Research on Supplier Evaluation of Chain Restaurant Companies Based on Analytic Hierarchy Process

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Abstract. Reasonable selection of suppliers is of great significance to the long-term development of chain restaurant companies, and high-quality suppliers help chain restaurant companies to reduce cost expenditures, improve comprehensive profitability, and then take the advantage in the market competition. This paper takes chain restaurant company C as a case study, and combines Dickson's supplier selection criteria to determine the supplier evaluation index of chain restaurant company. The judgment matrix is constructed using hierarchical analysis, and the maximum eigenvalue as well as the confidence interval are calculated. Under the condition of ensuring the validity of the conclusions, the indexes are ranked according to the importance of their weights, and finally, through the comparison between the current scheme and the analysis conclusions, we put forward rationalization suggestions for the chain restaurant company to optimize the supplier selection of the chain restaurant company.

Keywords: supplier evaluation, hierarchical analysis, supplier selection

1 INTRODUCTION

Supplier evaluation and selection is a pivotal issue in supply chain management, and choosing the right supplier can reduce procurement expenditure and avoid financial risks.

Liou James J.H., Chang Mu Hsin, Lo Huai Wei, Hsu Min Hsi take multinational electronics manufacturers as an example, and establish a new hybrid model by streamlining the core criteria, which is used to determine the green supplier prioritization and selecting the most appropriate green suppliers [1].R. Krishankumar, Karthik Arun, Arun Kumar, Pratibha Rani, K. S. Ravichandran, Amir H. Gandomi ensure that green suppliers can be selected in a stable interval by fixing decision matrix inconsistency, building a new numerical model, and ensuring that the stabilization interval can differentiate green suppliers [2]. By analyzing the procurement process of hospitals, Li Siyuan and Wang Min summarized the methods to solve the problems that may arise during supplier evaluation and emphasized the promotion of supplier evaluation for integrity from different perspectives [3]. Deng Chenghao analyzed the shortcomings of supplier evaluation in railroad construction and designed a model more suitable for evaluating suppliers of large and medium-sized railroad construction projects by using

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intuitionistic fuzzy theory on the basis of the original [4]. Citing examples, Li Feifei used Delphi method, hierarchical analysis method, fuzzy comprehensive evaluation method and other methods to study the social responsibility indicators in supplier evaluation, emphasizing the importance of social responsibility in business operations [5]. Gao Xiangyu carried out a detailed study by conducting a seminar on the setting of supplier performance evaluation indicators and evaluation methods [6]. Yang Fengling et al. concluded that the supplier evaluation of aviation manufacturing enterprises has deficiencies in several aspects, and the improvement of evaluation accurate results should start from optimizing the evaluation model and establishing the supplier evaluation information system [7]. Zhao Shuangjun et al. made reference to the reasonable selection of green suppliers for textile enterprises by constructing a green supplier evaluation index system for textile enterprises and determining the weights of the indexes based on the hierarchical analysis method [8]. In the new energy industry, Duan Rangda et al. combined with examples, used the hierarchical analysis method to calculate the evaluation indexes of wind power generation products, established a set of system for supplier selection of wind power generation enterprises and provided a reference program for supplier selection [9]. Jiang Yan designed and constructed evaluation indexes for hazardous chemicals through hierarchical analysis, which was used to analyze the differences between different suppliers, thus providing sufficient experience for selecting product suppliers in the chemical industry [10].

To summarize, the above scholars have studied supplier evaluation options from different perspectives. Based on the traditional supply and demand model, the domestic supplier evaluation indexes are not well combined with the background information such as market price fluctuation, and lack of market relevance. As a mature and reliable research method, hierarchical analysis is widely used in supplier evaluation and selection, which takes into account the scientific nature of the evaluation method and makes the data obtained quantitatively measurable. Therefore, this paper uses hierarchical analysis as the main research method to optimize the supplier selection of chain restaurant companies.

2 CONSTRUCTION OF CASE EVALUATION INDICATORS

As a large-scale chain restaurant company, Company C has more than 400 directly-managed chain stores and 7,000 employees, and its supply program is "food wholesaler - professional distribution center - chain restaurant outlets "[11]. Currently with a transportation and distribution services to improve the cooperation of agricultural technology companies, the agricultural technology company has a school restaurant, restaurant chains and unit canteens and many other cooperation objects, through cleaning and disinfection, refrigerated storage, turnover and transportation to the chain of food company stores to provide fresh ingredients. company C plans to choose from three suppliers to cooperate with another, change the situation of the single-supplier supply.

Supplier A has been engaged in the distribution of food ingredients for many years and has rich experience in the market. Supplier A has been engaged in food material delivery for many years and has rich experience in the market. It is better than Supplier

B and Supplier C in terms of service level, and has accumulated a certain reputation by launching the "vegetable package" service to consumers during the special period; Supplier B is a food material production base that takes the initiative to seek cooperation. Supplier B is a food ingredient production base that actively seeks cooperation. It owns large-scale land and is able to provide food ingredients at different times of the year, and its biggest advantage is the lowest price quotation, but it has no other advantages; Supplier C is an import and export food ingredient trading company. It has obtained food certifications from many foreign countries, and the quality of its ingredients, its ability to supply, and its reputation are better than the other two suppliers, but the price of its ingredients and the level of service are slightly lower than those of the other two suppliers.

Constructing the supplier evaluation index model of chain restaurant company should not only reflect the rigor and scientific nature, but also fit the reality. Therefore, this paper refers to the supplier selection criteria proposed by Dickson in 1966 [12].Dickson believes that among the 23 supplier evaluation indexes, quality is in the most important position, and seven indexes, such as delivery time, historical benefits, guarantee, production capacity, price, technical ability, financial status, etc., also occupy an important position. They are shown in Table 1.

Table 1. Dickson's vendor evaluation metrics

Vendor evaluation indicators	Degree of importance
Mass (in physics)	Extremely important
Delivery period	Quite important
Historical benefits	Quite important
Warranties	Quite important
Production capacity	Quite important
Prices	Quite important
Technical capability	Quite important
Financial position	Quite important
Maintenance service	General importance
Operational control	General importance
Posture	General importance
Visualization	General importance
Packaging capacity	General importance
Labor relations records	General importance
Geographic location	General importance
Cultivate	General importance
Past business volume	General importance
Traffic arrangements	Slightly important

To synthesize the above aspects, in order to take into account the practicality and scientificity, control the volume of data, and combine the requirements of ISO9000 quality management system, as well as the experience of stores and consumer suggestions, this paper finally selects the five evaluation indexes of ingredient quality, ingredient price, supply ability, service level, and credibility as the first-level evaluation

indexes. Selecting the traceability of the origin of the ingredients, safety testing of the ingredients, preservation of freshness during transportation, the offer of the ingredients, price changes, lower than the market price guarantee, the type of ingredients, storage environment, ordering channels, distribution level, return and exchange of goods guarantee, emergency program, access to honors, social responsibility, green and low-carbon as the second level evaluation indicators. They are shown in table 2.

Table 2. Hierarchy of Evaluation Indicators for Ingredient Suppliers

First level indicators	Second level indicators
Ingredient quality	The traceability of the origin of the ingredients
	Safety testing of the ingredients
	Preservation of freshness during transportation
Ingredient price	The offer of the ingredients
	Price changes
	Lower than the market price guarantee
Supply ability	Ordering channels
	Storage environment
	The type of ingredients
Service level	Return and exchange of goods guarantee
	Emergency program
	Distribution level
Credibility	Access to honors
	Social responsibility
	Green and low-carbon

3 MODEL DATA CALCULATION AND ANALYSIS

After establishing the hierarchical model, it is necessary to construct a judgment matrix to determine the weights between the factors at each level. In order to derive intuitive data to facilitate subsequent calculations, T.L. Saaty's 1-9 scale method was introduced in the process of constructing the judgment matrix. The method is shown in table 3.

Table 3. 1-9 Scale method

Scale	Significance
1	A is as important as B
3	A is slightly more important than B
5	A is significantly more important than B
7	A is more strongly important than B
9	A is more important than B
2, 4, 6, 8	Importance between 1, 3, 5, 7, 9

According to the supplier evaluation index, combined with the field survey and questionnaire survey results, the primary and secondary indicators are compared two by two to complete the construction of the judgment matrix. The result as shown in table 4.

Table 4. First level indicators judgment matrix

First level indicators	Ingredient quality	Ingredient quality	Ingredient quality	Ingredient quality	Ingredient quality
Ingredient quality	1	3	5	5	9
Ingredient price	1/3	1	3	3	7
Supply ability	1/5	1/3	1	1/2	3
Service level	1/5	1/3	2	1	3
Credibility	1/9	1/7	1/3	1/3	1

According to the constructed judgment matrix, the eigenvectors and weight values of each evaluation index are solved and shown in table 5. The obtained results are used to calculate the maximum characteristic root as well as the CI value.

Table 5. Second level indicators judgment matrix

Second level indicators	The traceability of the origin of the ingredients	Safety testing of the ingredients	Preservation of freshness during transportation
The traceability of the origin of the ingredients	1	1/5	1/7
Safety testing of the ingredients	5	1	1/3
Preservation of freshness during transportation	7	3	1
Second level indicators	The offer of the ingredients	Price changes	Lower than the market price guarantee
The offer of the ingredients	1	3	5
Price changes	1/3	1	3
Lower than the market price guarantee	1/5	1/3	1
Second level indicators	The type of ingredients	Storage environment	Ordering channels
The type of ingredients	1	1/3	1/5
Storage environment	3	1	1/3
Ordering channels	5	3	1
Second level indicators	Distribution level	Return and exchange of goods guarantee	Emergency program
Distribution level	1	1/7	1/3
Return and exchange of goods guarantee	7	1	3
Emergency program	3	1/3	1
Second level indicators	Access to honors	Social responsibility	Green and low-carbon
Access to honors	1	1/5	1/3
Social responsibility	5	1	3
Green and low-carbon	3	1/3	1

Taking the judgment matrix of the first-level indicators as an example, square root method is used to calculate the weight vector. Compute the mth power of the product of each row to obtain an m-dimensional vector.

$$\bar{\omega_i} = \sqrt[m]{\prod_{j=1}^{m} a_{ij}} \tag{1}$$

which in turn leads to $\bar{\omega}$1=3.6801, $\bar{\omega}$2=108384, $\bar{\omega}$3=0.631, $\bar{\omega}$4=0.8326, $\bar{\omega}$5=0.2814, ω i=7.2635.

Normalizing the vector is the weight vector.

$$\omega_i = \frac{\bar{\omega_i}}{\sum_{j=1}^{m} \bar{\omega_j}} \tag{2}$$

which in turn leads to ω 1=0.5067, ω 2=0.2531, ω 3=0.0869, ω 4=0.1146, ω 5=0.0387.

After finding the weight matrix, the maximum characteristic root λmax and the consistency index CI can be calculated.

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n} \frac{(A\omega)_i}{a_i} \tag{3}$$

$$CI = \left(\frac{\lambda - n}{n-1}\right) \tag{4}$$

Calculation can get the maximum characteristic root λmax =5.1416 of the judgment matrix of the first-level index, and the consistency index CI=0.0354.The result as shown in table 6.

Table 6. Hierarchical analysis results

First level indicators	Eigenvector (math.)	Weighting	Maximum characteristic root	CI value
Ingredient quality	3.6801	0.5067		
Ingredient price	1.8384	0.2531		
Supply ability	0.631	0.0869	5.1416	0.0354
Service level	0.8326	0.1146		
Credibility	0.2814	0.0387		

Since the judgment matrix may contain logical errors, a consistency test is required. The consistency test determines whether the importance between the elements is coordinated or not, in order to prove whether the calculation results are valid or not. Under normal circumstances, the smaller the consistency ratio CR value, the better the consistency of the judgment matrix, CR value is less than 0.1, the judgment matrix to meet the consistency test; if the CR value is greater than 0.1, the judgment matrix does not have consistency, should be adjusted to the judgment matrix after the consistency test again.

$$CR = \frac{CI}{RI} < 0.1 \tag{5}$$

Table 7. Consistency test results

Maximum characteristic root	CI value	RI value	CR value	Consistency test results
5.1416	0.0354	1.12	0.0316	pass

Table 8. Average Randomized Consistency Indicator RI Values

N	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45

Calculation results shown in table 7 that the maximum eigenvalue is 5.1416, in this paper N is 5, according to the table 8 the corresponding RI value is 1.12, so CR=0.0316< 0.1, so it passed the consistency test, the calculation results are true and valid.

The calculation method of the secondary indicators is consistent with that of the primary indicators.

In Ingredient quality, The traceability of the origin of the ingredients, Safety testing of the ingredients and Preservation of freshness during Transportation, the weight value ω is 0.0719, 0.279, 0.6491 respectively, the maximum eigenvalue is 3.0649, CI=0.0324, CR=0.0618<0.1, passed the consistency test, the calculation results are true and valid.

In Ingredient price, The offer of the ingredients, Price changes and Lower than the market price guarantee, the weight value ω is 0.637, 0.2583, 0.1047 respectively, the maximum eigenvalue is 3.0385, CI=0.0193, CR=0.367<0.1,passed the consistency test, the calculation results are true and valid.

In Supply ability, the weight value ω of The type of ingredients, Storage environment and Ordering channels are 0.1047, 0.2583, 0.637 respectively, and the maximum eigenvalue is 3.0385, CI=0.0193, CR=0.367<0.1, and the results passed the consistency test, the calculation results are real and valid.

In Service level, Distribution level, Return and exchange of goods guarantee and Emergency program the weight value ω is 0.0879, 0.6694, 0.2426 respectively, the maximum eigenvalue is 3.007, CI=0.0035, CR=0.0067<0.1,passed the consistency test, the calculation results are true and valid.

In Credibility, Access to honors, Social responsibility and Green and low-carbon the weight value ω is 0.1047, 0.637, 0.2589 respectively, the maximum eigenvalue is 3.0385, CI=0.0193, CR=0.0367<0.1,passed the consistency test, and the calculation results are true and valid.

Through the preliminary research, medium-term model construction and late calculation verification, the weights of comprehensive indexes are shown in the table 9.

Table 9. weights of composite indicators

First level indicators	Weighting of target layers	Second level indicators	Normative level weights	Combined weights
		The traceability of the origin of the ingredients	0.6491	0.328899

Ingredient quality	0.5067	Safety testing of the ingredients	0.279	0.141369
		Preservation of freshness during transportation	0.0719	0.036432
		The offer of the ingredients	0.637	0.161225
Ingredient price	0.2531	Price changes	0.2583	0.065376
		Lower than the market price guarantee	0.1047	0.0265
		The type of ingredients	0.637	0.073
Supply ability	0.1146	Storage environment	0.2583	0.029601
		Ordering channels	0.1047	0.011999
		Distribution level	0.6694	0.058171
Service level	0.0869	Return and exchange of goods guarantee	0.2426	0.021082
		Emergency program	0.0879	0.007639
		Access to honors	0.637	0.024652
Credibility	0.0387	Social responsibility	0.2589	0.010019
		Green and low-carbon	0.1047	0.004052

Company C selected representatives from the main stores, purchasing centers and distribution centers, using subjective weighting method, combined with the supplier evaluation index model constructed in this paper, to determine the distribution center representatives who have the most contact with the supplier has 40% of the opinion weight, the main store representatives and the purchasing center representatives each have 30% of the opinion weight. The three suppliers were scored and evaluated, and the comprehensive scores are shown in the table 10.

Table 10. Vendor composite score

Second level indicators	ABC's initial score			ABC's aggregate score		
The traceability of the origin of the ingredients	4.3	3.7	4	1.414266	1.216926	1.315596
Safety testing of the ingredients	3	2.6	4.3	0.424108	0.36756	0.607888
Preservation of freshness during transportation	3	2.7	4	0.109295	0.098366	0.145727
The offer of the ingredients	3.7	4.4	3	0.596531	0.709389	0.483674
Price changes	3.4	3.3	2.4	0.222277	0.21574	0.156902
Lower than the market price guarantee	3.7	4.4	4	0.098048	0.116598	0.105998
The type of ingredients	4.4	3	2.6	0.321201	0.219001	0.189801
Storage environment	3.7	3	4	0.109524	0.088804	0.118405
Ordering channels	4	3.7	4.7	0.047994	0.044395	0.056394
Distribution level	3.7	2.6	2.6	0.215232	0.151244	0.151244

Return and exchange of goods guarantee	3.4	2.7	3.7	0.071679	0.056921	0.078003
Emergency program	3.6	3.4	3.7	0.027499	0.025971	0.028262
Access to honors	3.7	3	4.7	0.091212	0.073956	0.115864
Social responsibility	3.7	4	4.6	0.037072	0.040078	0.046089
Green and low-carbon	3.6	2.7	4.7	0.014587	0.01094	0.019044
				3.800526	3.435888	3.618891

According to the weighted score results, it can be seen that Supplier A has a higher score compared to Supplier B and Supplier C, and is more suitable for cooperation with restaurant chains under the evaluation index model of ingredient suppliers constructed in this paper.

4 CONCLUSION

This paper focuses on the current situation of supplier selection of chain restaurant companies and puts forward relevant suggestions in combination with the evaluation index model. The rank as shown in table 11.

Table 11. Findings: weighting of vendor indicators

Rank	Evaluation indicators	Indicator weights
1	Ingredient quality	0.5067
2	Ingredient price	0.2531
3	Supply ability	0.0869
4	Service level	0.1146
5	Credibility	0.0387

On the basis of widely adopting the management experience of the operators and the experience and suggestions of consumers, we have identified five primary evaluation indexes and 15 secondary evaluation indexes, such as the quality of ingredients, the price of ingredients, the ability to supply, the level of service, reputation, etc., and introduced a series of favorable indexes, such as market price protection, social responsibility and green low-carbon, etc., for the market-targeted problems in the relevant literature, and constructed a supplier evaluation index model based on it. The supplier evaluation index model is constructed on the basis of this model, which helps to select suppliers for Company C, and also has certain reference significance for other chain restaurant enterprises.

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