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Evaluation of Enterprise Digital Transformation Degree Based on Synergy Theory

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Abstract

Digital transformation and the development of digital foundational capabilities have a synergistic relationship. The case of TRJ (Shenzhen Techrise Electronics CO) demonstrates the impact of digital transformation on business stability. Challenges in 2018 affected the enterprises' transformation but were recovered the next year. The enhancement of foundational capabilities enables broader digital applications and drives the rapid increase in transformation level. Effective regulation and adaptation to changes are key to maintaining a stable transformation level. The synergy between infrastructure, policies, and operational management is vital for successful transformation.

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1. Introduction

The dynamic landscape of digital transformation and its impact on businesses are the subjects of growing interest and scrutiny. This paper delves into the intricate relationship between digital transformation and the development of foundational digital capabilities. Drawing from a case study of TRJ (Shenzhen Techrise Electronics CO), it illuminates the profound influence of digital transformation on the stability and resilience of enterprises. In the year 2018, the challenges faced by TRJ temporarily disrupted their transformation efforts, but a swift recovery ensued in the subsequent year. This resurgence was underpinned by the augmentation of foundational capabilities, which, in turn, facilitated a broader spectrum of digital applications and propelled the acceleration of the transformation process. It becomes evident that the successful maintenance of a stable transformation level hinges upon effective regulation and adaptability in the face of changing circumstances. Crucially, the synergy among digital infrastructure, policies, and operational management emerges as the linchpin for the triumphant realization of digital transformation in enterprises. The subsequent sections of this paper will delve deeper into the multifaceted dimensions of digital transformation in enterprises, focusing on aspects such as infrastructure capabilities, the level of digital transformation, and the design of evaluation indices. Additionally, a case study of TRJ will be presented to empirically validate the proposed evaluation system. The paper will conclude by summarizing key insights derived from the synergy theory and their implications for successfully navigating the complex terrain of digital transformation in enterprises.

2. Literature review

The key to realize the digital transformation of enterprises is to have the ability to access external information. In addition, enterprises need to have the ability to dynamically allocate resources to maintain a competitive advantage. The change ability of the internal organization level is the key to build the dynamic core ability of the enterprise, thus it has strong "heterogeneity". Most scholars evaluate the degree of digital transformation of manufacturing enterprises from the aspects of technological innovation and organizational structure. Fu (2021) constructed the evaluation index system of industrial digitization from the perspective of digital capability and digital foundation.

2.1 Infrastructure Capabilities for Enterprise Digital Transformation

Digital infrastructure construction is the basic ability of enterprise digital transformation. Scholars generally believe that the infrastructure of the system is composed of computer hardware, software, network and others. Guo (2018) pointed out that digital infrastructure capabilities have universal characteristics, including the application and management capabilities of related facilities, which have an indirect impact on the competitiveness of enterprises in digital transformation. Su (2020) believes that in order to realize high quality development, it is necessary to have a considerable scale of development as a basis. The technology development and upgrading capability of digital transformation refers to the use of emerging technologies by enterprises to develop new technologies or update old hardware and software to enhance the competition level of enterprises. Fu (2021) studied manufacturing enterprises in the Yangtze River Delta region, indicated that high-quality development of enterprises requires differentiated division of labor from the perspective of integration, the core is to enhance innovation ability and the degree of intelligence. Zhu(2021) believes that enterprises need to strengthen the research and development of digital technologies such as big data, artificial intelligence and 5G to improve the level of industrial digital infrastructure. Wang (2023) believes that there is a big gap in technological innovation ability of manufacturing industry in different regions of China. The government can help enterprises improve their technological innovation capabilities by providing subsidies to enterprises,

jointly establish a technology research and development sharing platform to promote common progress of enterprises, and introducing foreign advanced technologies.

2.2 The Level of Enterprises Digital Transformation

Digital management is the inheritance and innovation of traditional organizational management in enterprises. While absorbing the essence of traditional management, enterprises digital management has made innovations and breakthroughs by using big data, artificial intelligence and other technologies, including management ideas, tools and methods. Duraivelu (2022) suggests that the success of the manufacturing industry is mainly related to three dimensions: organization, environment, and technology. Yang (2018) divide the digital transformation of manufacturing enterprises into production and organizational levels. The production level includes manufacturing technology and production processes, while the organizational level includes enterprise structure and personnel composition. Bao (2019) believes that starting with visual control, companies find it easier to obtain subsequent resources, and digital decision-making is also more sustainable and stable. Zhang (2019) considers financial management as an effective tool to enhance the digital transformation capability of enterprises and achieve optimal resource allocation. The larger the scale of the enterprise, the stronger its cost control and technological innovation capabilities, this indicates that the digital transformation capability and financial capability of the enterprise are also stronger. Managers and employees are the main participants in the digital transformation of enterprises. Their ability to apply digital technology and the degree of mastering digital-related knowledge have a direct or indirect impact on the effect of digital transformation of manufacturing enterprises Chen (2018) defined digital talents and argue that there is a shortage of top digital skills talents in the current labor market, and the cultivation of digital skills talents cannot keep up with the growing demand. To a certain extent, this restricts the improvement of enterprises' digital capabilities. Gao (2020) believes that manufacturing companies need to improve their talents' quality from multiple aspects while increasing automation levels and introducing high-tech, in order to achieve transformation and upgrading. Zhang (2021) argued that innovation capability plays a crucial role in promoting the high-quality development of the manufacturing industry.

2.3 Transformation Level Evaluation Index Design

This paper follows the principles of scientificity, objectivity, accessibility, systematicity, and a combination of qualitative and quantitative approaches. Based on the dynamic capability theory and the synergy theory, it analyzes and determines the evaluation measurement indicators for enterprise digital transformation capabilities from two dimensions: basic capabilities and transformation levels, thus establishing the evaluation indicator system for enterprises digital transformation capabilities. Through literature review, It is found that the core of digital transformation of manufacturing enterprises is data, integrating information technology with manufacturing technology comprehensively, and permeating it throughout the entire process of enterprise production and operation. This aims to enhance the enterprises' ability to respond to market changes and bring about transformation in various aspects such as production, manufacturing, organization, and management. Therefore, exploring the indicator system for enterprises digital transformation requires focusing on three aspects (primary indicators): technological capabilities, organizational capabilities, and managerial capabilities. In terms of technological capabilities, the development of next-generation information technologies such as 5G and the industrial Internet not only provides the support of technological resources but also brings new opportunities and challenges. However, digital transformation also faces challenges such as digital security, data privacy protection, and technological costs, which require enterprises to strengthen risk management

and cost control during the digital transformation process. The importance of organizational structure and digital talent cannot be ignored. Enterprises need to establish a flexible organizational structure to meet the needs of market changes and technological development. At the same time, the training and management of digital talents is also an important link in the digital transformation of enterprises, and enterprises need to pay attention to the establishment of talent training and incentive mechanism to attract and retain excellent digital talents. In terms of managerial capabilities, digital transformation can assist enterprises in achieving digital management in areas such as production, management, and finance. Digital transformation also requires enterprises to enhance their managerial capabilities, including the formulation of strategies for digital management, the application of digital technologies, and the cultivation of digital talents. Through analysis and summary, the evaluation system of enterprise digital transformation capability is constructed from two dimensions of digital basic capability and digital transformation level, and twenty detailed indicators from eight aspects, including digital infrastructure, digital research and development, digital investment, innovation ability, organizational structure, digital talents, and financial management, as shown in the following table 1.

Table 1: Digital basic capability and digital transformation level

Primary index	Secondary index	Primary index	Secondary index
R&D capability	Amount of government subsidy X1	innovation capability	Patent application success rate Y1
Technology input capability	R&D Input intensity X2	Organization structure	Number of organizational levels Y2
	Digital input X3		Data visualization rate Y3
	Digital operation and maintenance input volume X4		Product defect detection rate Y4
Basic investment capacity	Application rate of data security measures X5		Rate of return on total assets Y5
	Digital equipment input X6	Financial management ability	Net assets income rate Y6
	Digital technology application keywords frequency X7		Turnover of account receivable Y7
	Automation rate of production equipment X8		
Digital talent	Proportion of digital talents X9		Growth rate of main business income
	Digital skills personnel training expenditure ratio X10		Customer order on-time delivery rate
	Proportion of people using digital skills X11		

(Source: Wang & He, 2023; Guo, 2018; Su, 2020; Chen & Xu, 2020; Zhu & Wang, 2021; Chen & Ma, 2018; Zhang & Zhang, 2021; Yang et al., 2018; Bao et al., 2019; Zhang,2017; Wan et al., 2020)

3.Case study

This paper will take ShenZhen Techrise Electronices CO (Hereinafter Referred to as TRJ) as a case to make an empirical analysis of the enterprise digital transformation evaluation system introduced in this paper. TRJ is a leading company with broad influence in the industry and has been committed to the advancement and innovation of digital transformation. Through in-depth research and analysis of the data of this enterprise, we will verify the feasibility and effectiveness of the proposed evaluation system in practice.

3.1 Introduction to Parametric Contribution Model

By applying the cooperation theory in system science, we can draw a preliminary conclusion that cooperation leads to order. By analyzing the coordination degree of various indicators within the system, we can deduce the order degree of the whole system. The system contains multiple subsystems, but the common goal among subsystems is to promote the development

of the whole system. Statistics, data sorting and analysis were carried out, and the data were processed by dimensionless data processing method.

3.2 Parameter Contribution Degree Measurement Results and Analysis

The data in this paper comes from the internal data of the enterprise, selects the index data of TRJ from 2012 to 2021, and obtains the corresponding system efficacy of each sequence parameter component index on the original data according to the formula.

The calculation formula is as follows:

Efficiency function formula:

$$\mathrm{E}\ (X_{ij}) = \begin{cases} (X_{ij} - \beta_{ij})/(\alpha_{ij} - \beta_{ii}) \\ (\alpha_{ij} - X_{ij})/(\alpha_{ij} - \beta_{ij}) \end{cases}$$

Where X_{ij} represents the order parameter; i represents the i th indicator of X_{ij}; j represents the J th value of the order parameter X_{ij} (i = 1,2,3, ⋯, m, j = 1,2,3, ⋯, n); m represents the number of order parameter indexes; n represents the number of samples contained in each order parameter. β_{ij} and α_{ij} represent $P_{ij} < X_{ij} < a_{ij}$ as the upper limit and lower limit of the critic al point of the system order parameter X_{ij}, respectively. When X_{ij} has a positive effect, the first formula is used to calculate, when X_{ij} has a negative effect, the second formula is used to calculate. Therefore, after X_{ij} is obtained, the weight W_i of each subsystem's order parameter index to the corresponding subsystem is calculated respectively.

$$S_{ij} = \frac{\mathrm{E}(X_{ij})}{\sum_{j=1}^{n} \mathrm{E}(X_{ij})} \quad (1)$$

$$e_i = -\frac{\sum_{j=1}^{n} S_{ij} \ln S_{ij}}{\ln(n)} \quad (2)$$

$$g_i = 1 - e_i \quad (3)$$

$$W_i = \frac{g_i}{\sum_{i=1}^{m} g_i} \quad (4)$$

Among them, S_{ij} represents the contribution degree of X_{ij}, e_i represents the information of each order parameter, g_i represents the difference coefficient of each order parameter, and the weight W_i of each order parameter is finally calculated.

$$\mathrm{M}(X_i) = \sum_{i=1}^{m} W_j E(X_j) \quad (5)$$

$$\sum_{i=1}^{m} \mathrm{W}_{ij} = 1 \quad (6)$$

In this paper, all the order parameters are positive, so the first formula is used to calculate. In practice, because the future cannot be truly predicted, there is no standard in the calculation, usually the minimum value *(1+a) of the existing time series data is used to determine the lower limit, and the maximum value *(1+a) is used to determine the upper limit, where a is the average historical change amplitude or experience value, generally taking 5%-10%, and the obtained critical value has significant empirical characteristics. In addition, in order to avoid

the inconvenience caused by the inconsistency of the index units, the data is normalized to obtain the dimensionless data, and then the weights of the parameters of the two systems are calculated according to the formula. The result is shown in table 2.

Table 2: Order table of digital basic capability and digital transformation level of TRJ

Time	Basic capacity	Transformation level
2012	0.1779	0.2747
2013	0.1917	0.3147
2014	0.2584	0.3560
2015	0.3288	0.4518
2016	0.3201	0.3842
2018	0.3901	0.2855
2019	0.3763	0.5282
2020	0.5402	0.5456
2021	0.6619	0.6563

Based on the data of TRJ from 2012 to 2021, we analyze the trend of its digital basic capability and digital transformation level. The curve is shown in figure 1.

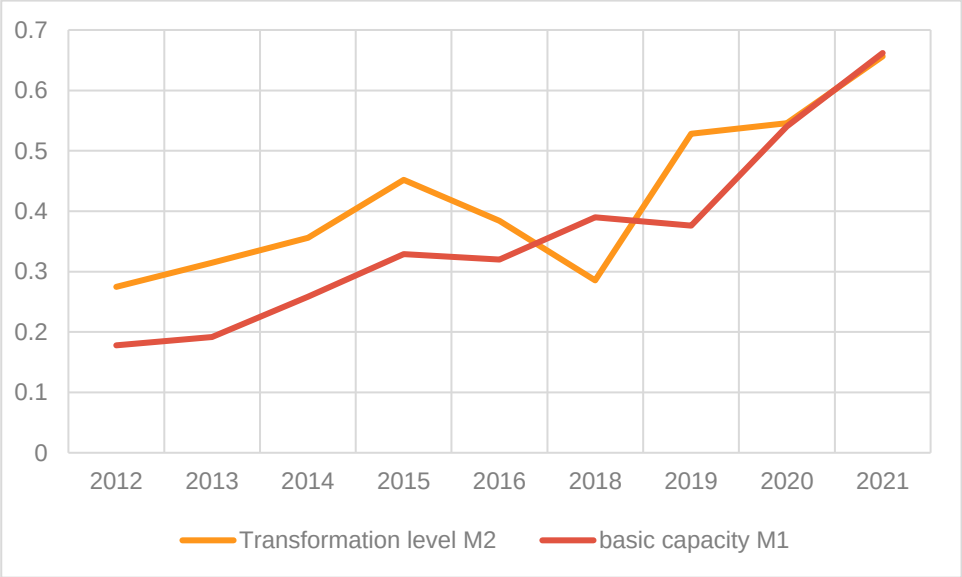

Figure 1: Order degree trend chart of basic competence and transformation level

According to the analysis of the data trend chart, enterprises show a continuous upward trend in terms of digital basic capabilities. This shows that over the past few years, enterprises have made continuous investment and improvement in digital infrastructure, technology and resources. In terms of the level of digital transformation, enterprises experienced an upward trend between 2012 and 2015, but experienced a downward trend between 2016 and 2018, reaching a low point in 2018, and then rapidly rising from 2019 and reaching a peak in 2021. The main reason is that the initial transformation phase is often accompanied by a series of challenges and problems, such as technology introduction, organizational change and personnel training. These challenges may result in a relatively slow upward trend in the level of digital transformation. During the period from 2016 to 2018, the company encountered some problems of improper management of operations, resulting in the relatively lagging efforts of the company in digital transformation and the decline of the level of digital transformation. Since 2019, the company has successfully made strategic adjustments, re-defined the goals and directions of digital transformation, and made the level of digital transformation rise rapidly. Digital basic capability and transformation level remain stable

under the control of enterprises, and the fluctuation of the two together also reflects the trend of synergy between digital basic capability and transformation level to a certain extent.

4.Conclusions and Enlightenments

This paper applies the synergy theory to evaluate the level of digital transformation in enterprises and analyzes the digital foundational capabilities and digital transformation level. The conclusions are as below: There is a certain synergistic effect between basic capability and transformation level. The trend of digital transformation is highly related to the development of digital foundational capabilities. In the case of TRJ (ShenZhen Techrise Electronices CO), there is a clear synergistic relationship between the increase in digital transformation level and the continuous enhancement of digital foundational capabilities. In 2018, due to the enterprises' improper management, the digital transformation was impacted, as a result, the business situation was affected and the digital transformation process was affected. However, this decline was recovered in the next year. This indicates that the company maintained a certain level of stability during this phase and was able to respond with appropriate measures when facing challenges. The improvement of digital foundational capabilities provides the enterprise with broader digital application scenarios and innovation opportunities, promoting a rapid increase in digital transformation levels. At the same time, the advancement of digital transformation further drives the demand for digital foundational capabilities, forming a synergistic effect of a virtuous cycle where collaboration between subsystems can drive the development of the entire system. When implementing digital transformation, enterprises need to not only focus on infrastructure construction and technology research and development, but also pay attention to policies implementation and operational management levels. The synergy of these two aspects is the key to promote successful transformation of the enterprise. It should be noted that although enterprises may encounter various challenges during the digital transformation process, such as policy changes and market fluctuations, as long as the company can effectively regulate and adapt to these changes, it can maintain a stable transformation level. Furthermore, we should make active use of synergy theory to coordinate various subsystems within the enterprise, jointly promote the development of enterprises. This theory provides an effective management strategy that can help enterprises achieve success in digital transformation.

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