The Enhanced Capability Building Method and Practice of Enterprise in the Age of Digital Economy Based on AHP
Take the Electronic Manufacturing Industry as an Example

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ABSTRACT

In the context of the state supporting for digital and intelligent upgrading, the proportion of China's digital economy GDP has been increasing year by year. The application of new generation information technology and the acceleration of digital transformation are the necessary choice of enterprises for surviving and developing in the new era. The fundamental task of digital transformation is value system reconstruction, and the core path is enhanced capability building. At present, the digital transformation has brought significant benefits and accelerated innovation development to enterprises. In this paper, the electronic manufacturing industry was taking as an example, the characteristics of the electronic industry, as well as the development situation, opportunities and challenges, risks and development prospects were discussed. Finally, combine with AHP, an appropriate enhanced capability building scheme was proposed.

Keywords: *Digital transformation, Enhanced capability, Electronics manufacturing, Analytic hierarchy process.*

1. INTRODUCTION

The world is changing, and the only certainty about the future is uncertainty. The resources on earth are decreasing entered the stock stage from the incremental stage. It is necessary to develop a new value space. With the integration of the real economy and information technology, the digital scale of the industry in china is gradually increasing. And this scale has reached to 28.8 trillion yuan till 2019, which accounts for 80.2% of the digital economy. Industry digitization has become the main driving force for the development of digital economy in China [1]. Meanwhile, the outbreak of "COVID-19" also forced traditional enterprises to carry out digital transformation. In this context, the digital transformation is leading Chinese enterprises to transform from scale economy to scope economy, of which the core path is enhanced capabilities building. It is a significant choice for

enterprises to survive and develop in the new age to apply the information technology and complete the digital transformation.

2. ENHANCED CAPABILITIES BUILDING FRAMEWORK FOR ELECTRONIC MANUFACTURING INDUSTRY

The fundamental task of digital transformation is the reconstruction of value system, and all digital transformation activities focus on value benefits. The core path of digital transformation is enhanced capabilities building. First, enterprises need to define their own needs for enhanced capabilities building. Then, enterprises should carry out a series of digital transformation work from strategy to management [2]. Furthermore, in the process of applying enhanced capabilities, enterprises need to keep improving the enhanced capabilities and optimize the digital process.
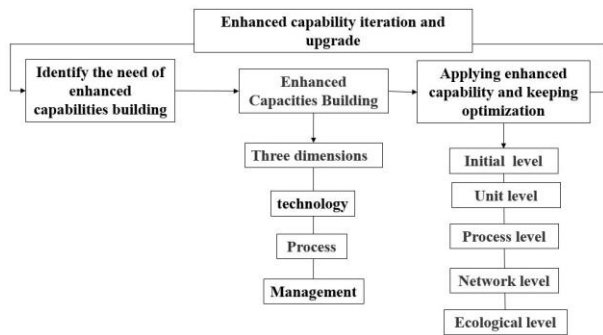
Fig. 1. The enhanced capability building process

2.1. *Identify enhanced capabilities building needs*

First, the needs of enhanced capabilities building should be identified. Based on the reconstruction of value system, the enterprise should identify the need of enhanced capabilities building, and define the key points when building enhanced capabilities [3]. For creating value, the enhanced capabilities can be divided into product innovation capability, data development capability, staff empowerment capability, production and operation management capability, user service capability, ecological cooperation capability.
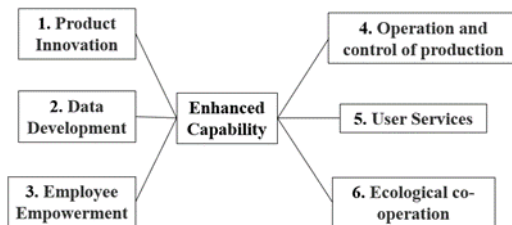

Fig. 2. the content of enhanced capabilities

2.2. *Enhanced capacities building*

After identifying the needs of enhanced capabilities building, based on the development strategy, enterprises need to further identify the details of the overall needs of enhanced capabilities building. Therefore, this paper systematically describes the construction and management of the enhanced capabilities unit from two levels of technology and management, and three dimensions of process, element and management.

The process dimension corresponds to the optimization and establishment of system process control mechanism. Which includes the planning of the enhanced capabilities building programs, the monitoring and evaluation in the process of the enhanced capabilities building, and the operation and improvement of the enhanced capabilities [4].

The element dimension refers to the basic role of technology. which includes optimizing business process and adjusting organizational structure. Through data development and utilization, promote and realize the interactive innovation and continuous optimization among data, technology, business process and organizational structure.

The management dimension corresponds to the adjustment and improvement of the control system at the organizational level. Which should strengthen the coordination of management system and digital construction plan from the aspects of digital management, organization mechanism, management method and organization culture.

2.3. *Application and optimization of enhanced capabilities*

The digital transformation has different stages. According to the characteristics of the different stages, the digital transformation can be divided into five levels: initial level, unit level, process level, network level and ecological level. Different levels correspond to different states and characteristics. The process dimension, element dimension and management dimension of corresponding capabilities also have different construction emphases. The building of enhanced capabilities is a continuous process. It needs to feedback the application effect in time in the process, and constantly improve and optimize. Thus, the enhanced capabilities level can be increased.

3. ENHANCED CAPABILITIES BUILDING NEEDS OF ELECTRONIC MANUFACTURING INDUSTRY

With the application of 5G, it brings great changes in productivity and production mode. And, it also promotes the further development of electronic manufacturing industry [5]. In addition, the trade friction between the United States and China has a great impact on China's electronic manufacturing industry. The disadvantages of China's electronic manufacturing industry are shown in the following aspects.

(1) The production and operation capacity is poor. These capabilities emphasize the management and control ability, digital operation ability and information security management ability of enterprises in intelligent production and operation. The production technology level of China's electronic manufacturing industry has not been significantly improved, the standard system in the production process is relatively lacking, and the technological level and manufacturing capacity are far behind the advanced level of foreign countries. As a result, the number of our high-end products are limited and cannot be compared with that of developed countries. In addition, our core technology and equipment do not have advantages.

(2) The user service ability is weak. This ability emphasizes the analysis of users' demand, so as to

respond to users' demand quickly. However, some enterprises emphasize the development of new products, but do not emphasize the product quality and service, which leads to the oversupply and increase the inferior products. However, product quality and after-sales service have not been improved [6].

(3) The ecological cooperation capability is low. This capability emphasizes ecological co-construction and supply chain coordination among partners. However, China's electronic manufacturing industry is an export-oriented industry [7], and most of them are dominated by foreign enterprises. The export market is relatively concentrated, so it is likely to be affected by external causes. And the whole industry chain is weak, which is a major factor restricting the development.
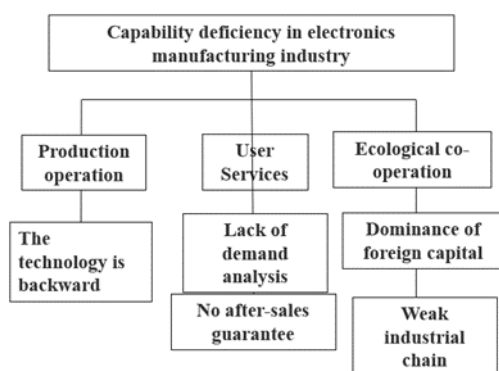

Fig.3. Capability deficiency in electronics manufacturing industry

4. THE CONSTRUCTION METHOD OF PRODUCTION AND OPERATION CAPABILITY IN ELECTRONIC MANUFACTURING INDUSTRY

4.1. Capacity building for production and operation

In view of the characteristics of the electronic manufacturing industry, this paper discusses how to develop the capability of production and operation management based on the proposed framework.

4.1.1. Process dimension

The framework of enterprise digital transformation is planned and designed, from the aspects of digital strategy, digital operation, digital architecture and Transformation Guarantee [8]. The specific contents include establishing the vision and goal of digital transformation suitable for the characteristics and basic conditions of the enterprise, constructing and operating the organization, business process, performance evaluation mechanism to support the digital transformation. So as to guide the direction of digital transformation. Evaluate the basis of digital transformation of enterprises, and identify the shortcomings and improvement direction.

4.1.2. Element dimension

(1) The platform of Internet of things is built to realize data sharing. Through data sharing, the status monitoring, efficiency analysis, remote diagnosis and history tracing of the production site can be realized. At the same time, the firewall is established to encrypt the data information and complete the security management.

(2) The intelligent Warehouse is established to improve the efficiency of the storage management. From warehouse in to warehouse out, the logistics path of intelligent warehouse is built, the storage and transportation platform crossing region and multi organization is established, and the unified material identification management is realized. Thus, the visualization, transparency and traceability of inventory are completed.

(3) The manufacturing process is optimized and the production is completed efficiently. First, the modeling of the workshop and the design of the process flow are carried out, the process data of the workshop, production line, process and materials are configured, and the reports of production, quality and efficiency and the Kanban management are improved. Then, according to the production plan and combined with the process route, the production sequence is intelligently arranged to achieve more efficient production scheduling and delivery control. Meanwhile, the production progress is tracked, the production progress and abnormal situation are displayed in real time, and the error proofing measures are taken for the whole production process.

(4) The quality management system is established to guarantee the product quality. From incoming material to finished product inspection, corresponding standard system, correction system and quality traceability system have been established. Based on the collection and analysis of production data, the corresponding quality evaluation report is formed to ensure the high quality of the whole production process [9].

(5) Through the management of fixed assets, preventive maintenance plan was implemented. Precise management of high-value assets such as equipment, instruments, molds, spare parts, vehicles is implemented. Preventive maintenance plan and work order are made for all kinds of assets. Through information technology, the implementation of the plan is monitored, and the maintenance of early warning, detection and traceability are completed.

(6) The intelligent logistics system is established to optimize the material transportation. From the map layout, path planning, equipment management and other aspects, realize the logistics optimization.

4.1.3. Management dimension

According to the stage of digital development, the appropriate digital management mode is formulated. From the production, storage, maintenance and other aspects, strengthen the skills training of workers and the ability of data management and control. At the same time, strengthen the ability of employees to develop and use data, so that data can play a greater utility value. In the process of management, it is necessary to strengthen the training and development of talents, endow the staff with the skills and knowledge of value creation, and stimulate the initiative and potential of staff value creation to ensure the high efficiency and timeliness of transformation [10].

4.2. Evaluation of production and operation capability

This paper evaluates capacity building through AHP (Analytic Hierarchy Process) and FCE (fuzzy comprehensive evaluation method). According to the indexes, the hierarchy model as follows.
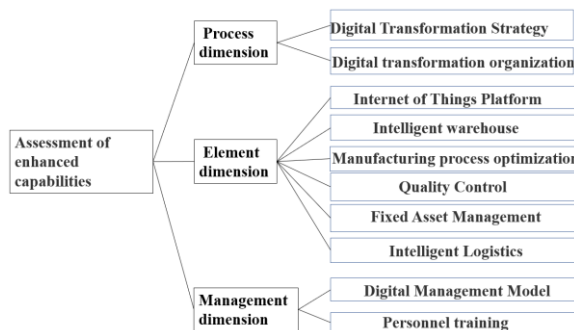

Fig. 4. Hierarchical Model.

Define conformance metrics：

$$C.I.=(\lambda max-n)/(n-1) \qquad (1)$$

Introducing random consistency index

Calculate the consistency ratio

$$R.I.=(\lambda' max-n)/(n-1) \qquad (2)$$

when $CR=(C.I.)/(R.I)<1$，Degree of consistency passed.

After consulting literatures and expert opinions to compare the weights of each indicator. The final result as follows

Table 1. Weight of capability index

Indicators	Weight
Digital Transformation Strategy	0.1709
Digital transformation organization	0.114
Internet of Things Platform	0.1114
Smart warehouse	0.0837
Manufacturing process optimization	0.066
Quality Control	0.1
Fixed Asset Management	0.0631
Intelligent Logistics	0.0735
Digital Management Model	0.1304
Personnel training	0.087

indexes is graded by FCE to establish a collection of comments {U1,U2,U3,U4,U5}.the corresponding scores were 10, 8, 6, 4 and 0. The higher the score, the better the result. Then, indexes were evaluated by experts to get fuzzy relation matrix.

$$R=\begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{n1} & \cdots & r_{nn} \end{pmatrix} \qquad (3)$$

In this paper, the result of AHP is used as the weight vector. Which combine with fuzzy relation matrix to obtain the result vector. And sum up the result vectors to get final score.

$$B=A\cdot R= (a_1,...,\ an\ )\cdot\begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{n1} & \cdots & r_{nn} \end{pmatrix}$$

$$=(b_1,b_2,...,b_n) \qquad (4)$$

$$I=\sum_{i=1}^{n} b_i \qquad (5)$$

The level of the enhanced capability as shown in the table below.

Table 2. Capability Level classification

Level	Score
initial level	0-2
unit level	2-4
process level	4-6
network level	6-8
ecological level	8-10

5. RELATED EXAMPLE

5.1. Enhanced capacity building of enterprise A

Enterprise A is a high-tech company with display panel and hardware manufacturing. The development of enterprise A has experienced the age of total dependence on imports of display screens, the age of rise of Chinese industry and semiconductors, and the age of global innovation in the field of semiconductors. Today, enterprise A is a pioneer and leader in the Chinese LCD industry.

In the age of digital economy, it is urgent for manufacturing enterprises to develop industrial internet and promote intelligent manufacturing. As a global innovative Internet of things enterprise, enterprise A has realized intelligent production, digital operation and

maintenance, lean management, and has more than 800 standard management and R & D platforms. Now, enterprise A has owned a intelligent industrial interconnection solutions for factory, industrial park, enterprise operation.

(1) intelligent production. Enterprise A optimized product line automation, increased information construction and product data processing investment. Combined artificial intelligence and big data technology to create intelligent factories that cover all aspects of production planning, production process management, equipment management, material management, warehouse management and quality control. which Overturning the traditional manufacturing model, bring a new experience of intelligent manufacturing service.

(2) the Internet of things. In order to complete intelligent manufacturing, logistics and production must be combined. Therefore, enterprise A built intelligent logistics systems in various factories.[5] Combined the Internet of things and virtual visualization technology, around at efficiency, safety and energy saving, created an intelligent park. The scheme integrates the resources of security, personnel, vehicles, equipment and other key points to achieve data sharing and maximize the park's resources management and services. Through the automatic warehouse, automatic handling system and information system to improve warehouse utilization and efficiency of production logistics.

(3) standardized and lean production. The most important foundation of intelligent manufacturing is product standardization and modularization. Enterprise A in 2016, set up a standardization and modularization work group, started with product design. And studied with customers and suppliers in every aspect of the production process. Reduced the types and specifications of materials, thus improving production efficiency, complete product standardization, modularization, create conditions for intelligent manufacturing.

Lean is the premise of intelligent, which could reduce inefficient, wasteful phenomenon in product. In intelligent factory, Enterprise A's core product is the industrial visual platform ADC system. It uses artificial intelligence learning algorithm and image recognition technology to detect and classify, and solves the risk of low efficiency, missing and wrong detection. Through artificial intelligence and image recognition, enterprise A can correct the mistakes more efficient, which greatly improve the efficiency, accuracy of enterprise quality inspection.

Today, many enterprises are doing refactoring, and one of the keys of refactoring is to digitize. Enterprise A takes artificial intelligence and big data technology as its core, through the industrial internet platform and above three major solutions, built a comprehensive connection between human, computer and material. The interconnection of data making the coordination of manufacturing, production capacity, industry and finance be better.

5.2. Evaluation of enterprise A

In this paper, scores of indexes were evaluated by 5 experts to get Enterprise A's degree of informatization. The results are shown in this table

Table 3. Score of enterprise A's indexes

Indicators	Weight	score	Weighted score
Digital Transformation Strategy	0.1709	8	1.3672
Digital transformation organization	0.114	7	0.798
Internet of Things Platform	0.1114	8	0.8912
Smart warehouse	0.0837	7	0.5859
Manufacturing process optimization	0.066	9	0.594
Quality Control	0.1	9	0.9
Fixed Asset Management	0.0631	6	0.3786
Intelligent Logistics	0.0735	8	0.588
Digital Management Model	0.1304	7	0.9128
Personnel training	0.087	6	0.522
Sum	1		7.5377

We can know the total score is 7.5377 from this table. The enhanced capabilities has reached the network level. Which means enterprise A have a high degree of information. Then sum up scores of three dimensions, and compare with the highest score of the index, the proportion as follows

Table 4. Scoring ratio in three dimensions

dimension	weight	Weighted score	ratio
Process dimension	0.2849	2.1652	76.00%
Element dimension	0.4977	3.9377	79.12%
Management dimension	0.2174	1.4348	66.00%
Sum	1	7.5377	75.38%

According to this table, the enhanced capability of Enterprise A has reached the network level in three dimensions. And the element dimension has the highest score, but management dimension needs to be improved.

6. CONCLUSION

This paper discussed the enhanced capacities building scheme in the digitalization transformation of electronic manufacturing enterprises. The contents of the enhanced capacities building in digitalization transformation are described. With the application of digital technologies such as artificial intelligence, big data, industrial internet, Internet of things and 5G, technology will become the most powerful force to reconstruct the industry. The development of technology has great impact on traditional life. Innovation is still the key point to realize digital transformation [11].

In the age of digital transformation, opportunities and challenges coexist for enterprises. Enterprises need to transform their thinking, embrace digital transformation, and improve their capabilities when facing change. Digital transformation is not a simple technical problem. It needs comprehensive analysis from development strategy, enhanced capability, systematic solution, governance system, business innovation transformation and so on. The electronic manufacturing industry contains many enterprise categories, each enterprise has its own characteristics and strategic objectives, which can not copy "Industry best practice" in transformation. For the development of electronic manufacturing industry, we should not only pursue the immediate interests, but also realize the independent intellectual property right creation. Concentrate on R & D, break through the blockade of foreign key technologies, master the lifeblood of core technologies, can create self-value and make enterprises in an invincible position.

Finally, enhanced capacity building is a difficult task for all enterprises, some work needs to be groped, enterprises should maintain a certain strategic focus on enhanced capacity building and innovation, make a determined advance toward the intended goal.

ACKNOWLEDGMENTS

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