

## Supplier Evaluation Research of Automobile Industry Chain Service Platform based on AHP

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**Abstract.** Automotive industry chain service platform is to focus on a series of processes about the automobile industry's products, such as production, trading, evaluation, etc. Among this, the transaction mode and the suppliers evaluation system have high complexity. In view of the problems existing in the evaluation of auto parts suppliers, a suppliers evaluation method based on analytic hierarchy process (AHP) is proposed, and the suppliers evaluation index is established. A multi layers evaluation model based on AHP is constructed. Finally, the model is used to evaluate the suppliers to validate the method.

### Introduction

The industrial chain is a whole organization which is composed of various enterprises. A lot of value exchanges exist the enterprises that interrelate.[1]The source of the automobile industry chain is in the production of raw materials, and finally flow to the users .At present, the vehicle manufacturing enterprises in the automotive industry chain with absolute advantages are in the core position, the whole industry chain expands mutual cooperation for the vehicle manufacturing enterprise leader, which constitute a wide range of strategic interests alliance.[2-4].

### Establishment and shortage of service platform for the SaaS automobile industry chain

The automotive industry chain service platform has been constructed on the basis of a large number of algorithms and the guidance of the Software-as-a-Service[5].This platform takes the vehicle manufacturing enterprises as the core, which use business information as the main data source to determine the evaluation index of the enterprise by the extraction of data and the investigation along with the interview of a large number of automobile factory. Different enterprises can set different weights that correspond with the index according to their own needs. This measure can not only solve the problem that the difficulty to get the enterprises assessment data and much subjectivity in data collection, but also met the different choices of enterprises' demands. At the same time, the service platform provides a convenient business information exchange channels, which strengthen the cooperation effectively between chief enterprises and cooperative enterprises[2][6].Figure 1 is the cloud platform collaborative service module. An enterprise can choose evaluation index to build cloud service system on the basis of their needs.

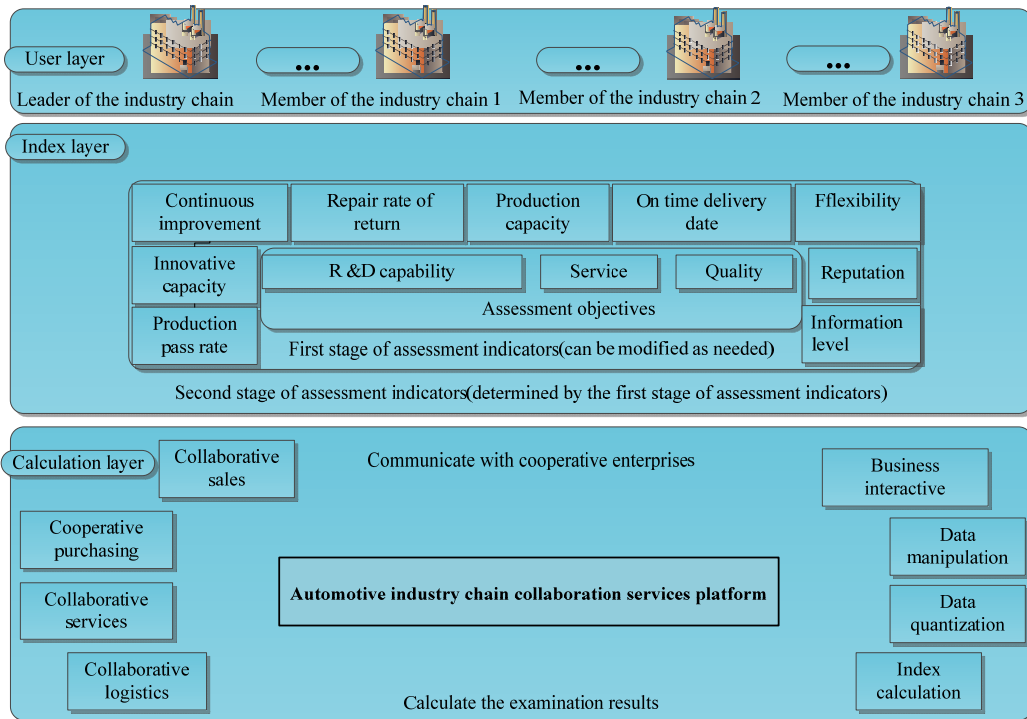


Figure 1 Cloud platform collaborative service module

However, the Platform for the assessment uses the idea of elimination, which does not particularly set access mechanism, the application of the platform is limited to the leader on the current assessment of cooperative enterprises, Leading to that the extension of the platform business is weak. Its disadvantages are shown in the following two aspects:

The data sources are still business data for business cooperation, as for the enterprises which have not established cooperation, could not make the excavation and evaluation due to the lack of data.

Assessment scheme is various but the way is single, and the assessment process is more complex, which unable to deal with a large number of enterprises cooperation requests quickly, and can't meet the needs that the enterprises of preliminary screening and rapid optimization.

Because of the core position in the automobile industry chain, the vehicle manufacturing enterprises urgently need to solve the evaluation and selection of the cooperative enterprises[7]. A large number of scholars have carried on the thorough research on the selection of the evaluation algorithms. among which the AHP method is more extensive and scientific[8-10].so this paper is based on the original SaaS automotive industry chain cloud services platform, using AHP algorithm to build platform evaluation system and set access qualification, to achieve rapid response and process enterprises cooperation requests.

## The construction of platform evaluation system

**The necessity of platform evaluation system.** Construction of service platform for SaaS automobile industry chain contributes to cooperative enterprises management, communication and assessment. But the member enterprises of Chinese automobile industry chain have a large gap in many aspects, such as manufacturing research and development or innovation. In this case, using service platform to assess the elimination or short-term management for quite a part of the enterprises which have poor ability will increase the heavy workload and have little significance. Therefore we set up the assessment index to inspect and select suppliers to enter the platform. It is convenient to customers that selecting the suppliers based on reference evaluation results to meet their needs by evaluating the suppliers to eliminate the weak enterprises. Meanwhile, the platform maintains communication with customers and feedback the customer's needs to the enterprises who continue to improve customers satisfaction, enhance customers stickiness, and thus enhance the competitiveness of enterprises[11].

**Establishment of evaluation index.** As for the small and medium-sized enterprises, only when reached a certain standard, they can be allowed to access the trading platform. As for the suppliers which have already entered the platform, customers can select the appropriate suppliers according to their own individual needs. setting up the platform's evaluation index needs to take full account of the index characteristics of the universal application, also be able to fully reflect the comprehensive strength of an enterprises, to this end, we set up three basic indexes under the platform evaluation system ,according to a large number of survey data collection and research, that is the product quality, R & D capability and service .Each basic index is setted up to two layers indexes which can reflect the basic situation of the enterprises, as shown in the figure 2.

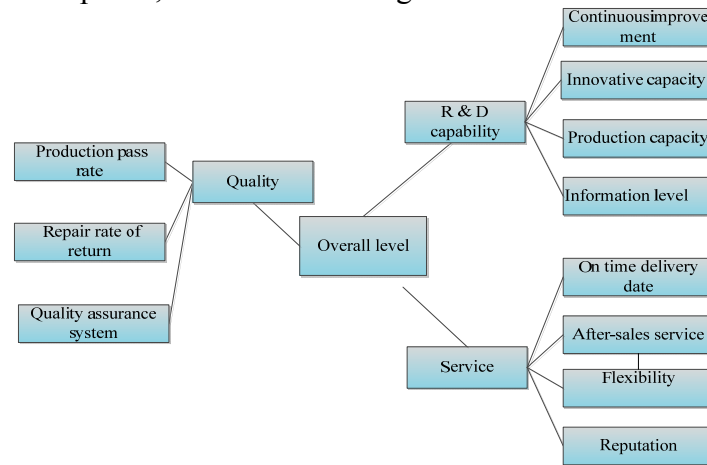


Figure 2 Index framework

**The construction of platform evaluation module based on AHP.** We use the database technology, SSH, web technology and the Java language to build platform evaluation module under the framework of SaaS automotive industry chain cloud services platform. The specific function is that, firstly, the member companies login, they enter the relevant information platform to access to the application according to the system prompts, the information will be stored in the system database. Secondly, management and monitoring system control the system to compare the indexes each other and determine the weight of each index, so we can calculate the total weight. Finally audit staff decides whether the companies pass the enterprise application according to the set of access standards and the evaluation results. The results will feedback to the customers who can choose the best suppliers.

### AHP algorithm

AHP is the method of comparing the sort for dealing with complex decision-making problems that is proposed by A.L.Saaty who is the professor of Pittsburgh University in the United States in 1970s [12].The core idea of AHP is to construct a hierarchical analysis model, and then compare the elements each other in the same layer to get the importance order that lowest is relative to highest layer. Specific steps are showed as follows[13-14].

First, we need to establish the judgment matrix, by comparing the elements each other in the same layer from the first index to the last one, we can get the judgment matrix according to the standard method [12].The value of the matrix can be found in Table 1.

Table 1

Scale	Definition
1	Two elements are equally important
3	one element is a little important than the other
5	one element is obviously important than the other
7	one element is more important than the other
9	The element is much more important than the other
Reciprocal	The importance of A is $\lambda$ times than B. The importance of b is $1/\lambda$ times than A.

Secondly, a  $n \times n$  judgment matrix is established, and the  $n$  is the number of the layers also is the dimension of the matrix. Because of the complexity and uncertainty of the practical problems which lead to inconsistency when compare the elements each other, it is necessary to carry out the consistency test of the above matrix in order to reduce the error. The concrete steps are showed below. firstly, calculating the consistency index.

$$CI = (\lambda_{\max} - n) / (n - 1) \quad (1)$$

$\lambda_{\max}$  is the largest eigenvalue of the matrix. Then finding out the average random consistency indexes from table 2 and calculating the random consistency indexes according to the formula(2).

$$CR = CI / RI \quad (2)$$

If  $CR < 0.1$ , the judgment matrix meet the consistency requirement.

Table 2 Average random consistency index

Dimension	1	2	3	4	5	.....
RI	0	0	0.52	0.89	1.12	.....

The last step is calculating the weight. We choice the eigenvector method to calculate the weight that is more convenient than others[15]. The maximum eigenvalues and eigenvectors of the matrix are obtained, and the weight vector can be obtained after the arithmetic average. The weight of each layer indexes that is relative to the last layer is got respectively, continually, the weight of each layer is multiplied from the bottom up, that is, the total weight of the indexes is obtained.

### Examples of AHP evaluation system

We take an example that automobile factory evaluates the spare parts suppliers. The platform will guide the suppliers to provide the relevant materials for the application after the suppliers login the SaaS automotive industry chain service platform remotely. When the suppliers initiate the application, the system stores the material in the database automatically. At this point, the management module control count module for all layers of platform access indicators by the comparison method to get the importance order of the various layers elements to the upper layers, so as to get the weight of each indexes weight finally, taking the second indexes that R & D capability as an example, the comparison matrix is shown in Table 3.

Table 3 Judgment matrix list

Evaluation Index	Continuous Improvement	Innovative Capacity	Production Capacity	Information Level
Continuous Improvement	1	1/2	3	2
Innovative Capacity	2	1	5	3
Production Capacity	1/3	1/5	1	1/2
Information Level	1/2	1/3	2	1

Solving matrix and getting the maximum eigenvalue  $\lambda_{\max} = 4.0145$ ,  $CR = 0.005 < 0.1$  according to formula 1 and 2, so the matrix pass conformance test. The weight vector can be worked out by using the eigenvector method:

$$W = (0.272 \ 0.483 \ 0.088 \ 0.157)^T$$

Three suppliers A, B, C, are extracted. The experts evaluate the three companies on four indexes. The evaluation judgment matrixes are showed from Table 4 to Table 7.

Table 4

Continuous Improvement	Supplier A	Supplier B	Supplier C
Supplier A	1	1/2	2
Supplier B	2	1	3
Supplier C	1/2	1/3	1

Table 5

Innovative Capacity	Supplier A	Supplier B	Supplier C
Supplier A	1	2	1/3
Supplier B	1/2	1	1/5
Supplier C	3	5	1

Table 6

Production Capacity	Supplier A	Supplier B	Supplier C
Supplier A	1	1/3	1/2
Supplier B	3	1	1
Supplier C	2	1	1

Table 7

Information Level	Supplier A	Supplier B	Supplier C
Supplier A	1	4	5
Supplier B	1/4	1	2
Supplier C	1/5	1/2	1

We can get the maximum eigenvalue and the weight vector after matrixes was solved, it is showed in Table 8.

Table 8

	Continuous Improvement	Innovative Capacity	Production Capacity	Information Level
$\lambda_{\max}$	3.009	3.004	3.018	3.025
Supplier A	0.297	0.226	0.169	0.683
Supplier B	0.540	0.123	0.444	0.200
Supplier C	0.163	0.651	0.387	0.117

All the matrixes pass the conformance test. Then we work out the compound weigh.

$$W_c = \begin{pmatrix} 0.297 & 0.226 & 0.169 & 0.683 \\ 0.540 & 0.123 & 0.444 & 0.200 \\ 0.163 & 0.651 & 0.387 & 0.117 \end{pmatrix} \cdot \begin{pmatrix} 0.272 \\ 0.483 \\ 0.088 \\ 0.157 \end{pmatrix} = \begin{pmatrix} 0.312 \\ 0.277 \\ 0.411 \end{pmatrix}$$

The index weight of the enterprise is determined then the system will submit the results to the audit staff, audit personnel to refer the standards that the system provide to audit the suppliers. In addition to the final decision-making process that is completed by system assisting the manual, the whole process is automatically completed by the system, greatly saving the audit costs, and through quantitative way, can be very easy to block, improve the utilization efficiency of the service platform. It greatly saves the audit costs, what's more, it can be very easy to block unqualified enterprise. As a result of which, it improves the utilization efficiency of the service platform. In this example, we get the results of the degree of importance that Supplier C > Supplier A > Supplier B, according to the platform access indicators must be bigger than 0.3, B is not qualified, and urge them to improve the R & D capability of the enterprises. The customers choose the appropriate supplier A or B, obviously, A is better.

## Conclusions

It greatly simplifies the process of selecting and eliminating the obvious non-qualified enterprises and improves the utilization efficiency of the service platform that setting the access standards for the SaaS automotive industry chain. Compared to the unmodified SaaS automotive industry chain cloud service platform, the platform has the following advantages:

Firstly, The establishment of the platform has the characteristics of universal application, any enterprise can easily get the relevant data to participate in the evaluation, it still has a strong operability although considering the differences of the assessment indicators among all the Suppliers.

Secondly, that calculating implement automatically by the system has fast calculation speed and meet the requirements that chief enterprises eliminate and prefer. Appropriate enterprise quickly

Thirdly, the evaluation model can evaluate the suppliers comprehensively and scientifically in different indexes, and meet all kinds of needs of different suppliers. It is suitable for all kinds of small and medium enterprises' suppliers selection.

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