

Research Article

The Performance Evaluation of Logistics Enterprises in Online Supply Chain Finance Based on Analytic Hierarchy Process

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With the accelerated pace of e-commerce, online supply chain finance (SCF) led by logistics enterprises (LE) has attracted increasing attention. On the basis of introducing the related concepts of online SCF dominated by LE, this paper constructs the performance evaluation index system of LE by integrating the balanced scorecard model. Then, we use the analytic hierarchy process (AHP) to evaluate the performance of LE and take company A as an example to calculate the total score of performance in the past seven years. Finally, according to the research results, we give some suggestions to optimize the performance of LE. The research results are conducive to promoting the online SCF model in reality.

1. Introduction

SCF appears when the financial industry enters the field of logistics and supply chain, that is, it is a more advanced form of the combination of logistics and finance after the logistics industry develops to the supply chain stage [1]. SCF is the result of the combination of logistics industry, financial industry, and supply chain management mode. It enables different organizations and related enterprises in the supply chain to jointly create value by planning, directing, and controlling the flow of funds and information between each other [2]. Online SCF is the development of SCF combining Internet technology and e-commerce, and it is also the result of breaking through traditional models and actively carrying out innovation in supply chain financial services [3]. As a new type of the SCF model, online SCF has the functions of risk shielding, double reviewing, and credit bundling and, at the same time, can improve social and economic benefits, so it has a lot of room for development [4–6]. Looking at the dominant player in online SCF, it can be either a bank, a core enterprise in the supply chain, a logistics enterprise, or a third-party trading platform. However, no matter who is in charge,

logistics companies are in the middle of communicating with all related parties [7–9]. As the intermediary connecting buyers and sellers and financial institutions in the supply chain, the status of LE in SCF cannot be underestimated [10].

With the acceleration of e-commerce, many logistics companies are actively developing online SCF services [11]. On the one hand, logistics companies seek new profit growth points and business models [12]. Since the logistics enterprise itself is an industry with a low threshold, they can enter with a certain financial strength. At present, the logistics industry generally has problems such as backward management methods, weak funds, and low utilization of advanced technology [13–15]. In this context, the online SCF services of LE have added new business models, which are conducive to enhancing their competitiveness [16]. On the other hand, LE participating in SCF can have a good grasp of logistics, capital flow, and information flow, which can greatly increase their own attractiveness, thus prompting more enterprises to cooperate with them [17–19]. In a word, LE hope to promote the value added of their own value chain by providing online SCF services and deepening cooperation with various enterprises in the supply chain [20].

Therefore, evaluating the performance of LE in online SCF has important theoretical and practical significance. However, previous studies have mainly focused on bank-led online SCF. Although the pace of e-commerce of LE is accelerating, there are few studies on online SCF dominated by LE. It is urgent to measure the performance of LE in online SCF. Therefore, this paper takes the online SCF dominated by LE as the starting point, selects performance evaluation indicators, and provides a performance evaluation method, in order to provide help for the widespread application of the online SCF model in real life in the future. The specific research ideas of the article are shown in Figure 1.

This paper is divided into six sections in total; the specific contents are as follows. Section 1 introduces the research background and significance of LE performance evaluation in online SCF. Section 2 introduces the research content of related literature. According to the principle of establishing performance evaluation index, Section 3 constructs the performance evaluation index system of LE with the support of concepts and theories. The Section 4 takes the LE company A as an example, using AHP to calculate its performance in the past seven years and analyze its performance evaluation results. Section 5 puts forward relevant countermeasures and suggestions to optimize the performance of LE and summarizes the conclusions of the article.

2. Related Work

At present, there are many related research studies on SCF, such as the application model of SCF, participants, risks, and preventive measures [21–23]. Wang and Wang [24] took the confirmed warehouse financing model in various models of SCF as an example and studied the financing risk in this model. And from the perspective of third-party logistics companies, they used the back propagation (BP) neural network model to analyze and measure the risk of the confirmed warehouse financing model. In order to study the impact of SCF on the financing of small- and medium-sized enterprises (SMEs), Lu et al. [25] used the questionnaire survey method to collect the financial data of SMEs and used multiple regression analysis and fuzzy set qualitative comparative analysis to study the information sharing ability and innovation ability of the supply chain network. The research results showed that the two capabilities of the supply chain network play an intermediary role in the financing process of SMEs, and they jointly affect the performance results.

Regarding the performance evaluation of LE, different scholars have carried out a lot of research studies from different perspectives. However, few literature evaluate the performance of LE based on the online SCF model. Therefore, this paper tries to seek an innovation based on the previous research results and forms an evaluation system of logistics enterprise performance management under the background of SCF. This will help bring new prompts to the improvement of the comprehensive competitiveness of LE and guide the main body of the supply chain to actively carry out the SCF business to achieve a situation where both are progressing together. In order to improve the operation and

management capabilities of LE, Yang [26] constructed a comprehensive evaluation model of LE competitiveness based on the SEM model. And the author used machine learning technology to analyze and evaluate it. Similarly, Cui [27] also used machine learning algorithms to evaluate the performance of LE. However, the difference is that this paper introduced the theory of the balanced scorecard (BSC) into the construction of the performance evaluation index system of LE and used various data analysis models such as the data envelopment analysis model, Malmquist index model, and Tobit regression model to evaluate the performance of LE. In addition, the paper also used the network SBM model to conduct a longitudinal comparative analysis of LE in different stages and industries and verified the validity of the model through example analysis.

3. Performance Evaluation Index System of Logistics Enterprise

3.1. Basic Principles and Ideas of Index System Construction. In order to improve the operation and management of LE, BSC can be used to construct the performance evaluation index system [28]. In terms of index selection, since LE adopting the online SCF model is self-paying in business development, they not only need to complete the selection of financial indicators but also select debt indicators from settlement, payment, and other aspects. And the performance of logistics companies in the supply chain will have an impact on upstream and downstream companies, so it is necessary to select nonfinancial indicators in three aspects: customers, internal processes, and learning and growth. In addition, some basic principles should be followed when constructing the index system of LE, as shown in Figure 2.

3.2. Construction of Performance Evaluation Index System of LE. According to the above ideas, the performance indicators of LE are selected, and the indicator system shown in Figure 3 can be obtained. And the specific indicators are explained as follows.

Financial indicators are the most important indicators to measure the performance of enterprises, which mainly reflect the capital operation ability and future development potential of enterprises. Its secondary indicators mainly include four aspects: profitability, development potential, operational efficiency, and debt paying ability. The profitability indicator mainly emphasizes the company's surplus cash guarantee multiple. The indicators of development potential mainly refer to the sales growth rate and economic value-added rate of the enterprise. Operational efficiency indicators mainly refer to maintaining a high inventory turnover rate and account receivable turnover rate, cash recovery rate, and current asset turnover rate in corporate cash flow management. The debt paying ability index is mainly reflected in two aspects of the company's cash flow-liability ratio and interest coverage ratio.

As a very important service business, online SCF, its service ability and service level to customers is another very important criterion to measure the performance of supply

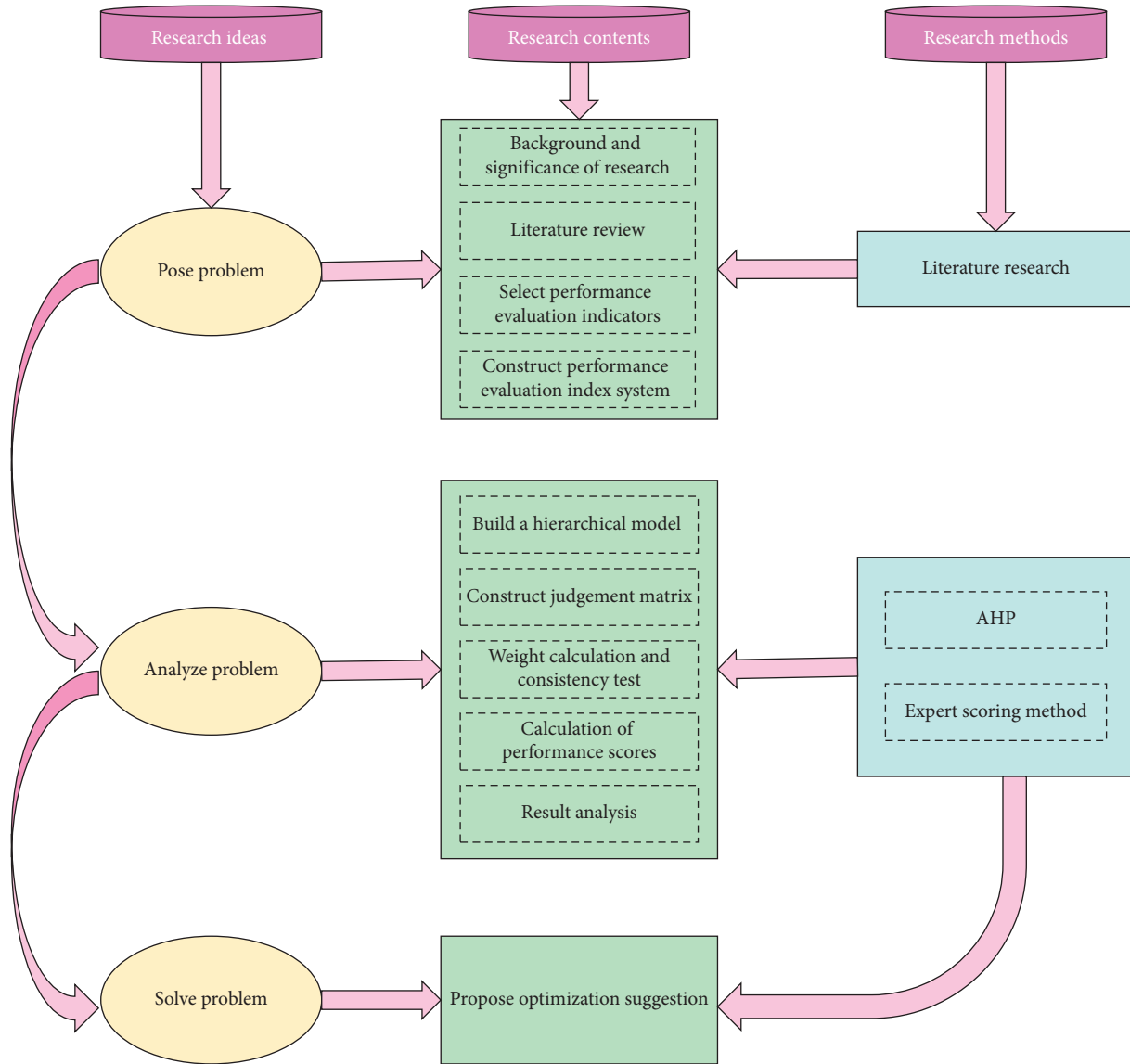


FIGURE 1: Research idea map.

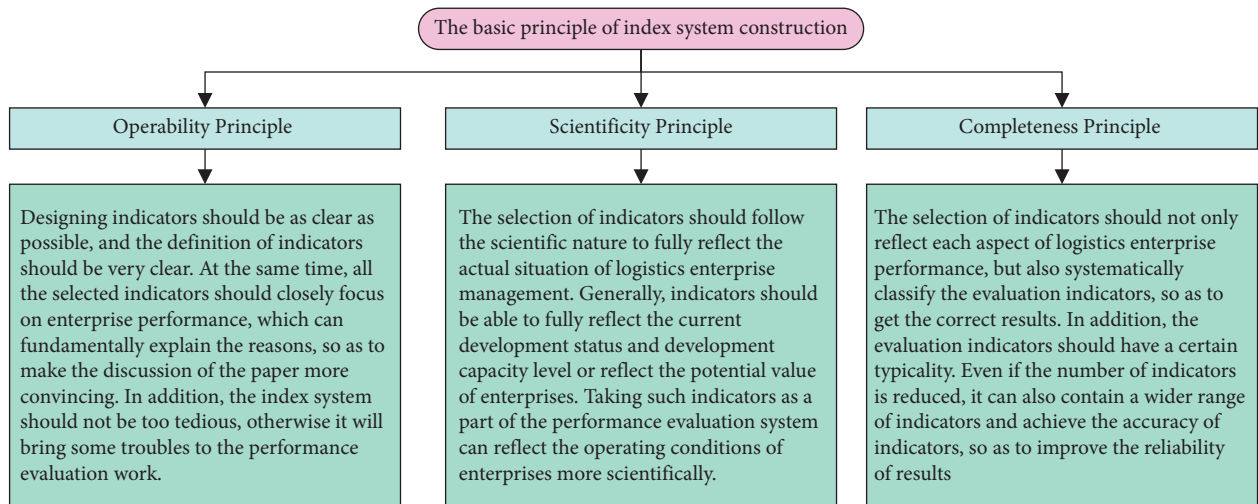


FIGURE 2: The basic principles of index system construction.

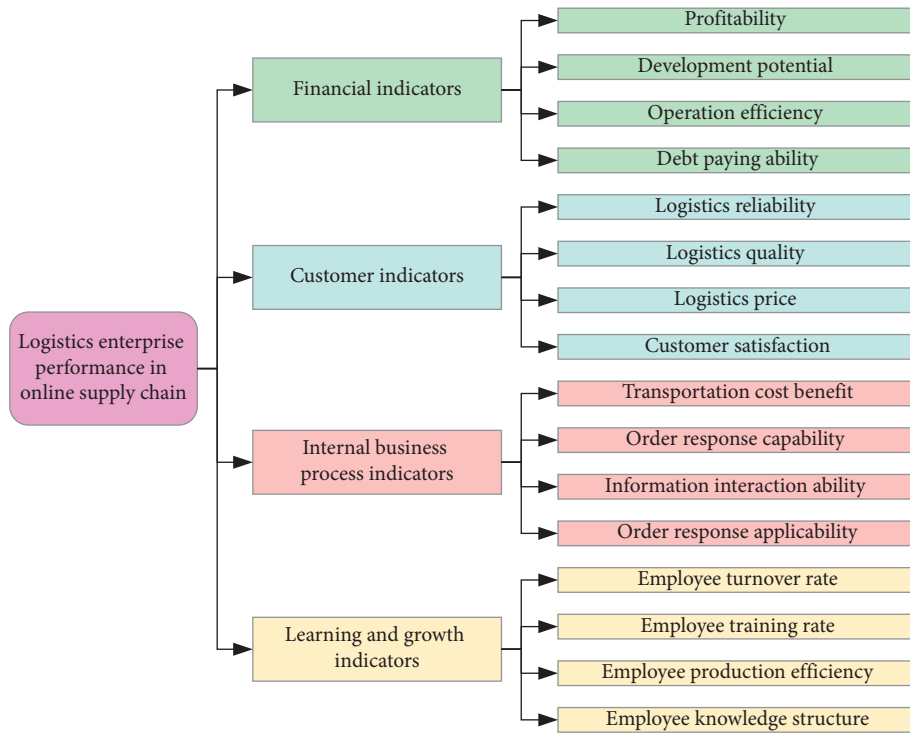


FIGURE 3: Performance evaluation index system of LE.

chain node LE. Customer indicators mainly include four secondary indicators of logistics reliability, logistics quality, logistics price, and customer satisfaction. The logistics reliability index is mainly reflected in the on-time delivery rate of LE in the process of serving customers. The connotation of the logistics quality index requires that the items are not damaged in the process of transporting items. The logistics price index mainly requires that the pricing level of logistics transportation must have a certain advantage compared with other LE in the market. This factor is now also regarded as an important means for LE to obtain competitive advantages. Customer satisfaction refers to the degree of customer satisfaction with the service quality and service attitude of the logistics enterprise in the process of serving customers.

Internal business process indicators mainly reflect the business capabilities of LE in the application of online SCF models and can be regarded as the basic core indicators to measure enterprise performance. The internal business process is evaluated from the four aspects of transportation economy, reliability, information, and applicability. The specific indicators are transportation cost benefit, order response capability, information interaction ability, and order response applicability. Among them, the transportation cost benefit index represents the economy of the logistics enterprise transporting goods and refers to the proportion of the profit in the transportation cost. Order response capability refers to the reliability of LE to complete orders. Information interaction ability mainly refers to the information communication ability between LE and other enterprises and customers in the supply chain financial business. The order response applicability index is to

evaluate the applicability by using the prediction accuracy and risk management ability.

Employees are the biggest production power and driving element of LE. The development potential of an enterprise is determined by factors such as employees' learning and training, quality, and work attitude. By building a team of logistics talents, enterprises can ensure the sustainable development of enterprises. The employee turnover rate indicator reflects employee satisfaction with the company. Satisfying employees can bring greater profitability to the development of the enterprise. The employee training rate indicator refers to the rate, at which the company provides training opportunities for employees and reflects the growth of employees. The employee production efficiency indicator refers to the average income of employees and the increase in the value created by employees in a unit time. It mainly reflects the working status of the employees of the enterprise. Employee knowledge structure indicator represents the level of education employees receive and, at the same time, reflects the overall quality and ability of the enterprise.

4. Case Analysis

4.1. The Concept and Characteristics of AHP. The evaluation system established in this paper contains not only qualitative indicators but also quantitative indicators. Therefore, combined with the structure of the index system, this paper adopts the AHP to achieve a reasonable evaluation of the performance of LE. AHP is based on the experience of decision makers to score, so as to achieve quantitative analysis of indicators [29]. Using this

method, some more complex problems can be decomposed into several levels and several factors according to a certain logic, so it is suitable for multicriteria and multilevel complex decision-making problems. The senior management personnel of the enterprise, industry experts, and scholars will also carry out unified scoring, determine the weight of each indicator, complete the consistency test, and then obtain the scientific evaluation results of SCF business performance [30].

4.2. Weight Determination of Performance Evaluation Index in Company A. This paper takes a Chinese logistics enterprise-company A as an example and uses the AHP to determine the weight of its performance evaluation indicators. The specific calculation steps are as follows.

4.2.1. Build a Hierarchical Model. We build a hierarchical structure model based on the performance evaluation index system of LE established, as shown in Figure 4.

4.2.2. Construct Judgment Matrix. In order to construct a reasonable judgment matrix, this paper invited 6 experts to score the performance evaluation indicators of LE. The experts we invite include senior managers of LE and elite talents from various departments, as well as experts and scholars in the logistics industry. And experts score it according to the 1–5 scale method, and the specific assignment meaning is shown in Figure 5. Experts form the judgment matrix E by comparing the relative importance of each factor pairwise.

4.2.3. Calculate the Indicator Weight Value and Do the Consistency Check. Since we score elements through subjective judgment, there may be unreasonable phenomena in element scoring and assigning weight values. Therefore, we must check the consistency of the selected matrix to satisfy the rationality of data processing. By consulting the literature, we choose the most commonly used sum-product method to check the consistency of the matrix.

To sum up, we use AHP to determine the process of LE performance evaluation index weight, as shown in Figure 6. And the value of RI is determined according to Figure 7.

Experts are worth judging the relative importance of each index according to the scale of importance judgment. We compare the factors of the criterion layer and the scheme layer to get the judgment matrix as follows. Among them, A refers to the criterion-level judgment matrix, and B₁, B₂, B₃, and B₄ refer to the scheme-level judgment matrix. It can be seen that these judgment matrices pass the consistency test, indicating that the weights calculated by us are effective. And the weight results of the performance evaluation index of company A are shown in Table 1.

$$A = \begin{bmatrix} 1 & 1/2 & 2 & 3 \\ 2 & 1 & 3 & 4 \\ 1/2 & 1/3 & 1 & 2 \\ 1/3 & 1/4 & 1/2 & 1 \end{bmatrix},$$

$$\lambda_{\max} = 4.051, CI = 0.017, CR = 0.019,$$

$$B_1 = \begin{bmatrix} 1 & 4 & 2 & 2 \\ 1/4 & 1 & 1/3 & 1/2 \\ 1/2 & 3 & 1 & 2 \\ 1/2 & 2 & 1/2 & 1 \end{bmatrix},$$

$$\lambda_{\max} = 4.074, CI = 0.025, CR = 0.028,$$

$$B_2 = \begin{bmatrix} 1 & 2 & 2 & 1/2 \\ 1/2 & 1 & 2 & 1/3 \\ 1/2 & 1/2 & 1 & 1/3 \\ 2 & 3 & 3 & 1 \end{bmatrix},$$

(1)

$$\lambda_{\max} = 4.106, CI = 0.035, CR = 0.039,$$

$$B_3 = \begin{bmatrix} 1 & 2 & 3 & 3 \\ 1/2 & 1 & 2 & 3 \\ 1/3 & 1/2 & 1 & 2 \\ 1/3 & 1/3 & 1/2 & 1 \end{bmatrix},$$

$$\lambda_{\max} = 4.112, CI = 0.037, CR = 0.041,$$

$$B_4 = \begin{bmatrix} 1 & 2 & 1/2 & 4 \\ 1/2 & 1 & 1/3 & 2 \\ 2 & 3 & 1 & 5 \\ 1/4 & 1/2 & 1/5 & 1 \end{bmatrix},$$

$$\lambda_{\max} = 4.040, CI = 0.013, CR = 0.015.$$

Then, we sort the final weights of the scheme layer indicators to get the total sorted weights graph shown in Figure 8.

4.3. Performance Evaluation of Company A. We select different types of indicators to evaluate the performance of company A, but different types of indicators cannot be directly used to evaluate. Therefore, we first make dimensionless treatment on the evaluation index so that the index is transformed into the same dimensionless relative index expressed by percentage as the weight. The dimensionless processing is to set the maximum value of each indicator in each year to 100 points, then divide the actual value of each indicator value by the maximum value, and finally multiply by 100. Then, the scores of all indicators are comprehensively weighted to form the final score of each indicator, and finally, the weighted scores of all indicators are added to obtain the final score of the comprehensive performance evaluation of company A. This paper analyzes the data of company A from 2015 to 2021, and the selected indicators are the 16 indicators in the performance evaluation index system of LE. And the

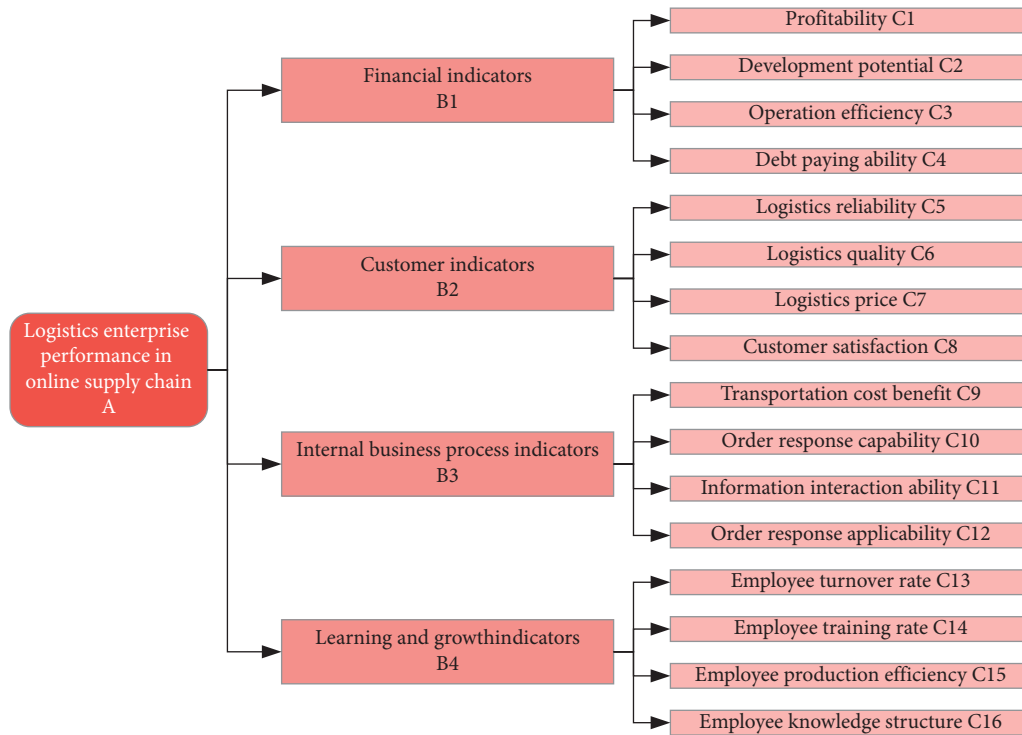


FIGURE 4: Hierarchical model.

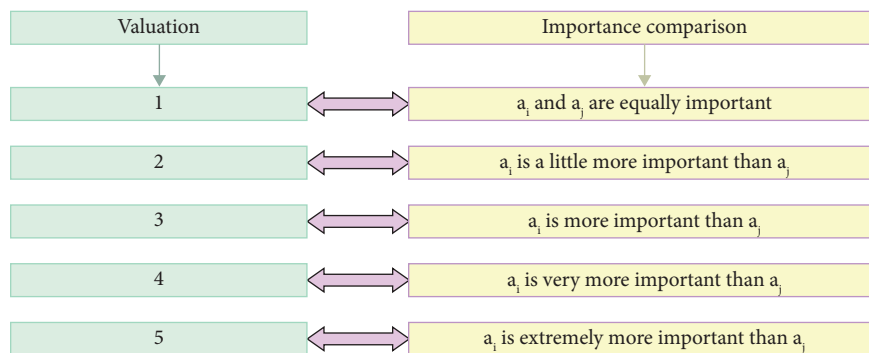


FIGURE 5: The assignment meaning of the 1-5 scale method.

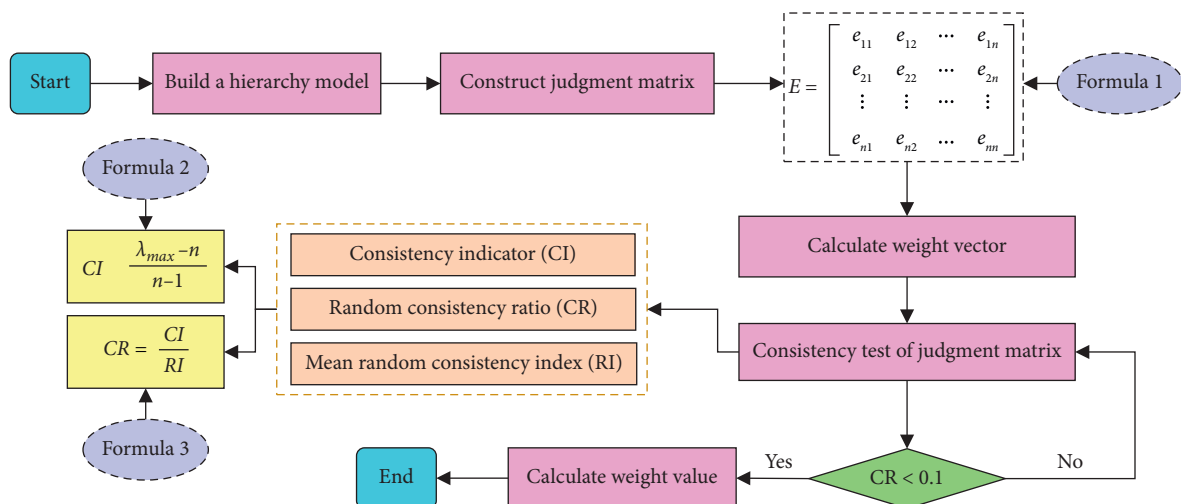


FIGURE 6: The process for determining the weight of performance evaluation indicators of logistics enterprise.

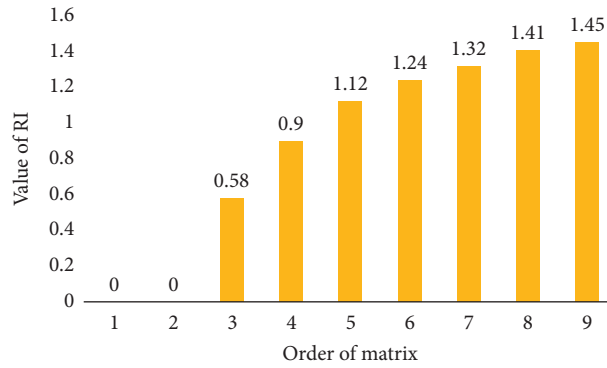


FIGURE 7: The value of RI.

TABLE 1: Weights of performance evaluation indicators for company A.

Criterion layer	Weight	Schematic layer	Weight	Ultimate weight
B1	0.290	C1	0.417	0.121
		C2	0.097	0.028
		C3	0.301	0.087
		C4	0.185	0.054
B2	0.446	C5	0.266	0.119
		C6	0.185	0.083
		C7	0.113	0.050
		C8	0.435	0.194
B3	0.171	C9	0.419	0.072
		C10	0.302	0.052
		C11	0.178	0.030
		C12	0.101	0.017
B4	0.093	C13	0.309	0.029
		C14	0.158	0.015
		C15	0.453	0.042
		C16	0.080	0.007

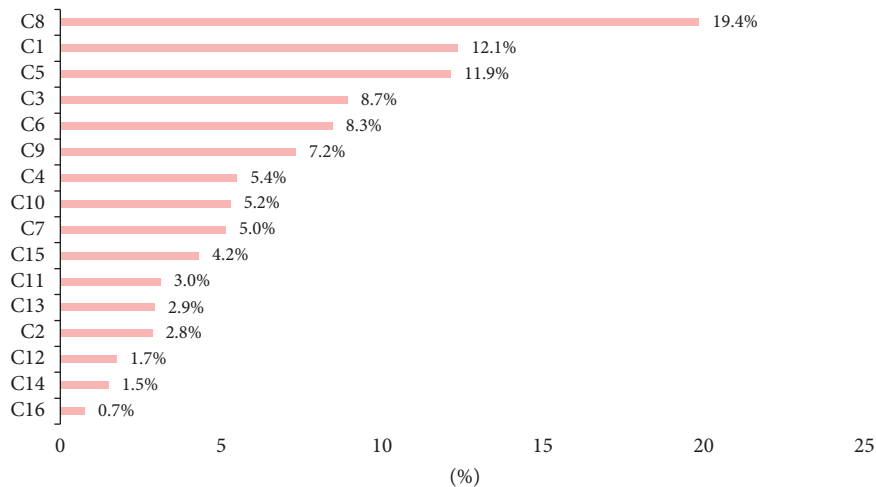


FIGURE 8: Total ranking of performance evaluation index weights of LE.

total performance score of company A in the past seven years is shown in Figure 9.

$$R = C_1 \times W_1 + C_2 \times W_2 + \dots + C_{16} \times W_{16}. \quad (2)$$

4.4. Analysis of Performance Evaluation Results. As can be seen from Table 1, the sum of the weights of financial indicators and customer indicators in the standard-level indicators is 73.6%, while the sum of the weights of the other

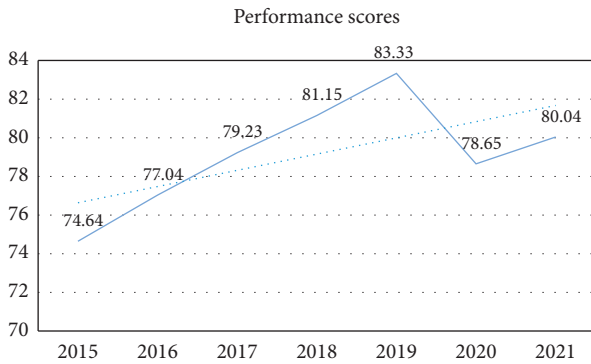


FIGURE 9: The total performance score of company A in the past seven years.

two indicators is only 26.4%. It shows that when evaluating the performance of LE, financial indicators and customer indicators are more important, followed by internal business process indicators, while learning and growth indicators are not the key factors compared with other indicators. Because of the fierce competition in today's market environment, good financial performance is one of the foundations of a company's long-term development, but that does not mean companies can focus less on learning and growth.

As can be seen from Figure 8, among the scheme-level indicators for evaluating the performance of LE, the highest weight is customer satisfaction, followed by profitability and logistics reliability. The weights of these three indicators all exceed 10%. However, the weight of employee knowledge structure is the lowest, only 0.007. In addition, the influence of employee training rate and order response applicability in evaluating the performance of LE is also relatively weak, with a weight of 1.5% and 1.7%, respectively. It shows that when evaluating the performance level of LE, enterprises should pay more attention to customer satisfaction and improve customer satisfaction with logistics transportation efficiency and service attitude. However, there is no need to invest too much energy in cultivating employee knowledge structure, increasing employee training rate and improving order response applicability.

Overall, we can find that the performance of company A declined in 2020, and the performance level increased in 2021. The performance score was the highest in 2019, decreased slightly in 2020, and gradually increased in 2021. And the trend line in the figure shows that the overall performance of company A shows a trend of continuous growth, indicating that the company's performance level is in a stage of steady development.

5. Conclusions and Suggestions

In the actual implementation of the online SCF model, LE should strengthen the establishment of performance index system in order to achieve a scientific evaluation of the changes in corporate performance. Only by timely finding the problems existing in enterprises can we take effective measures to promote the further development of enterprises. This paper first sorts out the related research on SCF and

online SCF and also discusses the causes and significance of the implementation of online SCF model in LE. Then, we sort out the LE performance evaluation system related research and find that most of the research is the use of BSC evaluation of logistics enterprise performance. We build a set of LE performance evaluation system by analyzing the related theory and logistics enterprise online SCF model. Finally, we use AHP to calculate the weight of logistics enterprise performance indicators and obtain the total score of company A in the past seven years. According to the results of performance evaluation, we put forward the following suggestions to optimize the performance of LE.

5.1. Meet Customer Needs and Improve Customer Satisfaction.

LE should always put the interests of customers first when applying the online SCF model. At present, the vast majority of supply chains in society are basically "pull" supply chains. Meeting customer needs is a prerequisite for the survival and development of the supply chain, and it is also the fundamental value of the supply chain. Among the needs of customers, the two most valued indicators of customers are product quality and product price, corresponding to LE, namely, logistics quality and logistics price. Especially in today's rapid development of information and network, the scope of customer choice has been infinitely enlarged. So, how to retain old customers and develop new customers? The key is to develop appropriate logistics pricing strategy and improve logistics quality.

5.2. Improve the Business Ability of Employees.

The working ability of employees in the SCF business should be improved. SCF services provided by logistics companies can help SMEs establish credit mechanisms and can also help banks achieve business expansion. As a new model, SCF has not been popularized in all walks of life. Whether LE can adapt to and skillfully apply this model as soon as possible and achieve first-come-first is the main way to improve their attractiveness and status. Therefore, LE must be widely launched and deeply tap the potential of employees so that they are familiar with and skilled in the operation of SCF as soon as possible. This can continuously improve their status and seek more cooperation, so as to achieve sustainable development.

5.3. Improve Operational Efficiency.

Logistics companies must continuously improve operational efficiency. In the logistics enterprise performance evaluation index system of the SCF model, the financial indicators are the most direct reflection of the business performance level of the enterprise, and among all the financial indicators, the enterprise operation efficiency is the most decisive index. After a logistics enterprise obtains working capital through the supply chain financial model, maximizing capital value has become the primary goal of the enterprise. Therefore, LE must do a good job of financial budgets and final accounts and maintain the smooth operation of the capital chain while ensuring the

normal operation of the main business, so as to effectively avoid the occurrence of the breakage of the capital chain.

Future research can be carried out from the following perspectives. On the one hand, whether the performance of online SCF led by LE is better than that of online SCF led by banks and how LE can play their own advantages? On the other hand, what new risks and challenges will LE face in online SCF and how LE can prevent risks and meet challenges?

Data Availability

The data used to support the findings of this study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest or personal relationships that could have appeared to influence the work reported in this paper.

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