Research on Digital Transformation Evaluation Indicator System of Logistics Enterprises

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Abstract. Whether the status and level of digital transformation of logistics enterprises can be effectively recognized determines the digital process and future development of logistics enterprises directly. Based on the existing research of digital transformation evaluation, this paper constructs the evaluation index system of digital transformation level of logistics enterprises from four dimensions by taking A logistics enterprise as a case study: digital logistics operation level, digital foundation, digital management and digital benefit. The quantum concept is introduced into the nomadic algorithm to form the quantum nomadic algorithm, and the weight is optimized in combination with the analytic hierarchy process, the transformation level is evaluated by the fuzzy comprehensive evaluation method. Transformation degree of A logistics enterprise is generally obtained through the actual measurement of the digital transformation data of logistics enterprise A. Finally, the direction and strategy for the digital transformation of logistics enterprise are presented according to the conclusion.

Keywords: logistics enterprise · digital transformation · indicator system · quantum nomadic algorithm · analytic hierarchy process

1 Introduction

In recent years, the wave of digitalization has swept the world, digital technologies such as artificial intelligence, 5G, and big data have developed rapidly, digital technology has been deeply integrated with the economy and society, and the digital economy has become a key force to promote the construction of a new development pattern, reshape the economic structure, and change the competitive landscape. The digital transformation of logistics enterprises can continuously accelerate the application of digital technology in the whole process and all scenarios, promote the digitalization of full-link business information and the accurate identification and tracking of full-life cycle business information, and realize dynamic prediction and scientific management of the whole process. The digital transformation of logistics enterprises improves network efficiency internally, empowers industry customers externally, and promotes the comprehensive upgrading of intelligent logistics supply chain. The digital transformation of the logistics industry is an inevitable trend of strategic change in the current era. Compared with other industries such as manufacturing and service industries, the digital transformation duration

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of logistics enterprises is comparatively short, and the research of scholars in various countries is relatively few. With the digital transformation of logistics enterprises, establishing an effective evaluation system of digital transformation level can not only meet the urgent needs of logistics enterprises, but helps local governments to understand the current situation of enterprise digitization and improve the efficiency of government guidance and support for enterprise development.

Enterprise digital transformation and upgrading refers to the process of triggering major changes in entity attributes through the combination of information, computing, communication and connection technologies, thereby improving the process of entity, and logistics digitalization is the process of further digitizing various elements in the logistics process [1, 2]. At present, scholars mainly focus on the following two aspects of digital transformation: Regarding the construction of the digital transformation evaluation system of enterprises, the existing literature mainly explores from the aspects of influencing factors and relationship research, influencing factors can be divided into external influencing factors and internal influencing factors, external influencing factors mainly include fiscal and taxation policies [3] and business environment [4], internal influencing factors include digital strategy [5], operational technology [6], dynamic capabilities [7] and organizational change [8]. Relationship research mainly refers to the changing relationship between digital transformation and enterprise efficiency [9]. In their study on evaluation methods for enterprise digital transformation, Gamache et al. [10] evaluated the impact of different concepts around digital transformation topics on firm performance through literature reviews, questionnaires and field interviews. The evaluation method of enterprise digital transformation based on the subjective experience of experts can no longer meet the management needs of modern enterprises, and Wu et al. [11] proposed a dynamic design quality evaluation method for enterprise digital system based on fuzzy information axioms. Chai et al. [12] established a GDM model of LZPRs by trustworthiness-based DMs combinatorial weights and a new language Z-number-weighted average (NLZWA) operator.

The digital transformation of enterprises is an all-round change, and the expansion of enterprise scale, technological innovation, and business model innovation will create impetus for it. By combing the relevant literature, it is found that scholars currently have more evaluation and research on the digital transformation of enterprises, but there are fewer evaluation studies specifically for the digital transformation of logistics enterprises, and the evaluation of the digital transformation of logistics enterprises is helpful for the government and enterprises to understand the current digital development status of logistics enterprises, grasp the development weaknesses, and invest resources and subsequent transformation in a more targeted manner. In view of this, this paper will use the analytic hierarchy process to analyze and study the digital transformation of logistics enterprises from the dimensions of digital logistics operation level, digital foundation, digital management and digital benefits, and propose the quantum nomadic algorithm-analytic hierarchy process (QNA-AHP). The consistency index of weight is the objective function, and the weight is intelligently optimized to make up for the shortcomings of traditional methods with strong subjectivity and long test time. In addition, there is more data in the evaluation process, and the heuristic algorithm is more efficient than other algorithms. In addition, in order to avoid the problem of local optimization in the search process, the quantum concept is introduced to achieve global optimum.

Based on the above discussion, the rest of this paper is organized as follows: The first section constructs the evaluation indicator system of digital transformation of logistics enterprises; The second section discusses the quantum nomadic algorithm-analytic hierarchy method (QNA-AHP), which is used for evaluation; In the third section, empirical research is carried out on the example of A logistics enterprise, and the feasibility and effectiveness of the evaluation method are proved through experimental results; Section four draws conclusions and recommendations based on empirical findings.

2 Construction of Evaluation Indicators System for Digital Transformation of Logistics Enterprises

2.1 Evaluation Indicators Selection Principles

There are many indicators related to the digital transformation of logistics enterprises, in order to make the indicator system more authentic and effective, this article tries to follow the following principles when determining indicators:

Scientific.

Indicators cannot be fictive。They must be actual in reality. When selecting indicators, it is necessary to have a deep understanding of their meaning, follow basic scientific principles, which have evaluative significance for the target object.

Completeness.

Completeness requires that all aspects of evaluation should be considered as comprehensively as possible when constructing the index system, and indicators should be selected systematically, so that the evaluation results of the digital transformation capabilities of logistics enterprises can be closer to the real situation.

Objectivity.

The selection of evaluation indicators cannot be subjectively hypothesized, which needs to be decided on the basis of existing research combined with one's own ideas, and at the same time, it should also be considered comprehensively in combination with the evaluation object.

Operability.

On account that relevant personnel need to score the selected indicators, it is necessary to consider whether the indicators can be accurately understood by the respondents, which also reflect the digital transformation capabilities of the enterprise.

2.2 Evaluation Indicators of Digital Transformation of Logistics Enterprises

This paper constructs the evaluation indicator system of digital transformation level of logistics enterprises from four dimensions: digital logistics operation level, digital foundation, digital management and digital benefit, as shown in Table 1.

Digital Logistics Operation Level.

The level of digital logistics operation reflects the degree of economic penetration of digital technology. It is a significant manifestation of the digital economy, which can reflect the ability of logistics enterprises to use digital technology. This paper selects indicators from two aspects: technology application and technology integration. Indicators such as business data visualization rate, intelligent warehousing capability, precise distribution capability, cargo tracking rate, network management level, and logistics monitoring and optimization capabilities are used to indicate the level of digital logistics operations.

Digital Foundation.

Digital infrastructure is the primary condition for digital transformation and a prerequisite for the digital economy. Therefore, the consideration of digital foundation mainly selects indicators from two aspects: infrastructure and capital investment. This paper uses digital equipment coverage, data aggregation and application degree, logistics information platform construction, research and experimental development (R&D) investment intensity, and network security degree to express digital basic capabilities.

Digital Management.

Digital management is a necessary condition for digital transformation and an inevitable developing trend of enterprise digital transformation. Improving digital management can, therefore, effectively improve the overall work efficiency of enterprises, improve customer groups, reduce management costs, and improve market competitiveness. Digital management mainly selects indicators from two aspects: management system and management level, and this paper uses the degree of improvement and implementation of transformation plan, the degree of digital awareness of employees, the level of digital management system and the degree of digitalization of operation management to indicate digital management capabilities.

Digital Benefits.

Digital efficiency capability is the last link that determines whether the digital transformation of logistics enterprises can develop for a continuous time. This paper selects indicators from the two aspects of enterprise benefit and social benefit, and uses the main business income rate, cost profit margin, energy saving, green and other social benefits to express the digital benefit capability.

3 Digital Transformation Evaluation Method of Logistics Enterprises

At present, most of the evaluation methods such as analytic hierarchy, fuzzy comprehensive evaluation method, and TOPSIS are directly used in the evaluation level of enterprise digital transformation. There are problems, however, such as strong subjectivity and long inspection duration. Therefore, this paper proposes an evaluation method for the digital transformation of logistics enterprises based on quantum nomadic algorithm-analytic hierarchy method (QNA-AHP), introduces quantum concepts into nomadic algorithms

Table 1. Evaluation indicator system of digital transformation of logistics enterprises

Target layer	Criterion layer	Indicator layer
The level of digital transformation of logistics enterprises	The level of digital logistics operationsB1	Business data visualization rateB11
		Logistics monitoring and optimization capabilitiesB12
		Precision delivery capabilitiesB13
		Shipment tracking rateB14
		The degree of network managementB15
		Intelligent warehousing capabilitiesB16
	Digital foundationsB2	Construction of logistics information platformB21
		Data aggregation and application degreeB22
		Digital device coverageB23
		Research and Development input intensityB24
		Degree of network securityB25
	Digital managementB3	The level of digital management systemB31
		The extent to which the transformation plan has been improved and implementedB32
		The degree of digital awareness of employeesB33
		The degree of digitalization of operations managementB34
	Digital benefitsB4	Revenue rate of main businessB41
		Energy saving, green and other social benefitsB42
		Cost profit marginB43

to form quantum nomadic algorithms, and combines them with analytic hierarchy to optimize the weights, so as to achieve an objective evaluation of the digital transformation level of logistics enterprises.

3.1 Nomadic Algorithms

The migration of nomadic tribes could be seen as a process of research and optimization. The vast savannah is regarded as a research space, where the best places to live represent the best solutions. The herders and scouts were served by members of the tribe. The former is responsible for local mining, working and searching within a range around tribes; The latter is responsible for exploration and can quickly explore further areas. Based on the above description, nomadic tribes consist of pastoralist grazing, scout expeditions, and tribal renewal. The best solution at the moment is that tribes are always in the most habitable location found.

When nomadic algorithms are executed to the nth generation, the coordinates of the tribe are defined as d-dimensional vectors $X_n = \left\{x^1, x^2, \ldots, x^d\right\}$. Each of these elements indicates the variable to be optimized for the objective function. n is randomly generated when the algorithm is initialized and updated through iteration. Herders graze their cattle around the tribe. The grazing radius is calculated as follows

$$R_m = \begin{cases} X_a - X_b & m = 1or2 \\ R_{m-1} \times \gamma & f_{m-1} < f_{m-2} \\ R_{m-1} \times \varepsilon & f_{m-1} = f_{m-2} \end{cases} \tag{1}$$

R_m is the grazing radius when iterating on generation m. X_a and X_b represent the lower and upper bounds of the search space. γ is an amplification factor greater than 1, and ε is the reduction factor in the range (0,1). Values that are too large or too small can cause exponential fluctuations, destabilizing the search. Verified by experiments, finding $\gamma = 1.1$ and $\varepsilon = 0.9$ guarantees reliable efficiency for most problems. f_m represents the optimal value of the fitness value of the nomadic tribe's location at the m-generation iteration of m.

Equation (1) indicates that the initial value of the herdsman's grazing radius is the entire search space. In subsequent searches, if a better solution is found in the previous iteration, it means that this area has more potential, so the radius of activity is expanded. If the previous iteration did not reveal a better solution, the herders should reduce the range of activities to conduct a more refined search of smaller areas. This strategy makes the current search have a greater probability of finding a better solution.

The herders randomly search the surrounding area with the current tribal position X_n as the center and R_m as the radius, which ensures the local mining ability of the algorithm near the optimal solution, but does not ensure that the search is near the global optimal solution. Some locations seem to be better than the surrounding area, but are not the best in the entire search space, which is called the local optimal solution. To prevent nomadic tribes from being stuck in a local optimum, the algorithm sends scouts to explore a wider area. The search amplitude of the scout follows the Gaussian probability distribution $\mathrm{N}(X_{n-1}, {\sigma_m}^2)$ with X_{n-1} as the mean and σ_m as the standard deviation. The exploration amplitude at the m-generation iteration is calculated as follows:

$$\sigma(m) = \begin{cases} x_a - x_b & m = 1or2 \\ \sigma(m-1) \times 0.5 & f_{m-1} = f_{m-2} \\ x_a - x_b & f_{m-1} < f_{m-2} \end{cases} \tag{2}$$

This process can be thought of as Gaussian probability sampling, where the exploration amplitude σ_0 is set to the search space size when the algorithm starts. In subsequent iterations, if no better solution is found, the search amplitude is rapidly halved and decayed, while when a new optimal solution is found, the search amplitude returns directly to the initial range. Different from the fixed-range uniform random sampling used by herders' local search, this kind of Gaussian sampling has a higher probability search for the area near the optimal solution, and also effectively improves the probability of finding a new solution. At the same time, no matter how small the search amplitude is reduced, Gaussian sampling still has the probability of exploring anywhere in the entire space.

The proportion of these two search methods will determine the trade-off between local mining and global mining. Under a fixed population size, nomadic tribes should choose more scouts to explore to avoid local optimality. Instead, if they find a promising area, more pastoralists should be hired for local intensification. We hypothesized that nomadic tribes could learn useful information from their previous migrations to balance the ratio of herders and scouts. When the tribe falls into a local optimal after generation H, the formula for increasing the number of scouts in the next iteration with probability p is as follows.

$$P = 1 - exp\left(-\left(\frac{h}{\alpha M_{max}}\right)^2\right) \tag{3}$$

M_{max} is the maximum number of iterations, α is the sensitivity coefficient in the range (0,1) which is used to determine the rate of change of probability, where smaller values correspond to more drastic changes.

3.2 Quantum Nomadic Algorithm-Analytic Hierarchy Process

Quantum Nomadic Algorithm (QNA) is a probabilistic search optimization algorithm that introduces quantum concepts such as quantum states, quantum gates, quantum state characteristics, and probability amplitudes into nomadic algorithms.

In quantum nomadic algorithms, qubits are their smallest unit of information, and qubit states are represented by Eq. (4):

$$|\varphi = \alpha||0> + \beta|1> \tag{4}$$

where α and β represent the probability amplitude of the corresponding state of the qubit, respectively; $|\alpha|^2$ is the corresponding probability when the quantum state reaches the $|0\rangle$ state; $|\beta|^2$ is the probability that the quantum state reaches the $|1\rangle$ state, and the Eq. (5) is satisfied.:

$$|\alpha|^2 + |\beta|^2 = 1 \tag{5}$$

$$\left|\varphi >= cos\frac{\theta}{2}\right|0 > +e^{i\varphi}sin\frac{\theta}{2}\left|1 >\right. \tag{6}$$

Quantum nomadic algorithms use complex pairs to encode quantum information, and quantum chromosomes composed of m-group qubits can be represented as:

$$\begin{bmatrix} \alpha_1 \\ \beta_1 \end{bmatrix} \begin{vmatrix} \alpha_2 \\ \beta_2 \end{vmatrix} \begin{matrix} \cdots \\ \cdots \end{matrix} \begin{vmatrix} \alpha_m \\ \beta_m \end{vmatrix} \tag{7}$$

where $|\alpha_i|^2 + |\beta_i|^2 = 1(i = 1, 2, \cdots, m)$. The linear superposition of any quantum state can be represented by the encoding method of Eq. (7), and Eq. (8) indicates the corresponding quantum gate update process:

$$\begin{bmatrix} \alpha_i' \\ \beta_i' \end{bmatrix} = U(\theta_i)\begin{bmatrix} \alpha_i \\ \beta_i \end{bmatrix} = \begin{bmatrix} cos(\theta_i) & -sin(\theta_i) \\ sin(\theta_i) & cis(\theta_i) \end{bmatrix}\begin{bmatrix} \alpha_i \\ \beta_i \end{bmatrix}. \tag{8}$$

where $U(\theta_i) = \begin{bmatrix} cos(\theta_i) & -sin(\theta_i) \\ sin(\theta_i) & cis(\theta_i) \end{bmatrix}$ is the quantum revolving door, θ_i is the quantum rotation term angle, realized by the chromosome renewal process of the above nomadic algorithm, this paper combines the basic principles of analytic hierarchy to calculate the weight between the evaluation indicators of the criterion layer and the scheme layer, and when the consistency test is carried out, the quantum herd algorithm is introduced, which makes up for the shortcomings of the analytic hierarchy method, and the QNA-AHP method for evaluating the weight of the indicator is constructed in this paper, and the basic steps of its calculation are as follows:

Step 1: The digital evaluation indicators of logistics enterprises are selected and a ladder hierarchy is constructed: target layer, criterion layer and indicator layer.
Step 2: Based on the principle of analytic hierarchy, the upper and lower indicators are compared, the judgment matrix of each level is constructed, and the 1–9 scale is adopted to represent the elements in the judgment matrix.
Step 3: In this paper, the quantum nomadic algorithm is used to calculate the single sorting weight of each index by using the fitness function. Since the weights obtained by the traditional analytic hierarchy method after the correction of the judgment matrix are not necessarily the best weights, this paper introduces the quantum nomadic algorithm to search for the best weights by taking advantage of its fast and intelligent optimization. The judgment matrix is $\mathrm{W} = \{\mathrm{t_{pq}}\}_{\mathrm{o}\times\mathrm{o}}$, $\mathrm{p} = 1, 2, \ldots, \mathrm{n}$, t_{pq} indicates the importance of indicator p relative to indicator q within that level. Assuming that the single-sort weight of each indicator at the corresponding level is β_i, If W meets the following conditions: ① $\mathrm{t_{pq}} = \beta_p/\beta_q = 1$; ② $\mathrm{t}_{qp} = \beta_q/\beta_p = 1/t_{pq}$; ③ $t_{pq}t_{qk} = (\beta_p/\beta_q)(\beta_q/\beta_k) = \beta_p/\beta_k = t_{pk}$。Then there is the following relationship between $\mathrm{t_{pq}}$ and the weight β_i:

$$t_{pq} = \beta_p/\beta_q \tag{9}$$

where condition ③ is the consistency of the matrix, which is obtained from Eq. (9):

$$\sum\nolimits_{q=1}^{n} (t_{pq}\beta_q) = \sum\nolimits_{q=1}^{n} (\beta_p/\beta_q)\beta_q = n\beta_p \tag{10}$$

$$\sum\nolimits_{p=1}^{n} \left|\sum\nolimits_{q=1}^{n} (t_{pq}\beta_q) - n\beta_p\right| = 0 \tag{11}$$

If Eq. (9)~(11) is true, it means that the judgment matrix achieves the best consistency. Convert Eq. (11) as follows:

$$F_{CI} = min \sum\nolimits_{p=1}^{n} \left| \sum\nolimits_{q=1}^{n} \left(t_{pq}\beta_q\right) - n\beta_p \right| /n. \tag{12}$$

The constraint (13) is met

$$\beta_p > 0, \sum\nolimits_{p=1}^{n} \beta_p = 1, p = 1, 2, \cdots, n \tag{13}$$

where F_{CI} is the consistency indicator function. The nomadic algorithm is used to solve Eq. (12), β_i is used as the optimization variable, F_{CI} is the fitness function, and the nonlinear optimization problem is solved, so as to obtain the single ranking weight of each indicator. When the consistency indicator function is less than 0.1, the optimization is completed and the result is output, otherwise the next iteration is performed.

Step 4: The total sorting weight of the indicator is calculated. The ranking weight of each level indicator relative to the target layer indicator is calculated from the highest level to the lowest level, and the total ranking weight of the indicator can be obtained.

4 Empirical Research

Founded in 2005, Company A is a professional group company integrating logistics park operation, freight warehousing, logistics information platform, import and export trade service platform and port services. With the advent of the digital economy era, Company A has continuously accelerated the pace of corporate transformation due to the situation. The digital transformation has become an important support for the company's sustainable development.

Firstly, the "Questionnaire on the Digital Transformation Level of Logistics Enterprises" is designed according to the indicators of the digital transformation level evaluation system of logistics enterprises, and the senior managers of logistics enterprises A fill in the questionnaire according to the situation of the enterprise, and provide actual data for the quantitative indicators in the three levels, and provide reference values for the indicators that cannot be quantified; Secondly, logistics enterprise reform experts are invited to verify the filled in data through on-site research and in-depth interviews, and finally the expert group scores various indicators that cannot be quantified.

4.1 Calculation Process

Through the specific investigation of the enterprise, the discussion and analysis with a number of logistics enterprise reform experts, according to the experts' judgment of the importance of various evaluation factors and the comparison of the actual situation, the weight set of the corresponding indicators is established as follows:

$$W = (0.4776, 0.2078, 0.2284, 0.0863)$$
$$\theta_1 = (0.3507, 0.1764, 0.0655, 0.1421, 0.1338, 0.1314)$$
$$\theta_2 = (0.4154, 0.1173, 0.1084, 0.2638, 0.0951)$$
$$\theta_3 = (0.3600, 0.1201, 0.4542, 0.0657)$$
$$\theta_4 = (0.1167, 0.4465, 0.4368)$$

The weight vectors of each indicator in the indicator layer are calculated using the above QNA-AHP evaluation method as follows in Table 2.

Table 2. Evaluation index weight of logistics enterprises' digital transformation

Criterion layer		B1	B2	B3	B4	Weight
		0.4859	0.1793	0.2528	0.0819	
Indicator layer	B11	0.3769				0.1831
	B12	0.1613				0.0608
	B13	0.0199				0.0032
	B14	0.1390				0.0028
	B15	0.1465				0.0204
	B16	0.1564				0.0229
	B21		0.5136			0.0921
	B22		0.1055			0.0189
	B23		0.0743			0.0133
	B24		0.2840			0.0509
	B25		0.0225			0.0040
	B31			0.3674		0.0929
	B32			0.0966		0.0244
	B33			0.4835		0.1222
	B34			0.0525		0.0133
	B41				0.1148	0.0094
	B42				0.4436	0.0363
	B43				0.4416	0.0362

The expert group in the A logistics enterprise evaluates the indicators of the indicator layer according to the evaluation object, which obtains the fuzzy matrix as follows:

$$R_1 = \begin{bmatrix} 0.300.250.250.150.05 \\ 0.050.100.200.250.40 \\ 0.200.350.100.200.15 \\ 0.320.150.180.200.15 \\ 0.050.250.350.200.15 \\ 0.200.250.150.300.10 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.100.200.350.200.15 \\ 0.050.250.300.300.10 \\ 0.150.320.250.180.10 \\ 0.200.300.250.150.10 \\ 0.100.250.400.050.20 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 0.100.200.300.250.15 \\ 0.150.200.400.150.10 \\ 0.050.200.350.200.20 \\ 0.100.200.450.150.10 \end{bmatrix}$$

$$R_4 = \begin{bmatrix} 0.300.150.200.200.15 \\ 0.400.250.150.150.05 \\ 0.350.200.200.150.10 \end{bmatrix}$$

The criterion layer fuzzy evaluation result is:

$$B_1 = \theta_1 \cdot R_1 = (0.2080, 0.2139, 0.2282, 0.2049, 0.1448)$$
$$B_2 = \theta_2 \cdot R_2 = (0.1268, 0.2437, 0.3100, 0.1915, 0.1279)$$
$$B_3 = \theta_3 \cdot R_3 = (0.0807, 0.2000, 0.3417, 0.2109, 0.1667)$$
$$B_4 = \theta_4 \cdot R_4 = (0.3664, 0.2164, 0.1778, 0.1557, 0.0836)$$

The target layer fuzzy evaluation result is:

$$B = W \cdot R = (0.4879, 0.1793, 0.2528, 0.0819) \cdot \begin{bmatrix} 0.20280.21390.22820.20490.1448 \\ 0.12680.24370.31000.19150.1279 \\ 0.08070.20000.34170.21090.1667 \\ 0.36640.21640.17780.15570.0836 \end{bmatrix} = (0.1743, 0.2159, 0.2674, 0.1999, 0.1423)$$

According to the maximum subordination principle of fuzzy comprehensive evaluation, the evaluation level of the digital transformation degree of A logistics enterprise is determined to be v3, indicating that the degree of digital transformation is average. There is, therefore, still much room for improvement.

4.2 Experimental Analysis

The calculation results show that the investment in digitalization of logistics enterprises A has a certain degree of inclination in the process of transformation, but the degree of transformation is general. There are still certain problems in the process of digital transformation, and the main dimensions and weights of digital transformation level are digital logistics operation level (0.4859), digital foundation (0.1739), digital management (0.2528), and digital benefit (0.0819). It can be seen that the main efforts of digital transformation are concentrated on the level of logistics operations, indicating that A logistics enterprises are currently only stuck in the use of some Internet of Things technologies or intelligent logistics and other technologies, but have not really mined and used the data itself. In terms of digital management, enterprises should accelerate the cultivation of employees' digital awareness, digital management of enterprises is an important aspect of digital transformation, and the development and further improvement of other aspects need the support of digital management. In view of the short transformation time of enterprises, it is normal for digital benefits to account for a small proportion of the total, and its main focus should be targeted on reducing cost and profit margins.

From the interpretation level of the indicator layer, the business data visualization rate B11 (0.1831) and logistics monitoring and optimization ability B12 (0.0608) in the logistics operation level are the two indicators with the greatest impact on the logistics operation level. The business data visualization is relatively easy to achieve, but the data is used for data mining and analysis after data visualization. The data becomes real resources and even capital is the key, and the logistics monitoring and optimization ability is based on this indicator. In the digital foundation, logistics information platform construction B21 (0.0921) and R&D investment intensity B24 (0.0509) are the indicators that directly affect the digital foundation of enterprises. Enterprises build a suitable set of information systems, which can effectively help enterprises solve the current problems of low utilization of information resources, high human resources and information costs. The information system can promote enterprise business process reengineering which also help enterprise decision-makers make better decisions. A large amount of R&D capital can accelerate the digital transformation process of enterprises.

Digital management, Employee digital awareness B33 (0.1222) and digital management system level B31 (0.0929) are two important indicators of enterprise digital transformation management. In the process of enterprise transformation of employees themselves cognitive change is the first step. Employees have a keen insight into digital trends and industry development, having a certain perception of cutting-edge technology can help enterprises combine the actual situation to develop a good development strategy and make it land; the level of digital management system not only refers to the digitalization of management links, but also the use of enterprise information platform and data to promote data integration in all links, visualization and intelligent analysis. Therefore, enterprises can achieve a target which accurately controls logistics process. Enterprises can achieve efficient management, and the macro strategy of enterprises could be adjusted effectively. Among the digital benefits, social benefits B42 (0.0363) and cost profit margin B43 (0.0362) are more significant indicators of the digital transformation level of enterprises The cost profit margin level determines the future development of enterprises, and for an enterprise, the increase of social benefits will also promote its future development, hence, social benefits and social benefits are indispensable for enterprises.

5 Conclusion

The digital transformation of logistics enterprises is a key factor to effectively promote the deep integration of digital economy and logistics industry. Effectively identifying and evaluating the degree of digital transformation will help logistics enterprises to grasp the process and results of digital transformation and upgrading. In this paper, QNA-AHP evaluation method is proposed. The quantum concept is introduced into the nomadic algorithm, and the analytic hierarchy method is optimized. The digital transformation level of logistics enterprises A is identified and evaluated through the digital transformation level evaluation indicator of logistics enterprises. Targeted countermeasures and suggestions are put forward based on the results. The specific conclusions are as follows:

(1) The digital transformation level of logistics enterprises is a comprehensive representation formed by the synergy of the four dimensions of digital logistics operation level, digital foundation, digital management and digital benefits in the process of digital transformation of logistics enterprises. This synergistic process highlights the criteria for the value judgment and decision-making of the environment and the future of the logistics company entity or manager.
(2) Enterprises should strengthen the application of digital technology in the level of logistics operations. According to its own business and future development, it is vital that logistics enterprises are supposed to improve the logistics information platform as soon as possible and achieve full coverage of business. Meanwhile, it should strengthen the mining of logistics data, and intelligently apply data as a logistics element.
(3) Enterprises should increase the construction of employees' digital awareness. On the one hand, employees have the advantage of in-depth understanding of their own business, and the construction of enterprise digital organizational structure and talent system have been promoted. On the other hand, enhancing the introduction of digital-related talents is significant. Besides, special digital talent performance pay system and other relevant institutional norms are supposed to be established.

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Cai Jinbo:Constructing an idea or hypothesis for research;

Planning methodology to reach the conclusion;

Taking responsibility in writing and modifying essay draft;

Taking responsibility in logical interpretation and presentation of the results;

Hao Bolun: Translating thesis and reviewing the article before submission not only for spelling and grammar but also for its intellectual content.

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