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Research on Key Success Factors of Logistics Enterprises Digital Transformation Based on Interpretative Structural Model

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Abstract: This paper is to clarify the key success factors of logistics enterprises digital transformation, and the relationship between them. Key success factors are extracted through literature review, expert interviews and membership evaluation methods, and a hierarchical model of factors is constructed by using the interpretative structural modeling method to obtain the hierarchical relationship of factors and further analyse the digital transformation strategy of logistics enterprises. This paper provides new ideas for logistics enterprises to break through the bottleneck and accelerate digital transformation.

Keywords: logistics, enterprise digital transformation, interpretative structural model

In China, artificial intelligence, big data, Internet of Things etc. are maturing, so data has become the most critical production factor and digital economy has become the new kinetic energy for China's industrial transformation and upgrading[1]. The logistics industry, as the basic industry supporting the national economy and social development, has gradually slowed down its growth scale and entered a critical period of transformation and upgrading[2]. More and more logistics companies are actively exploring the digital transformation. Among them, Cainiao puts into use the automatic sorting system in Guangzhou, and the picking accuracy rate is close to 100%. China Materials Storage and Transportation Corporation is on the line of China Storage Intelligence Platform; Wo56 as the supplier of intelligent logistics operation platform is developing rapidly. In the digital economic tide, logistics companies can only respond to the economic cycle and industry subversion by adapting to the trend and making full use of digitization to accelerate business transformation[3].

How do traditional logistics companies break through the bottleneck and find a broken point? According to the above problems, this paper firstly extracts the success factors of logistics enterprises digital transformation through literature research and expert interviews, then establishes an Interpretative Structural Model (ISM), to analyze the interdependence and constraints among components of the system, so as to provide theoretical basis for logistics enterprises to identify the key links of digital transformation, and to promote the sustained and rapid development of enterprises.

1. INTERPRETATIVE STRUCTURAL MODEL

1.1 Overview of interpretative structural model

The ISM was proposed by Professor Warfield in 1974 to analyze complex social and economic systems[4]. It is characterized by decomposing a complex system into several sub-elements, and then using the practical experience or expert knowledge to construct the system into a multilevel hierarchical structural model. The advantage is that it transforms the ambiguous factors into a model with clear hierarchy and enhances the understanding of the problem. Therefore, it is suitable for analyzing systems with many factors, interlaced relationships, and unclear structures, as well as for the sequencing of schemes[5-6]. The limitation is that when modeling the relationship between the various elements of the system, it depends on people's practical experience to some extent[7].

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1.2 Application status of interpretative structural model

The ISM is widely used. Both macro or micro, abstract or specific problems can be effectively processed by ISM. Chen WC, etc. used ISM to determine the feedback and dependencies between key success factors in new product development projects[8]; Poduval P, etc. used ISM to analyze the obstacles of implementing total productive maintenance in the production management process, to help managers clear minds and take action to alleviate obstacles[9]; Zhang J etc. analyzed the influencing factors of learners' continuous learning behaviors in online education platform and their hierarchical relationship and role path through ISM[10]; Liu ZY studied the factors that affect the emergence and development of female entrepreneurs' entrepreneurial performance. By constructing the ISM, the basic conditions, key factors, and production path leading to entrepreneurial performance development were defined[11]; Wu XL etc. combined the Ordinal Probit model with ISM to explore the influencing factors of farmers' cognition breadth and depth of green agricultural technology, which made up for the shortcomings of ignoring the hierarchical relationship between factors in Probit model[12]. It can be seen that the ISM has good applicability for analyzing enterprise digital transformation with numerous variables, complicated relationships and unclear structure.

2. ANALYSIS OF KEY SUCCESS FACTORS OF LOGISTICS ENTERPRISES DIGITAL TRANSFORMATION BASED ON ISM

This paper takes G company as an example. It is a large central enterprise Guangdong branch that provides logistics services such as shipping, air transportation, international express, road and rail transportation, shipping agency, warehousing and distribution. It is based on the Pearl River Delta Economic Circle to provide domestic and foreign customers with end-to-end supply chain solutions and is the largest freight forwarding company in East China. G has industry-leading logistics information systems and has been committed to improve its digital level and innovate its business model, so we select it as an example.

Based on insights into the core competencies of the digital transformation leaders, Accenture developed a comprehensive model- the Accenture China Enterprise Digital Transformation Index[13], and applied it to logistics and other industries to assess enterprises digital maturity. However, the model does not target the logistics industry, and lacks analysis of the hierarchical relationship between factors which makes it difficult for logistics enterprises to clarify the transformation path. Therefore, it was chosen as alternative success factors. In this model, the success factors of enterprise digital transformation are generally summarized into two dimensions: intelligent operation and digital innovation. Intelligent operation means that enterprises generate data insights from massive data, support decision-making and enhance customer experience, so as to reduce cost and increase efficiency, and consolidate the original core business. Digital innovation means that enterprises accelerate the innovation of products and services, explore new market opportunities, and create new business models with the help of digital technology. The specific secondary and tertiary indicators are shown in Table 1.

Then, in order to facilitate the establishment of ISM and analyze the system, we screen out key success factors. Based on the principles of system engineering, we determine the relevance of alternative success factors to G's successful digital transformation:

$X=\{X_1 , X_2 , X_3 , X_4 \}=\{$ very important, important, general, irrelevant $\}=\{0.8 , 0.6 , 0.4 , 0.2\}$

We conduct cyclic surveys and assessments with 10 experts (mainly stakeholders in G's digital transformation, including department managers, project managers, developers, etc.), and summarize the number of people select each alternative success factor as the comment set to obtain an evaluation set of alternative success factors (Table 2). Finally, the importance evaluation value y_i of each factor is calculated by the following method:

Table 1. Alternative success factors of enterprise digital transformation

Primary indicators	Secondary indicators	Tertiary indicators	Number
Intelligent operation	Digital channel and marketing	Realize accurate marketing according to customers' individualized demand	1
		Realize online and offline all-round channel construction	2
		Protect own and customers' data privacy	3
	Intelligent production and manufacturing	Using digital technology to achieve agile development	4
		Cooperative R&D based on digital platform	5
		Achieve intelligent manufacturing and flexible supply chain	6
	Intelligent support and control	Flexible adjustment of functional department structure according to business needs	7
		Achieve seamless integration of data flow and business processes across departments	8
		Build a decision-making system and management system based on data analysis	9
Digital innovation	Product and service innovation	Digital upgrade of existing products and services	10
		Develop smart products or services	11
		Customized products or services based on individual customer needs	12
	Digital business model	Digital platform-based business model	13
		Develop data realization mode	14
		Iterative improvement of digital business model	15
	Digital venture capital and incubation	Establish an internal venture capital department to promote digital new business	16
		Establish mechanisms to encourage internal innovation and entrepreneurship	17
		Collaborate with start-ups to develop digital technology	18

$$y_i = \sum_{j=1}^{4} x_j * d_{ij} / d_a \quad (1)$$

x_j represents the weight of the No.j evaluation value, d_{ij} is the number of people who select the No.j evaluation value for the No.i factor; d_a is the total number of people participating in the evaluation. The importance evaluation value y_i of each alternative success factor is calculated (Table 2). The alternative success factors of the evaluation value y_i<0.65 are removed, remaining 9 factors which are the key success factors of G's digital transformation(Table 3). Among them, the factors with large evaluation value are concentrated in four dimensions: digital channel and marketing, intelligent support and control, digital business model, digital venture capital and incubation.

Table 2. Evaluation value of alternative success factors

Indicator number	Importance				Evaluation value y_i
	Very important	Important	General	Irrelevant	
1	7	3	0	0	0.74
2	7	2	1	0	0.72
3	7	3	0	0	0.74
4	2	7	1	0	0.62
5	3	6	1	0	0.64
6	2	8	0	0	0.64
7	5	5	0	0	0.7
8	8	2	0	0	0.76
9	3	5	2	0	0.62
10	4	4	2	0	0.64
11	4	3	3	0	0.62
12	5	2	3	0	0.64
13	8	2	0	0	0.76
14	5	4	1	0	0.68
15	4	5	0	1	0.64
16	6	3	1	0	0.7
17	4	6	0	0	0.68
18	1	5	3	1	0.52

Table 3. Key success factors of G company digital transformation

Number	Key factors	S_i
1	Realize accurate marketing according to customers' individualized demand	S_1
2	Realize online and offline all-round channel construction	S_2
3	Protect own and customers' data privacy	S_3
4	Flexible adjustment of functional department structure according to business needs	S_4
5	Achieve seamless integration of data flow and business processes across departments	S_5
6	Digital platform-based business model	S_6
7	Develop data realization mode	S_7
8	Establish an internal venture capital department to promote digital new business	S_8
9	Establish mechanisms to encourage internal innovation and entrepreneurship	S_9

On the basis of determining the key success factors of logistics enterprises digital transformation, the relationship between factors is analyzed by further establishing the ISM. The specific steps are as follows:

(1) Adjacency matrix. We analyze the impact relationship between the nine key success factors in conjunction with the actual situation of G, and fill out the adjacency matrix A(Table 4) according to the following rules:

When i=j, a_{ij} =1;

When i≠j, if S_i has an effect on S_j, a_{ij} =1; if S_i has no effect on S_j, a_{ij} =0; (i, j=0,9).

Table 4. Adjacency matrix A

M_{9*9}	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9
S_1	1	0	0	1	1	0	0	0	0
S_2	1	1	1	0	0	0	0	0	0
S_3	0	0	1	0	1	0	0	0	0
S_4	0	0	0	1	0	0	0	1	1
S_5	0	0	0	0	1	0	1	0	0
S_6	0	0	0	0	0	1	0	0	0
S_7	0	0	0	0	0	1	1	0	0
S_8	0	0	0	0	0	1	0	1	0
S_9	0	0	0	0	0	1	0	0	1

(2) Reachable matrix. According to the law of transition and the rules of Boolean algebra, the reach matrix R is calculated by the adjacency matrix A. The specific calculation rules are as follows:

Let $A_1=A$, $A_n=A_n$; When $A_1=A\neq A_2 \neq \ldots \neq A_{n-1}=A_n$, $R=A_{n-1}$ is the reachable matrix.

In this example, $A_1\neq A_2\neq A_3\neq A_4=A_5$, so $R=A_4$ is the reachable matrix (Table 5).

Table 5. Reachable matrix R

M_{9*9}	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9
S_1	1	0	0	1	1	1	1	1	1
S_2	1	1	1	1	1	1	1	1	1
S_3	0	0	1	0	1	1	1	0	0
S_4	0	0	0	1	0	1	0	1	1
S_5	0	0	0	0	1	1	1	0	0
S_6	0	0	0	0	0	1	0	0	0
S_7	0	0	0	0	0	1	1	0	0
S_8	0	0	0	0	0	1	0	1	0
S_9	0	0	0	0	0	1	0	0	1

(3) Hierarchical division. According to the reachable matrix, the reachable set $R(S_i)$, antecedent set $A(S_i)$ and the $R(S_i)\cap A(S_i)$ of each factor are obtained(Table 6). Where $R(S_i)$ is a set of elements corresponding to the columns in which all elements in the S_i row of the reachable matrix are 1; $A(S_j)$ is a set of elements corresponding to the rows in which all elements in the S_j column of the reachable matrix are 1 .

Table 6. Key success factors hierarchical division

S_i	Reachable set $R(S_i)$	Antecedent set $A(S_i)$	$R(S_i)\cap A(S_i)$
S_1	1,4,5,6,7,8,9	1,2	1
S_2	1,2,3,4,5,6,7,8,9	2	2
S_3	3,5,6,7	2,3	3
S_4	4,6,8,9	1,2,4	4
S_5	5,6,7	1,2,3,5	5
S_6	6	1,2,3,4,5,6,7,8,9	6
S_7	6,7	1,2,3,5,7	7
S_8	6,8	1,2,4,8	8
S_9	6,9	1,2,4,9	9

(4) Establish ISM. According to the above hierarchical classification results, the ISM is established by placing the success factors of the same level at the same level and connecting them with arrows according to the reachable path. That is to form the ISM of the key success factors of the logistics enterprises digital transformation(Figure 1).

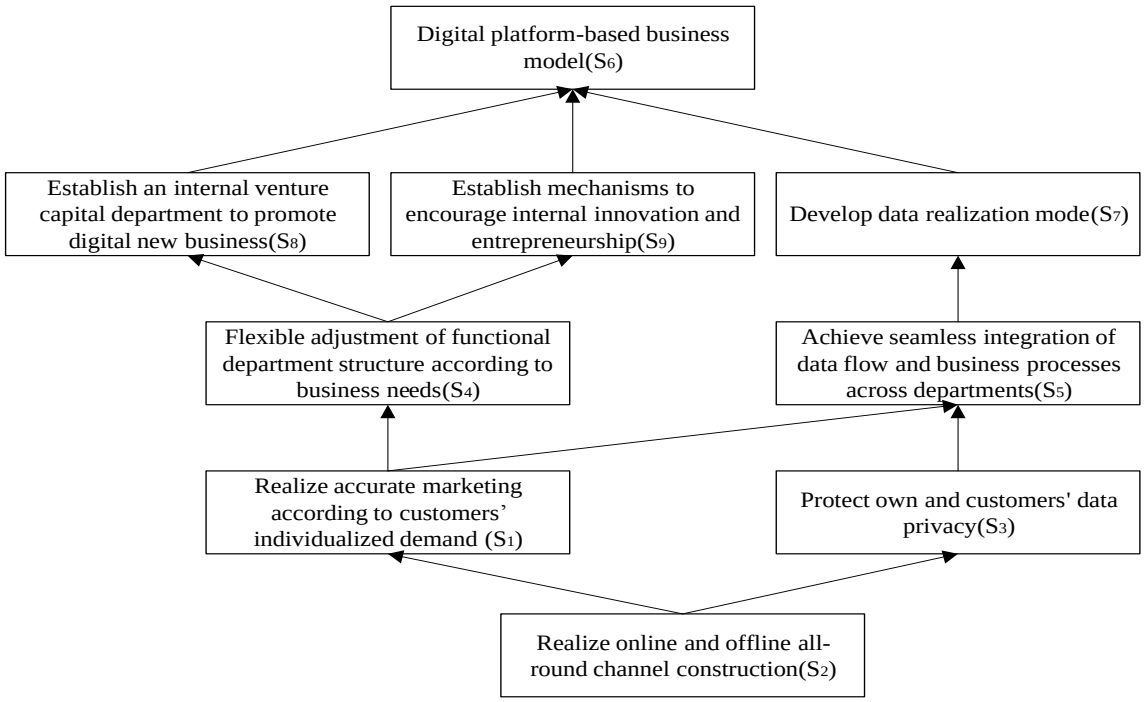

Figure 1. Results of ISM

(5) Findings. According to the ISM, there are hierarchical relationships between the factors of digital channels and marketing, intelligent support and control, digital business model, digital venture capital and incubation: the three factors of digital channel and marketing are located in the first and second layers of the ISM , which are the basic links of enterprise digital transformation; the two factors of intelligent support and control are located in the middle layer of the model, which are affected by digital channels and marketing capabilities and support enterprise digital innovation at the same time; the three factors of digital business model and digital venture capital incubation are located in the fourth and fifth layers of the model, where the digital platform-based business model is at the top. It can be seen that in the digital transformation process of G Company, they first focus on the ability of intelligent operation, on the basis of consolidating the original core business, they use their accumulated data and experience, to develop the ability of digital innovation, cultivate new business, and finally realize transformation and upgrading.

(6) Management enlightenment.

The ability to realizing online and offline all-round channel construction is located at the bottom of the ISM, indicating that it plays a vital role in the enterprise digital transformation, and directly affects the ability to realize accurate marketing according to customers' individualized demand and protect own and customers' data privacy. Therefore, logistics enterprises can start from the existing business and fully utilize the advanced technologies such as Internet of Things, cloud computing and artificial intelligence to construct intelligent logistics online platforms, realize transparent logistics management, inventory visualization, accelerate the integration and optimization of logistics resources, and improve efficiency and quality of logistics operations. At the same time, companies should also incorporate information security into their strategic planning, construct

information security management system, and guard against the risk of information leakage.

Enterprise intelligence support and control capability is intermediate factor. Through the IT systems of various functional departments in the enterprise, realizing the smooth flow of operational data and other information flows within the enterprise can not only enhance internal communication and collaboration, as well as intelligent control of various business links, but also provide a data foundation and decision-making basis for enterprises to develop new business.

The digital platform-based business model is at the top of the model, and is directly affected by the ability of developing data realization mode, establishing an internal venture capital department to promote digital new business, and establishing mechanisms to encourage internal innovation and entrepreneurship. It indicates that to achieve innovation and transformation, enterprises should build new business models based on digital platforms from a strategic perspective. This capability can be realized by adjusting the organizational form, including changing the organizational structure, increasing venture capital department to promote new business development; or creating organizational culture, using dynamic performance management and incentives to promote internal innovation and entrepreneurship, making digital transformation a new normal for enterprise development.

3. RESEARCH LIMITED

The key success factors of logistics enterprises digital transformation include digital channels and marketing, intelligent support and control, digital business model and digital venture capital and incubation. By adopting the ISM, we discussed the hierarchical relationships between the key success factors and proposed the path of selecting digital transformation strategy for logistics enterprises. This study provides a theoretical basis for enterprises to cultivate core competencies and achieve digital transformation, but there are still some limitations. First of all, the ISM has subjective limitations, which depend on people's practical experience to some extent. Secondly, the research sample has limitations. Only one logistics enterprise is selected as the research sample, and different enterprises may be affected by more factors in the actual transformation process.

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