Uso racional de medicamentos antibacterianos y pérdida de conocimiento de la cadena de suministro basada en Fuzzy AHP

Rational Use of Antibacterial Drugs and Supply Chain Knowledge Leakage based on Fuzzy AHP

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Resumen
Los estudios han demostrado que el uso correcto de los medicamentos antibacterianos puede prevenir o tratar eficazmente las infecciones quirúrgicas postoperatorias, reducir las complicaciones correspondientes y aumentar la seguridad de la cirugía. En la selección de medicamentos, las cefalosporinas y quinolonas de tercera generación son los principales agentes antimicrobianos. Al mismo tiempo, el transporte y almacenamiento de medicamentos antibacterianos es una forma importante de garantizar la efectividad de los medicamentos, y la efectividad de la gestión de la cadena de suministro de medicamentos debe ser mejorada. En este artículo, el autor analiza el uso racional de los fármacos antibacterianos y la pérdida de conocimiento de la cadena de suministro según el modelo de AHP y el análisis de seguridad de los fármacos. Al construir el modelo de fuga de conocimiento de la cadena de suministro, el resultado muestra que el competidor externo recopila, analiza, infiere y utiliza el conocimiento privado para obtener más ganancias, lo que lleva a la crisis de confianza y la disminución del rendimiento del intercambio de conocimientos. Al analizar los factores de riesgo del "intercambio de conocimientos, la filtración de conocimientos y la inferencia de conocimientos", utilizando métodos de división de la estructura, análisis integral y desarrollo de índices, encontramos los factores relevantes y presentamos sugerencias para mejorar.

Palabras clave: riesgo en la cadena de suministro, medicamentos antibióticos, pérdida de conocimiento, quinolonas, seguridad de los medicamentos.

Abstract
Studies have shown that the correct use of antibacterial drugs can effectively prevent or treat postoperative surgical infections, reduce the corresponding complications, and increase the safety of surgery. In drug selection, the third generation cephalosporins and quinolones are the main antimicrobial agents. At the same time, the transportation and storage of antibacterial drugs is an important way to ensure the effectiveness of drugs, and the effectiveness of drug supply chain management needs to be improved. In this paper, the author analyse the rational use of antibacterial drugs and supply chain knowledge leakage based on AHP model and drug safety analysis. By constructing the knowledge leakage model of supply chain, the result shows that the third-party competitor collects, analyzes, infers and utilizes the private knowledge to get more profit, which leads to the crisis of trust and the decline of the performance of knowledge sharing. Through analyzing the risk factors of "knowledge sharing, knowledge leakage and knowledge inference", using methods of dividing structure, comprehensive analysis and index development, we found the relevant factors and put forward suggestions for improvement.

Key words: Supply chain risk, Antibiotics drugs, Knowledge leakage, Quinolones, Drug safety

1. Introduction
With the rapid development of knowledge economy, knowledge has become an important strategic resource for supply chain member enterprises to obtain innovation advantages and competitiveness. Through the sharing of supply chain knowledge resources, the richness of knowledge resources of supply chain member enterprises can be effectively guaranteed, the whole supply chain knowledge stock can be increased, and the overall operation efficiency and competitiveness of supply chain can be improved. In the process of knowledge sharing, the recipient absorbs and uses knowledge from the sender, and realizes and brings high profit to the enterprise even realizes knowledge innovation. However, in the process of knowledge sharing, due to the existence of opportunism and moral hazard, the knowledge receiver may divulge the core technology and knowledge contained in the information to the sender’s competitors by means of transferring, sailing, etc. Competitors will also analyze, infer and use this knowledge for their own benefit. A typical example is a supply
chain consisting of two competing manufacturers and one retailer, where the leading manufacturer shares knowledge such as cost and inventory with the retailer. The retailer may leak this information to a following manufacturer for lower wholesale costs. The following manufacturer determines its wholesale price to gain a competitive advantage. This knowledge leakage behavior directly leads to the negative deviation between the actual performance and the expected performance of the supply chain, which affects the overall performance of the knowledge sharing in the supply chain. Therefore, it is of great significance to identify the risk factors of knowledge leakage in supply chain, evaluate the effect of risk factors of knowledge leakage, and then put forward measures to prevent the risk of knowledge leakage in supply chain. Based on the above considerations, this paper analyzes the risk factors of knowledge leakage in the process of knowledge sharing in supply chain enterprises based on the improved fuzzy analytic hierarchy process, and establishes a risk factor evaluation model. The theoretical analysis framework of knowledge leakage risk on knowledge sharing performance in supply chain is also constructed which can provide some suggestions for supply chain members about knowledge sharing and knowledge management.

Scholars have done a lot of researches on knowledge sharing behavior in supply chain. Szulanski(1996) firstly concluded the concept of knowledge sharing. He believed that knowledge sharing was to spread knowledge across borders between different organizations in different ways with excellent purpose and plan. In the process of dissemination, knowledge sender and receiver achieve knowledge transfer, acquisition, absorption and utilization through effective interaction[1]. Kim(2002) thought knowledge sharing among supply chain enterprises is the foundation of long-term cooperation between supply chain enterprises. Taking the supply chain of automobile manufacturing enterprises as an example, he pointed out that the knowledge sharing of supply chain enterprises can be realized effectively when retailers join in the supply chain design[2]. In recent years, more and more scholars have studied the connotation of knowledge sharing on the basis of predecessors. Wu et al. believed that knowledge sharing can further enhance the knowledge owned by individuals and organizations. Chen et al. thought that the development of knowledge economy makes knowledge become a scarce resource day by day, and the scarcity of knowledge becomes one of the important factors restricting the efficiency of supply chain operation. It is necessary to strengthen the knowledge sharing among the members of the supply chain and promote the knowledge innovation and operation efficiency[4]. Zhang et al. taking Toyota as an example, analyzes the advanced experience and enlightenment of knowledge sharing between Toyota and suppliers, and provides experience for Chinese enterprises to share knowledge in supply chain[5].

The problem of knowledge leakage in supply chain knowledge sharing has attracted wide attention with the research development on knowledge sharing in the supply chain. Li(2002) pointed out that there are direct effect and leakage effect in vertical knowledge sharing. Leakage effect is regarded as a manifestation of knowledge sharing risk in supply chain. Therefore, most of scholars described the phenomenon of knowledge leakage in the context of knowledge sharing. Qi(2007) thought that Supply chain knowledge sharing risk involves content risk, management risk, technical risk and so on. The risk of knowledge disclosure is defined as the probability of intentional or unintentional disclosure of trade secrets or economic loss to knowledge-sharing member enterprises such as suppliers, manufacturers, retailers and IT service providers in the process of knowledge sharing[7]. Dong(2009)[8] and Anand&Goyal(2009)[9] revealed the mechanism of "intentional knowledge leakage" by using the method of economic game theory and put forward the corresponding management measures. Kumara&Pugazhendhib(2012) summarized the risk factors of knowledge sharing into technical constraints, knowledge security, trust loss, knowledge system collapse, financial constraints and so on[10]. Through in-depth interviews, Li(2014) constructed the research framework of enterprise knowledge transfer risk by using the method of rooted theory[11]. Zhang(2011)[12] comprehensively analyzed and verified the risk of the knowledge receiver inferring the private information (knowledge) of the shared party by virtue of its own knowledge and technology. At present, the research on knowledge sharing in supply chain is focused on knowledge transfer, knowledge inference and utilization, the quantitative analysis of risk factors of knowledge sharing in supply chain is few. There are only a few piecemeal studies on the risk of intellectual property loss. There is a Lack of a comprehensive and systematic theoretical framework for quantitative identification and assessment of risk factors of supply chain knowledge leakage. Therefore, this paper uses the improved fuzzy analytic hierarchy process (AHP) to identify and evaluate the risk factors of knowledge leakage in the process of knowledge sharing in the supply chain, and sums up the weight of the risk factors of knowledge leakage in the supply chain. The countermeasures and suggestions to avoid the risk of knowledge leakage are put forward, which can be used for reference in knowledge sharing and knowledge management for supply chain companies. Correct use of antibiotics during operation can effectively prevent or treat postoperative surgical infections, reduce the corresponding complications and increase the safety of surgery. But at present, the clinical application of antibiotics is generally unreasonable, especially in perioperative period. At the same time, the logistics transportation of drugs is very important, and the supply chain management of drugs is the current research hotspot.

2. Rational application of antibiotics
At present, there is a big gap in the level of rational use of antibiotics in perioperative period in China. According to the survey report published by the World Health Organization, the utilization rate of antibiotics in hospitalized patients in China is as high as 80% (58% of them use broad-spectrum antibiotics and combined use of more than two kinds of antibiotics), which is much higher than the international level of 30%. According to the survey data of antimicrobial drugs, the frequency of drug use during perioperative period in European and American countries is low, the timing of administration is accurate, the overall rational rate is high, and the irrational phenomena are few. Specific data are as follows: European data show that the prophylactic use rate of antibiotics is 97.5%, the rational rate is 85%; the most commonly used drugs are penicillins and enzyme inhibitors; the average daily use of antibiotics in outpatients and in-patients is 19.35 DDD and 2.2 DDD, respectively; the proportion of the first preventive use of antibiotics in surgery is 19%; U.S. data show that the proportion of the first preventive use of antibiotics in surgery is 19%. The prophylactic application rate of antibiotics in patients undergoing aortic transplantation, hip replacement and colon resection was 86%, and the prophylactic use of antibiotics within 2 hours before operation accounted for 63%. The common phenomena in the application of antimicrobial drugs in China are: no indication or weak indication of preventive drug use, unreasonable drug selection and high starting point of drug use, inappropriate drug use time, too many or too few daily doses, too large or too small single dosage, unreasonable route of administration, improper choice of solvent and solvent, etc. Specific data are as follows: the prophylactic use of antibiotics accounted for 98%; in drug selection, the third generation of cephalosporins, the second generation of cephalosporins and quinolones were in the top three; and the third generation of cephalosporins occupied 50.4%; the proportion of cases without preoperative and postoperative use of antibiotics was 52.2%.

### Antibiotics

<table>
<thead>
<tr>
<th>Drug</th>
<th>Use</th>
<th>ADR</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actinomycin D</td>
<td>Very potent antineoplastic drug, highly efficacious in Wilms' tumour and rhabdomyosarcoma</td>
<td>Vomiting, stomatitis, diarrhoea, erythema and desquamation of skin, alopecia</td>
<td>15 μg/kg i.v. daily for 5 days</td>
</tr>
<tr>
<td>Daunorubicin</td>
<td>Effective in many solid tumours</td>
<td>Marrow depression, alopecia, stomatitis, vomiting and local tissue damage</td>
<td>Daunorubicin: 20 mg/vial inj</td>
</tr>
<tr>
<td>Doxorubicin</td>
<td>Capable of causing breaks in DNA strands by activating topoisomerase II and generating quinone type free radicals</td>
<td></td>
<td>Doxorubicin: 60-75 mg/m²</td>
</tr>
<tr>
<td>Epirubicin</td>
<td>Newer drugs similar to doxorubicin</td>
<td>Adj. therap. For breast cancer, G1, bladder cancer</td>
<td>Dose: 60-90 mg/m²</td>
</tr>
</tbody>
</table>

**Figure 1.** Antibiotics drug effect

In recent years, there are more popular views on rational use of antibiotics at home and abroad, such as 3R principle, step-down treatment strategy, short-term treatment strategy, strategic replacement of antibiotics, etc. Step-down therapy is an empirical anti-infective treatment, which can treat most of the critically infected patients. It is the basis of rational drug use strategy. It has the following two characteristics: (1) at the beginning of anti-infective treatment, single, broad-spectrum and powerful antibiotics are selected to cover the bacteria that may cause infection as far as possible; (2) after that (48-72 hours), the use of antibiotics is adjusted according to the results of microbiological examination and drug sensitivity, so as to make the treatment more targeted. For patients, repeated debugging of antibiotics caused by bacterial resistance can be avoided, and the best effect of anti-infective treatment can be guaranteed as much as possible. It is especially suitable for patients with severe or life-threatening infections. In the absence of drug sensitivity, it can reduce or avoid the toxic and side effects of repeated blind exchange of antibiotics or combination drugs.
A typical example of the knowledge leakage risk is consisted two competing manufacturers and one retailer in a supply chain, when the leading manufacturer will share cost and inventory information with the retailer. But the retailer may disclose the leading manufacturer's inventory and the cost of information to the following manufacturer. The following manufacturer determine its wholesale price according to the cost and inventory information afforded by the retailer. If the market demand is determined, the direct loss to the leading manufacturer caused by information or knowledge leakage is the backlog of stocks, economic losses and lower environmental performance (resulting in more carbon emissions).

Referring to the existing research results on risk management and knowledge transformation, this study defines the risk of knowledge leakage in competitive supply chain as Negative deviation between actual performance and expected performance of knowledge sharing parties, knowledge innovation ability, cooperation relationship, core competence, etc. which caused by obstacles or unfavorable factors of knowledge sharing subjects, objects and environment. The risk factors affecting knowledge leakage in supply chain include the sharing party, the receiving party and the competing party, which are systematic and dynamic. This research divides it into three aspects: knowledge sharing party risk factor, knowledge receiver divulging risk factor and competitor knowledge inference using risk factor. It is used as a starting point to evaluate the negative deviation between the actual performance and expected performance of knowledge sharing in supply chain.

3.1. Risk factors of knowledge sharing party

Supply chain knowledge sharing includes demand prediction information, customer demand information, inventory information, production information, order status information, promotion information, quality information, technological progress information and so on. For competitive reasons, knowledge-sharing party are not willing to share private knowledge that contains key tacit knowledge. However, it is also possible that excessive knowledge sharing may occur due to improper knowledge management. If the scope and extent of shared knowledge exceed the limits stipulated in the contract, knowledge leakage risk may occur. In addition, the lack of the knowledge sharing contract, the reward and punishment mechanism, the control ability will lead to confusion in the management of the knowledge sharing. Therefore, the risk of knowledge sharing party can be measured by the level of knowledge sharing, the completeness of sharing contract, the knowledge sharing organization management level [13].

3.2. Risk factors of knowledge receiver

From the economic view, the cooperative enterprises in supply chain sometimes have very different motivations for their own benefits, which leads to the existence of both competition and cooperation. There are two kinds of leakage risks when the knowledge receiver receives the knowledge sharing information from the partner: one is that the knowledge receiver deliberately conceals the valuable knowledge and artificially reduces the performance of the knowledge provided by the sharing party. Reducing the willingness of knowledge-sharing parties to transfer knowledge; another is opportunistic behavior and ethical factors on the part of the knowledge receivers, who take action that maximizes their own benefits and minimizes costs when they receive the knowledge of the sharing party. For example, the sharing party's private knowledge will be leaked to competitors, resulting in malicious encroachment and embezzlement of business knowledge. Therefore, this
The study measures the risk of knowledge receiver by using the conflict of will among supply chain member enterprises and the influence of the difficulty of monitoring knowledge sharing activities on the performance of knowledge sharing in supply chain. There are two kinds of knowledge leakage risks when the knowledge receiver receives the knowledge sharing information from the partner. Firstly, the knowledge receiver deliberately hides valuable knowledge and artificially reduces the effectiveness of the knowledge provided by the sharing party and reduces the willingness of the knowledge sharing party to transfer knowledge. Secondly, because of opportunism behavior and moral factors, Knowledge receiver will make actions in order to maximize their own interests and minimize their costs, such as the sharing party's private knowledge will be leaked to competitors. Therefore, this paper measures the risk of knowledge receiver by using the conflict of will among supply chain member enterprises and the difficulty of monitoring knowledge sharing activities in supply chain [14].

3.3. Risk factors of competitors' knowledge inference and utilization

The knowledge leakage risk of knowledge sharing party is positively related to the knowledge inference and utilization of the competitor. Therefore, this paper uses the factors of competitors' knowledge inference and utilization to measure the risk of knowledge leakage.

Generally speaking, the ability of knowledge acquisition, knowledge inference and utilization, the characteristics of knowledge and the transformation mechanism directly affect the performance of knowledge transfer. The leadership, the trust level, the cooperation level and so on indirectly affect the performance of knowledge transfer. The knowledge management ability of enterprises is an important index to evaluate the inference and utilization of new knowledge. The research on the performance of knowledge sharing in enterprise management capability is also a hot issue in the field of knowledge management [15]. Therefore, this paper uses four indexes: knowledge base, absorption intention, learning culture and staff quality to measure the risk of competitors' knowledge inference and utilization by.

4. Mathematical model of improved fuzzy AHP

This paper takes the typical competitive supply chain as the research object, analyzes the influence degree of the above three kinds of risk factors on the supply chain performance, and constructs the whole process of knowledge sharing, knowledge leakage and knowledge inference and utilization of the competitive supply chain. This is a systematic process and a multi-level system engineering problem while each risk factor contains corresponding factors.

For the complex fuzzy attributes problems such as the knowledge leakage risk factors of supply chain, the improved fuzzy analytic hierarchy process (i-F-AHP) can be used to solve the problems and provide scientific basis by combining the subjective judgment of experts with quantitative description. Compared with the traditional AHP method, the i-F-AHP introduced fuzzy consistency judgment matrix, without the need of consistency testing and less iterations. The convergent speed is improved to meet the requirement of calculation precision. Through research the three stages of knowledge sharing, knowledge disclosure and knowledge transformation, this paper use the i-F-AHP to evaluate index and weight of knowledge leakage risk in supply chain between the actual performance and expected performance and establish the index system.

4.1. Data sources and sample analysis

Engineering consulting industry is a typical knowledge-intensive industry. This paper investigated Shaanxi Zhengheng Group Company, China. Because knowledge sharing, knowledge leakage and knowledge inference and utilization exist in individual, team and company, this paper also take into account the employees at all levels of the company in the questionnaire survey. The study also took into account the employees at all levels of the organization in the selection of questionnaire subjects. 160 questionnaires were sent out to the company executives, department managers and ordinary employees respectively, and returned 147 questionnaires. The index value of Table 1 is obtained by selecting and synthesizing the relevant survey data.

In this study, the quantitative index system was established according to Delphi method. After two rounds of expert consultation, the name and connotation of evaluation index were modified according to experts’ suggestion, and the relative importance of each index was determined by combining with AHP’s 1-9 scale method. Finally, the evaluation index system of competitive supply chain knowledge leakage risk is obtained by synthesizing the results of experts’ scoring and survey data, as shown in Table 1.

<table>
<thead>
<tr>
<th>Knowledge sharing party $A_i$</th>
<th>Slightly important(3)</th>
<th>Knowledge sharing level $B_i$</th>
<th>Completeness of sharing</th>
<th>More important(7)</th>
<th>More important(9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk factors (level one index)</td>
<td>Factor importance degree</td>
<td>Influencing factors (level two index)</td>
<td>Factor importance degree</td>
<td>Knowledge acquisition</td>
<td>Knowledge inference</td>
</tr>
</tbody>
</table>

Table 1 Quantitative criteria for knowledge leakage risk indicators in competitive supply chain
4.2. Risk measurement

1) the judgment matrix of risk factors and its weight determination

Based on the values assigned to each index in Table 1, a judgment matrix of risk factors is constructed, as shown in Table 2.

Table 2 judgment matrix of risk factors for knowledge disclosure

<table>
<thead>
<tr>
<th>Knowledge sharing risk R</th>
<th>Knowledge sharing party A_i</th>
<th>Knowledge sharing receiver A_2</th>
<th>Competitor A_3</th>
<th>weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge sharing level</td>
<td>1</td>
<td>3/5</td>
<td>3/7</td>
<td>0.200</td>
</tr>
<tr>
<td>Completeness of sharing contract B_2</td>
<td>Knowledge sharing organization management level B_3</td>
<td>Willing Conflict B_4</td>
<td>Difficulty in monitoring knowledge sharing activities B_5</td>
<td>Knowledge base B_6</td>
</tr>
</tbody>
</table>

\[
M_i = 1 \times (3/5) \times (3/7) = 9/35 \approx 0.257; \quad W_1 = \sqrt[3]{0.257} = 0.636, \quad W_2 = 1.060, \quad W_3 = 1.484
\]

\[
w_i = W_i / \sum W_i = 0.636 / 3.180 = 0.200, \quad w_2 = 0.333, \quad w_3 = 0.467, \quad W = \begin{bmatrix} 0.200 & 0.333 & 0.467 \end{bmatrix}^T
\]

\[
AW = \begin{bmatrix} 1 & 3/5 & 3/7 \\ 5/3 & 1 & 5/7 \\ 7/3 & 7/5 & 1 \end{bmatrix} \times 0.333 = \begin{bmatrix} 0.6 \\ 1 \\ 1.4 \end{bmatrix}
\]

Characteristic root is

\[
\lambda_{max} = \frac{1}{m-1} \sum_{i=1}^{m} (AW)_i / W_i = 3
\]

The largest characteristic root is

\[
CI = \frac{\lambda_{max} - m}{m-1} = 0
\]

It can be seen that the judgment matrix has satisfactory consistency test results.

2) Judgment matrix of influencing factors and its weight determination

According to the values assigned to each index in Table 1, the judgment matrix of the factors affecting the risk of the knowledge sharing party, the knowledge receiver and the competitor is constructed, which is shown in Table 3, Table 4 and Table 5 respectively.

Table 3 judgment matrix of influencing factors of knowledge sharing party risk

<table>
<thead>
<tr>
<th>Knowledge sharing party A_i</th>
<th>Knowledge sharing level B_i</th>
<th>Completeness of sharing contract B_2</th>
<th>Knowledge sharing organization management level B_3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge sharing level B_i</td>
<td>1</td>
<td>7/5</td>
<td>7</td>
</tr>
</tbody>
</table>

Data Source: collated according to expert survey
By calculation, the weight of the judgment matrix is \( W_{A1} = \begin{pmatrix} 0.538 & 0.385 & 0.077 \end{pmatrix} \), the results show that the consistency of the judgment matrix is satisfactory.

**Table 4** judgment matrix of influencing factors of knowledge receiver risk

<table>
<thead>
<tr>
<th>Knowledge receiver ( A_2 )</th>
<th>Willing Conflict ( B_4 )</th>
<th>Difficulty in monitoring knowledge sharing activities ( B_5 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completeness of sharing contract ( B_2 )</td>
<td>5/7</td>
<td>1</td>
</tr>
<tr>
<td>Knowledge sharing organization management level ( B_1 )</td>
<td>1/7</td>
<td>1/5</td>
</tr>
</tbody>
</table>

By calculation, the weight of the judgment matrix is \( W_{A2} = \begin{pmatrix} 0.75 & 0.25 \end{pmatrix} \), the results show that the consistency of the judgment matrix is satisfactory.

**Table 5** judgment matrix of influencing factors of competitors' risk

<table>
<thead>
<tr>
<th>Competitor ( A_3 )</th>
<th>Knowledge base ( B_k )</th>
<th>Absorption intention ( B_7 )</th>
<th>Learning culture ( B_8 )</th>
<th>Staff quality ( B_9 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge base ( B_k )</td>
<td>1</td>
<td>5/7</td>
<td>5</td>
<td>5/3</td>
</tr>
<tr>
<td>Absorption intention ( B_7 )</td>
<td>7/5</td>
<td>1</td>
<td>7</td>
<td>7/3</td>
</tr>
<tr>
<td>Learning culture ( B_8 )</td>
<td>1/5</td>
<td>1/7</td>
<td>1</td>
<td>1/3</td>
</tr>
<tr>
<td>Staff quality ( B_9 )</td>
<td>3/5</td>
<td>3/7</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

By calculation, the weight of the judgment matrix is \( W_{A3} = \begin{pmatrix} 0.313 & 0.438 & 0.063 & 0.188 \end{pmatrix} \), the results show that the consistency of the judgment matrix is satisfactory.

**4.3. Evaluation system of risk factors for knowledge leakage in competitive supply chain**

Through the above calculation process, the corresponding weights of each indexes are obtained, and all of them pass the consistency test, which shows that the judgment matrix given by investigation is acceptable. The composite weight index of different knowledge leakage risk factors in the process of information and knowledge sharing is obtained.

**Table 6** Index weight of knowledge leakage risk of competitive supply chain

<table>
<thead>
<tr>
<th>Knowledge leakage risk</th>
<th>risk factors ( A ) (level one index weights)</th>
<th>risk factors ( B ) (level two index weights)</th>
<th>Composite weight ( W_{ki} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge sharing party ( A_1 ) (0.200)</td>
<td>Knowledge sharing level ( B_i (0.538) )</td>
<td>Completeness of sharing contract ( B_2 (0.385) )</td>
<td>0.108</td>
</tr>
<tr>
<td>knowledge receiver ( A_2 ) (0.333)</td>
<td>Completeness of sharing contract ( B_2 (0.385) )</td>
<td>Knowledge sharing organization management level ( B_1 (0.077) )</td>
<td>0.077</td>
</tr>
<tr>
<td>competitor ( A_3 ) (0.467)</td>
<td>Completeness of sharing contract ( B_2 (0.385) )</td>
<td>Knowledge sharing organization management level ( B_1 (0.077) )</td>
<td>0.015</td>
</tr>
</tbody>
</table>

| knowledge receiver \( A_2 \) (0.333) | Difficulty in monitoring knowledge sharing activities \( B_5 (0.25) \) | Willing Conflict \( B_4 (0.75) \) | 0.250 |
| Knowledge base \( B_k (0.313) \) | Absorption intention \( B_7 (0.438) \) | Learning culture \( B_8 (0.313) \) | 0.083 |
| Absorption intention \( B_7 (0.438) \) | Learning culture \( B_8 (0.313) \) | 0.146 |
| Learning culture \( B_8 (0.313) \) | 0.204 |
| Absorption intention \( B_7 (0.438) \) | 0.029 |
5. Measures to guarantee the risk of knowledge leakage in supply chain

With the increasing frequency of knowledge updating, the rate of return on knowledge sharing decreases gradually, and the risk of knowledge leakage in supply chain impacts the performance of knowledge sharing in supply chain. Based on the improved fuzzy analytic hierarchy process (i-F-AHP), the knowledge leakage risk elements of competitive supply chain are summarized into three aspects: knowledge sharing party risk, knowledge receiving party risk and competitor risk. The influence of different risk factors on the negative deviation between the actual performance of knowledge sharing and expected performance is obtained. Knowledge is an inexhaustible driving force for the development of supply chain member enterprises and a source for improving the overall operation efficiency of supply chain. It is necessary to reduce the risk of knowledge leakage in supply chain while ensuring the smooth progress of knowledge sharing. Therefore, we need to strengthen the risk prevention and control measures of knowledge transfer from three aspects:

Firstly, knowledge sharing party. In order to maintain their own competitive advantage, supply chain member enterprises should not completely rely on their own knowledge adequacy, but also exchange knowledge and technology with other supply chain members through export-oriented knowledge-sharing behavior. Look for more opportunities for cooperation. In the process of knowledge sharing party releasing knowledge and authorizing knowledge and technology, their own value can also be promoted through external channels. Knowledge sharing can bring more economic benefits to enterprises through commercial transformation. Therefore, we need to improve the knowledge sharing level and organization management level, establish perfect contract to encourage knowledge sharing behavior, reduce the failure risk of knowledge sharing. On the one hand, the knowledge sharing party needs to enhance the knowledge reserve. The more knowledge accumulation, the more knowledge can be shared with the knowledge receiver in the process of knowledge sharing. With the increase of knowledge reserve, the level and ability of knowledge sharing will be further improved. At the same time, it can reduce the cost of knowledge sharing and improve the performance of knowledge sharing. It is necessary to establish a learning-type supply chain mechanism, strengthen the communication and exchange among enterprises, open the channels of communication and exchange among enterprises, improve the learning and training programs among members. Through these measures, the risk of knowledge-sharing reduced and the management level of knowledge sharing organizations improved. On the other hand, the completeness of sharing contract and the level of knowledge sharing organization management are important factors of knowledge sharing performance. Therefore, it is necessary to establish a reasonable incentive mechanism for knowledge transfer and to encourage knowledge sharing parties to transfer knowledge actively step by step. Through material rewards and spiritual rewards to enhance the willingness of knowledge sharing. In the cooperation contract of supply chain members, the incentive mechanism are set up according to the ability of the enterprise knowledge transfer, transfer content value. Finally, the contribution of knowledge sharing is regarded as the reference basis of income distribution.

Secondly, the knowledge receiving party. Enterprises acquire internal and external knowledge through knowledge sharing, utilize valuable knowledge or core technology resources through cooperation with upstream and downstream enterprises. In the process of knowledge sharing, the boundaries of supply chain enterprises become blurred. The improvement of the whole operation performance of the supply chain is based on the quantity of knowledge absorbed by the member enterprises and the improvement of the operation efficiency of the member enterprises. Therefore, the knowledge sharing and the knowledge receiver should sign a clear knowledge sharing protocol, according to the common knowledge of the two parties to establish the mechanism of reward and punishment about knowledge transfer and knowledge protection. By continuously obtaining the knowledge provided by the knowledge sharing party, the knowledge receiver improves the level of knowledge reserve and the ability of knowledge integration. And the ability to absorb and transform knowledge, strengthen the absorption and transformation of core knowledge, and acquire more advanced knowledge and advanced technology. If the receiver conceals the effect of absorption, integration and utilization of knowledge, it is easy to reduce the knowledge provider's willingness to share knowledge. The knowledge receiver needs to feedback the real effect of knowledge transfer and knowledge absorption and utilization to the knowledge sender in a specific way, and to strengthen the knowledge sender's willingness to share knowledge and reduce the conflict between the two sides by adopting such measures as spiritual motivation and material incentive. On the other hand, we should establish and improve the management mechanism and transfer platform of knowledge sharing, guarantee the smooth communication of knowledge transfer parties, establish knowledge database through knowledge classification, and widen the channels of knowledge transfer. In order to reduce the risk of knowledge leakage caused by opportunism and moral problems and improve the performance of knowledge sharing in supply chain, the live detection of knowledge sharing is carried out to reduce the risk of knowledge leakage caused by opportunism and moral problems.
Third, the competitor. In order to quickly acquire valuable knowledge and core technical knowledge, reduce the cost of searching for knowledge, reduce R & D investment, and shorten the R & D cycle, it is likely that the competitor will acquire the sharing knowledge through improper means to improve its own performance. If the ability of knowledge absorption and transformation of competitor is stronger, the risk of knowledge leakage will be greater. Generally speaking, the knowledge management level of the competitor is mainly composed of knowledge base, absorption intention, learning culture, staff quality and so on. To avoid declining the performance of knowledge sharing in supply chain, it is necessary to sign strict knowledge sharing confidentiality agreement and knowledge sharing system between the knowledge sharing party and the knowledge receiver. The security level of all kinds of explicit knowledge and tacit knowledge shared by enterprises should be classified, and the knowledge receiver should be restricted from having access to the knowledge of high security level. All the staff should be better aware of confidentiality through regular and institutionalized security education. Strengthen the protection of core knowledge and reduce the risk of knowledge leakage.

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