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Challenges and Optimization Path of Digital Transformation of Manufacturing Industry

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Abstract: With the continuous development and improvement of digital technologies such as the Internet, information and data resources have become the key factors determining market share and play a core value role in enterprise development. Traditional manufacturing enterprises are facing the dilemma of gradually falling into market passivity, and their traditional business and production models are difficult to sustain. Therefore, they need to use digital technology to complete enterprise transformation in order to achieve sustainable development. This paper introduces the concept and motivation of Digital transformation of manufacturing industry, analyzes the current status and challenges of Digital transformation of manufacturing industry, studies the optimal application of digital technology in the production and operation of manufacturing industry, summarizes the trend and five optimization paths of Digital transformation of manufacturing industry, and hopes to have a certain impact on the exploration and development of Digital transformation of manufacturing industry.

1. Introduction

From the initial "electronization" and "informatization" to today's "intelligence", the Digital transformation of the manufacturing industry has lasted for many years. For manufacturing enterprises, digital capability is gradually occupying the core position of enterprise competitiveness, and Digital transformation has become the decisive factor for improving enterprise innovation capability [1]. Many manufacturing enterprises have developed certain digital capabilities during the transformation process and are driving their continuous development.

The current manufacturing industry relies on digital technology and concepts, with the goal of improving product services, quality, and efficiency, and the focus on improving management innovation and support capabilities. It continuously creates new production and operation management models, laying the foundation for the development of the manufacturing industry in the new situation and driving the development potential of the manufacturing industry. We should accelerate the Digital transformation and upgrading of manufacturing enterprises, deeply implement intelligent manufacturing engineering, and give full play to the industrial integration and development effect of the digital economy [2].

Digital transformation is extremely important for manufacturing enterprises. The manufacturing

industry is the foundation of the real economy. Seizing the opportunity to realize Digital transformation is the key for the manufacturing industry to move towards the middle and high end of the global value chain and enhance its core competitiveness [3]. However, traditional manufacturing enterprises face many challenges in the process of transformation, and need to find a scientific Digital transformation path to complete enterprise optimization and transformation to achieve sustainable development. Therefore, it is of great significance to explore the challenges and optimization path of Digital transformation of manufacturing industry.

2. The Concept and Motivation of Digital Transformation of Manufacturing Industry

2.1. The Concept of Digital Transformation in Manufacturing Industry

The Digital transformation of the manufacturing industry is to use Big data, cloud computing, artificial intelligence, blockchain, industrial Internet, Internet of Things and 5G and other digital technologies to carry out digital upgrading and transformation in product R&D, manufacturing, procurement, warehousing, transportation, sales and other business links and Enterprise architecture, promote the multi-directional transformation of manufacturing enterprise production mode and operation management mode, and promote its industrial chain Collaborative optimization of supply chain and optimization of resource allocation.

The integration of digital technology into various business processes of manufacturing enterprises includes a holistic approach such as monitoring, testing, controlling, and predictive analysis through data information analysis from each step. The aim is to meld the entire lifecycle of the manufacturing industry into digitalization and to attain a state of comprehensive lean production and ecologically intelligent production so as to enhance core competitiveness.

2.2. Motivation of Digital Transformation of Manufacturing Industry

At present, the high enthusiasm of many manufacturing enterprises for Digital transformation mainly depends on the influence of both internal and external factors. The internal reason comes from enterprise efficiency, and the external reason comes from industry pressure.

The level of enterprise efficiency is reflected in three aspects: increasing efficiency, reducing costs, and improving quality. The key to improving enterprise efficiency lies in solving the information asymmetry between organizational departments, and the information data of each department can be connected through digital platforms to achieve resource sharing, thereby improving the efficiency of resource optimization and allocation in the organization. In the cost aspect, the use of digital simulation and dynamic optimization can greatly reduce the production transaction costs of manufacturing enterprises. During the product quality improvement stage, digitization can enable online dynamic monitoring and real-time optimization of the entire production process, which can promote the improvement of product quality stability.

Industry pressure is reflected in the internal and external environment. Domestically, foreign-funded enterprises in the same industry took the lead in seizing a large number of markets through Digital transformation, with obvious competitive pressure. In addition, the national sustainable development strategy requires manufacturing enterprises to achieve supply side structural reform, so Digital transformation is imminent. Externally, with the contraction of the global economy, the trend of anti-globalization has become increasingly evident. Developed countries represented by the United States have formulated trade protectionism policies, guided the return of manufacturing through tax cuts, implemented punitive tariffs, and set technical barriers to protect local enterprises [4]. As one of the most competitive countries in the global manufacturing industry, Germany has proposed the concept of "Industry 4.0" to further enhance international competitiveness, using the Internet of

Things and manufacturing to improve the level of manufacturing [5]. Under this international trend, the manufacturing industry is facing various challenges such as market expansion, trade barriers, and a lack of core technology. Therefore, if manufacturing enterprises want to break through the positioning of the industrial chain, they must accelerate the exploration of the road of Digital transformation.

3. Current Situation and Challenges of Digital Transformation of Manufacturing Industry

3.1. Current Situation of Digital Transformation of Manufacturing Industry

According to production processes, manufacturing is divided into continuous manufacturing, discrete manufacturing, and hybrid manufacturing [6]. At present, in the process of Digital transformation, most of the three types of manufacturing industries have experienced digital technology introduction, organizational structure transformation, process system reengineering and other links, and most of them have gradually promoted Digital transformation by means of production line pilot. The difference is that continuous manufacturing tends to digitize technology, while discrete manufacturing tends to digitize business.

There are two main differences in Digital transformation of different manufacturing enterprises. On the one hand, there are differences in resources and capabilities. Large manufacturing enterprises usually have abundant capital resources, and at the same time, they have relatively complete IT technology resources and human resources to support the Digital transformation of enterprises, compared with large manufacturing enterprises, small and medium-sized manufacturing enterprises are relatively small in scale and scarce in resources, Their Digital transformation may face more severe and embarrassing environment and conditions [7]. On the other hand, there are differences in the entry points of Digital transformation. Large manufacturing enterprises usually solve Digital transformation with system architecture as the entry point, while small and medium-sized manufacturing enterprises generally solve Digital transformation with their own key business problems as the entry point.

3.2. Challenges of Digital Transformation of Manufacturing Industry

At present, most manufacturing enterprises understand that it is impossible to successfully complete Digital transformation only by introducing digital technology into the enterprise. They also need to improve their business strategy, business process, organizational structure, organizational culture and other aspects to adapt to the process of Digital transformation, such as taking business development strategy as the top-level design of Digital transformation, integrating business process and digital technology perfectly Let the organizational structure flatten gradually from vertical to horizontal, make the members of the organization accept the ideas and concepts of Digital transformation, and constantly improve their digital skills.

There are three outstanding challenges in Digital transformation. In enterprise management, firstly, organizational structure change will involve changes in personnel work habits, job adjustments and layoffs, making it difficult for enterprises to abandon traditional management models. Secondly, due to the deep-rooted influence of inherent organizational culture, it is very difficult to apply an "information data value oriented" organizational culture in a short period of time. In terms of enterprise capability, it is very important to carry out Digital transformation business and Technological convergence. However, traditional manufacturing enterprises usually separate business and IT technology, which often leads to difficulties in business and technology collaboration. At the same time, Digital transformation will inevitably involve new production and operation modes and the application of digital technology, which requires enterprises to absorb a large number of

talents with relevant skills. In terms of enterprise benefits, there will be a choice between short-term benefits and long-term value in the process of Digital transformation. Digital transformation requires a lot of time and effort, which results in the cost of transformation investment far greater than short-term benefits. But if you choose to give up, you will bear more losses, so you must make the right choice [8].

4. Optimization and Application of Digital Technology in the Production and Operation of Manufacturing Industry

In the process of Digital transformation, the manufacturing industry needs to optimize the application of digital technology in product R&D and design, production and manufacturing, procurement, warehousing and transportation, sales, and Enterprise architecture, so as to achieve the integration and development of digitalization and enterprises.

In the research and development design phase. Develop industrial intelligent APP, collect users' Functional requirement, habits, preferences and other relevant information on the products developed by the enterprise through the terminal, establish a user demand structure model, design products that can meet user needs to the greatest extent through model analysis, achieve zero distance between product design and users, and receive real-time feedback from product users during the product launch phase, so as to continuously improve product quality and upgrade. The use of electronic labels on product components not only ensures after-sales service and maintenance efficiency and quality, but also comprehensively collects and analyzes data on the lifespan, reliability, and other aspects of the components, thereby promoting the improvement and optimization of the R&D department.

In the production and manufacturing process. The sensor data collection is realized through the Internet of Things. The sensor data of production equipment is connected to the Big data platform, and the production operation data is collected in real time. Through the collection, processing and intelligent analysis of the data, the performance status information of production equipment is mined to realize the visual management of the whole life cycle of production equipment. By obtaining historical data from equipment maintenance logs and conducting intelligent predictive modeling, equipment performance and fault occurrence time can be predicted, thereby timely controlling equipment maintenance and replacement time of vulnerable parts, greatly reducing the interference of uncertain factors and avoiding the loss of productivity and efficiency in actual operation. Through the use of artificial intelligence, hardware such as cameras and IoT sensors can analyze products and achieve precise and efficient automatic detection. At the same time, it automatically determines how to handle unqualified and defective products. When there is human error or danger in the production workshop, the equipment can automatically stop working, making the production line more efficient, high-quality, accurate, and safe, and reducing the uncertainty caused by manual operations. When conducting Lean manufacturing, the use of AI and memory systems can save the highly difficult manual processes in the form of data and operate them through industrial robots, thus reducing the time cost of human resources training.

During procurement, blockchain technology was used to build a supply chain trust chain. Blockchain technology is known as the "trust machine" and is the infrastructure of the digital economy era [9]. By building a supply chain trust chain, we can share and trust the public general ledger of each link in the supply chain, ensure that each link in the supply chain is more transparent, so that when there is no mutual trust and no central system, we can achieve mutual cooperation and improve work efficiency.

In the process of warehousing and transportation, Big data information collection and analysis play a crucial role. By mining and statistical analysis of historical inbound and outbound data, along with external factors, it is possible to predict future trends in the types and quantities of inbound and

outbound goods in the future and assist warehouse management personnel to make timely adjustments to the warehouse partition and location distribution. This, in turn, allows for the prediction of potential cost increases due to excessive warehousing, and as well as the mitigation of losses caused by interruptions in the supply chain and production chain arising from insufficient warehousing. Ultimately, this approach enhances the resilience of the supply chain.

In the sales process, it is effective to leverage Big data information collection for precise product market positioning. The establishment of user-profiles facilitates precise sales efforts. As a result, unnecessary investments in sales costs can be minimized, along with boosted product sales.

Within Enterprise architecture, through cloud computing technology, enterprise organizational systems can share resources and information, promote the flattening of organizational structure, efficient collaboration among various business departments, and improve the efficiency of problem handling and decision-making. The combination of public cloud and Private cloud effectively reduces the difficulty of local IT technology development and the cost of server construction, and can quickly and flexibly expand the demand for computing resources and services. At the same time, it can also store information and sensitive data with high security compliance requirements locally to ensure the security of enterprise core information.

5. Digital Transformation Trend and Optimization Path of Manufacturing Industry

5.1. Digital Transformation Trend of Manufacturing Industry

The current trend of Digital transformation in manufacturing industry is mainly divided into two aspects: technology and business.

Technically, manufacturing enterprises collect and analyze data through Big data, Industrial internet of things and other digital technologies to achieve scientific prediction of market demand and production risk. Using artificial intelligence to quickly execute actions using algorithms based on the large amount of data collected by machines, helps manufacturing enterprises achieve production automation and intelligence, and improves production efficiency and quality. 5G mobile communication technology is the information transmission foundation for the development of the Internet of Things industry [10]. Use 5G technology to support the operation of the Industrial internet of things and promote the rapid development of intelligent manufacturing with its fast, high capacity, wireless flexibility and low latency.

In terms of business, manufacturing enterprises establish digital strategic planning, construct phased transformation goals, maintain a decentralized management philosophy, and jointly participate in strategic decision-making between business and IT departments, transforming digital technology from an auxiliary means to a primary means. It is of equal importance to implement digitalization through pilot projects. Once a pilot project phase attains the expected results, extend the transformational results from the pilot scope to the entire organization. Additionally, summarize insights and valuable lessons learned from these efforts.

5.2. Optimization Path of Digital Transformation of Manufacturing Industry

The optimization path of manufacturing Digital transformation can be divided into five stages.

The first stage is system integration optimization, where the system architecture is migrated to the cloud to achieve efficient integration among various business departments and improve the collaboration and decision-making efficiency of the enterprise. The second stage is cost oriented optimization, which optimizes production and operation processes through data resource analysis to reduce costs. The third stage is optimization of capability trading, online release of enterprise manufacturing capabilities, real-time docking of supply and demand information, and realization of

cross enterprise optimization of manufacturing resource allocation. The fourth stage is research and development design optimization, which achieves zero distance between product innovation design and users through the development of industrial intelligence apps. The fifth stage is ecological construction optimization, which integrates digital technology to build an intelligent manufacturing ecosystem, enabling intelligent optimization and adjustment between manufacturing equipment and production processes, and achieving sustainable development throughout the entire product lifecycle.

6. Conclusion

The continuous progress and development of technology have led to the widespread application of digital technology in various aspects of the manufacturing industry. By integrating digital technology, enterprises promote the optimization and upgrading of industrial structure and the continuous improvement of production automation level, enabling the manufacturing industry to gradually develop towards intelligent and ecological production. In the process of Digital transformation, manufacturing enterprises need to find appropriate optimization paths for their main problems according to their own actual development to achieve the development of Digital transformation, so as to improve product quality and efficiency, reduce production costs, and increase enterprise benefits, thereby improving market share and achieving sustainable development of enterprises.

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