Journal of Computing and Electronic Information Management
ISSN: 2413-1660 | Vol. 11, No. 3, 2023

Research on Industrial Digital Transformation Strategies for the Construction of a New Industrialized City

Yiyuan Wang [1], Yanlu Yang[2] *

[1]School Of Economics and Management, Taishan University, Taian, China
[2] Department of Business, Incheon National University, Incheon, Korea

* **Corresponding author**: Yanlu Yang (Email: yangyanlu07@163.com)

Abstract: Industrial digital transformation is the appropriate intention and an inevitable choice to empower the construction of a new industrialized city, which holds great significance for the efficient allocation of industrial resources, the optimized layout of the industrial structure, and the enhancement of industrial development quality. However, industrial digital transformation will encounter two major problems: the data security of enterprise information-knowledge spillovers and the willingness of enterprises to transform, reflected in the enterprise input-output ratio for industrial digital transformation. Therefore, constructing an industrial digital transformation strategy that can effectively address these two problems has become a focal point. In light of this, the study builds an industrial digital transformation strategy from the perspectives of research institutions such as universities, industrial enterprises, trade associations, and government departments by exploring the causes of industrial digital transformation problems. Universities and research institutions should expedite the construction of compatible big data models for industrial digital transformation paradigms, such as the industrial Internet. Leading manufacturing enterprises should actively establish "satellite-type" industrial digital transformation platforms. Trade associations should redirect their functions toward the construction of standardized industrial know-how systems. Government departments should take a leading role in promoting industrial digital transformation among scientific research institutions, industrial enterprises, trade associations, and government departments. The government should lead efforts to promote synergistic cooperation among research institutions, industrial enterprises, and trade associations to ultimately realize the systematic and holistic promotion of industrial digital transformation.

Keywords: Industrial Digital Transformation; New Industrialized City; Digital Transformation Strategy; Information-Knowledge Spillover.

1. Introduction

Industrialization and digitization are important development features of today's human society. Industrialization promotes and integrates digitization, giving birth to new forms of digital economy with "digital industrialization" and "industrial digitization" as its specific development methods. Facing the construction of a new industrialized city, the industrial digital transformation has become the proper meaning and inevitable choice to empower the construction of a new industrialized city. The industrial digital transformation, through the externalization, sharing and integration of information and knowledge in the industrial sphere, is conducive to promoting the adjustment of industrial resource categories, the enhancement of industrial resource allocation efficiency and improvement in industrial resource utilization; is conducive to the optimization of the layout of the industrial structure and the promotion of the combination of strengths and weaknesses among industrial enterprises; is conducive to the clarification of the strengths and deficiencies of the supply chain and the industrial chain, to make up for the shortcomings of the supply chain and the industrial chain, and to enhance the quality of the development of the supply chain and the industrial chain as a whole; and is also conducive to providing a precise target for the service of the universities to the development of the local economy, and effectively promotes the integrated development between the industry and education.

However, once industrial enterprises carry out digital transformation, they will inevitably face the two problem: the risk of losing their competitive advantages due to the spillover of enterprise's information-knowledge and the input-output ratio of enterprise digital transformation, which affect the willingness of enterprise digital transformation. Therefore, in the construction of new industrialized cities, the industrial digital transformation must solve the data security and input-output ratio of industrial enterprises and the lack of willingness derived from the problem. The companion characteristics of digital security technology and decryption technology and the irreversibility of enterprise data spillover, which is obvious that digital security technology alone cannot completely dispel the worries of industrial enterprises about digital transformation, and it is more necessary to innovate the transformation strategy. Based on this, this paper, oriented to the construction of new industrialized cities, seeks to explore the causes of the problem of insufficient willingness of industrial digital transformation enterprises, and to construct a system of industrial digital transformation strategies that can effectively avoid the problems of willingness and security of industrial enterprises in industrial digital construction.

2. Theoretical traceability

Different scholars offer varying perspectives on the understanding of the concept of industrial digital transformation. LI Teng, SUN Guoqiang, and CUI Gege

(2021) assert that digital industrialization and industrial digitization are integral components of the digital economy, each playing distinct roles in its development [1]. They posit that digital industrialization forms the foundation of the digital economy, while industrial digitization represents an extension of its development. Lv Tie (2019) posits that industrial digitization involves the deepening integration of digital technology with the value chain[2]. This process releases amplification, superposition, and multiplication effects of digital technology on economic development. According to Tie, industrial digitization is a crucial pathway for traditional industries to achieve qualitative, efficient, and powerful changes.

XIAO Xu & QI Yu-dong (2019) believe that industrial digitization refers to the process in which traditional industries utilize digital technology to upgrade and transform relevant business operations, thereby enhancing the production quantity and efficiency of traditional industries [3]. LIU Hang, et al. (2019) propose that industrial digitization involves the innovative combination of production factors through new digital technologies, empowering the transformation and upgrade of traditional industries [4]. Although scholars have different understandings of the concept of industrial digitization transformation, there are strong common characteristics. Industrial digitization primarily refers to the integration and development process of new digital technologies, as technological elements, with micro-level enterprises and their entire supply chain factors, meso-level industries and their entire industry chain factors, and macro-level national economic development and its overall factors. Therefore, to realize the effectiveness of industrial digitization transformation, the key lies in the integration of digital technology with the real economy. However, in the process of the integrated development of digital economy and the real economy in China, compared to the relatively positive development situation of digital industrialization, the development status of industrial digitization is relatively pessimistic [5].

Scholars' opinions on the functional roles of industrial digitization transformation can generally be categorized into three main perspectives. The first viewpoint suggests that industrial digitization transformation can create new points of value growth. For example, HE Fan & LIU Hong-xia (2019) argue that industrial digitization enables deep integration between digital technology and physical enterprises, creating a new economic form primarily driven by data [6]. This empowers companies to achieve continuous innovation in technology, products, processes, and business, leading to the continuous creation of new business value. PEI Changhong, NI Jiangfei & LI Yue (2018) propose that industrial digitization can help companies externalize and diversify value creation [7]. XIE Kang, XIAZheng-hao & XIAO Jing-hua (2020) suggest that industrial digitization is conducive to promoting collaborative value creation between companies and users, thereby meeting continuously changing personalized consumption demands [8]. Wang Wei-ling & Wang Jing (2019) posit that industrial digitization can assist companies in integrating, sharing, and comprehensively utilizing various resource elements, constructing a new production model based on data-driven approaches [9].

The second perspective holds that industrial digitization transformation can drive high-quality development. For instance, Qi Yudong & Xiao Xu (2020) argue that industrial digitization can prompt enterprises to undergo changes in organizational structure, production models, and labor patterns, thereby propelling high-quality development of businesses [10]. Wei Jiang, Liu Jialing & Liu Yang (2021) suggest that industrial digitization can bring about transformations in production entities, organizational methods, production processes, and production relationships, promoting high-quality development in industries [11]. LI Chun-fa, LI Dong-dong & ZHOU Chi (2020) propose that industrial digitization can empower the scale customization of intelligent manufacturing, driving high-quality development in the manufacturing industry [12]. Li Yingjie & Han Ping (2021) contend that industrial digitization can facilitate deep integration between the digital economy and high-quality development in manufacturing, contributing to the improvement of development quality, efficiency, and power in the manufacturing sector [13]. Lan Qingxin & Zhao Yongchao (2021) assert that industrial digitization is a key driver of China's economic development in the internal circulation, facilitating high-quality development of the internal circulation [14]. Li Tian-yu & Wang Xiao-juan (2021) argue that industrial digitization can empower the construction of dual circulation, promoting the establishment of a high-quality dynamic operating system for economic development [15].

The third perspective holds that industrial digitization transformation can help enterprises reduce costs and increase efficiency. For example, QI Yu-dong & CAI Cheng-wei (2019) argue that industrial digitization, through promoting the penetration of digital technology and the interconnectedness and deep integration of elements, can enhance the efficiency of resource allocation for enterprises [16]. Ding Yulong (2021) also believes that industrial digitization is conducive to improving the efficiency of resource allocation in production and operations, promoting cross-industry integration among enterprises [17]. In summary, the mechanisms through which industrial digitization transformation impacts enterprises, industries, and economic development are comprehensive. It not only creates new points of value growth and engines for growth but also promotes the transformation of production models, business models, and organizational structures. This, in turn, enhances the high-quality development of all elements in enterprises, industries, and economic development. Additionally, it helps enterprises scientifically allocate resource elements, improve the efficiency of resource allocation, and facilitate cost reduction and efficiency improvement.

Regarding the current status of industrial digitization transformation, different scholars have expressed diverse viewpoints. ZHAO Jianbo (2022) vividly likened digital industrialization and industrial digitization to "low-hanging fruit" and "fruit at the top of the tree," suggesting that once the "low-hanging fruit" of a certain digital technology is harvested, the "fruit at the top of the tree" becomes a formidable challenge that businesses, industries, and economic development urgently need to overcome [5]. In the current development process of China's digital economy, the progress of digital industrialization and industrial digitization is not synchronized. The development trend of the former is relatively positive, while the latter lags behind. The relatively lagging development of industrial digitization is mainly manifested in several technological paradigms that remain largely in the visionary development concepts and goals proposed by the academic and industrial communities. The practical acceptance by enterprises is low, lacking necessary

operational means and measures, thereby hindering the successful realization of industrial digitization transformation. The current failure rate of enterprise digital transformation even exceeds 70%[18], constituting the current state of industrial digitization transformation in China.

3. Current constraints on digital transformation of industries

Based on the relationship between data, information, and knowledge, the construction of the industrial digitization transformation strategy for the development of a strong city in the context of new industrialization primarily focuses on the digital transformation of traditional manufacturing enterprises. The development of relevant transformation strategies needs to adhere to the organizational learning process and knowledge management flow of industrial digitization transformation, aiming to construct an industrial digitization transformation model that aligns with the current national conditions and development status in China.

Since the generation of knowledge and the process of organizational learning start from individual tacit knowledge [19], the mechanism for the transformation of industrial digitization information and knowledge begins with the conversion of tacit knowledge within the organizational meaning structure of enterprises. It transforms into explicit knowledge within the organizational meaning structure. Individuals within the organization then share part of this explicit knowledge, forming explicit knowledge that can be shared within the organizational meaning structure of job positions. The explicit knowledge within the organizational meaning structure of job positions is absorbed and combined by the entire organization, forming collective explicit knowledge within the organizational meaning structure. Through sharing and socialization processes among industry enterprises, industry standard explicit knowledge within the meaning structure is developed, which is further refined, integrated, and structured into a systematic and industrialized body of knowledge within the industry system.

As the collective explicit knowledge within the organizational meaning structure, industry standard explicit knowledge, and industrial system explicit knowledge constitute a collection of various job position knowledge within the same organization, industry, and industrial sector, they provide strong reference significance for the creation of tacit knowledge within the organizational meaning structure of job positions for organizational individuals. Through the process of internalization, this contributes to the production and innovation of tacit knowledge within the organizational meaning structure of job positions. Eventually, it forms a closed-loop, spiral-ascending mechanism for the transformation of industrial digitization information and knowledge.

Setting TK_{ijk}, EK_{ijk}, SEK_{ijk}, EEK_{ijk}, TSK_{ijk} and ISK to represent tacit knowledge within the organizational meaning structure of job positions, explicit knowledge within the organizational meaning structure of job positions, explicit knowledge within the organizational meaning structure of job positions that can be shared within the enterprise, collective explicit knowledge within the organizational meaning structure, industry standard explicit knowledge, and explicit knowledge within the meaning structure of the industrial system, respectively. Let i represent the job category, j represents the enterprise category, and k represent the industry category. Within the organization, the relationships among TK_{ijk}, EK_{ijk}, SEK_{ijk} and EEK_{ijk} are as shown in Formula (1) and Formula (2).

$$TK_{ijk} > EK_{ijk} > SEK_{ijk} \quad \text{Formula (1)}$$

$$EEK_{ijk} = \sum_{i=1} SEK_{ijk} \quad \text{Formula (2)}$$

Based on the relationship between Formula (1) $TK_{ijk} > EK_{ijk} > SEK_{ijk}$ and Formula (2) $EEK_{jk} = \sum_{i=1} SEK_{ijk}$, when the information and knowledge stock of TK_{ijk}, EK_{ijk} and SEK_{ijk} are higher, and the information and knowledge stock transformed from TK_{ijk}, EK_{ijk} and SEK_{ijk} to EEK_{jk} is larger, the information and knowledge stock of EEK_{jk} is also higher. This higher information and knowledge stock of EEK_{jk} plays a more significant role in the transformation and upgrade of the enterprise.

However, in the process of the transformation from TK_{ijk}, EK_{ijk} and SEK_{ijk} to EEK_{ijk}, there inevitably exists a loss of value in individual information and knowledge among organizational members. To achieve a win-win situation for personal and organizational interests, internal performance feedback within the enterprise can effectively drive the maximization of TK_{ijk} production, the maximization of TK_{ijk} transformed into EK_{ijk} and SEK_{ijk}, and the maximization of the stock EEK_{ijk}.

However, due to the bidirectional limitations of EEK_{ijk} in terms of job knowledge categories and job knowledge stock, the digital transformation of industries inevitably requires breaking through the extension of collective explicit knowledge within organizational meaning structures. It involves constructing explicit knowledge systems for industry-standard meaning structures and national standard meaning structures, ultimately forming an explicit knowledge system with an integrated industrial framework meaning structure. Assuming that the explicit knowledge within industry-standard meaning structures is the average value of job-based collective explicit knowledge within all enterprises in that industry, the knowledge stock relationship model between collective explicit knowledge within enterprises and explicit knowledge within industry-standard meaning structures and explicit knowledge within industrial framework meaning structures can be formulated as shown in Formulas (3) and (4).

$$TSK_{ijk} = \sum_{i=1}^{j=1} EEK_{ijk} \Big/ j \quad \text{Formulas (3)}$$

$$ISK = \sum_{k=1} ITK_{ijk} \quad \text{Formulas (4)}$$

Whether from an industry or a sector perspective, it is evident that the more comprehensive the job knowledge categories and the larger the stock of job knowledge for TSK_{ijk} and ISK, the greater their support for industrial digitization transformation. Consequently, the effects of industrial digitization transformation are also more significant. However, since industry-standard explicit knowledge is derived from the transformation of collective explicit knowledge within enterprises, when there are more job knowledge categories and a larger stock of job knowledge in the transformation from collective explicit knowledge within enterprises to industry-standard explicit knowledge, the industry-standard explicit knowledge tends to have a more comprehensive range of job knowledge categories and a

larger stock of job knowledge.

The transformation of collective explicit knowledge within enterprises into industry-standard explicit knowledge has a voluntary and autonomous nature, lacking direct performance feedback. Alternatively, the performance feedback resulting from industrial digitization transformation often exhibits strong lag and global characteristics. This leads to the phenomenon that, under the knowledge spillover effect, the more job knowledge categories and the larger the stock of job knowledge in the transformation from collective explicit knowledge within enterprises to industry-standard explicit knowledge, the greater the potential losses for the enterprise. Moreover, as industrial digitization transformation typically requires significant investments in human resources, physical resources, and finances, this inevitably affects the enthusiasm of enterprises for industrial digitization transformation. From the perspective of game theory, those enterprises that choose not to transform or transform less knowledge but can still achieve similar effects of industrial digitization transformation exhibit characteristics of maximizing benefits. This aligns with the current state of industrial digitization development, where the actual acceptance of digital transformation by enterprises is not high. This phenomenon is specifically reflected in several aspects.

First, from the perspective of enterprises, there is still significant concern about the cost-effectiveness of industrial digitization transformation. Although academia and industry generally recognize the common understanding that digital technology can enhance the production efficiency of traditional industries and drive the transformation and upgrading of traditional industries, most enterprises have not yet formed a systematic understanding of digital transformation, including transformation routes, data collection, data processing, application destinations, and investment in transformation [20]. Faced with the uncertainty in the cost-effectiveness relationship between the relatively low value of digital transformation, which is focused on single business or single enterprise data collection, processing, and utilization, and the substantial human and financial investments with uncertain subsequent returns, there is doubt about the investment returns. Small and medium-sized enterprises, in particular, are constrained by their own limitations in terms of human resources, physical resources, and finances.

Secondly, from the industry perspective, the data modeling, specific functions, and business models supporting big data systems for enterprise digital transformation are not yet well-established. Taking the development process of China's industrial Internet platforms as an example, under the support of new digital technologies, a batch of industrial Internet platforms integrating manufacturing and service development are expected to emerge and lead industrial ecosystem [21]. However, the current big data systems of industrial Internet platforms in China still face challenges in data modeling and analysis [22]. The industrial cloud platform (PaaS), as the core of industrial Internet platforms, is still in its early stages. The compatibility of the data collection and analysis models currently built with the industry and even the sector is relatively low. Many platforms have more of a demonstrative or exhibitionist nature and are rarely practically applied by enterprises, making it difficult to comprehensively collect and effectively mine data value. The specific functions and business models of the currently built industrial Internet platforms are not yet sound, with unanswered questions regarding which information of enterprises to collect, how to handle this data, who owns the data, and how these data can be more valuable. Infrastructure as a Service (IaaS) platforms are more monopolized by oligopolistic enterprises [23]. Once enterprise data information enters the platform, it is difficult to effectively ensure the security management and utilization of enterprise data information. This situation risks becoming a satellite of large enterprises. Concerns about the security of information data based solely on technology are difficult to address for small and medium-sized enterprises effectively.

Thirdly, from a macro perspective, the model of integrating the development of industrial digitization with the real economy is not yet mature. The evolution of the digital economy from consumer Internet to industrial Internet poses significant differences in terms of network architecture, stakeholders, application scenarios, competitive landscape, and other aspects. The complexity is substantial. In the context of immature industrial and industrial Internet, the drawbacks of consumer Internet are becoming evident. The most prominent manifestation is that consumers cannot effectively and scientifically assess the quality of products in the consumer Internet. More often, this judgment of product quality depends on personal experience, lacking standardized reference value. This situation is detrimental to the sustainable development of the consumer Internet. Regarding industrial Internet, the concept has been introduced for over a decade, but the concrete nature, construction, specific functions, and effective connection between industrial Internet and consumer Internet are still subjects of significant debate in both academia and industry. Many concepts appear more like "research agendas," with limited available implementation paths and methods.

4. Strategy Construction for Industrial Digitization Transformation

To advance the digital transformation of traditional industries in the construction of a new industrial city, it is imperative to propel the transition of the industrial digitization paradigm from theory to practical implementation, especially through the establishment of industrial Internet or industrial Internet platforms. Industrial Internet or industrial Internet, by transcending the scope of individual enterprises, inherently possesses strong characteristics of public infrastructure. In the face of the constraints of industrial digitization transformation and the specific requirements and objectives of the construction of a new industrial city, the construction of industrial digitization technology paradigms such as industrial Internet or industrial Internet necessitates overcoming limiting factors and devising feasible operational plans. This study suggests proposing strategies for industrial digitization transformation from the perspectives of four key entities: university research institutions, enterprises, industries, and government.

From the perspective of university research institutions, it is essential to strengthen the intellectual empowerment role of universities and other research institutions in the industrial digitization transformation. Given that the constraints on industrial digitization transformation lie in the insufficient scientific, efficient, and secure big data modeling, the intellectual empowerment role of university research institutions in basic research should be fully utilized. Facing the requirement of digital modeling characterized by "micro-front desk + large and medium-sized platform + strong back-

end," it is crucial to actively promote in-depth research by university research institutions into traditional manufacturing enterprises. Firstly, at the city level, construct a "regional" big data model, with industries, sectors, and enterprises as vertical contexts and industrial chains and supply chains as horizontal contexts. Actively establish an industrial digitization transformation platform. Secondly, university research institutions should assist traditional manufacturing enterprises in constructing a "satellite" big data model that aligns with the enterprise's process flow. This model should be based on vertical contexts such as enterprises, positions, and skills and horizontal contexts like product chains, process chains, and technology chains, ultimately building an intelligent manufacturing platform for enterprises. Thirdly, considering that big data serves as a digitized mapping of all elements of an enterprise and is a core element for the future development of the digital economy, with significant economic value, once the "satellite" industrial digitization platform of an enterprise connects with the "regional" industrial digitization platform of the entire city, there will inevitably be an overflow effect of the economic value of private data towards public welfare value, leading to the risk of information knowledge overflow and value loss for enterprises, impacting their development and willingness to integrate. Therefore, there should be active assistance in formulating scientific and reasonable connection measures, operation mechanisms, and feedback mechanisms for the government and enterprises to achieve a scientific, efficient, and secure connection between the "regional" industrial digitization platform and the "satellite" industrial digitization platform. This approach is crucial for thoroughly exploring the data value brought about by industrial digitization transformation, promoting the transformation and innovation of new business formats, new models, new products, new services, etc., while also protecting the legitimate rights and interests of enterprises. It helps the government and enterprises establish a path for industrial digitization transformation that includes "pilot construction - promotion application - deep expansion," ultimately achieving a comprehensive digital transformation to accelerate the realization of the objectives and requirements of the construction of a new industrial city in the task of advancing the new industrialization.

At the enterprise level, it is essential to clarify that leading manufacturing enterprises play a key role as pivotal nodes and breakthroughs in the industrial digitization transformation. Firstly, actively promote deep collaboration between leading manufacturing enterprises with comprehensive job knowledge categories and rich job knowledge reserves and research institutions such as universities. Construct industrial Internet digital models that match the manufacturing process of leading manufacturing enterprises, laying the foundation for the construction of the "satellite" industrial Internet platform. Secondly, continue to deepen the collaboration between leading manufacturing enterprises, research institutions, information service leading enterprises, and Internet platform enterprises. Support enterprises in constructing and improving the digital infrastructure of leading manufacturing enterprises, building a "satellite" industrial Internet platform based on the explicit knowledge of the enterprise's collective meaning structure. Create a demonstrative and replicable architecture for the "satellite" industrial Internet platform. Thirdly, replicate and promote the mature operation of the "satellite" industrial Internet platform among enterprises and industries. Enhance the business information collection and data processing capabilities of all industries. This is to comprehensively connect with the "regional industrial Internet platform and fully leverage industrial data for the innovative development and efficient matching of industrialization across all factors.

From the perspective of industry associations, it is crucial to enhance and improve the digital transformation functions of industry associations. Industry associations, as a common form of non-profit social-economic organizations in mature market economies, serve as social governance mechanisms that maintain and connect relationships between enterprises within the industry, as well as between the industry and the government and society. They are embedded in society and interact with other stakeholders, possessing both market-oriented and public-oriented characteristics. However, the weakening of organizational capabilities in Chinese industry associations is a widespread and acknowledged phenomenon [24]. Examining the organizational nature and composition of industry associations in China, they are often government-run associations, with managers often appointed from retired leaders of government or relevant state-owned enterprises. The service orientation, digitization, and level of specialization in these associations are relatively weak. The current organizational forms, personnel composition, and operational characteristics of Chinese industry associations hinder the socialization process of transferring explicit knowledge from the collective meaning structure of enterprises to the industry standard explicit knowledge. This, in turn, impedes the systematic construction of the industry framework explicit knowledge, making it challenging to effectively drive industrial digitization transformation. To address this issue, it is necessary to adjust the organizational structure of industry associations, establish specialized leadership structures, and empower industry associations with knowledge management and digital transformation functions. This adjustment aims to accelerate the transfer and systematic construction of explicit knowledge from the collective meaning structure of enterprises to industry-standard explicit knowledge. This effort will provide strong support for the development of industrial Internet in city in terms of organizational entities, information knowledge, and other aspects.

At the government level, it is crucial to actively establish the leadership role of the government in industrial digital transformation. Given the characteristics of the public infrastructure attributes of the industrial Internet platform and the functional deficiencies of industry associations in China, this underscores the crucial role of government departments, especially in the establishment of industrial Internet platforms. Firstly, government departments should actively support local universities and research institutions in collaboration with leading manufacturing enterprises to conduct research on big data modeling for industrial digital transformation. This is essential to overcome the fundamental and critical constraints of insufficient big data modeling in industrial digital transformation. Secondly, governments should actively promote and support in-depth collaboration between leading manufacturing enterprises and local universities and research institutions to build the technological paradigm of the "satellite-type" industrial Internet platform for industrial digital transformation. This model should be actively promoted and applied. Furthermore, to achieve the long-term and sustainable development of the digital economy,

government support is needed to strengthen the basic research of digital technology. This includes creating a long-term research and development model for industrial digital transformation technology, accelerating the industrial application of digital transformation technology, and actively cultivating digital technology talents and high-end leaders in the field of industrial digital transformation. Additionally, governments should actively introduce digital economy service-oriented enterprises and internet platform enterprises with leading standards both domestically and internationally. This will drive innovative development in digital industrialization, construct a mutually reinforcing cycle of digital industrialization and industrial digitization in the form of a digital economic development model, and ultimately achieve the development and growth of digital economy in line with the goals of the new industrialization and the construction of a strong city with new industries.

5. Conclusion

This study firstly explores the causes of the current low acceptance willingness of enterprises to industrial digital transformation from the technical theory level; secondly, it proposes industrial digital transformation strategies from several organizational perspectives: university research institutes, enterprises, industries, and governments.

The learning process of industrial digital transformation can be broadly divided into two tiers, one is the organizational learning process within an enterprise, and the other is the cross-organizational learning process on an industry-wide basis or on a larger scale. For digital transformation within an enterprise, there is an input-output relationship between digital transformation inputs and digital transformation benefits. The low knowledge stock of a single enterprise, especially SMEs, leads to an imbalance in the input-output ratio of digital transformation of a single enterprise, which in turn affects the willingness of enterprises, especially SMEs, to undergo digital transformation; Digital transformation outside the enterprise does not exist direct performance feedback, is a long-term indirect benefits, and subject to the transformation of the success or failure of the concerns, constraints on the construction of a mature mode of operation, resulting in the benefits of digital transformation is also mostly confined only to the scope of the manufacturing industry's leading enterprises in the field of intelligent manufacturing, has not yet achieved the scale of the industry or the industry, holistic benefits, which in turn affects the willingness to digitally transform the enterprise, especially the small and medium-sized enterprises with a low stock of knowledge. Based on the analysis of the causes of the willingness of enterprises to digital transformation, from the point of view of universities and other scientific research institutions, it is necessary to accelerate the promotion of industrial Internet and other industrial digital transformation paradigm model construction research, from the level of basic research to overcome the constraints of industrial digital transformation of the deep-seated model constraints; from the perspective of the enterprise, it is necessary to support the manufacturing industry with a high stock of knowledge in the construction of leading enterprises to build a "satellite" industrial digital transformation platform, to enhance the level of enterprise's intelligent manufacturing, and for the realization of the supply chain, industrial chain docking between the docking to provide the foundation for the digital transformation of the industrial docking; From the industry perspective, it is necessary to adjust the functional role of industry associations, give industry associations the functional role of cross-organizational knowledge production and transformation for industrial digital transformation, and actively build standardized and systematic industry standard knowledge and industrial system knowledge of the industry; from the government perspective, it is necessary to assume the leading role of the government departments in industrial digital transformation, support universities and other scientific research institutes, enterprises, and industry associations to play the role of their respective strengths, and promote synergistic cooperation among universities and other scientific research institutes, enterprises, industry associations, and government departments, so as to achieve the systematic and holistic advancement of industrial digital transformation..

The shortcomings of this study are mainly reflected in the paradigm construction of industrial digitization, especially the much-needed breakthroughs in the construction of digital models of the industrial Internet, which is the main direction of future research. The digital model of the future industrial digital transformation technology paradigm represented by the industrial Internet will have the following characteristics. First, the digital model of industrial digital transformation is a big data model that is vertically coherent and horizontally integrated between the internal organizational learning process of enterprises and the cross-organizational learning process of industries and industries. Secondly, the digital model of industrial digital transformation is composed of a large number of digital platforms with hierarchical and systematic outlines mapped by various types of knowledge of industries, industries and enterprises. Third, the digital model of industrial digital transformation is a big data platform that can effectively promote the integration and development of the industrial Internet big data platform, the consumer Internet big data platform, and the industry-education integration big data platform.

Acknowledgements

The authors gratefully acknowledge the financial support from Taishan University Doctoral Research Initiation Fund Project (Project No: Y-03-2022012).

Reference

[1] LI Teng, SUN Guoqiang, CUI Gege. Digital industrialization and industrial digitization: two-way linkage, industrial network characteristics, and digital economy development. Industrial Economics Research,2021, 114(05):54-68.

[2] Lv Tie. Trend and Path of Digitalized transformation of the Traditional Industries. Frontiers, 2019,178(18):13-19.

[3] XIAO Xu, QI Yu-dong. Value Dimension and Theoretical Logic of Industrial Digital Transformation. Reform, 2019(8): 61-70.

[4] LIU Hang, FU Lin, LI Tao, SUN Baowen. The Summary of the 1st Forum for Internet and Digital Economy. Economic Research Journal, 2019, 54(3): 204-208.

[5] ZHAO Jianbo. Enterprise Digital Transformation: Mechanism, Paradigm and Paths. Journal of Beijing University of Technology (Social Sciences Edition), 2022, 22(01):94-105.

[6] HE Fan, LIU Hong-xia. The Performance Improvement Effect of Digital Transformation Enterprises from the Digital Economy Perspective,2019, 4:137-148.

[7] PEI Changhong, NI Jiangfei, LIYue. Approach Digital Economy from the Perspective of Political Economics. Finance & Trade Economics, 2018, 39(9):5-22.

[8] XIE Kang, XIA Zheng-hao, XIAO Jing-hua. The Enterprise Realization Mechanism of Big Data Becoming a Real Production Factor: From the Product Innovation Perspective.2020, 37(5):42-60.

[9] Wang Wei-ling, Wang Jing. Research on Trend and Policy of Digital Economy Development in China. Economic Review Journal,2019, 1: 69-75.

[10] Qi Yudong, Xiao Xu. Transformation of Enterprise Management in the Era of Digital Economy. Journal of Management World, 2020,36(6):135-152,250.

[11] Wei Jiang, Liu Jialing, Liu Yang. Digital Economy: Connotations, Theoretical Basis and Future Research. Science & Technology Progress and Policy, 2021,38(21):1-7.

[12] LI Chun-fa, LI Dong-dong, ZHOU Chi. The Mechanism of Digital Economy Driving Transformation and Upgrading of Manufacturing: Based on the Perspective of Industrial Chain Restructuring. Commercial Research, 2020,2:73-82.

[13] Li Yingjie, Han Ping. Mechanism and Path of High Quality Development of the Manufacturing Industry in Digital Economy. Macroeconomic Management,2021, 5: 36-45.

[14] Lan Qingxin, Zhao Yongchao. The Digital Economic Development Under the New Developing Pattern of the Double-cycle. Theory Journal, 2021,1:24-31.

[15] Li Tian-yu, Wang Xiao-juan. Digital Economy Empowers China's "Dual Cycle" Strategy: Internal Logic and Practice Path. Economist, 2021,5: 102-109.

[16] QI Yu-dong, CAI Cheng-wei. The Nature of Digital Enterprises: An Economic Interpretation. Research on Financial and Economic Issues, 2019,5: 121-129.

[17] Ding Yulong. Origin, Connotation and Measurement of Digital Economy: A Literature Review. 2021,08: 57-63.

[18] Tony Saldanha. Why Digital Transformations Fail: The Surprising Disciplines of How to Take Off and Stay Ahead. San Francisco: Barrett-Koehler Publishers Inc.2019.

[19] Nonaka I, Takeuchi H. The knowledge-creating company [M]. New York: Oxford University Press,1995.

[20] Li Yongjian. Digital Transformation of Small and Medium-sized Enterprises: Theoretical Logic, Practical Dilemma and International Experience. Frontiers, 2022,18: 37-51.

[21] GUO Chaoxian. Integration of Advanced Manufacturing Industry and Modern Service Industry to Promote High Quality Development of Manufacturing Industry. Journal of Beijing University of Technology (Social Sciences Edition), 2019, 19(4):49-60.

[22] Wang Chen, Song Liang, Li Shaokun. The Industrial Internet Platform: Trend and Challenges., 2018, 20(2): 15-19.

[23] Zhou Jian, Xiao Linlin. Status quo, trends and countermeasures for the development of industrial Internet platforms. Wisdom China, 2017, 2:56-58.

[24] Xiao Fengxiang Jia Min. Mechanism, Dilemma and Thoughts about the Participation of Industry Associations in Modern Vocational Education Governance. Journal of Southwest University (Social Sciences Edition),2016, 42(04): 84-91+190.