

Construction of Digital Capability Evaluation Index System for Manufacturing Enterprises

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Abstract: Currently, with the booming development of the Internet and information technology, the digital economy has become an absolute trend for future economic development, making the promotion of comprehensive digitalization another important issue in the new journey of building a modern country. Under such circumstances, to rapidly improve the R&D and innovation of manufacturing products as well as overall efficiency, companies must make digitalization strategy the primary strategy for innovation. By analyzing the factors related to digital transformation of manufacturing enterprises, this paper constructs the evaluation index system of digital transformation capability of manufacturing enterprises from the perspectives of digital technical capability, digital organizational capability and digital output capability. Four indicators of data collection and processing, technical input, data security capability and information system integration are taken as secondary indicators of digital technical capability, four indicators of organizational strategy, organizational learning, organizational structure and organizational culture are taken as secondary indicators of digital organizational capability, and two indicators of comprehensive efficiency and comprehensive benefit are taken as secondary indicators of digital output capability. This paper applies hierarchical analysis to calculate index weights and carry out the evaluation of digital transformation capability of manufacturing enterprises to provide theoretical reference for the evaluation of digital transformation capability of enterprises.

1. Introduction

With the deepening of a new round of scientific and technological revolution and industrial transformation, digital technology has become an all-round, all-angle, whole-chain transformation means, which has injected new vitality and vitality into traditional manufacturing enterprises, and provided important opportunities for their transformation and development.

The influencing factors driving the digital transformation of enterprises are mainly focused on two aspects, one is due to the development and application of digital technology, and the other is the change of user behavior. First, the development of digital technology is the main driver of digital transformation of enterprises. The widespread application and popularity of digital technology has changed the competition model and intensified the competition among enterprises [1]. Enter-

prise digital transformation is primarily driven by breakthroughs in digital technology and also includes the Internet of Things, cyber-physical systems, cyber-human systems, and cyber security [2]. The process of applying digital technology to promote the transformation and innovation of its production service operation can be regarded as the process of digital transformation, while promoting digital transformation will also strengthen the processing of market information and apply digital technology to optimize or change its production service process [3]. Second, the widespread use of digital technology has enabled user participation in corporate innovation, and changes in user behavior have required companies to adapt to new business rules. The diffusion and application of digital technologies are influenced by people's behaviors and attitudes toward digitalization [4] with the continuous development of digital tools such as social media and artificial intelligence, users' behavior has become more autonomous and the connection between users has gradually increased [5]. The application of next-generation digital technology enhances the information exchange between enterprises and customers, prompting a clustering effect on customer value [6].

As a new technological revolution, digitalization has brought about a transformative impact on enterprises. Companies face challenges in realizing the business value of digitalization in terms of people, management and technology, and they need to build organizational capabilities that are able to serve the challenges, create value for the company with digital technologies, improve manufacturing expertise, increase productivity and competitiveness, and maintain a competitive edge - digital capabilities [7]. Enterprise digital capability is the ability of an enterprise to fully integrate digital assets and business resources, innovate products, services and processes using digital networks, and achieve organizational learning, customer value creation and management innovation to build sustainable competitive advantage [8].

In recent years, many scholars have started to evaluate the digital capabilities of companies from several aspects. Matt et al. [9] proposes to integrate four dimensions of technology adoption, value creation changes, structural changes and financial management and their dependencies into a joint digital transformation framework to support companies in evaluating their current level of digitalization and developing digital transformation strategies. Sambit et al. [10] identified and explained how digital capabilities enable value co-creation with customers through sensing and response mechanisms by analyzing data comparing four manufacturing companies and conceptualizing the three fundamental subcomponents of digital capabilities, i.e., intelligent capabilities, linking capabilities, and analytical capabilities. Isaev et al. [11] proposed seven evaluation indicators that affect the overall successful development prospects of the digital business of the company, namely: digital culture strategy, organizational process optimization, customer relationships, partner relationships, resource integration, technological capabilities, and innovation capabilities. Nasiri et al. [12] proposed that companies can measure the success of digital transformation in four areas: customers, products and services, operations, and people, and the level of competence in these four areas can be used as a basis for evaluating the level of digital transformation and the stage of digital development.

At present, the digital level of China's manufacturing enterprises is generally low, and there is still a certain gap compared with developed countries in production management, research and development design. According to Accenture's China Enterprise Digital Transformation Index, only 7% of Chinese enterprises have achieved significant results in digital transformation, which indicates that many manufacturing enterprises lack the foundation for digital transformation, the application of digital technology is insufficient, and there is a large difference in digital capabilities among enterprises.

Therefore, how to scientifically measure the performance level of digital transformation of manufacturing enterprises has become an urgent problem to be solved. Research on the evaluation index system of digital transformation capability of manufacturing enterprises is of vital significance for

in-depth understanding of the current situation of digital transformation of enterprises, promoting the improvement of digital transformation capability of manufacturing enterprises, and thus enhancing market competitiveness.

2. The Principle of Constructing the Evaluation Index System of Digital Capability of Manufacturing Enterprises

The premise and foundation of digital capability evaluation is to establish a set of scientific, reasonable, comprehensive and systematic evaluation index system, identify the key points and difficulties of enterprise digitalization, and apply it to practical work. Therefore, in order to establish a more standardized and realistic indicator system, the following basic principles should be met when selecting indicators:

2.1. Scientific Principle

Scientific theories and reasonable methods should be followed when selecting the evaluation indicators of enterprise digital capability, and the selected indicators must be able to objectively, truly and comprehensively reflect the process and characteristics of enterprise digital transformation. When establishing the indicator system, it is necessary to make full reference to the opinions and suggestions of experts and effectively combine the actual situation of enterprises. At the same time, the calculation of quantitative indicators should have scientific basis, not only pay attention to the calculation method, but also pay attention to the specification of the calculation process.

2.2. Validity Principle

The selected indicators must be targeted to avoid missing or wrong indicator information. The index system can reasonably evaluate the digital level of enterprises, and the indicators are operable to achieve the purpose and effect of evaluation.

2.3. The Principle of Hierarchy

When establishing the evaluation index system, it is necessary to sort out the evaluation indicators according to the connotation and main contents of the enterprise's digital capability, select important indicators as the first-level indicators, and then establish the second-level indicators and third-level indicators through target decomposition and deduction according to the principle of rationality, so as to establish an evaluation index system with internal logic and clear hierarchy.

2.4. The Principle of Combining Systematism and Independence

The systematic principle means that when selecting an enterprise digital capability evaluation index system, it is necessary to start from multiple dimensions, consider the production, operation and management of the manufacturing enterprise and the external environment, the lower indicators should accurately reflect the content of the upper indicators, and the selected indicators should maintain a certain correlation to fully reflect the real situation of the enterprise. However, in the process of selecting indicators, in addition to ensuring the systematicness of the indicator system, we should also pay attention to the relative independence of each indicator, avoid the overlap and cross of the scope of indicators and the vague definition of indicators, and improve the quality of indicators.

2.5. The Principle of Combining Qualitative and Quantitative

The combination of qualitative and quantitative means that in the process of enterprise digital capacity building, not all characteristics can be measured by specific values. For indicators that cannot be expressed by specific values, a combination of qualitative and quantitative methods should be adopted to establish a more scientific and reasonable indicator system.

3. Design Direction of Digital Capability Evaluation Model for Manufacturing Enterprises

The digital transformation of manufacturing enterprises involves the comprehensive change of organization, process and management. The first thing an enterprise should have the adaptability of organization and the ability to respond quickly in the face of complex external environment. Secondly, enterprises should also have the ability to apply digital technology to promote technological innovation. Finally, the enterprise must have a certain output capacity. The digital output capacity reflects the final result of the matching between various elements in the digital transformation process of the manufacturing enterprise, and drives the construction of the digital transformation capacity of the manufacturing enterprise. To sum up, the research on digital capability evaluation of manufacturing enterprises from the three aspects of technology, organization and output is in line with the existing research ideas.

4. Design of Digital Capability Evaluation Model for Manufacturing Enterprises

On the basis of following the standardization and rigor of academic research, according to the three first-level indicators proposed in this paper: digital technology ability, digital organization ability, digital output ability, combined with literature research, the three key indicators of digital ability corresponding to the secondary indicators are initially formed. The four indexes of data collection and processing, technology input, data security capability and information system integration are initially taken as the secondary indexes of digital technology capability, the four indexes of organizational strategy, organizational learning, organizational structure and organizational culture are taken as the secondary indexes of digital organizational capability, and the two indexes of comprehensive efficiency and comprehensive benefit are taken as the secondary indexes of digital output capability. The specific evaluation indicators of digital capability of manufacturing enterprises are shown in Table 1.

Table 1: Digital capability evaluation index system of manufacturing enterprises

Primary index	Secondary index
Digital technology capability	Data management capability
	Technical input
	Data security capability
	Information system integration
Digital organization capability	Organizational strategy
	Organizational learning
	Organizational structure
	Organizational culture
Digital output capability	Overall efficiency
	Comprehensive benefit

5. Analysis of Digital Capability Evaluation Index System of Manufacturing Enterprises

5.1. The Method of Analyzing the Evaluation Index System of Digital Capability of Manufacturing Enterprises

Through the review and analysis of a large number of previous academic literature, it can be found that in the analysis of digital capability evaluation index system of manufacturing enterprises, most experts adopt the analytic hierarchy process (AHP) method to determine the weight of indicators in the system, which is because the analytic hierarchy process can be used to deal with complex problems combining qualitative and quantitative analysis. It can help decision-makers quantify subjective experiences and recommendations and import them into models. This method is very consistent with the characteristics that a variety of qualitative indicators and quantitative indicators are required to make comprehensive decisions in the evaluation of digital capability of manufacturing enterprises, so the analytic hierarchy process is used in this paper to determine the weights of indicators in the selected index system of digital capability evaluation of manufacturing enterprises.

5.2. The Result of Analyzing the Evaluation Index System of Digital Capability of Manufacturing Enterprises

In the discussion among the experts in the group, the importance degree of each first-level indicator and the second-level indicator was ranked, and the analytic hierarchy process was applied to analyze the indicators in the system, so as to determine the weight ratio of each indicator in the entire evaluation system of digital capability of manufacturing enterprises. The ratio represents the importance of the indicator in the entire evaluation system. The more important it becomes. After the analytic hierarchy process is used to determine the weights of the indexes in the evaluation index system of digital capability of manufacturing enterprises, the importance degree of the specific evaluation indexes in the whole evaluation system can be basically obtained through the order of weights. The AHP analysis results of digital capability of manufacturing enterprises are shown in Table 2.

Table 2: AHP analysis results of digital capability of manufacturing enterprises

Primary index	Secondary index	weight
Digital technology capability	Data management capability	0.175
	Technical input	0.196
	Data security capability	0.060
	Information system integration	0.569
Digital organization capability	Organizational strategy	0.506
	Organizational learning	0.138
	Organizational structure	0.263
	Organizational culture	0.094
Digital output capability	Overall efficiency	0.333
	Comprehensive benefit	0.667

6. Conclusion

On the basis of literature research and practical investigation, this paper establishes a suitable index system for manufacturing enterprise capability evaluation, which can provide a scientific and comprehensive theoretical model for the majority of manufacturing enterprises in the digital capability evaluation. This paper uses analytic hierarchy process to determine the weights of indicators

in the index system of digital capability evaluation of manufacturing enterprises, and reflects the weights of each indicator in the form of a table, which provides a clear idea for the digital transformation evaluation of the digital department of manufacturing enterprises. Enterprises should strengthen the digital technology in production management.

For the digital transformation of enterprises, the following recommendations are available: Enterprises should strengthen the application of digital technology in production management. The indicators of production digital management and business digital management have a high weight, which are the key indicators to measure the digital transformation ability of enterprises. In the process of applying digital technology, manufacturing enterprises should focus on improving the digital level of production. It is necessary to pay attention to the all-round application of digital technology in the production process, open up the data link, and prevent the emergence of "data islands". Enterprises should increase research and development and investment in digital technology. At the technical level, digital investment and digital R & D capability index have a large weight, reflecting that digital investment plays an important role in transformation and development. Therefore, enterprises should increase investment in digital-related technologies, especially in digital equipment, operation and security. At the same time, enterprises should focus on the research and development of the digital content of products, so as to improve the added value of products and reduce the homogenization effect. Enterprises strengthen the construction of digital talent team. According to the application case evaluation of the digital transformation ability of manufacturing enterprises, it is found that the shortage of digital-related talents in manufacturing enterprises is prominent. On the one hand, manufacturing enterprises should strengthen the introduction of digital-related talents according to the needs; On the other hand, it is necessary to establish and improve the training system of digital talents, and improve the literacy of existing employees on digital technology and management.

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