, J. H., & Wu, D. (2020). 制造企业服务化战略与运维商业模式创新的匹配——基于多案例的研究 [The fit between servitization strategy and maintenance business model innovation in manufacturers: Based on multi-case study]. *管理评论* [Management Review], (2), 308–326.

Zhang, Y. H., Li, X. H., & Liu, S. W. (2024). 数据要素赋能服务型制造发展: 场景应用、作用机制与政策建议 [Data empowers the development of service-oriented manufacturing: Application in scenarios, mechanism, and policy suggestions]. *改革* [Reform], (1), 69–81.

Zhang, Z. G., Yang, Y. L., & Chen, Y. H. (2022). 制造企业数字服务化: 数字赋能价值创造的内在机理研究 [Digital servitization of manufacturing firms: The value creation driven by digital enablement]. *科学学与科学技术管理* [Science of Science and Management of S.& T.], (1), 38–56.

Zhu, X. M., Lin, X. Y., Wang, T. D., & Miao, S. J. (2023). 数据价值化: 研究评述与展望 [Data valued process: A review and prospects]. *外国经济与管理* [Foreign Economics & Management], (12), 3–17.