Digital Transformation Path Design Research of Energy Enterprise Based on SPACE Analysis

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Abstract. With the development trend of low-carbon and digitization energy system transformation, digital strategic choice of energy enterprises becomes the key to the transformation and upgrading of energy system. Starting from the driving factors of the digital transformation of energy enterprises, this paper divides the digital transformation into two types: internal-driven and external-driven. Therefore, the Strategic Position and Action Evaluation(SPACE) model is constructed. The entropy weight method is used to calculate the evaluation scores of internal and external driving factors of 107 energy enterprises. According to this, the types and paths of enterprise digital transformation are identified. And put forward targeted digital transformation promotion strategies for energy enterprises, so as to promote the high quality development of energy enterprises.

Keywords: Energy enterprises, SPACE model, digital transformation, driving factor, path design.

1. Introduction

With the vigorous development of digital technology and industrial Internet, the transformation strategy featuring digitalization, low carbonization and multi-win cooperation becomes a key choice for the construction of emerging energy systems [1]. Digital transformation enables energy enterprises to use digital technologies to optimize supply chain efficiency, and create new production models[2]. Along with the digital transformation process of Chinese energy enterprises, some large state-owned energy enterprises have made initial progress. However, they still face many challenges in their development, such as data application obstacles and the formation of synergies on digital platforms [3]. The development of digitalization level in energy enterprises is unbalanced. Therefore, exploring the scientific and efficient path and providing digital transformation strategies of digital transformation for different types of energy enterprises has become the key to speed up the high quality development of the energy system.

Energy enterprise is an important basic industry of national economy. Reconstructing enterprises' core competitiveness through digital enabling becomes a new impetus for the transformation and upgrading of China's energy system [4]. Some scholars have studied the meaning of digital transformation from the perspectives of business model[5]. And some scholars mainly define the connotation of digital transformation from the perspective of industry [6]or enterprise [7]. The above research provides a rich perspective for understanding the

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meaning of digital transformation. Analyzing the digital transformation of enterprises from the influence degree of internal and external factors can further reveal the types and development paths of digital transformation.

As for the research on the digital transformation path, scholars have divided digital transformation into two paths from the focus of transformation: one is the path of production automation, another is the user experience-oriented path [8]. Or from the perspective of products, Frank et al. (2019) puts forward the path of synergistic development of digital technology and service innovation ability[9]. Or according to the characteristics of the transformation stage, the enterprise digital transformation can be divided into three transformation stages: product or service digitization, process digitization, business model and organizational model digitization [10]. However, few previous studies have carried out targeted path design and its influencing factors based on the characteristics of an industry. In addition, the scientific quantitative method of path design needs to be further expanded.

As for the research on the energy enterprise digital transformation, on the one hand, existing researches focus on the impact of digital transformation of energy enterprises on enterprises. For example, Ren and Li (2023) analyzed the impact of digital transformation mediated by green technology innovation on the financial performance of Chinese energy enterprises[11]. Zhang et al. (2022) studied the impact of digital economy on energy conservation and emission reduction of energy enterprises[12]. On the other hand, some scholars analyzed the key elements in the process of digital transformation of energy enterprises, such as the physical environment and time factors [13].However, the existing researches lack the path design promotion strategy for the stage of digital transformation.

In view of this, this paper starts with the driving factors of energy enterprise, uses The Strategic Position and Action Evaluation(SPACE) analysis method to design different types of digital transformation paths for energy enterprises. It hopes to promote the digital transformation of energy enterprises and lay the foundation for the high quality development of the energy system.

2.Theoretical analysis of energy enterprises digital transformation

2.1 Analysis on digital transformation driving factors of energy enterprises

With the development of digital industrialization and industrial digitalization, energy enterprises, influenced by the development needs of external digital economy and industrial competition, carry out digital transformation on internal structure, organization and management mode of enterprises, so as to promote the overall digital transformation of enterprises [14]. Therefore, The digital transformation of energy enterprises is driven by many internal and external factors as shown in Figure.

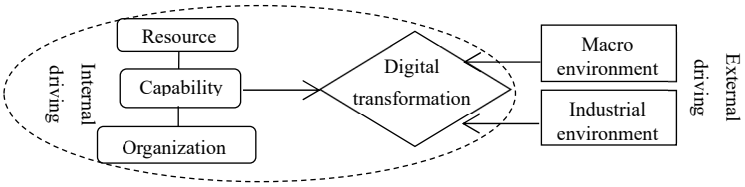

Figure 1 Digital transformation driving factors of energy enterprises

2.1.1 Internal driving factor

As can be seen from Figure 1, the internal driving factors for energy enterprises digital transformation include resource, capability and organization in Figure 2.

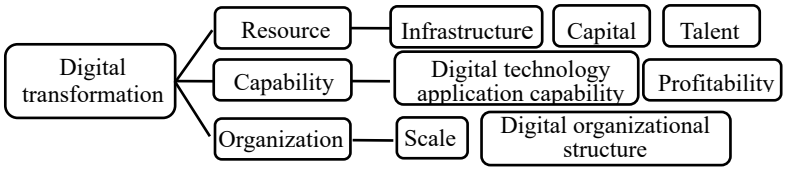

Figure 2 Digital transformation internal driving factors of energy enterprises

As the key element, digital infrastructure can be used to improve the operational efficiency of an enterprise's overall supply chain. The investment of digital capital can ensure the sustainability of energy enterprises' digital upgrading. The quantity and quality of enterprise digital talents can help energy enterprises optimize organizational structure, improve decision-making efficiency[15].

The digital capability is the comprehensive embodiment of energy enterprises' digital technology application ability and profitability[16]. The application ability of enterprise digital technology reflects its technology transformation and application in energy production. The enterprise's digital profitability is the economic performance and direct output of enterprises' digital transformation.

The change of organizational management mode can enable energy enterprises to make more scientific and effective decisions. Upgrading of digital management and organizational structures can facilitate communication and knowledge flow in enterprises, and the efficiency of work cohesion can be improved [17].

2.1.2 External driving factor

As can be seen from Figure 3, the external driving factors for digital transformation of energy enterprises can be divided into macro and industrial environment, as shown in Figure 3.

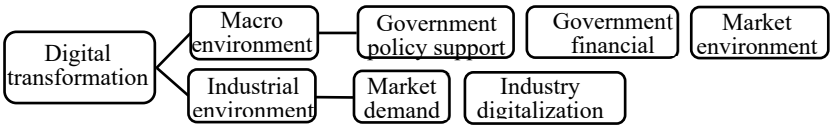

Figure 3 Digital transformation external driving factors of energy enterprises

The government’s preferential tax policies can help ease the cost and pressure of the digital transformation of energy enterprises[18]. Digital capital provides guarantee for the introduction of digital infrastructure. The optimization of the market environment reflects the degree of digital services provided by the government and market management departments.

The industry growing market demand can drive energy enterprises to implement digital strategies. To some extent, the overall digitalization of the industry determines the degree of digital resources and technologies that can be obtained by the enterprise [19].

2.2 Type of energy enterprise digital transformation

As different driving factors have different impacts on enterprises’ digital transformation. Therefore, according to the role of internal and external driving factors, energy enterprise digital transformation can be divided into two types, namely, internal-driven and external-driven.

Internal-driven digital transformation means that the main driving force of energy enterprise transformation comes from inside the enterprise. Enterprises take the initiative to develop digital transformation strategies based on the evaluation of their existing resources and availability of resources, the learning and application ability of all aspects and the adaptability of organizational structure.

External-driven digital transformation means that the main driving force of energy enterprise transformation comes from the outside. Due to the guidance of government policies in the macro environment, as well as the influence of market demand and competition requirements within the industry, the energy enterprise passively adopt the digital transformation strategy.

3. Model construction of energy enterprise digital transformation path

3.1 Design of SPACE model for digital transformation path of energy enterprise

Strategic Position and Action Evaluation (SPACE) method is a method of strategic position and action evaluation [20]. It provides reference for enterprise to make strategic decisions. Based on the theoretical basis of the internal and external driving factors for the digital transformation of energy enterprise, this paper constructs a SPACE model. Figure 4 shows the conceptual model:

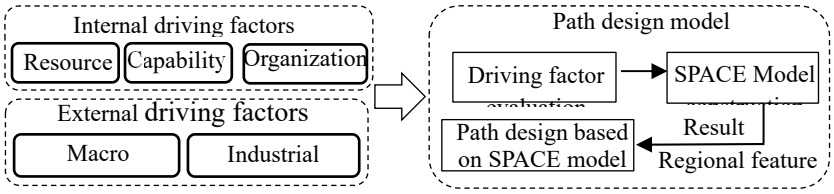

Figure 4 SPACE conceptual model of digital transformation path

As shown in Figure 4, the evaluation index system of internal and external driving factors for the digital transformation of energy enterprises should be constructed first. The entropy weight method is used to evaluate the driving factors scores of energy enterprise, thus identifying the types of enterprise digital transformation. Then, according to the position of the identification and evaluation results in the SPACE model, different types of scientific and accurate digital transformation paths are designed.

3.2 Construction of digital transformation driver evaluation index system

According to the analysis in 2.1.1 and 2.1.2 above, the evaluation index system of the internal and external driving factors of the digital transformation is shown in Table 1.

Table 1 Digital transformation evaluation index system

Primary index	Secondary index	Three-level index	Index measure content	Attribute
External driving factor	Macro environment	x1: Government financial support	Amount of government subsidy (Hu&Huang, 2023)[21]	Positive
		x2: Government policy support	Number of projects of government subsidy	Positive
		x3: Market environment	Enterprise gross profit margin (Correa, 2014)[22]	Negative
	Industrial environment	x4: Market demand	The ratio of the enterprise's sales revenue to its local GDP	Positive
		x5: Industry digitization degree	Industrial digital technology intensity	Positive
Internal driving factor	Resource	y1: Digital infrastructure	Amount of new hardware and software equipment added by the enterprise (Luo&Zhao, 2022)[23]	Positive
		y2: Digital capital investment	The ratio of the sum of digital intangible assets and fixed assets to total assets of an enterprise (Liu, 2020)[24]	Positive
		y3: Digital talent	Number of R&D technicians	Positive
	Capability	y4: Digital technology application capability	Enterprise digital application scoring	Positive
		y5: Profitability	Return on total assets (Liu et al., 2017)[25]	Positive
	Organizatio	y6: Enterprise	Total number of employees	Positive

	n	scale y7: Digital organization structure	The proportion of employees with bachelor degree or above in the total number of employees (Qiu&Xu, 2022)[26]	Positive

3.3 Evaluation of driving factors

The entropy weight method is used to calculate the normalized weight of each indicator according to the data of internal and external driving factors of the energy enterprise digital transformation. The entropy weight model of internal driving factors is firstly constructed:

(1) Establish the sample set: $X=\{X_1,\ X_2,\cdots,X_i\}\ \ i=1,2,\cdots,m$. Each sample corresponds to n indicators, that is $X_i=\{z_{i1},z_{i2},\cdots,z_{ij}\}\ \ \mathrm{j}=1,2,\cdots n$. The index matrix can be established as $Z=\{z_{ij}\}_{mn}$, where z_{ij} represents the value of the j th indicator in the i th sample.

(2) The calculation formula of sample standardization processing is:

Positive index: $$z_{ij}=\frac{z_{ij}-\min\{z_{1j},\cdots,z_{nj}\}}{\max\{z_{1j},\cdots,z_{nj}\}-\min\{z_{1j},\cdots,z_{nj}\}} \tag{1}$$

Negative index: $$z_{ij}=\frac{\max\{z_{1j},\cdots,z_{nj}\}-z_{ij}}{\max\{z_{1j},\cdots,z_{nj}\}-\min\{z_{1j},\cdots,z_{nj}\}} \tag{2}$$

(3) Calculate information entropy:

Computed probability matrix P: $$p_{ij}=\frac{z_{ij}}{\sum_{i=1}^{n}z_{ij}},\ \ i=1,2\cdots,n\ ;\ j=1,2\cdots,m \tag{3}$$

Then calculate the information entropy value: $$e_j=-k\sum_{i=1}^{n}p_{ij}\ln p_{ij}\ ,j=1,2,\cdots m,\ \ k=1/\ln n \tag{4}$$

(4) Calculate the information utility value: $$d_j=1-e_j\ ,j=1,2,\cdots,m \tag{5}$$

(5) Calculate index weight: $$w_j=\frac{d_j}{\sum_{i=1}^{n}d_j}\ ,\ j=1,2,\cdots,m \tag{6}$$

3.4 Construction of path recognition model

According to the weight calculation results, the evaluation score of internal and external driving factors can be further calculated, and the formula is as follows:

$$P_1=\sum_{i=1}^{m}p_iw_i \tag{7}$$

$$P_2=\sum_{j=1}^{n}p_jw_j \tag{8}$$

Where P_1 is the score of internal drive. m is the number of indicators of internal drive factors. P_2 is the score of external drive. n is the number of indicators of external drive factors. If $P_1 < P_2$, the enterprise belongs to the external-driven digital transformation. On the contrary, the enterprise belongs to internal-driven digital transformation.

According to the calculation results, the evaluation point P (x, y) is constituted by taking the internal drive evaluation score P_1 as the X-axis and the external drive evaluation score P_2 as the Y-axis. The coordinate diagram of point P (x, y) in the SPACE model can be obtained in Figure 5.

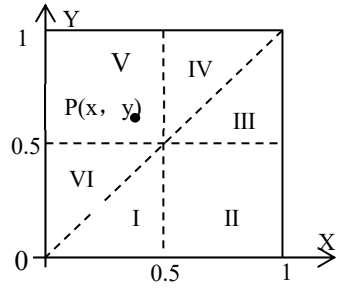

Figure 5 SPACE model coordinate

As can be seen from Figure 5, the driving factor evaluation point P of energy enterprises' digital transformation in different regions of the model shows the strengths and weaknesses of the enterprises at present, thus providing guidance for their digital transformation path design.

Combined with the features of region Ⅰ-Ⅲ of internal-driven digital transformation in the SPACE model, when point P (x, y) is located in region Ⅰ, the internal and external driving factors of energy enterprises' digital transformation are weak, and the advantages of internal digital transformation are not obvious. Its digital transformation is in embryonic stage. When point P (x, y) is located in region Ⅱ, the resources, capabilities and organization of energy enterprises can support the further development of enterprise digital transformation. Its digital transformation is in growth stage. When point P (x, y) is located in region Ⅲ, which can provide both internal and external support for enterprises. Its digital transformation is in mature stage.

According to the regional characteristics of Ⅳ-Ⅵ in the SPACE model, when point P (x, y) is located in the Ⅵ region, it poses a great threat to the enterprise in the environment faced by the external enterprise, and has a small driving force for the enterprise's digital transformation. The enterprise is still in embryonic stage. When point P (x, y) is located in region Ⅴ, energy enterprises are faced with more opportunities outside, which can provide the required technology and resources for enterprises. But the enterprise itself is not driven enough, its digital transformation is in growth stage. When point P (x, y) is located in area Ⅳ, the external environment of energy enterprises can meet the needs of enterprises for digital transformation, and promote the improvement of their own digital ability by using the external environment. Its digital transformation is in mature stage.

4.Evaluation and analysis of driving factors for digital transformation of energy enterprises

4.1 Data source

The sample enterprises in this paper come from listed energy enterprises from multiple industries in China. After excluding enterprises with ST, *ST, missing indicators, no digital input, and negative economic indicators, 107 listed energy enterprises are finally obtained in this study. Among them, 57 are traditional energy enterprises and 50 are new energy enterprises. Each index data is collated by 2021 enterprise annual report data and industry data published by CSMAR Database.

4.2 Evaluation results of driving factors

According to the calculation of driving factor evaluation proposed in 3.3 above, entropy weight method is first used to calculate the weights of internal and external driving factor indicators respectively. The results are shown in Table 2 and Table 3.

Table 2 Indicator weight of internal driving factors

Secondary index	Weight	Three-level index	Entropy value (e_j)	Utility value (d_j)	Indicator weight (w_j)
Resource	0.568030	y1	0.711874	0.288126	0.194491
		y2	0.873750	0.126250	0.085221
		y3	0.572876	0.427124	0.288318
Capability	0.205481	y4	0.755019	0.244981	0.165368
		y5	0.940575	0.059425	0.040113
Organization	0.226489	y6	0.721436	0.278564	0.188036
		y7	0.943035	0.056965	0.038453

Table 3 Indicator weight of external driving factors

Secondary index	Weight	Three-level index	Entropy value (e_j)	Utility value (d_j)	Indicator weight (w_j)
Macro environment	0.607081	x1	0.569440	0.430560	0.438148
		x2	0.846447	0.153553	0.156259
		x3	0.987546	0.012454	0.012674
Industrial environment	0.392919	x4	0.774252	0.225748	0.229727
		x5	0.839634	0.160366	0.163193

According to Table 2, resources (0.568030) are the most influential among the internal driving factors. Among the resources, digital talents (0.288318) inject the blood of digital innovation into enterprises. Digital infrastructure (0.194491) lay the foundation for the implementation of enterprise digital transformation.

According to Table 3, the government financial support for enterprises (0.438148) and the market demand within the industry (0.229727) are the important external influencing factors for the digital transformation of enterprises.

4.3 Heterogeneity analysis of driving factors of traditional and new energy enterprises

4.3.1 Comparative analysis of external drivers of digital transformation

Traditional energy enterprises and new energy enterprises are respectively calculated to compare the importance of external drivers of digital transformation in different industries. The calculated weight comparison results are shown in Figure 6.

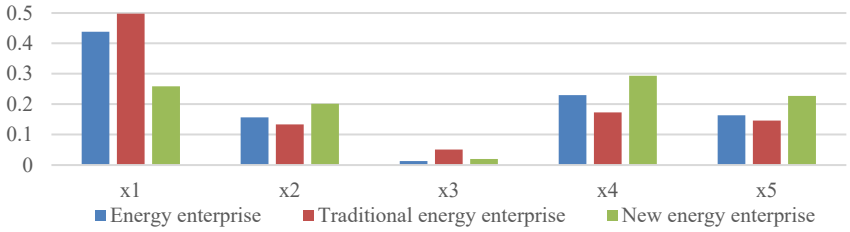

Figure 6 Weight comparison of external drivers of digital transformation

As can be seen from Figure 6, among traditional energy enterprises, government financial support has a greater impact than that of new energy enterprises. Traditional energy enterprises have mature energy exploitation and sales business, and their capital chain is relatively stable. Among the new energy enterprises, the impact of government policy support and industrial environment is greater. This is because there are many development paths for new energy enterprise, and its development direction is more dependent on the guidance of government policies, as well as the overall development of the industry and customer demand.

4.3.2 Comparative analysis of internal drivers of digital transformation

Compare the importance of internal drivers of digital transformation in traditional and new energy enterprises. The calculated results are shown in Figure 7.

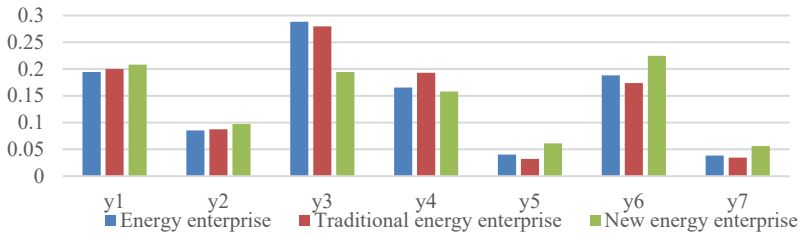

Figure 7 Weight comparison of external drivers of digital transformation

As can be seen from Figure 7, digital technology application capability has a relatively high impact. This is because the traditional technology of traditional energy enterprises is relatively stable in the industry. The application of digital technology innovation in enterprises can help enterprises innovate, so as to improve the digital level of enterprises. In the digital transformation of new energy enterprises, the importance of enterprise scale is greater than that of traditional energy enterprises.

4.4 Evaluation results of driving factors

According to formula (7), (8), the evaluation scores of internal driving scores (P1) and external driving scores (P2) of all energy enterprises can be calculated. Taking new energy enterprises as an example, the calculation results are shown in Table 4.

Table 4 Evaluation results of driving factors of new energy enterprises

ID	P_1	P_2	Type	ID	P_1	P_2	Type
1	0.032554	0.006675	Internal	26	0.054366	0.011344	Internal
2	0.019765	0.017034	Internal	27	0.025536	0.013737	Internal
3	0.020616	0.032225	External	28	0.004399	0.008286	External
4	0.020261	0.030581	External	29	0.014408	0.004327	Internal
5	0.030310	0.032322	External	30	0.018540	0.027494	External
6	0.028693	0.032975	External	31	0.004114	0.002894	External
7	0.018329	0.031670	External	32	0.011154	0.010867	Internal
8	0.026300	0.038999	External	33	0.174360	0.071914	Internal
9	0.015791	0.007730	Internal	34	0.078105	0.109617	External
10	0.002718	0.003350	External	35	0.009591	0.017824	External
11	0.037750	0.030933	Internal	36	0.015770	0.031603	External
12	0.003466	0.018876	External	37	0.044005	0.015287	Internal
13	0.001433	0.003644	External	38	0.029383	0.010184	Internal
14	0.003850	0.008259	External	39	0.010915	0.024511	External
15	0.002681	0.003800	External	40	0.022542	0.028388	External
16	0.004904	0.007752	External	41	0.016224	0.012601	Internal
17	0.002341	0.006665	External	42	0.020714	0.011817	Internal
18	0.017688	0.007409	Internal	43	0.014637	0.053958	External
19	0.005227	0.002067	Internal	44	0.012562	0.003993	External
20	0.002146	0.007385	External	45	0.008606	0.019202	External
21	0.006900	0.001539	Internal	46	0.002791	0.007593	External
22	0.023628	0.009763	Internal	47	0.008230	0.010623	External
23	0.011425	0.021409	External	48	0.022801	0.081126	External
24	0.005915	0.009731	External	49	0.014376	0.019718	External
25	0.005295	0.010767	External	50	0.011886	0.007533	Internal

According to the evaluation results in Table 4, there are 18 internal-driven digital transformation enterprises. There are 32 external-driven digital transformation enterprises. It can be seen that fewer enterprises currently choose active digital transformation. This is due to the industrial characteristics of energy enterprises and the overall development of the current energy system, and the choice of active digital transformation requires greater investment and risk. The use of external environment to obtain digital resources, so as to gradually improve the digital business capability has become the choice of most energy enterprises.

5. Digital transformation path design and promotion strategy of energy enterprise

5.1 Internal-driven digital transformation path design and promotion strategy

There are two types of enterprises applicable to this path: one is energy enterprises with a certain scale. They have high visibility and brand degree, large size, complex structure. The other is to deal with new small energy companies set up in the digital economy. They are younger and smaller, but they are usually more innovative. Figure 8 shows the path framework.

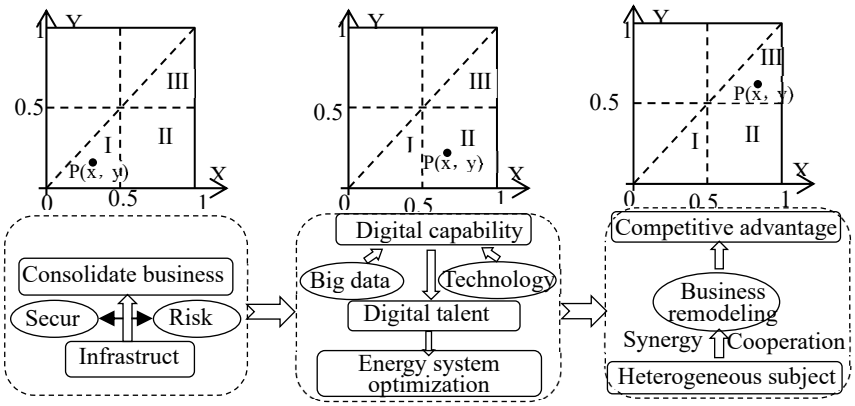

Figure 8 Internal-driven digital transformation path framework

5.1.1 Defensive path

In the embryonic stage of internal-driven digital transformation, that is, when they are located in region Ⅰ of the SPACE model, enterprises should take the defensive path. At this stage, energy enterprises should not take radical risks and consolidate their business foundation. Enterprises should strengthen the construction of digital transformation infrastructure, strengthen information security, improve technical standards, and prevent various risks.

5.1.2 Developmental path

In the growth stage of internal-driven digital transformation of energy enterprises, that is, when they are located in region II of SPACE model, the enterprise should implement the developmental path. Firstly, the enterprise can build a digital application platform that gathers energy digital elements to provide hardware support for the digital transformation of energy enterprises. Secondly, enterprises should accelerate the promotion of digital technology innovation ability of energy enterprises to enhance their core competitive position in the industrial chain. Finally, it is necessary to accelerate the construction of energy digital talent team to enhance personnel's digital technology application ability.

5.1.3 Competitive path

In the mature stage of internal-driven digital transformation, that is, when energy enterprises are located in the region Ⅲ of SPACE model, enterprises should take the competitive path. At this stage, energy enterprises should actively introduce heterogeneous subjects to enhance competitive advantages through business remodeling. Within the enterprise, it is necessary to improve and innovate the organizational model and operation mechanism of the integration of digital technology and business. Outside the enterprise, strengthen the cross-regional technical cooperation with other energy enterprises, give full play to the advantages of heterogeneous subjects and realize collaborative innovation.

5.2 External-driven digital transformation path design and promotion strategy

External-driven digital transformation is mainly applicable to small and medium-sized energy enterprises with flexible organizations, which have weak investment in capital, technology and facilities for digital transformation. But it is able to make quick adjustments to its business and production models in a timely manner. Figure 9 shows the path frame.

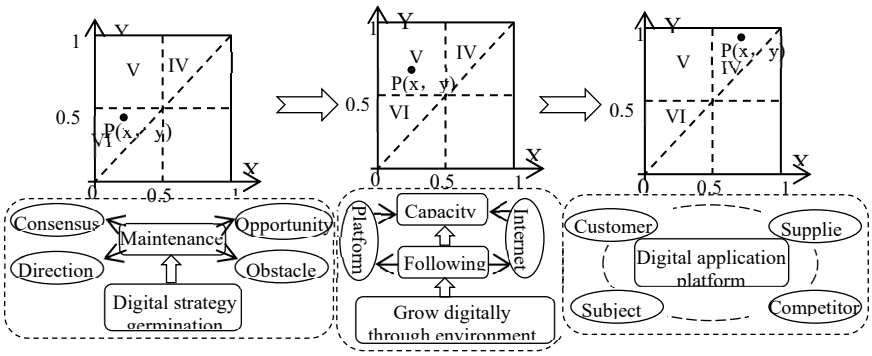

Figure 9 External-driven digital transformation path framework

5.2.1 Maintenance path

In the embryonic stage of external-driven digital transformation, that is, when they are located in the Ⅵ area of the SPACE model, enterprises should take the maintenance path. At this stage, energy enterprises should maintain their own advantages and further wait and see the development trend of industrial environment. On the one hand, the direction of digital transformation should be clearly defined within the enterprise. The digital transformation strategy is planned systematically according to the development situation of driving factors. On the other hand, it should observe the process of industry digitization and seize opportunities, and strive to overcome the obstacles brought by the external environment of digital transformation.

5.2.2 Flexible and adaptive path

In the growth stage of external-driven digital transformation, that is, when they are located in the Ⅴ area in the SPACE model, energy enterprises should adopt the flexible and adaptive path. At this stage, energy enterprises need to use external platforms to complete data management and gradually form a digital value creation model. In addition, it should make full use of external digital resources to enhance its digital innovation capabilities, improve the own digital technology application capabilities, and ensure the smooth progress of the next stage of digital transformation.

5.2.3 Active transformation path

In the mature stage of external-driven digital transformation of energy enterprises, that is, when they are located in area Ⅳ of SPACE model, energy enterprises take the active transformation path. At this stage, energy enterprises should adjust the initiative of digital strategy according to their own situation, strengthen participation in the construction of large data centers and digital application platforms in the industry. At the same time, it should transform and upgrade the value chain to multi-entity parallel and coordinated development. Through the construction of multi-agent digital innovation ecosystem to obtain digital sustainable development power, to achieve the digital transformation of business model.

6. Conclusion

Under the background of digital wave, the digital transformation is not only a strategic choice to support the energy industry to achieve the overall national development goals, but also an inevitable choice to achieve the goal of “carbon neutrality”. Taking energy enterprises as the research object, this paper breaks through the previous research perspective of digital transformation path, and uses entropy weight method and SPACE model to evaluate and identify the types of digital transformation of some new energy enterprises from the perspectives of internal and external driving factors of digital transformation of energy enterprises, combining quantitative and qualitative analysis. This provides strategic guidance for energy enterprises to scientifically match the digital transformation path and development strategy. The main work and conclusions of the research are as follows:

(1) The digital transformation of energy enterprise is the transformation and upgrading of energy value creation mode under the comprehensive action of internal and external driving factors. According to the influence degree of internal and external driving factors, digital transformation of energy enterprises can be divided into two types: internal-driven type and external-driven type.

(2) The influence degree of internal and external driving factors of digital transformation of energy enterprises, traditional energy enterprises and new energy enterprises is analyzed respectively. Across the sample of energy companies, digital talent is the internal driver with the highest impact. Digital capital investment is the most influential external driver. The most influential factors of new energy enterprises are market demand and enterprise scale.

(3) It provides a scientific method for energy enterprises to determine the types and paths of digital transformation. In this paper, entropy weight method is used to calculate the evaluation

scores of internal and external driving factors of 107 energy enterprises based on the data of their digital transformation. According to the influence of driving factors, the digital transformation of energy enterprises is divided into three stages: embryonic stage, growth stage and maturity stage. Each stage in the SPACE model reflects the type of digital transformation and the magnitude of opportunities and threats in the environment.

(4) The digital transformation paths of internal-driven and external-driven in energy enterprises are designed. According to the evaluation results of driving factors of energy enterprises digital transformation and their SPACE model characteristics, the internal-driven digital transformation path is divided into defensive, developmental and competitive path. The external-driven digital transformation path is divided into maintenance, flexible adaptive and active transformation path.

Of course, there are some limitations in this study. In this study, the stage of energy enterprise digital transformation is not comprehensive only from the position of the influence degree of driving factors in the SPACE model. In the future research on digital transformation path of energy enterprises, a more comprehensive and systematic index system should be constructed to evaluate the stage of digital transformation quantitatively. It should provide a more scientific and systematic method and reference basis for enterprises to identify the digital development level and make targeted improvement strategies.

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