Organizational Routine Innovation Driven Digital Strategy Transformation of Traditional Manufacturing Enterprise: A Case Study in China

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Abstract. In digital era, digital strategy transformation has become an inevitable trend of traditional manufacturing enterprises development. In this paper, taking the traditional manufacturing enterprise DQ as the case study object, it deeply discussed "how organizational routine innovation driven digital strategy transformation of traditional manufacturing enterprise". This study found that three key processes of this topic have been identified, and these three key processes of ORI are sequentially implemented on the three levels of manufacturing process, value chain and industry boundary. This research benefits both academics and practitioners by contributing to cumulative theoretical developments and by offering practical insights.

Introduction

With the advent of the era of big data, digital strategy transformation has gradually become a hot spot for enterprises and academics. Because digitalization provides both opportunities and challenges for enterprises [1]. For example, Haier Group has built a "smart factory" with digital industrial platform and Internet of Things technology. The product development cycle has been shortened by more than 20%, the delivery cycle has been shortened from 21 days to 7 - 15 days, and energy utilization has increased by 5%. Therefore, enterprises must embrace digital technology from a strategic perspective to ensure competitiveness, and digital strategy transformation has become an inevitable trend of enterprise development [2], especially for traditional manufacturing enterprises. As the overall level of application of emerging digital technologies is relatively backward, and the cost advantage is gradually losing, it is more urgent for traditional manufacturing industries to implement the digital strategy transformation.

However, the digital strategy transformation of traditional manufacturing enterprises is by no means a simple application of digital technology, and is confronted with great challenges in all aspects [3]. For example, in terms of technology application, traditional manufacturing enterprises realize that they need to introduce cutting-edge digital technologies and deeply integrate them with their business, so as to build leading manufacturing capabilities of digitalization, networking, integration and intelligence. However, enterprises lack sufficient understanding of how to select and apply these digital technologies. In terms of organizational structure, as the existing organizational structure is not enough to support the goal of mass customization, it is necessary for traditional manufacturing enterprises to redesign the organizational structure, but enterprises are still at the stage of exploring how to adjust the organizational structure. There are also challenges in organizational culture. Mass customization

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advocated by digital transformation is quite different from the existing mode (mass production or customized production) of traditional manufacturing enterprises, so companies need to change organizational culture to adapt to new organizational practices. But it is not easy to change organizational culture in a targeted manner. Regardless of the obstacles encountered in the application of technology, organizational structure or organizational culture, it is fundamentally the challenge that enterprises face in organizational routines.

Managing organizational routines is critical to business transformation. *Organizational routine* refers to a repeatable, identifiable, interdependent behavioral pattern that is implemented by multiple actors [4]. This behavioral pattern represents the regularity of organizational behavior and are the primary means of organizing most activities [5]. The existence of organizational routines is the fundamental reason for the formation of organizational inertia [6], which reflects the tendency of organizations to maintain consistent structure and behavior without external influences. Therefore, inertia will result in organizations failing to respond and change quickly in the face of transformation. In other words, the core issue of enterprise transformation is to innovate organizational routines by overcoming organizational inertia and based on the new internal and external environment, that is, to retain, modify, delete and add various behaviors that constitute a specific organizational routine [7].

Organizational routines are the analysis unit of enterprise transformation [5]. However, there is a lack of existing literature to deeply discuss how traditional manufacturing companies implement digital transformation from the perspective of organizational routine [7], and research on organizational routine innovation (ORI) is still in its infancy.

In this paper, taking the traditional Manufacturing Enterprise DQ as the case study object, three key processes of how ORI can promote the digital strategy transformation of the traditional manufacturing enterprise have been identified, and these three key processes of ORI are sequentially implemented on the three levels of manufacturing process, value chain and industry boundary.

Case Background

Daqian Zhenyu Group (DQ) was founded in 1996 and is located in Xiamen, China. It was formerly the hand-made factory for making industrial models. With the continuous improvement of China's industrialization level, 90% of industrial design enterprises began mass production. Since CNC used computer to replace the original numerical control device composed of hardware logic circuit, it can improve the production efficiency of the model. Therefore, DQ introduced CNC numerical control machine tools to realize mass production in 2001.

With the continuous popularization of digital technology, DQ realized that personalization is a market development trend, which requires industrial design companies to have rapid prototyping capabilities, and existing CNC technology cannot fully meet this requirement. DQ believes that it is necessary to introduce digital technology to strategically transform existing production processes. Therefore, in 2010, DQ quickly cooperated with European companies to develop 3D printing control software and 3D printer equipment suitable for them. Compared with CNC technology (Table 1), 3D printing technology does not require a mold, and the design can be carried out simultaneously with the model manufacturing. The integrated molding feature shortens the manufacturing process by 90% and can process products with very complicated structures.

Table 1 Comparison of CNC technology and 3D printing technology

	CNC technology	3D printing technology
Process characteristics	(1) Reduced material manufacturing (2) For parts with complex structures, it needs to be split and processed, then bonded and assembled, and the production cycle is long	(1) Additive manufacturing (2) Design scheme and model manufacturing can be carried out simultaneously, and the model can be formed in one piece, and the production cycle is short
Costs	(1) Low material cost, but the raw materials are not recyclable and reused, and the utilization rate is low (2) The higher the complexity of the part, the greater the workload that needs to be split and programmed. The more complicated the post-processing splicing process, the more labor time is required, and the higher the cost	(1) High material cost, the remaining raw materials can be recycled and reused, and the utilization rate is high. (2) The production cost is basically independent of the complexity of the parts, which can achieve "unattended" and low labor costs.
Applicable fields	Suitable for making various solid parts with relatively simple structure and relatively heavy structure	Suitable for making various complex structures, or parts with time limit requirements

In 2012, DQ established the Vistar international 3D printing base, applying 3D printing technology that has been incubating for many years to the production line. At the same time, it uses Internet technology to integrate customers and design resources from the client and base platforms respectively to improve the intellectualization of the production process. In 2013, DQ led the construction of "Dream Alliance" platform, which is an e-commerce service platform integrating start-up fund raising, product R & D, mass personalized production and online and offline sales.

Through the above-mentioned series of digital transformation measures, DQ has developed from a traditional manufacturing enterprise into a smart manufacturing enterprise centering on design and R & D, integrating raw materials and equipment supply, sales and service by 2019.

Case Analysis

The core goal of the digital transformation of traditional manufacturing is to realize intelligent production operations with advanced digital technology, and finally realize the transformation of manufacturing production mode with the goal of "mass customization" [8]. According to the case data we collected, DQ continued to innovate by constantly breaking the original organizational practices, and finally successfully realized the digital strategy transformation. This process includes: reconstructing core manufacturing process, reconstructing traditional value chain, and reconstructing original industry boundary.

ORI for Reconstructing Core Manufacturing Process. Advances in technology can lay the foundation for effectively meeting the changing needs of users [9], and companies acquiring new technologies can help in various behavioral innovations in specific organizational routines [7]. In 2012, DQ combined its proficient 3D printing technology with its accumulated design experience to form a stable digital manufacturing process. It not only makes the enterprise no longer limited to the original

design and mold opening business, but also simplifies the tedious procedures of the manufacturing process, which makes the design and the final product come into place in one step, omitting the mold opening, assembly and other links, so that the enterprise can quickly and accurately respond to the user's personalized design needs. DQ uses 3D printing technology to provide personalized products for users, and provides a foundation for enterprises to establish a direct transaction relationship with users. As DQ 3D printing base design director said:

"3D printing allows products to be made in 7 days instead of 20 or 30 days, so the first thing this technology solves is customization. The second is that the products produced by 3D printing technology are completely based on the drawings of engineers, without any deviation, and the surface smoothness will be very high.3D printing production lines can also produce many products that traditional manufacturing processes cannot, such as nested products."

Therefore, ORI in the core manufacturing process has promoted the digital transformation of DQ, and also lays a foundation for the next stage of industrial chain reconstruction by utilizing the emerging digital technology.

ORI for Reconstructing Traditional Value Chain. Some key steps in the process of productization from scratch are fragmented, which makes it difficult for users to obtain products [9].The connectivity brought by digital technology can break the traditional value chain and enable enterprises to link their business with external isolated organizations or resources [10], so as to meet users' demand for one-stop product purchase from one enterprise.

With the use of 3D printing technology to reconstruct the manufacturing process, DQ has the basis for personalized production. In response to the user's demand for the overall product solution, the 3D printing base of DQ linked the user to the manufacturing process. On the one hand, the user can participate in the design, manufacturing and logistics of the product in the whole process, helping to design and optimize the product to meet the demand of personalized customization of products, saving the cost of "running around" between different companies, shortening the product delivery cycle; on the other hand, this behavior can achieve value creation between the company and the user [11].

At the same time, DQ built the "Dream Alliance " platform through Internet technology. On the one hand, it integrates global designer resources, promotes the implementation of mass innovation by sharing production resources within the enterprise, and accepts external design resources. On the other hand, the "Dream Alliance" platform has also become an online sales channel of enterprises, complementing the original offline sales channels. In addition, DQ also independently develops 3D printing equipment and materials to reduce dependence on external suppliers. As the chairman of DQ said:

"Our philosophy is to do front-end industrial design, back-end to personalized production, design platform, 3D printing materials and equipment development, production, sales, and 3D printing base to assist. In this way, we take industrial design as our foundation and form a closed loop ecological chain."

Therefore, ORI in the value chain has promoted the digital transformation of DQ. This company used the digital technology such as 3D printing technology and the Internet to reconstruct the relationship between the original traditional value chain upstream and downstream design, sales and users. These behaviors not only helped companies integrate complementary resources across their organizational boundaries onto their own platforms, but also built partnerships with new entities on a larger scale, such as global designers, college academics, etc., to meet the one-stop shopping needs of users.

ORI for Reconstructing Original Industrial Boundaries. As ORI reconstructs the value chain, the boundary between enterprises becomes more and more blurred [10]. Enterprises should not be confined to the original business scope, but should make use of existing resources and cooperate closely with cooperative enterprises in more businesses [12], so as to break through the original industry boundary and find new sources of value growth.

Based on the disruptive effect of 3D printing technology on manufacturing process and material development, DQ strives to find new sources of business growth. For example, DQ worked with external materials manufacturers to develop new high-temperature paint materials, coated on the surface of 3D printed products to meet the requirements of aerospace components, and expand its industrial design expertise to more industries such as aerospace, biotechnology, automotive parts and other industries, and no longer limited to the original cultural creativity, home decoration industries. In this process, DQ shared some patented 3D printing materials with material suppliers, and the relationship between organizations is no longer an integration but a sharing relationship. Through the introduction and application of 3D printing technology, DQ promoted enterprises to expand their business to more industries and reconstructs the original industry boundary. As chairman of DQ said:

"New materials and new technologies can be reflected in our new products. Our design range is radiated to the world, and in various fields, not a mobile phone field, or a refrigerator field, home appliances field."

Therefore, DQ generates new product solutions through a series of innovative behaviors, such as the combination of digital technology and innovative processes, and acquisition of new markets, so as to promote the formation of a sharing relationship between DQ and more subjects in the industry. ORI has driven traditional manufacturing companies to break the boundaries of their services and further consolidate their core position in the industry.

Conclusions

Theoretical and Practical Contributions. The theoretical contributions of this study are mainly presented in two aspects.

First, this study contributes to the existing literature by opening the black box of how ORI drives digital strategy transformation of traditional manufacturing enterprises. Although existing studies emphasize the importance of digital strategy transformation [2, 3], especially for traditional manufacturing enterprises, this demand is more urgent, but it is still difficult to provide an operable paradigm and path for how to carry out digital strategy transformation. As organizational routine is the analysis unit of organizational change [5], every aspect of organizational routine should be changed accordingly in the process of digital strategy transformation. Therefore, it is necessary to introduce the perspective of organizational routine to conduct in-depth research on the dynamic process of digital strategy transformation of traditional manufacturing enterprises. However, existing research lacks research on this topic. Through the case study, we identify three processes of this black box, which includes reconstructing core manufacturing process, reconstructing traditional value chain, reconstructing original industrial boundaries. The findings contribute to the organizational routine and digital strategy transformation literatures.

Second, this study extends the literature on the strategy transformation to the context of digital technology. The development of emerging digital technologies has brought about ubiquitous opportunities for connectivity, subverting the value creation logic and innovative ways of enterprises in the past [13], which makes the previous experience of enterprise transformation and upgrading formed

under the industrial system seem weak [11]. At the same time, with the changes of the times, digital technology is no longer a secondary factor in creating value, but an important source of value creation [14]. Hence, to address this theoretical gap, this study points out the importance of digital technology in the strategy transformation process of traditional manufacturing enterprises. This is particularly valuable given the growing importance of emerging digital technologies as the core driver of industrial development [3], as well as extends the literature on the strategy transformation [2].

This study also has practical implications. First, this study proposes an actionable process model for digital strategy transformation from ORI perspective. More specifically, the process model has identified three key processes. Second, the digital strategy transformation of traditional manufacturing enterprises faces many challenges. Therefore, enterprises need to pay attention to the application of digital technology in all aspects, not just the application of production.

Limitations and Future Research. This study has revealed the process of how OR innovation drives digital strategy transformation of traditional manufacturing enterprises and drew several conclusions with theoretical and practical values. However, there are some shortcomings. On the one hand, even though there are abundant data from multiple sources to certify mutually, some study conclusions in this paper cannot be effectively generalized to other enterprise organization practices. The accuracy of the conclusions should be verified further through large sample data. On the other hand, the case enterprise showed the digital strategy transformation process with continuity. However, in practice, this process may have jumping and fault-like development. Future studies may explore the driving factors of digital strategy transformation and the construction process under such situation.

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