

The connotation characteristics, realistic challenges and implementation path of digital intelligent transformation in manufacturing industry

Junbao Xu

*School of Public Administration, Xi'an University of Finance and Economics, Xi'an, China
exujunbao12@126.com*

Keywords: Manufacturing; Digital intelligent transformation; Data governance; Digital ecology

Abstract: Manufacturing industry is an important embodiment of national creativity, competitiveness and comprehensive national strength. With the continuous advancement of the digital transformation of the manufacturing industry, the continuous improvement of the economic level, and the continuous upgrading of the level of market demand, many places in the country have sounded the high-quality development horn of the manufacturing industry to become an important starting point of high-end, intelligent and green. Taking the development of digital intelligence in China's manufacturing industry as an entry point, this paper studies and explores three connotation characteristics of digital intelligence transformation in China's manufacturing industry, and puts forward four practical challenges that manufacturing enterprises face in the transformation process, such as slow pace of transformation, pending innovation in transformation mode, insufficient data security, and lack of consensus in digital ecology. Based on these practical challenges, it is proposed that China's manufacturing industry should steadily promote digital intelligent transformation, innovate new transformation models, strengthen data security governance, and build digital ecological platforms to promote the implementation of digital intelligent transformation of manufacturing industry.

1. Introduction

With the continuous advancement of the digital transformation of the manufacturing industry, the continuous development of the digital economy, the level of market demand continues to upgrade, the demand for high-end, high-quality and diversified products increases, and the contradiction between the industrial structure and the demand structure is increasingly apparent. The report of the 20th National Congress of the Communist Party of China proposed the implementation of industrial base reconstruction projects and major technological equipment research projects to support the development of specialized and special new enterprises. At this point, many places in the country have sounded the horn of high-quality development of the manufacturing industry to high-end, intelligent and green. Local governments have actively promoted digital transformation actions and digital empowerment actions in manufacturing enterprises, introduced policies and measures to

promote the digitalization of equipment, strengthened the transformation of green and low-carbon technologies, and supported the green development of manufacturing. At the same time, in the face of the complex situation of the world's unprecedented changes in a century, the manufacturing industry has always been the "ballast stone" to cope with various risks and challenges, and promoting the high-quality development of the manufacturing industry is a major task entrusted by history, and it has become an inevitable choice to lead the manufacturing industry to high-end fields and links with innovation. Therefore, the development model of the manufacturing industry should be transformed to intelligence on the basis of the empowerment of the digital economy, and promote the development of Chinese manufacturing to China's "intelligent" manufacturing. On this basis, the definition of digital intelligent transformation of the manufacturing industry is proposed, that is, in the context of the development of the digital economy, on the basis of a new generation of digital technology, the deep integration of digitalization and intelligence, the use of data analysis, cloud computing and other ways to deploy real-time and accurate production strategies, to promote the production mode of manufacturing enterprises to high-end, intelligent, green change.^[1]

The transformation of digital intelligence is not only the development direction of manufacturing industry, but also the only way for enterprises to form core competitiveness. Digital intelligent transformation has an important impact on improving the product quality and production management efficiency of China's manufacturing industry. It is a key action for manufacturing enterprises to have new competitive advantages under unknown conditions, and it is also a "must-choose" for survival and long-term development^[2]. However, for most manufacturing enterprises, digital intelligent transformation is only a goal and direction, and lacks specific methods and effective paths for implementation, thus causing manufacturing enterprises to fall into a dilemma of "change" and "unchanged". On the one hand, digital intelligent transformation is the only way for manufacturing enterprises to innovate and develop, and is a key factor to gain competitive advantage; On the other hand, the transformation of digital intelligence to produce benefits is a long-term process, and in the transformation process to continue to invest in research and development funds, resulting in huge costs, resulting in most manufacturing enterprises do not dare to turn, do not want to turn. Based on this, this paper starts from the actual development of the digital intelligent transformation of the manufacturing industry, analyzes the realistic challenges faced in the process of the digital intelligent transformation of the manufacturing industry, and puts forward the corresponding implementation path, which has important reference value for the transformation and upgrading of the manufacturing industry and the improvement of international competitiveness.

2. Literature review

The digital transformation of manufacturing industry is a long-term and systematic project that requires continuous planning, implementation and iteration. The overall digital transformation is divided into three stages, namely informatization, digitalization and digital intelligence, which do not exist independently, but gradually upgrade and integrate with each other.

2.1. Informatization stage

The information stage refers to the process of transforming some manually completed work into automation and information through information equipment such as computers. At this stage, organizations are undergoing organizational changes driven by new trends in information technology and information science. It began to use information tools such as spreadsheets, databases, emails, and websites for management and collaboration. The application of these tools eliminates a lot of repetitive work and manual operation, and improves labor efficiency and work quality. Through informatization, enterprises standardize business and processes, promote data-based information

transparency and symmetry, and thus improve the efficiency of internal management and collaboration. However, when enterprises step into the information stage, practical problems such as data islands and data security also arise, and the mutual independence and non-collaboration between enterprises have become the chasm that digital transformation must cross.

2.2. Digitization stage

In the process of information construction, there is a lack of communication among various enterprises, which forms an information island. The process of digitization is to open up various information islands so that data resources can be shared. With the gradual popularization of the Internet, the concept of informatization and digitalization has penetrated into the development concept of all walks of life. China has become a manufacturing power, but to continue to develop into a world manufacturing power, it is necessary to improve the digital level of domestic enterprises^[3]. The factors influencing the transformation and upgrading of the manufacturing industry mainly include five aspects: transformation and upgrading intention, transformation and upgrading ability, transformation and upgrading environment, transformation and upgrading resources, and development trend^[4]. Therefore, digital transformation is no longer a future trend, it has become a necessary condition for enterprises to grow and maintain market competitiveness^[5]. Digital technology can enable enterprises to obtain more profits, thus promoting their own continuous optimization^[6]. But the process of digital transformation is not just about implementing new technologies, investing in tools, or upgrading existing systems, companies need to develop three core competencies related to awareness, informed decision making, and rapid implementation^[7]. At the same time, digital transformation has a significant promoting effect on the modernization of the manufacturing industry chain, and strongly promotes the high-quality development of Chinese manufacturing enterprises.

2.3. Digital intelligence stage

On the basis of digitalization, it uses machine learning technology and artificial intelligence technology to realize the process of enterprise automation, intelligence and rationalization. Its goal is to use digital intelligence technology to empower all aspects of production and management, and gradually cultivate the digital intelligence capabilities of enterprises to cope with dynamic changes in the environment. In the stage of digital intelligence, the degree of information asymmetry between market participants can be effectively reduced, so that the cost of competition can be reduced. We will promote the transformation and upgrading of traditional manufacturing enterprises and improve the efficiency of resource allocation and labor productivity. Number intelligence includes two levels of digital intelligence and intelligent digitalization, the first level is to promote the grafting and application of number intelligence technology in enterprises, and the second level emphasizes the number intelligence reform of enterprise management thinking. Therefore, the digital intelligent transformation of manufacturing enterprises can be regarded as the deep integration of data and business under the empowerment of digital intelligent technology. We will promote the formation of high-end, intelligent and green modern industrial chains in manufacturing enterprises.

To sum up, the essence of digital intelligent transformation of manufacturing enterprises is the intelligent innovation of operation management. The transformation of digital intelligence includes the digital intelligence of production links, the digital intelligence of operation management and the integration of production and operation decisions, which needs to comprehensively link online and offline, internal and external, consumer and industrial data, and realize the interactive mapping and overall optimization of physical space and cyber space. Its development is a complex, long-term and challenging process. The existing research focuses more on the analysis of the current situation, and

does not discuss the problems encountered in the process of digital intelligence transformation in the manufacturing industry. Based on this, by combing the connotation and characteristics of digital intelligent transformation in manufacturing industry, the realistic challenges faced by enterprises in the process of digital intelligent transformation are discussed, and the corresponding implementation path is proposed.

3. The connotation characteristics of digital intelligent transformation in manufacturing industry

In the context of the digital economy era, in order to promote the implementation of the strategy of digital China and manufacturing power, the Chinese government has issued a series of relevant policies and guidance. It will deeply integrate information and industry, and establish an industrial Internet system compatible with China's economic system. At the same time, the Chinese government should focus on intelligent manufacturing and improve the innovation capacity of the manufacturing industry. Accordingly, China's manufacturing digital intelligent transformation has the following characteristics:

3.1. The "Zhi" in the high-end

With the continuous promotion of the digital intelligent transformation of the manufacturing industry, the consumption structure is increasingly upgraded, and meeting the new demand of high standards has become an important driving force to lead the industrial change. Driven by the strategy of manufacturing power, manufacturing enterprises continue to increase investment in research and development of high-end equipment innovation, and tackle key core technology fields. Data from the National Bureau of Statistics show that in 2022, the added value of high-tech manufacturing and equipment manufacturing industries above designated size increased by 7.4% and 5.6% over the previous year, 3.8 and 2 percentage points higher than the growth rate of the added value of all industries above designated size, respectively. At the same time, manufacturing enterprises rely on digital information platforms and core technology innovation, and gradually promote the quality revolution. On the one hand, starting from the production of products on the demand side, big data analysis is carried out based on the digital information platform to further develop high-quality and affordable products needed by consumers; On the other hand, through core technology innovation, strictly control product quality standards from the supply side, effectively improve the degree of consumer goods to meet consumer demand, and promote the digital intelligent transformation of the manufacturing industry.

3.2. The "Zhi" in intelligence

Intelligence is the main feature and development focus of the new round of industrial revolution. From the Industry 4.0 proposed by Germany in 2011 to the Industry 5.0 released by the European Union in 2021, the development of digital intelligence increasingly emphasizes the deep integration of industry and the entire economic-technology-social system. By July 2022, China has built and operated 1.968 million 5G base stations and 475 million 5G mobile phone users, making it the world's largest 5G network. The steady development of 5G has provided strong support for the digital intelligent transformation of various manufacturing enterprises. Enterprises use data networks to expand reverse customization, and use digital technology to achieve multidimensional detection of the whole scene, making the production process more visual, autonomous and intelligent. At the same time, in the process of transformation, enterprises should respond to changes in the external environment in a timely manner, develop a variety of targeted marketing strategies, and promote the

intelligent innovation of enterprise business model and process management. It provides strong support for building an independent, controllable, safe, efficient, intelligent and reliable modern industrial chain and the implementation of the "lighthouse factory" strategy.

3.3. The "Zhi" in green

Greening has become a major trend in the development of manufacturing. "Green development" refers to an economic development model that achieves efficient, coordinated and sustainable development. The "green" process of China's industrial development has accelerated, and with the continuous deepening of "green manufacturing", "green" industry has gradually formed. According to the latest statistics of the Ministry of Industry and Information Technology, the energy consumption of China's GDP is decreasing year by year, and the per capita GDP consumption of GDP in the first quarter of GDP decreased by 2.3% compared with the same period last year. The output value of green energy and environmental protection industry exceeded 800 billion yuan, with an average annual growth rate of more than 10%. With the continuous advancement of the digital intelligent transformation of the manufacturing industry, the manufacturing enterprises have gradually carried out fine management, reducing the waste of resources such as repeated construction of enterprises, and promoting the digitalization, networking and intelligent production of the entire industry. At the same time, through the empowerment of digital technology, continuous innovation of production process, reduce unnecessary energy consumption and loss in the production process, and take the green and low-carbon development road of efficient, clean, intensive and circular.

4. The realistic challenge of digital intelligence transformation in manufacturing industry

Since the reform and opening up, China has gradually established a set of independent and complete industrial system. In the face of a new wave of technological change, the global industrial structure has a new change, the traditional production mode has been difficult to support the sustainable development of the industry, the traditional production mode must be changed. Despite the gradual expansion of the development scale of China's manufacturing digital transformation market, many new progress has been made. However, China's manufacturing industry in the process of realizing the digital economy, there are still many weak links and bottlenecks, including: originality, originality, high-end technology, high-end chips, industrial software, etc., are still limited, and the supply of high-end technology is still poor. Therefore, it is necessary to improve China's high-level self-reliance as soon as possible, reverse the passive position of China's major technologies, and ensure the autonomy and stability of the entire industrial chain.

4.1. The pace of transformation is relatively slow

In the process of the early digital transformation of the manufacturing industry, a large amount of funds are needed to provide support for its transformation, which directly causes the slow progress of the digital intelligent transformation of China's manufacturing industry. First of all, in the process of promoting digital transformation, manufacturing enterprises should change their traditional production methods and replace traditional manual production equipment with intelligent production equipment. For example, the external communication interface of traditional equipment is different, some equipment systems are more closed, and most equipment does not consider the future digital development trend at the beginning of design. There is no digital communication interface embedded in the device. And also to carry out software equipment update and purchase, will produce huge capital costs, resulting in the enterprise "can not turn" situation. Secondly, manufacturing enterprises lack the strategic awareness of the combination of Internet emerging technologies and industrial

production and development, and do not develop reasonable transformation strategies according to the actual situation of their own development, coupled with the lack of unified industry data standards, resulting in the increase of hidden costs in the transformation process, and the situation of "will not turn". Finally, because the results of the digital transformation of manufacturing enterprises are unknown, once the transformation fails, the losses caused are immeasurable. In addition, the large amount of investment in the early stage of the original development path will cause enterprises to rely on the original development path and appear "unwilling to turn" situation. These situations directly lead to the slow transformation of digital intelligence of small and medium-sized enterprises, which is not conducive to the long-term development of Chinese manufacturing enterprises.

4.2. The transformation mode needs to be innovated

The digital transformation of the manufacturing industry is not only a simple information construction, but also a combination of emerging technologies such as the Internet and the production and operation mode of enterprises under the trend of the digital age to meet the needs of diversified and intelligent social environment. At present, some manufacturing enterprises have insufficient cognition of digital intelligent transformation, believing that digital intelligent transformation is only technological innovation and simple upgrading of basic information, and they do not fundamentally realize that the essence of digital intelligent transformation is strategic transformation, which requires systematic consideration of external demand and internal business innovation under the digital background. Innovation in digital technologies, artificial intelligence, business processes and operating models is combined to explore a transformation model that suits each manufacturing company's own development. At the same time, with the accelerated integration of digital technology and manufacturing, there is a great demand for versatile talents with both digital information technology and manufacturing expertise. Although we have a large number of industrial talents and information technology talents, in the process of digital transformation, there is an urgent need for leading and application-oriented composite talents. Due to the lack of composite innovative talents, the lack of core innovation ability of enterprises also restricts the innovation of digital transformation mode of manufacturing industry to a certain extent.

4.3. Data security is inadequate

The digital intelligent transformation and upgrading of manufacturing industry is an industrial upgrading and innovation model led by digital technology. Its core lies in the fact that data, as a new production factor, changes the composition and interrelationship of the factors in the production function. With the deepening of the transformation of digital intelligence, the problem of data security protection is gradually exposed, which includes production equipment data, product data, business data, user data and so on. However, in the process of digital intelligent transformation of manufacturing industry, the transformation focus of enterprises mainly focuses on the transformation of production mode, industrial network and service, and insufficient attention is paid to the enterprise network, data transmission and personal data security protection in the process of digital intelligent transformation. First of all, it is the security of the enterprise network. For the enterprise network access rights, intrusion detection, healthy network access and other aspects, the security protection of the enterprise network port is not comprehensive and detailed, which will cause the leakage of production data, and the enterprise's own technical support ability needs to be strengthened and improved. Secondly, it is the security of data transmission and storage. Enterprises do not analyze, identify and integrate the acquired data in time, resulting in data loss and omission, data tampering, and repeated data collection in the process of transmission. Data tampering will lead to the loss of production or consumption information, chaos in the production process, and affect the normal

production and operation of enterprises. Finally, the protection of personal data security. In the process of production and operation, enterprises will collect and analyze users' personal information data. However, existing laws do not clearly restrict and control the collection and utilization of users' personal information data by enterprises, and lack a unified legal system, which is easy to cause the disclosure of users' personal information and is not conducive to the long-term development of digital intelligence of enterprises.

4.4. The digital ecology lacks consensus

Problems such as the slow pace of transformation of some of the above enterprises and the need for innovation in the transformation mode directly lead to the unbalanced development of digital intelligence among enterprises. Although the popularity of digital platforms can alleviate the difficulties of small and medium-sized enterprises in obtaining external data information to a certain extent, the gap between them and leading enterprises is difficult to overcome due to the differences in industrial base and technical capital. The unbalanced development between leading enterprises and small and medium-sized enterprises is easy to cause large enterprises to seize the market based on their own transformation advantages and use their own digital platforms, resulting in disorderly competition and vicious competition, which directly affects the play of the coordination ability of the industrial chain, and indirectly makes it difficult to play the potential of the digital intelligent transformation of the manufacturing industry. At the same time, the lack of open and sharing of data and information has blocked the flow of information among various industries, resulting in information barriers between industries, easy to cause homogenized competition, and increase the cost of enterprise decision-making and production. Besides, the lack of symbiotic logic among enterprises cannot give full play to the potential of digital platforms, thus aggravating the phenomenon of "information island" and hindering the establishment of the ecological concept of digital platforms.

5. The implementation path of digital intelligent transformation in manufacturing industry

Strengthening the development and utilization of data and promoting the innovation of business forms is a main way and goal to realize the development of digital manufacturing industry. Therefore, under the general trend of digital intelligent transformation, leading enterprises should be more courageous to try, explore new roads, sum up new experiences, build a digital ecological platform, and promote the digital intelligent transformation of manufacturing. At this stage, traditional manufacturing enterprises should formulate digital strategies, clarify goals, use digital technology to enhance their competitiveness, and open up a new path in line with their own digital transformation according to their different strengths.

5.1. To steadily advance the transformation of digital intelligence

Due to the high cost and slow return of enterprises' early investment in digital intelligent transformation, it will restrict the acquisition of digital resources and transformation innovation of small and medium-sized enterprises. Therefore, governments at all levels should base on the fact that there is a large gap in the digital level of manufacturing enterprises, start with improving external environment such as public service infrastructure, comprehensively plan and coordinate the construction of information infrastructure, reduce the cost and risk of digital transformation of manufacturing enterprises through data disclosure, tax relief, and the establishment of a support mechanism, and form a good environment for digital transformation. In this way, it can effectively break the situation that small and medium-sized enterprises are difficult to transform. Secondly, it is

necessary to build a community of enterprise industry development and transformation, enhance the overall information and digital foundation of the manufacturing industry, and accelerate the flow of data information in the upper, middle and downstream industries. In this way, it can effectively reduce the uncertainty risks brought by the process of digital transformation, break the dependence of small and medium-sized enterprises on the traditional development path in the past, and solve the problem of small and medium-sized enterprises "unwilling to turn". Finally, we should actively promote the unification of data standards. Manufacturing enterprises have a large number of different types of equipment, different equipment with different application environments, resulting in large differences in data formats, the government should actively negotiate with different levels of manufacturing enterprises, formulate data standards that meet the actual industry, to promote information exchange and sharing between enterprises, reduce the hidden cost of information transmission and transformation, and promote the transformation of manufacturing data intelligence.

5.2. To create new models for transformation

The transformation of digital intelligence should not only be limited to the improvement of digital infrastructure, but should combine digital technology with its own traditional benign development mode to meet the diversified and personalized needs of society, and then show its own competitive advantages. For example, Baosteel Group actively thinks about change and implements strategic changes to build steel ecological service system; Haier Group, a household appliance manufacturing enterprise, is the "human-centered" human resource system and organizational reform concept. In view of this, in the digital intelligent transformation, it is not possible to completely abandon the inherent competitive advantages to blindly develop emerging businesses, but to expand new businesses through digital transformation while adhering to the healthy development of traditional businesses. It is necessary to build a digital research system to make research institutions more flat and decentralized, so as to enhance the efficiency of research and promote the innovation of digital transformation models. At the same time, it is necessary to actively build a school and enterprise talent incubation base, vigorously develop and improve the comprehensive quality of skilled talents, and provide talent support for enterprise R&D and innovation. We will speed up the building of an important global talent center and innovation hub, and further deepen international personnel exchanges. The enterprise should also strengthen the digital training of employees and implement personalized training, so that employees can display their talents in the appropriate position.

5.3. To strengthen data security governance

The means of data theft and tampering are endless, and strengthening the protection of enterprise data and user information is the premise of ensuring the effective use of data. First of all, it is necessary to strengthen enterprise network security and improve security supervision systems such as network access, access control, intrusion detection and security audit. At the same time, it is necessary to strengthen the security control of digital equipment of enterprises, improve the level of equipment security evaluation, improve the physical security of equipment, network security, data security and other security protection systems, strengthen the development and operation of new technologies, and promote the promotion of virtual defense and data encryption and other technologies. Secondly, it is necessary to strengthen the security of enterprise data storage, build an enterprise information management system, promote the classification and classification of data, and take into account the collection, discovery and storage of data. In the process of data storage, analysis and exchange, data management and identification of data information should be used to achieve data security protection. Finally, it is necessary to strengthen data security protection legislation and improve legislation in the field of data security. Security supervision should be carried out from

various aspects such as technical operation and maintenance, service outsourcing, upgrading and transformation, and severe punishment should be given to bad acts such as data theft and tampering, and the collection process should be controlled and supervised. At the same time, it is necessary to strengthen the security protection of personal data information and limit the excessive acquisition and utilization of user data by enterprises, so as to escort the transformation and sound development of the digital intelligence of the manufacturing industry.

5.4. To strengthen data security governance

Based on the accelerating transformation of digital intelligence, enterprises have established their own digital platforms, but the platforms still maintain a relatively independent competitive relationship, the potential of digital platforms can not be fully utilized, which is not conducive to creating a mutual trust, inclusive, open digital ecological environment. Therefore, it is necessary to promote the cooperation and development of open digital platforms, coordinate the relationship between government, industry, university and research institutes, improve the efficiency of resource utilization and allocation, scientific research institutions invest in basic technology research and development, universities provide composite innovative personnel training, enterprises realize technology productization, platforms realize the transformation and matching of results and help improve the production and product promotion capabilities of enterprises. At the same time, we should encourage the development of a mutually beneficial digital platform ecological concept. It is necessary to use the symbiotic logic to build a digital platform and promote the platform economy idea of "stakeholder first". On this basis, it is necessary to strengthen the supervision of the platform, in order to eliminate the public's concerns about platform monopoly. Finally, we need to increase the openness and sharing of information. Based on the digital information sharing platform, it breaks the original technical blockade and industry boundaries, and carries out all-round information sharing. Through the empowerment of digital technology, it breaks through the boundaries of time and space, realizes the transmission and sharing of data information within enterprises, between enterprises and between industries, forms a virtual agglomeration of various industries, and promotes technological innovation and enterprise digital transformation.

6. Conclusions

China's manufacturing industry ranks first in the world. As an important pillar industry in China, digital technology has played an incomparable role in promoting the development of traditional manufacturing industry, helping enterprises to improve production efficiency, reduce hidden costs, and promote the green and low-carbon development of enterprises. The digital transformation of China's manufacturing industry started late, and the supporting infrastructure construction is relatively backward, and the popularization of digital technology and the construction of Internet platforms should be continued. This paper divides the digital transformation into three stages: informatization, digitalization and digital intelligence. Combined with the relevant policies of manufacturing industry, this paper discusses the connotation characteristics, practical challenges and implementation paths of the digital intelligence transformation of China's manufacturing industry. The digital intelligent transformation of manufacturing industry is a long-term and systematic project, which needs continuous planning, landing and iteration. Starting from the three characteristics of the digital intelligent transformation of the manufacturing industry, the wisdom is in the high-end, the wisdom is in the intelligent, and the wisdom is in the green, it is proposed that the manufacturing enterprises face four practical challenges in the transformation process, such as the slow pace of transformation, the transformation mode needs to be innovative, the data security guarantee is insufficient, and the digital ecology lacks consensus. Based on these practical challenges, it is

proposed that China's manufacturing industry should steadily promote digital intelligent transformation, innovate new transformation models, strengthen data security governance, and build digital ecological platforms to promote the implementation of digital intelligent transformation of manufacturing industry. Through these new paths, we can solve the problems encountered in the process of digital transformation of China's manufacturing industry and promote the steady progress of digital intelligent transformation of China's manufacturing industry.

Acknowledgement

Xi'an University of Finance and Economics Graduate Innovation Fund Project "Research on Data Elements Empowering Urban Digital Innovation Governance" (Project Number: 23YC047).

References

- [1] Lin T C, Sheng M L, Jeng Wang K. *Dynamic capabilities for smart manufacturing transformation by manufacturing enterprises*[J]. *Asian Journal of Technology Innovation*, 2020, 28(3): 403-426.
- [2] Osterrieder Philipp, Budde Lukas, Friedli Thomas. *The smart factory as a key construct of industry 4.0: A systematic literature review* [J].*Autonomic neuroscience: basic & clinical*, 2019, 221(1)
- [3] Lei Deng. *Progress and Evaluation Index of Digital Transformation of China's Manufacturing Industry* [J]. *Scientific Journal of Economics and Management Research*, 2020, 2(7).233-237
- [4] Shuili Y, Xiang L, Yi Y. *Research on the Influencing Factors of Manufacturing Transformation and Upgrading Based on Grounded Theory*[C]//*Journal of Physics: Conference Series*. IOP Publishing, 2021, 1827(1): 012103.
- [5] Butt J. *A conceptual framework support digital transformation in manufacturing using an integrated business process management approach* [J]. *Designs*, 2020, 4(3): 17.
- [6] Calligaris S, Criscuolo C, Marcolin L. *Mark-ups in the digital era*[J].*OECD Science, Technology and Industry Working Papers*, 2018, (10):1-26.
- [7] Albukhitan S. *Developing digital transformation strategy for manufacturing* [J]. *Procedia computer science*, 2020, 170: 664-671.