DOI 10.15302/J-SSCAE-2020.04.002

Strategic Updating of Internet Plus Considering Digital Transformation

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Abstract: Since the Internet Plus initiative was proposed five years ago, innovations associated with next-generation information technology have accelerated, and digital transformation of the economy and society has exhibited many new features. These changes necessitate the construction of a new system and the exploration of new paths for transformation. Measures currently taken under the Internet Plus initiative need to evolve and be upgraded. This study followed the objective laws of transformation in the technological industry and is based on the theoretical paradigm of technology economics. It analyzed the new trends and research frontiers of digital transformation at a technology, application, and policy level. The study revealed that the current technology system and technological capabilities of digital transformation have gradually improved, a new blueprint for the transformation has emerged, and the integration of information technology with the real economy has entered a new phase. However, the digital transformation framework system needs to be reconstructed, the key elements of transformation need to be strengthened, and key breakthroughs need to be achieved. To this end, in the follow-up policy design of the Internet Plus initiative, and during the formulation of the 14th Five-Year Plan, China should focus on exploring the potentials of digital elements, promote the construction of the digital transformation ecology, establish transformation and innovation networks, and upgrade the policy support system for the Internet Plus initiative, thereby promoting the digital transformation of the economy and society to a higher level.

Keywords: technology industry transformation; digital transformation; Internet Plus; strategic upgrade

1 Introduction

In 2015, China launched the Internet Plus action plan. A new generation of information technology (IT) represented by the Internet, big data, and artificial intelligence (AI) is advancing by leaps and bounds. The large-scale application of technology products expands daily, and new business models and formats continuously emerge. The demand side is undergoing profound changes, and the demand for personalized customization, intelligence, products, and services continues to grow. Progress in IT is accelerating the maturity of the transformational technology system and supply capabilities, the release of economic and social transformation needs and will, and consensus in the advantages of comprehensive digital transformation.

In this context, digital transformation has become a focal point for all sectors of society. In terms of transformation architecture, thinking about the transformation technology system has deepened, and a multi-level transformation system framework that includes capability, application, business, and industry layers has been introduced. The value of research and development, production, management, operations, and maintenance has also been established. The transformation technology system of links, especially the proposal of an industrial Internet system architecture, has laid the foundation for a digital transformation framework that covers all aspects of technology, business, function,

Received date: June 03, 2020; **revised date:** July 28, 2020

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Funding program: CAE Advisory Project “Strategic Studies on the Internet Plus Action Plan (2035)” (2018-ZD-02)

Chinese version: Strategic Study of CAE 2020, 22 (4): 010–017

Cited item: He Wei et al. Strategic Updating of Internet Plus Considering Digital Transformation. *Strategic Study of CAE*, https://doi.org/10.15302/J-SSCAE-2020.04.002

and implementation [1]. Regarding key industry paths, relevant studies have combined industry attributes, differences in industry pain points, and transformation demands to classify transformation types, and sort and summarize different transformation paths to provide specific references for industry applications [2]. To guide the transformation of enterprises, many institutions, especially consulting companies and solution providers, have proposed transformation models and methodologies to meet the transformation needs and participated in the digital transformation processes through practical evaluations and plan provisions [3].

Based on China's overall economic and social digital transformation, this article opens with new developments in digital transformation technology and business and policy systems and builds theoretical understanding of new features, systems, and paths to implement strategic measures. Changes in policy recommendations and updated key links and elements of digital transformation are highlighted. From the perspective of the manuscript's structure, the core content is divided into two sections. The first section focuses on the status of new technologies and applications, emphasizing that technological capabilities have jumped to new heights, as well as the new characteristics of transformation applications. The second section targets new paths and applications. The exploration of new elements proposes to construct a new framework to achieve breakthroughs in key links.

2 The new situation of Internet Plus upgrade for a new era

2.1 New Internet technology and systems are evolving

In the late 20th century, Internet technology started a new wave of technological innovation, which has continued to deepen and evolve over time. In the past 10 years, Internet technology no longer monopolizes the content of this technological innovation wave. IT innovation is accelerating the spread from computers and the Internet to the wider field of digital technology, and new technical capabilities and technical systems are being formed.

2.1.1 The deployment of new networks has accelerated

To support the large-scale deployment and improvement of general broadband networks performance, new networks such as "the fifth-generation mobile communication (5G) + time-sensitive network (TSN)/industrial Ethernet + narrowband Internet of Things (NB-IoT)" technology is stimulating group breakthroughs. Peak network speeds can now reach 1 TB/s, and delays have been reduced to 0.1 ms. New network protocols such as OPC Unified Architecture (OPCUA) accelerate the application, which can meet the massive, real-time, and differentiated connection needs of industrial applications and guarantee the comprehensive connection of all elements of industry. Real-time data upload and release have promoted the rapid emergence of digital application scenarios based on massive real-time data.

2.1.2 Computing power continues to increase exponentially

Computing architecture has changed from Feng's architecture to a comprehensive multi-layer architecture. General-purpose chips have been steadily updated while neuron chips have accelerated development. Computing power has entered an era with trillions of calculations per second, and computing power consumption has been greatly reduced. Relevant developments will promote the low-cost and large-scale popularization of on-site computing power, allowing large scale permeability of computational intelligence on production sites, thereby creating the possible use of digital technology to improve the operating efficiency of production site equipment.

2.1.3 Intelligent analysis level has increased significantly

The explosive development of a new AI technology generation, represented by deep learning and knowledge graphs, promotes the development of simple intelligence to multiple and complex intelligence. This is expected to solve many complex and multi-dimensional problems through known and unknown mechanisms, and further improve the analysis and decision-making levels of enterprises.

2.1.4 Continuous strengthening of technology portfolio synergy

Information and communication technologies are joining in new synergistic ways. On one hand, perception, transmission, calculation, analysis, and other technologies are being combined and coordinated to solve industrial problems. For example, the basic mechanism of the industrial Internet starts from the perception of the physical world; it then goes through a series of digital space modeling analysis and optimization decision-making before returning to the physical world. On the other hand, combined technology architecture has shifted from the monolithic technology architecture of the past to a new technology system centered on cloud-based collaboration. This is a more agile, scalable, and flexible technology system that can significantly reduce transformation costs. Diminishing

DOI 10.15302/J-SSCAE-2020.04.002

technical barriers increase the possibility for enterprises to enter the comprehensive digital era faster.

2.2 Internet Plus technology deepens industry reform

New technological systems and capabilities have continuously enhanced industry transformation and combined with the service industry to form a wealth of new models and formats. The integration with industry has also achieved remarkable results as the trend and effect of Internet Plus in-depth penetration into the industry has appeared.

2.2.1 Service industry

New digital models are emerging, profoundly changing the fragmented and inefficient situation in the service industry. New developments in technological capabilities have changed the traditional attributes of the service industry that lacked economies of scale by greatly reducing marginal costs for the service industry and heavily promoting economies of scale. For example, during the coronavirus disease (COVID-19) epidemic, new digital services effectively supported the resumption of work and production, and low-cost access services to digital platforms, such as online offices and online meetings, allowed nearly 300 million people to work from home. E-commerce platforms use big data technology to not only support peak order traffic exceeding 5.44×10^5 orders/s, but also through data intelligence, it can effectively adjust for surplus and shortfalls to realize the efficient docking of supply and demand.

2.2.2 Manufacturing sector

The emergence of new types of infrastructure such as the industrial Internet has significantly improved quantity, quality, and value, optimized resource allocation. It has also accelerated industrial fission innovation and the industrial chain's advancement. On one hand, the enabling role of the industrial Internet has become increasingly apparent, with new digital production models such as the online deployment of industrial resources, collaborative manufacturing, capacity sharing, and cross-domain collaboration emerging, which have greatly alleviated problems in the development of enterprises. On the other hand, with the redesign and adjustment of the global production systems, improving the industrial chain level and stability has become more crucial. Manufacturing companies are accelerating digital transformation and using digital technology to enhance the flexibility and agility of the industrial chain; therefore, it is more realistic and urgent for industry to increase value as well.

On the whole, new waves of technological innovation are still rising, the technological background of the development of Internet Plus has been significantly deepened, and a new situation has emerged that will drive industrial transformation. The digital transformation driven by the new generation of IT is deepening and expanding. New technological innovations and the popularization of the current industrial revolution are starting to peak, so upgrading Internet Plus technology, industry, and policy systems is inevitable.

3 Digital transformation in the new era presents new characteristics

With the in-depth and innovative application of technologies such as the Internet, big data, and AI, coupled with the synergies of combined technology systems, the digital transformation of traditional industries presents more new features, drawing a new picture for the Internet Plus upgrade. At a macro level, the deep integration and application of IT is the essence of the economic and societal digital transformation. With the support of innovative digital technologies, the deep integration of the physical and digital world is being realized. This promotes the optimization and upgrading of economic and social resource allocation and reshapes the economic and social development paradigm. At an industry level, digital transformation fully utilizes the in-depth integration of digital technology and industry to integrate all elements and links in the entire industrial sector value chain and use information flow to correspondingly drive capital, material, talent, and technology flows. This can potentially and significantly improve the industrial efficiency, quality, and value to achieve profound changes in production methods, business models, and organizational forms.

3.1 Digital transformation encourages enterprises to build a new production paradigm featuring ubiquitous perception, intelligent decision-making, agile response, and dynamic optimization

Extensively deploying sensing terminals and data collection facilities with comprehensive, deep, and real-time information monitoring on components and processes can ensure that the entire value chain is realized and the ubiquitous perception capability of the enterprise is created. Based on the massive industrial data formed by ubiquitous perception, analyses and optimizations can be carried out through the fusion of industrial models and data

science. This can be applied to equipment, production lines, enterprises, and other fields to form enterprise intelligent decision-making capabilities. For example, agile response capabilities are increased with the full and efficient integration of information and data in response to uncertain factors such as changes in external demand or the flexibility of internal operations. Precisely describing the physical system and the linkage between virtual and real can establish a twin digital system. While the physical system is monitored, the operation of the physical system is analyzed and optimized online and in real time, so that the operation of the enterprise is always in an optimal state [4].

3.2 Digital transformation encourages enterprises to break organizational boundaries and achieve social collaboration

Current economic and social development has emerged from historically close connection between enterprise and the external environment. Only when industry is closely embedded in the external environment and realizes dynamic social collaboration among partners, different stakeholders, and even between organizational units, can it be fully optimized. At present, enterprise digital capability construction encourages enterprises to break through existing barriers within and between enterprises, as well as between enterprises and customers, which improves the response and delivery speed to market changes and demands. Breaking organizational boundaries and realizing social collaboration are the inevitable results of digital transformation at an organizational level. Through the extensive application of digital technology, especially technology based on ubiquitous perception, comprehensive connectivity, and deep integration, collaboration of R&D, production, and management sectors within the enterprise and efficiency can be optimized. In addition, various operations can also be realized outside an enterprise. Coordinating production and social resources optimizes the efficiency of industrial resource allocation, and finally establishes Internet Plus global coordination capability.

3.3 Digital transformation accelerates the evolution and upgrade of industry knowledge and intelligent development

From a global perspective, digital transformation aims to innovate and create knowledge, realizing global intelligent decision-making that unites knowledge and actions (Fig. 1). Knowledge creation mainly refers to the knowledge spiral formed by the mutual transformation of explicit knowledge and tacit knowledge. On one hand, digital transformation is essentially a process of making knowledge explicit and creating new knowledge. The digital space is reconstructed through digital technologies such as virtual simulation, digital twins, and visualization, structuring and reproducing the tacit knowledge collected by sensors and edge devices, which greatly promotes the explicitness of implicit knowledge in production and operation. On the other hand, software technology has realized the tradability and sharing of knowledge. By creating “encapsulated knowledge,” software technology has become a carrier of knowledge, creating conditions for overcoming the decentralization, personalization, and invisibility of knowledge. Substantial cross-industry and cross-field industrial experience, knowledge, and methods are deposited on the industrial Internet platform via applications (APP) and micro-service components. The industrial Internet platform has become a new system for restructuring knowledge creation, dissemination, and reuse, while promoting the formation of intelligent foundations such as knowledge engineering and knowledge graphing [5].

4 Creating a new system for digital transformation

The new characteristics and current trend in digital transformation is more holistic and systematic when compared with earlier digital transformation. To further achieve the significant effects of digital transformation in the new era, we should not only rely on partial and single-point application advancement, but should aim for more systematic leaps, building a new system that adapts to digital transformation and laying a solid foundation for forward-looking planning and applications.

4.1 The main goal of digital transformation is to create a closed loop of comprehensive collection, analysis, aggregation, and intelligent applications of data resources

Whether a German Industry 4.0, United States Industrial Internet system level planning, or the cyber-physical system (CPS) and tool level digital twin, these all essentially express the material production factors, physical production processes, and business decision-making in a broad and comprehensive data form through the digitalization of material production. Scientific and efficient material production-related knowledge and decision-

DOI 10.15302/J-SSCAE-2020.04.002

making instructions are formed through analysis and modeling of data that carry the laws of material production. The effective mapping and intelligent feedback of the knowledge and instructions to the material production process facilitates the construction of a closed loop where correct data can be delivered to the appropriate person and machine most efficiently and effectively. The goal of optimizing resource allocation efficiency and improving the material production process is thus finally achieved (Fig. 2) [6].

In the new context, the service and manufacturing sectors plan to implement digital transformation, taking the creation of closed-loop data as the main line for advancement. The leading idea of digital transformation is to realize the comprehensive connection of equipment, systems, and environments based on ubiquitous connections. The goal is to acknowledge mutual recognition and interoperability upgrades, and then realize the orderly flow of data, laying the foundation for intelligent decision-making.

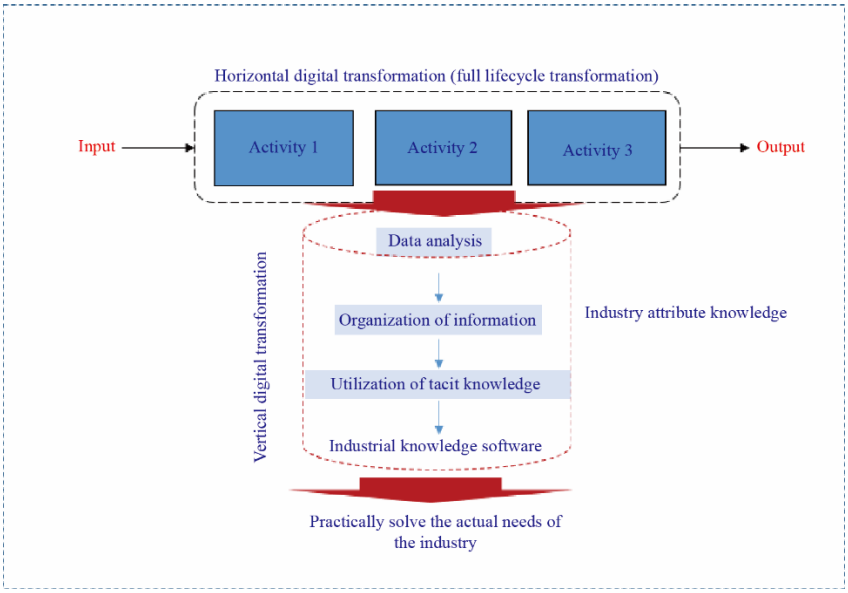

Fig. 1. Schematic of the knowledge system for digital transformation.

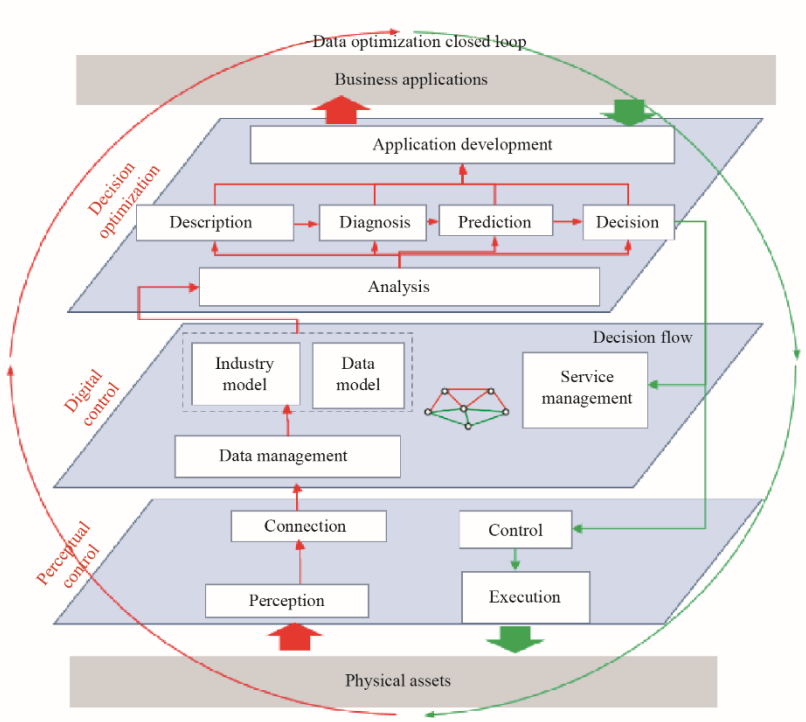

Fig. 2. Schematic of closed loop of data for digital transformation [7].

4.2 The main content of digital transformation is to ultimately digitize elements, processes, and products

To digitize elements, digital technology can transform and enhance the form and efficiency of basic resources such as traditional materials, power, and energy, which are indispensable in the production process. Extensive data collection produces integrated digital talents, knowledge, and their innovative combinations, which will become new independent production factors and promote the industry's further transitions.

In digitizing processes, digital means are used to manage complex production processes in which multiple systems interact at the production site, including the digital transformation of equipment, production research and development, and other business processes. The reengineering of production processes and the flexible development of production organizations are also promoted for the comprehensive improvement of production and collaboration efficiency.

Finally, product digitization catalyzes service-oriented manufacturing. Transforming smart products to smart product systems and then to smart service models is the key to the extension of the manufacturing value chain. It is the vehicle to spur the value of digital transformation. In this phase it is important to plan for the digital transformation implementation; focus on key areas such as elements, processes, and products; combine their different characteristics and content; develop technical tools and model methods; and achieve systematic breakthroughs through classified policies.

4.3 The direct manifestation of digital transformation is the integration of IT and operation technology, which in turn forms new knowledge, new models, and new paths

For a long time, the obstacles to digital transformation have mainly been IT and operational technology (OT) barriers. Particularly in the manufacturing industry, IT and OT have had different goals, developed along different paths, and operated in different ecosystems. At present, enterprise IT and OT are integrated at a basic level, and there is still a long way to go before true integration. This gap essentially constitutes a direct obstacle to enterprises making full use of data resources to realize intelligent production.

With improvements in the industrial Internet technology system, the following elements continue to mature, providing a more complete framework for the integration of IT and OT : business architecture (e.g., business strategy, organization, and processes), application architecture, data architecture (e.g., knowledge and its logic and structure), technical architecture (e.g., supporting business, data, and the software and hardware capabilities of application service deployment, including IT infrastructure, middleware, networks, communications, processing, and standards). More critically, through the integration of IT and OT, new knowledge and applications will be generated, and the data on production sites can be directly used to support intelligent decision-making, thus creating the basic conditions for breaking through the bottleneck of digital transformation [8]. Therefore, the key to planning and implementing digital transformation lies in the development of convergent technologies, which requires the targeted development of technical standard protocol frameworks that support convergence.

5 Key points to promote digital transformation

Looking at the new trends in digital transformation, various practical experiences are also emerging, in addition to a series of systemic characteristics. The identification of various key elements, key supports, and key means to promote transformation is of great significance for promoting the revolution in the IT industry and accelerating the continuous upgrading of the Internet Plus action plan.

5.1 Data and talents become key factors

Global industrial development has entered a new stage featuring paradigm shift, system reconstruction, and power conversion. Data and talent have increasingly become the key factors affecting the success or failure of transformation. The potential value of data elements is substantial. Industrial powers such as the United States and Germany are accelerating the construction of a new data-driven development ecosystem, overcoming the complexity and uncertainty in the changing data flow, and enhancing the value creation ability of enterprises' production and operation activities.

Data has become increasingly prominent as the engine in China's innovation and development as a new means of production, strategic resource, key factor, and part of the technological system. Its sustained and healthy development is important for China to respond to emerging changes in the technology industry and optimize the opportunities presented by the fourth industrial revolution. In the face of rapidly changing technological innovation

DOI 10.15302/J-SSCAE-2020.04.002

applications, talent elements are the key bottleneck; digital literacy talent and operational skills are the keys to undertaking technological innovation and accelerating practice transformation. Insufficient supply of integrated talent is a challenge faced by major industrial countries. Therefore, the cultivation of digital skills and the elimination of the digital divide are long-term development tasks.

5.2 Building a transformational ecology becomes a key support

Ecological development has become an important feature of digital transformation. Especially in the new era, digital transformation has increasingly prominent new requirements for full-link connection, full-data aggregation, and fully intelligent decision-making. The ecological expansion of digital transformation has more obvious effects on the transformation of the entire industry chain and has become key to achieving global transformation and winning in the global digital competition.

Major countries have actively promoted upgrading their policy goals for digital transformation to that of ecological construction. The *Germany 2030 Vision for Industry 4.0* (2019) suggests that Germany will build a global digital ecosystem as a macro goal for digital transformation within the next 10 years and portrays the core elements of the global digital ecosystem from the three aspects of autonomy, interoperability, and sustainability. This shows that Germany has made a leap forward from the existing planning goals (2013) based on market leadership and technological leadership. As a global benchmark, Germany's Industry 4.0 attaches great importance to the transformation of ecological construction and deserves our attention [9].

5.3 Building an innovation network becomes key to transformation

Countries are changing the implementation mechanism of leading industrial policies, actively promoting industrial policies from a traditional government-led vertical development model to a non-governmental organization-led networked development model, focusing on strengthening the design of mechanisms, and innovating organizational forms. Among them, the construction of an innovation network has become the common direction for promoting basic technology research and development, scientific and technological achievements in transformation, promotion through demonstration, and other industrial functions.

Some countries have developed several non-profit organizations in the digital transformation market for the purpose of testing, verification, demonstration, and promotion. These organizations have taken the lead in building "demonstration projects" and "smart factories" that utilize digitalization, networking, and intelligence to demonstrate the feasibility of integrated applications and to simulate the needs of potential customer groups for digital transformation.

As a cutting-edge technology laboratory based on the Internet of Things, German Smart Factory OWL and Smart Factory KL are committed to solving the most important digital research topics on the factory floor of the future by building an Industry 4.0 demonstration production line that is independent of manufacturers and demonstrates cross-disciplinary collaboration across enterprises and elements to realize the possibility of integration. Driven by the national network of manufacturing innovation (NNMI, renamed Manufacturing America), the Digital Manufacturing and Design Innovation Institute (DMDII, renamed MxD) has become an authoritative third-party organization in the United States to promote digital design and manufacturing technology and explore and practice application promotion. It has gradually established a unique position as a collaborative innovation platform for digital manufacturing and a source of digital transformation for small and medium enterprises.

6 Countermeasures and suggestions

Currently, China's digital transformation is still facing a series of problems and challenges, and there is still a big gap between reality and the requirements of the new situation. Innovation in the technology industry is insufficient, new infrastructure has not yet fully manifested, understanding of the transformation system architecture is still lacking, and platform support and application demonstration to stimulate the momentum of transformation are insufficient. These issues reflect the distance the Internet Plus action plan must still cover to upgrade. Beyond strengthening the technology industry and infrastructure, we can also focus on accelerating policy upgrades from the following aspects.

6.1 Upgrade element basis

It is necessary to comprehensively improve the quality and application level of data elements. First, construction

of the data resource system should be strengthened. Collection and convergence of data resources needs to be promoted and management capabilities of the entire chain must improve to establish a basic data resource management system, as well as manage and use data resources well. Second, integrated applications need to be comprehensively strengthened. Converged application is the key link in the expression of data value. The next requirements are to focus on deepening the innovative application of data elements and working from both ends of supply and demand; to expand enterprise application paths, strengthen the application supply capabilities, and stimulate the internal driving forces for new business data models and new businesses; and to promote data solution capabilities for the in-depth development of fusion applications.

The cultivation of high-level integrated human resources elements should be strengthened. It is necessary to accelerate education system reform to cultivate integrated talents with digital technology and industry experience and cultivate a labor force that has mastered digital technology and has a deep understanding of the industry. To realize the transformation of low-skilled and low-cost to high-skilled and high-value-added labor forces, universities should also be encouraged to build “new engineering” majors and strengthen vocational education for the needs of integrated development to improve national digital literacy.

6.2 Upgrade application support

Support for the transformation ecology should be strengthened. First, priority must be directed to promote general standardization and consolidate the ecological foundation; accelerate the formulation and promotion of relevant common standards and key technical standards in the process of digital transformation, including data standards, algorithm standards, information processing and interface standards, integrated application standards; and lay a solid foundation for the ecological development of digital transformation. Second, the ecological construction of digital transformation, development, and application should be accelerated by giving full play to the industrial Internet’s all-factor connection hub and the core content of digital transformation. The key role of organizations is to strengthen the ecological construction of application and development around the industrial Internet platform, to promote the accumulation of unique technical knowledge in the industrial field by multiple subjects, and to form a new pattern of social development and application.

An innovative network support system should be built to further strengthen the construction of the innovation ecosystem and to promote the transformation of traditional R&D institutions into digital innovation networks by focusing on traditional R&D organizations such as universities, scientific research institutes, and enterprises, as well as new organizational forms such as manufacturing innovation centers, encouraging consortium formation, building digital transformation R&D networks, creating integrated innovation platforms and industrial innovation service complexes, and providing various professional services. The design of systems and mechanisms should be strengthened and new entities in various forms should be cultivated. In addition, it would be necessary to explore the creation of new types of innovation organizations with government funding, private investment, revenue sharing, and self-financing; gather innovative resources from all parties; stimulate the vitality of innovation and the transformation of technological achievements; and cultivate a digital transformation innovation network that carries out testing and verification, formulating industry standards and promoting solutions.

6.3 Upgrade policy guarantee

Policy guarantees should be continuously upgraded. In addition, it is important to identify the focus of the integration of new technologies and traditional industries, continue introducing policy measures to support integration, break down barriers to the integration of vertical industries and general technologies, properly manage fiscal funds, encourage the industry to use IT initiatives, and cultivate policies suitable for integrated development surroundings.

Supporting policies and regulations should be improved. The legal and regulatory system that guarantees digital transformation should be continuously improved, and the promotion of data-related legislation should be accelerated to better release the value of data elements. Governance systems, such as digital market access and competition supervision in various fields, should be adjusted and improved as soon as possible to promote the large-scale, normalized, and standardized development of digital transformation.

Demonstration guidance, evaluation, and monitoring should be strengthened. The following should be encouraged: initiate digital transformation demonstration projects, build several digital transformation benchmark factories, experience centers, and other demonstration projects, and use pilot demonstration effects to drive popularization and application. Through statistical monitoring and standard implementation evaluation, appropriate

DOI 10.15302/J-SSCAE-2020.04.002

rewards should be given to local governments, typical enterprises, and best practice cases that promote valuable transformation effects to stimulate the internal motivation of enterprises to actively transform.

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