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Optimization of Procurement Management Based on the AHP

Wei Liu*, Yawen Mei

Xiamen University Tan Kah kee college, Zhangzhou, Fujian, China
**Corresponding author*

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Abstract: The logistics activities of enterprises involve several links, and procurement has always been an important part of it, and the savings in procurement costs often affect the profits of enterprises. In this paper, through the research and analysis of the procurement process of Company P, we understand the current status of the company's procurement development, and also find out the problems in the supplier management. In response to the problems, the reasons for their existence are analyzed and studied, and solutions are proposed based on theories such as analytic hierarchical process on the basis of supply chain procurement management. Through the analysis of theoretical and practical data, this paper improves the supplier management system for Company P. The experience of procurement management in Company P can be used in the same type of manufacturing enterprise.

1. Introduction

In recent years, the trend of globalization has become more and more obvious, and information technology has also experienced a qualitative leap, leading to a more complex overall business market environment and more intense competition among enterprises. If enterprises want to be able to develop for a long time, it is not enough to rely on the traditional management mode alone. But must rely on a more systematic and scientific management approach to obtain higher profits. The supply chain can help enterprises to use the least cost to bring higher quality products and services. Therefore, the comparison between supply chains gradually becomes the key element of competition.

In modern business management, procurement is an important component and the core of the supply chain. Procurement management is the management and control of many behaviors and environments in the production process, including production planning, supplier selection, performance evaluation, and so on. At present, most enterprises have formulated the corresponding procurement process, but in practice, they do not follow this process, which greatly increases the operating costs of enterprises. Therefore, in order to improve the overall efficiency of the supply chain, it is necessary to improve the ability of enterprise procurement management from within.

As an OEM company in the snack food industry, Company P had to optimize its internal environment under the premise that the company was expanding and sales were increasing without

any significant increase in profit margin, and procurement management was an important part of it. At present, in order to adapt to the development of the company's business, and to take advantage of the casual food industry, Company P needs to optimize its existing procurement process, so as to improve efficiency, reduce waste and optimize development.

In this paper, we have studied the information of Company P, as well as interviewed internal employees, and conducted field research to understand its internal procurement operation and identified some problems. The selection of suppliers was set up in a more scientific way, and the overall rating of the suppliers' credit rating, size, quality, price, and other indicators were selected to achieve the purpose of selecting the best suppliers. This change can help company P to purchase the most cost-effective products and improve its competitiveness in the casual food industry. At the same time, it helps the company and its suppliers to form a win-win partnership, which ensures the quality of its products and reduces the management difficulties of the company. By organizing and analyzing these problems of Company P, we find out the causes of the problems and propose solutions to them. This paper uses supply chain optimization theory, AHP and other methods, as well as an internal survey of the company to obtain real data and understand its procurement status and problems, so as to make suggestions for optimizing the procurement management of Company P.

2. Purchasing Management Related Theory

2.1. Supply Chain And Procurement Management

The concept of the supply chain emerged in the 1980s and is a very broad theory. It is a kind of organization that takes customer demand as the guide, aims at improving quality and efficiency, and integrates resources as the means to achieve efficient coordination of the whole process of product design, procurement, production, sales, and service.

Harrison defines a supply chain as "the functional chain that performs the procurement of raw materials, converts them into intermediate and finished products, and sells the finished products to users". According to STEVENS, "Controlling the flow from suppliers to users through value-added processes and distribution channels is the supply chain. It starts at the source of supply and ends at the end of sale". China's "Logistics Terminology" defines a supply chain as the network structure formed by upstream and downstream enterprises involved in the production and distribution process to deliver products and services to the final customers.

Supply chain management (SCM for short) is the management of all links of the supply chain, i.e., the management of a series of processes such as procurement, production, delivery, etc. It is a process of coordinating internal and external resources to meet consumer demand, and is an integrated management method.

Supply chain management involves four areas: supply, planning, logistics, and customer and service. Based on the concept of the supply chain, procurement management has also ushered in a systematic transformation. Unlike traditional procurement, the entire procurement process of supply chain procurement is a management object, including information flow, capital flow, and logistics, all of which need to be monitored and managed in a unified manner, mainly reflected in the full realization of electronic procurement, the development of strategic partnerships, external resource management instead of procurement management, and the transformation from inventory-driven to order-driven.

2.2. AHP Hierarchical Analysis

2.2.1. Overview of Hierarchical Analysis

Analytic Hierarchical analysis (AHP) was proposed by Satty, a professor at the University of Pittsburgh, around the 1970s, as an analytical method for determining decision weights in multi-criteria situations, which provides a more scientific solution for multi-criteria decision making [1]. It mathematizes people's thoughts and subjective ideas in the process of thinking about the problem, so that problems that are difficult to deal with completely quantitatively will not have too subjective judgments, and finally arrive at a more reasonable basis for decision-making. The final output of the hierarchical analysis is the priority list of each decision option, which is the weight of the decision option among all decision options [2,3].

2.2.2. Steps For Applying Hierarchical Analysis

(1) Establishing a hierarchical structure

Using hierarchical analysis, the first step is to identify the problem to be solved, i.e., to define an objective. Next, identify the factors that affect the problem or goal, i.e., the criteria for measuring the problem. Finally, analyze the interactions and connections among the factors to construct a top-down hierarchical structure chart, including three levels: goal level, criterion level, and decision solution level.

(2) Establish a two-comparison judgment matrix

Based on the established hierarchy chart and according to the objectives, the relative importance between every two indicators in the criterion layer is determined by combining human experience and judgment, and this relative importance is determined by a two-by-two comparison [4]. Replacing the expression of the relative importance of the two indicators with numerical values requires the use of the 1 to 9 scales of the AHP comparison scale for the importance of each criterion, and the values of the relative importance are determined based on these scales to derive the judgment matrix [5].

(3) Calculate the weights of the criterion layer to the target layer

The weights of each index in the criterion layer relative to the target layer are calculated through the two-by-two comparison of the judgment matrix derived above, generally by calculating the maximum eigenvalue of the judgment matrix and its corresponding eigenvector to find out the weights of each index.

(4) Consistency test

In the process of a two-by-two comparison of each indicator, if more than two indicators are compared, it may make the two-by-two comparison inconsistent, and such inconsistency is allowed to exist within a reasonable range due to the subjective judgment of decision-makers. The degree of consistency can be checked by calculating the consistency ratio [6,7]. If the consistency ratio is less than or equal to 0.1, then it is more reasonable. Otherwise, it needs to be re-examined, and the judgment matrix needs to be adjusted.

(5) Calculate the weights of the scheme layer to the criterion layer

Calculate the relative importance weights of each decision option under a single indicator. There are various methods to calculate the weights, which can be chosen according to the difficulty of the method.

(6) Total hierarchical ordering

The weights of the criterion layer to the target layer are combined with the weights of the solution layer to the criterion layer to determine the weights of the final solution layer to the target layer.

(7) Analysis of results

The results from the previous step are analyzed, and the best solution is selected.

3. Analysis of The Current Situation of Procurement Management In Company P

3.1. The Profile And Organizational Status of Company P

Founded in 2012, Casual Food P is a company located in the Internet casual food brand, dedicated to providing consumers with healthy and high-quality casual food. The company's main business scope is the production, processing and sales of fried food and nut food, finished tea products and fruit products, etc. Up to now, the company has more than two hundred kinds of its own single products, which better meet the diversified needs of different consumers.

The company mainly sells through diversified channels such as Tmall, Jingdong, and other Internet platforms, as well as offline experience stores. In the era of rapid development of the Internet, the company has seized the opportunity of e-commerce development and combined the development characteristics of leisure food to establish a set of vertical leisure food research and development, procurement, testing, sub-assembly, and Internet-centered business model.

In terms of products, based on its ability of independent innovation and grasp of consumer needs, the company has continuously improved its product layout, forming a portfolio covering five categories of casual foods: nuts, dried fruits, dried fruits, flower tea, and snacks; in terms of brand, the company has improved its brand connotation from service upgrade, experience upgrade and cultural upgrade at multiple levels, and is committed to establishing a connection with consumers based on products and services, supported by brand connotation and cultural experience. The company is committed to establishing a connection with consumers based on products and services, supported by brand connotation and cultural experience.

P Company has been adhering to the concept of "customer first", and through its personalized branding strategy, it has conveyed the cultural concept of "love and happiness" to consumers, expanding the simple relationship of product sales into consumer culture.

3.2. Supplier Management of Company P

Company P's suppliers are mainly involved in five categories: nuts and fried foods, meat snacks, confectionery and cakes, dried fruits and preserved fruits, and vegetarian mountain treasures, among which the main focus is on nuts and fried foods, and currently, Company P has nearly 300 suppliers.

In terms of the supplier development process, Company P has its own screening system before working with new suppliers, including on-site inspections and other methods. In addition, Company P also conducts integrity training for its partners, and only suppliers who pass the ethics training have the opportunity to work with them. For suppliers who have already started cooperation, Company P will monitor their raw material procurement process and production process.

3.3. Analysis of Procurement Management Problems of Company P

3.3.1. The Development and Assessment of Suppliers Are Not Rigorous

Although Company P has its own process for supplier development, evaluation, and selection, there are still many problems in the actual operation process. The problems in supplier management make Company P get more complaints compared with other similar brands.

In addition to the complaints, Company P was even subject to administrative penalties for quality issues. This series of signs indicate that Company P still needs to strengthen the supervision and

control of its suppliers from procurement to production, a part of the process that is mostly the responsibility of its partner suppliers.

Company P pursues the concept of "self-arrangement of the core link + non-core link" outsourcing model, so the production of products is basically the responsibility of the partner suppliers. Therefore, if there are problems with suppliers, it is difficult to guarantee the quality of products.

For example, a supplier of Company P in 2018 was once fined by the Market Supervision Administration in December 2018 for producing and selling substandard pine nuts. And from the enterprise check APP, we can see that the enterprise has been punished up to seven times for food quality and pollution of water resources, and the enterprise also has the credit problem of providing false statistics.

In addition, the cooperative supplier's plant is remote, small in size, and old, and the production process is very worrying, and the plant is staffed by local villagers who have not received professional training.

This indicates that Company P did not do what it promised in the initial supplier development, and probably lacked field research, professional training and other links, and the evaluation criteria for suppliers were not designed rigorously and comprehensively, and the plant settings of many partners may lack the most basic production conditions and sanitary conditions.

3.3.2. Unstable Relationship With Suppliers

At present, P company has more than 500 suppliers, but in fact, each purchase volume is very small. Take its top five suppliers of nut products procurement volume, each of the procurement percentage is relatively small, not more than 10%. In fact, this is related to the choice of suppliers P company, in order to enhance the upstream bargaining power, its partners are mostly established soon small and medium-sized enterprises, limited production scale, resulting in its procurement volume of each very small and scattered suppliers, the management difficulties have increased.

Secondly, many of P's downstream cooperative suppliers are in a semi-stoppage state. On the one hand, they are under financial pressure due to the long payment period of P, and on the other hand, they face the possibility of being dumped at any time due to the low profit given them by P. Therefore, many suppliers will look for other ways out during the cooperation period to avoid being too dependent on Company P. The relationship between the two parties is not equal, and Company P does not give due help and support to its suppliers, which is not conducive to their long-term development.

4. Optimization Program of P Company Procurement Management

4.1. Evaluation Management optimization

If Company P wants to strengthen the management of suppliers and control the quality as much as possible from the front, the most important point is to select the right suppliers. After understanding the existing supplier selection process and selection criteria of Company P, and after reviewing various literature for research and analysis, we decided to use AHP hierarchical analysis to determine the evaluation index of Company P's suppliers. By optimizing its evaluation index to select the most suitable suppliers, it also achieves the purpose of optimizing supplier management and improving the overall supply chain level [8,9].

4.1.1. Supplier Evaluation Index Selection

Evaluation indicators are parameters or factors of the evaluation analysis, which are determined by the characteristics of the chosen solution. Based on these indicators, the degree of advantages and disadvantages between different suppliers can be compared. Therefore, choosing the right evaluation indicators can reflect the characteristics of suppliers more correctly and help companies make the best choice.

Lehmannn and O'Shauhnessy believe that the basic supplier evaluation criteria are price, quality, delivery, and service in Table 1.

Table 1: Dickson Supplier Selection 23 Metrics

1	Quality	2	Delivery Period	3	Past Performance	4	Customer Complaint Policy
5	Equipment and Capacity	6	Price	7	Technical Capabilities	8	Financial Status
9	Customer complaint handling procedures	10	Communication System	11	Reputation in the industry	12	Business Relationships
13	Management Organization	14	Management Control	15	Restoration Services	16	Service attitude
17	Past Impressions	18	Packaging Capability	19	Industrial Relations	20	Location
21	Past Turnover	22	Training	23	Inter-agency coordination		

4.1.2. Establishing the Index System and Hierarchical Model

In order to simplify the complex decision problem and to analyze it more systematically, we generally use a hierarchical structure to decompose the problem. The second level of evaluation criteria is decomposed into primary and secondary evaluation criteria, so that the entire structural model becomes a structural model with the objective at the top, the primary evaluation criteria at the second level, the secondary evaluation criteria at the third level, and the selected feasible solution at the bottom [10].

According to the existing evaluation indexes of company P, after combining the current advanced supplier selection evaluation indexes, the supplier selection evaluation indexes of company P are set into the main criteria level of service and culture, quality, price, production and supply, safety and technology; and each main criteria level is subdivided into 3-4 sub-criteria levels.

4.1.3. Setting the Weight of Each Evaluation Index

Table 2: Table of scales and descriptions of scoring at each level of the goal tree diagram

Comparison Scoring	Relative Importance	Description
1	Equally important	Factor i and j contribute equally to the target
3	Slightly more important	Factor i is evaluated slightly more favorably than j
5	Basic importance	Factor i is more favorable than j evaluation
7	Important indeed	Factor i is evaluated favorably over j and tested
9	Absolutely important	Factor i is significantly more important than j

2, 4, 6, 8	The middle value of two adjacent degrees	Factors i and j are used when a compromise is required
Countdown	When comparing factor j with i	

For the importance of each evaluation indicator, Saaty et al. proposed to assign values on a scale of 1-9, as shown in the Table 2.

4.1.4. Invite Several Experts With Relevant Work Experience To Score The Target Numbers

A hierarchy from top to bottom through the above criteria is to build a judgment matrix in Table 3.

Table 3: Judgment scale of target layer of main criterion layer

	Service and Culture	Quality	Price	Production and delivery	Security and Technology
Service and Culture	1 (a_{11})	0.207 (a_{12})	0.26 (a_{13})	0.323 (a_{14})	0.333 (a_{15})
Quality	4.820 (a_{21})	1 (a_{22})	0.41 (a_{23})	0.435 (a_{24})	0.943 (a_{25})
Price	3.76 (a_{31})	2.43 (a_{32})	1 (a_{33})	0.448 (a_{34})	0.565 (a_{35})
Production and delivery	3.1 (a_{41})	2.3 (a_{42})	2.23 (a_{43})	1 (a_{44})	0.714 (a_{45})
Security and Technology	3 (a_{51})	1.06 (a_{52})	1.77 (a_{53})	1.4 (a_{54})	1 (a_{55})

Construct the judgment matrix as follows.

$$A=\begin{pmatrix} 1 & 0.207 & 0.26 & 0.323 & 0.333 \\ 4.820 & 1 & 0.41 & 0.435 & 0.943 \\ 3.76 & 2.43 & 1 & 0.448 & 0.565 \\ 3.1 & 2.3 & 2.23 & 1 & 0.714 \\ 3 & 1.06 & 1.77 & 1.4 & 1 \end{pmatrix}$$

(1)Service and culture sub-criteria weighting factor

The table of weighting coefficients for service and culture sub-criteria in Table 4.

Table 4: Table of weighting coefficients for service and culture sub-criteria

	After Sales Service	Corporate Culture	Corporate reputation
After Sales Service	1 (b_{11})	0.585 (b_{12})	0.578 (b_{13})
Corporate Culture	1.7 (1b_{21})	1 (b_{22})	0.385 (b_{23})
Corporate reputation	1.73 (b_{31})	2.6 (b_{32})	1 (b_{33})

Construct the judgment matrix.

$$B_1=\begin{pmatrix} 1 & 0.585 & 0.578 \\ 1.7 & 1 & 0.385 \\ 1.73 & 2.6 & 1 \end{pmatrix}$$

(2)Quality sub-criteria weighting factor
The table of weight coefficients of quality sub-criteria in Table 5.

Table 5: Table of weight coefficients of quality sub-criteria

	Shipping Quality	Reliability of goods	Quality stability
Shipping Quality	1 (b_{11})	0.485 (b_{12})	1.471 (b_{13})
Reliability of goods	2.06 (b_{21})	1 (b_{22})	3.333 (b_{23})
Quality stability	0.68 (b_{31})	0.3 (b_{32})	1 (b_{33})

Construct the judgment matrix.

$$B_2=\begin{pmatrix} 1 & 0.485 & 1.471 \\ 2.06 & 1 & 3.333 \\ 0.68 & 0.3 & 1 \end{pmatrix}$$

(3)Price sub-criteria weighting factors
The table of price sub-criteria weighting coefficients is in Table 6.

Table 6: Table of price sub-criteria weighting coefficients

	Price competitiveness	Cost control capability	Service Price
Price competitiveness	1 (b_{11})	0.353 (b_{12})	0.485 (b_{13})
Cost control capability	2.83 (b_{21})	1 (b_{22})	0.909 (b_{23})
Service Price	2.06 (b_{31})	1.1 (b_{32})	1 (b_{33})

Construct the judgment matrix.

$$B_3=\begin{pmatrix} 1 & 0.353 & 0.485 \\ 2.83 & 1 & 0.909 \\ 2.06 & 1.1 & 1 \end{pmatrix}$$

(4)Production supply sub-criteria weighting factor
The table of weighting coefficients of production sub-criteria is in Table 7.

Table 7: Table of weighting coefficients of production sub-criteria

	Production capacity	Delivery accuracy	Out-of-stock resilience	Safety stock
Production capacity	1 (b_{11})	0.333 (b_{12})	0.294 (b_{13})	0.327 (b_{14})
Delivery accuracy	3 (b_{21})	1 (b_{22})	0.331 (b_{23})	0.420 (b_{24})
Out-of-stock resilience	3.4 (b_{31})	3.02 (b_{32})	1 (b_{33})	1.538 (b_{34})
Safety stock	3.06 (b_{41})	2.38 (b_{42})	0.650 (b_{43})	1 (b_{44})

Construct the judgment matrix.

$$B_4=\begin{pmatrix} 1 & 0.333 & 0.294 & 0.327 \\ 3 & 1 & 0.331 & 0.420 \\ 3.4 & 3.02 & 1 & 1.538 \\ 3.06 & 2.38 & 0.650 & 1 \end{pmatrix}$$

(5)Safety and technology sub-criteria weighting factors

The Safety and technology sub-criteria weighting factors are in Table 8.

Table 8: Safety and technology sub-criteria weighting coefficient table

	Plant configuration	Staff Training	Security Management	Risk Protection
Plant configuration	1 (b_{11})	1.538 (b_{12})	2.439 (b_{13})	1.923 (b_{14})
Staff Training	0.65 (b_{21})	1 (b_{22})	0.472 (b_{23})	1.786 (b_{24})
Security Management	0.41 (b_{31})	2.12 (b_{32})	1 (b_{33})	3.125 (b_{34})
Risk Protection	0.52 (b_{41})	0.56 (b_{42})	0.32 (b_{43})	1 (b_{44})

Constructing the judgment matrix

$$B_5=\begin{pmatrix} 1 & 1.538 & 2.439 & 1.923 \\ 0.65 & 1 & 0.472 & 1.786 \\ 0.41 & 2.12 & 1 & 3.125 \\ 0.52 & 0.56 & 0.32 & 1 \end{pmatrix}$$

4.1.5. Consistency Test of Judgment Matrix

(1)Input the input data in SpassAu, first input the judgment matrix A, and conclude the following in Table 9.

Table 9: Matrix A hierarchical analysis results in table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
Service and Culture	0.323	6.469%	5.383	0.096
Quality	0.909	18.173%		
Price	1.046	20.929%		
Production and delivery	1.397	27.947%		
Security and Technology	1.324	26.481%		

From above Table 9, it can be seen that the maximum eigenvalue is 5.383

Consistency Indicator CI

$$CI=\frac{\lambda_{max}-m}{m-1} \quad (1)$$

CI = (5.383-5) / (5-1) = 0.096

Consistency ratio CR

$$CR=\frac{CI}{RI}$$

Where RI is the average random consistency indicator, the RI values are shown in the following Table 10.

Table 10: Table of RI values

Number of steps	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.52	0.89	1.12	1.26	1.36	1.41	1.46

According to the formula, the consistency ratio is

CR= 0.096 / 1.12 = 0.085 < 0.1

Therefore, the calculation results of the main criterion hierarchical ranking have satisfactory consistency.

By analogy, the other five judgment matrices applying the above steps lead to.

(2)For the judgment matrix B1, The following conclusions are in Table 11.

Table 11: Matrix B1 Hierarchical analysis results table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
After Sales Service	0.659	21.983%	3.100	0.050
Corporate Culture	0.820	27.335%		
Corporate reputation	1.520	50.682%		

The maximum eigenvalue is: 3.100

CI1 = (3.100-3) / (3-1) = 0.050

CR1 =0.050/0.52=0.096< 0.1

Therefore, the calculation results of the supply-level responsiveness sub-criteria hierarchical ranking are in satisfactory agreement.

(3) The judgment matrix B2 has the following conclusion in Table12.

Table 12: Matrix B2 Hierarchical analysis results table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
Shipping Quality	0.793	26.421%	3.001	0.001
Reliability of goods	1.685	56.174%		
Quality stability	0.522	17.405%		

The maximum eigenvalue is: 3.001

$$CI2 = (3.001-3) / (3-1) = 0.001$$

$$CR2 = 0.001/0.52 = 0.001 < 0.1$$

Therefore, the calculation results of the supply-level responsiveness sub-criteria hierarchical ranking are in satisfactory agreement.

(4)For the judgment matrix B3, there is the following conclusion in Table13.

Table 13: Matrix B3 Hierarchical analysis results table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
Price competitiveness	0.517	17.218%	3.019	0.009
Cost control power	1.268	42.258%		
Service Price	1.216	40.524%		

The maximum eigenvalue is: 3.019

$$CI3 = (3.019-3) / (3-1) = 0.009$$

$$CR3 = 0.009/0.52 = 0.018 < 0.1$$

Therefore, the calculation results of the supply-level responsiveness sub-criteria hierarchical ranking are in satisfactory agreement.

(5)For the judgment matrix B4, there is the following conclusion in Table 14.

Table 14: Matrix B4 Hierarchical analysis results table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
Production capacity	0.374	9.346%	4.118	0.039
Delivery accuracy	0.709	17.719%		
Out-of-stock resilience	1.681	42.034%		
Safety stock	1.236	30.902%		

The maximum eigenvalue is: 4.118

$$CI4 = (4.118-4) / (4-1) = 0.039$$

$$CR4 = 0.039/0.89 = 0.044 < 0.1$$

Therefore, the calculation results of the supply-level responsiveness sub-criteria hierarchical ranking are in satisfactory agreement.

(6) For the judgment matrix B5, there is the following conclusion in Table 15.

Table 15: Matrix B5 Hierarchical analysis results table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
Plant configuration	1.504	37.610%	4.226	0.075
Staff Training	0.783	19.575%		
Security Management	1.200	30.011%		
Risk Protection	0.512	12.804%		

The maximum eigenvalue is: 4.226

CI5 = (4.226-4) / (4-1) = 0.075

CR5 =0.075/0.89=0.085< 0.1

Therefore, the calculation results of the supply-level responsiveness sub-criteria hierarchical ranking are in satisfactory agreement.

4.1.6. Hierarchical Single Sort

Table 16: AHP hierarchical analysis results table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
Service and Culture	0.323	0.0646	5.383	0.096
Quality	0.909	0.1817		
Price	1.046	0.2092		
Production and delivery	1.397	0.2794		
Security and Technology	1.324	0.2648		

Table 16 shows that the relative weights for the five criteria of service and culture, quality, price, production and supply, and safety and technology are 0.0646, 0.1817, 0.2092, 0.2794, and 0.2648, respectively.

Table 17: AHP hierarchical analysis results table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
After Sales Service	0.659	0.2198	3.100	0.050
Corporate Culture	0.820	0.2733		
Corporate reputation	1.520	0.5068		

The relative weights of the three criteria for after-sales service, corporate culture, and corporate reputation are 0.2198, 0.2733, and 0.5068, respectively, in Table 17.

Table 18: AHP hierarchical analysis results table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
Shipping Quality	0.793	0.2642	3.001	0.001
Reliability of goods	1.685	0.5617		
Quality stability	0.522	0.1740		

The relative weights for the three criteria of shipment quality, goods reliability, and quality stability are 0.2642, 0.5617, and 0.1740 in Table 18.

Table 19: AHP hierarchical analysis results table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
Price competitiveness	0.517	0.1721	3.019	0.009
Cost control power	1.268	0.4525		
Service Price	1.216	0.4052		

The relative weights for the three criteria of price competitiveness cost control, and service price are 0.1721, 0.4525, and 0.4052 in Table 19.

Table 20: AHP hierarchical analysis results table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
Production capacity	0.374	0.0934	4.118	0.039
Delivery accuracy	0.409	0.1771		
Out-of-stock resilience	1.681	0.4203		
Safety stock	1.236	0.3090		

The relative weights for the four criteria of capacity, delivery accuracy, out-of-stock resilience, and safety stock are 0.0934, 0.1771, 0.4203, and 0.3090 in Table 20.

Table 21: AHP hierarchical analysis results table

Item	Eigenvector	Weighting value	Maximum Eigenvalue	CI value
Plant configuration	1.504	0.3761	4.226	0.075
Staff Training	0.783	0.1957		
Security Management	1.200	0.3001		
Risk Protection	0.512	0.1280		

The relative weights for the four criteria of plant configuration, staff training, safety management, and risk protection were 0.3761, 0.1302, 0.3001, and 0.1280 in Table 21.

4.1.7. Total Hierarchical Ordering

Before performing the hierarchical total ordering, a consistency check of the hierarchical total ordering is performed. The test is performed layer by layer, from the top-level down. Let the consistency index of some factors in the kth level for the single ordering of the jth element in the k-1th level be $CI_j^{(k)}$, and the average random consistency index be $RI_j^{(k)}$, (it is not necessary to

consider when the jth element in the kth level is not related to the k-1th level), then the consistency ratio of the total ordering in the kth level is

$$CR^{(k)} = \frac{\sum_{j=1}^{n_k} w_j^{(k-1)} CI_j^{(k)}}{\sum_{j=1}^{n_k} w_j^{(k-1)} RI_j^{(k)}} \quad (2)$$

Again when $CR^{(k)} \leq 0.10$, we consider the calculation of the hierarchical total ranking to have satisfactory consistency.

According to the calculation results as above, it is known that n = 5 and w_j denotes the weights of the five criterion layers relative to the target. $w_1 = 0.0646$, $w_2 = 0.1817$, $w_3 = 0.2092$, $w_4 = 0.2794$, and $w_5 = 0.2648$ have been obtained by the calculation of the judgment matrix A in the Table 22. By the consistency test of the judgment matrix, $CI_1 = 0.050$, $CI_2 = 0.001$, $CI_3 = 0.009$, $CI_4 = 0.039$, $CI_5 = 0.075$. Accordingly, according to the above table, it is known that $RI_1 = RI_2 = RI_3 = 0.52$, $RI_4 = RI_5 = 0.89$.

$$CR = sum(w \times CI) / sum(w \times RI) \quad (3)$$

CR = 0.0499

CR<0.1, indicating satisfactory consistency of the hierarchical total ranking.

Table 22: Total hierarchical ranking table

Main Guidelines	Tier weights	Sub-criteria	Weights
Service and Culture	0.0646	After-sales service D1	0.2198
		Corporate Culture D2	0.2733
		Corporate reputation D3	0.5068
Quality	0.1817	Shipping quality D4	0.2642
		Goods reliability D5	0.5617
		Quality stability D6	0.1740
Price	0.2092	Price competitiveness D7	0.1721
		Cost control power D8	0.4525
		Service Price D9	0.4052
Production and delivery	0.2794	Production capacity D10	0.0934
		Delivery accuracy D11	0.1771
		Out-of-stock resilience D12	0.4203
		Safety stock D13	0.3090
Security and Technology	0.2648	Plant configuration D14	0.3761
		Employee Training D15	0.1957
		Security Management D16	0.3001
		Risk Protection D17	0.1280

4.2. Supplier Classification Management

Company P currently has a large number of suppliers, and if each supplier is managed in the same way, it will not only take a lot of time and effort but also easily lead to confusion in management. Therefore, we can strengthen the performance evaluation of suppliers and classify them into different levels according to their evaluation results and then adopt different management modes.

Table 23: Supplier evaluation grading table

Score	≥85	75-85	60-75	<60
Grade	Grade A	Grade B	Grade C	Grade D

According to the scores in above Table 23, the suppliers are divided into four levels: A, B, C, and D. A-class suppliers can meet P's requirements well, provide qualified quality and quantity of products, and are excellent suppliers, so they can cooperate with them for a long time and adopt the mode of "encouragement"; for B class suppliers of this good type, they can provide assistance to them and try to transform them into A-class suppliers; and C class suppliers are those who have many problems in the process of cooperation. For B-type suppliers, we can help them and try to turn them into A-class suppliers; while C-type suppliers are those who have many problems in the process of cooperation, so P should try to find out the problems and solve them together with them. For suppliers who cannot improve, they will be classified as Class D. The last Class D suppliers are unqualified suppliers, and Company P should choose to terminate their cooperation in order to avoid the risk in the process of cooperation.

4.3. Partnership Optimization

In the subsequent cooperation, we can try to establish long-term cooperation with Class A and Class B suppliers and use our own advantages to "empower" the suppliers in the daily cooperation.

In the subsequent cooperation process with suppliers, in addition to strict supervision and control, we empower them in terms of technology, capital, and channels. For example, through data sharing, technical support, professional training, and other ways to provide support for suppliers, and strive to form a long-term good cooperation relationship with them. Especially at present, most of the suppliers of Company P are small and medium-sized enterprises that have been established recently, and the suppliers themselves are in an early stage and inevitably have problems with technology and equipment. Therefore, Company P should strengthen its guidance and staff training to help them produce qualified products.

At the same time, improve the supplier incentive policy. In addition to appropriately increasing the profit margin of suppliers, for high-quality suppliers to give "order incentives", that is, to increase the number of orders with the supplier or extend its cooperation time, to reduce its cooperation with the supplier's "sense of unease", but also from another level To ensure the quality of their products.

Secondly, you can also let quality suppliers join the research and development process of new products of P company. By letting suppliers join the R&D process earlier, not only can we save communication time between the two sides, but also help suppliers better grasp the production process of new products, and they can both profit from the process and feel that they are valued.

5. Conclusion

This paper is an analysis of the purchasing department of Company P from a supply chain perspective. This paper will mainly address supplier selection in the procurement department. Through the form of research and interview, we obtain real data, and analyze and organize these data to find out the problems of the company in procurement management. The problems in the procurement department of Company P will be analyzed mainly through supplier evaluation management, and solutions will be proposed through the theories learned.

In terms of supplier evaluation management, this paper adopts the AHP hierarchical analysis method to classify and analyze the weighting of supplier evaluation. This method makes up for the shortcomings of traditional manual scoring, where subjective factors are greater than objective

factors, and selects indicators suitable for supplier evaluation of Company P after integrating various indicators, so that the weighting results are more in line with the actual situation. In this paper, a total of 17 evaluation indicators were selected and combined with the use of PASSAU software to finally arrive at the weights of each indicator. At the same time, suppliers are classified according to their daily performance to improve the efficiency of supplier management in Company P.

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