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# Research on Green Supplier Evaluation System of Medical Device Industry based on Entropy Weight TOPSIS

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## Abstract

**In this paper, aiming at the environmental and economic benefits of the medical device industry in the selection of suppliers, and reducing the damage and impact of production activities on the environment, the index evaluation and analysis method is used to study the selection of suppliers in the medical device industry. From the perspective of green supply chain, enterprises can not only reduce the procurement cost of the enterprise, but also improve the environmental problems in the operation activities of enterprises by selecting suitable suppliers and establishing long-term and stable cooperative relations with them. This paper constructs the relevant primary and secondary indicators, adopts the entropy weight TOPSIS method to select the most suitable green suppliers of medical devices, and provides a practical evaluation method for related enterprises in the medical device industry.**

## Keywords

**Medical Device; Green Supplier; Entropy Weight; TOPSIS.**

## 1. Introduction

The medical device industry is a sub-industry in the pharmaceutical industry, which involves many fields such as medicine, equipment, electronics, chemical industry, etc. At present, the competition among enterprises in the medical device industry is increasingly fierce, so the implementation of green supply chain management has a very important strategic significance for the development of medical device enterprises. The implementation of green supply chain management in the medical device industry not only pays attention to the coordinated development of environment and economy, but also promotes the sustainable development of the entire medical device industry. In the green procurement link of green supply chain management, suppliers can magnify their own achievements in green environmental protection in the downstream follow-up process of the supply chain. The higher the green degree of upstream and downstream suppliers in the supply chain, the easier it will be for downstream enterprises to carry out green procurement. Therefore, it is very important for current medical device companies to choose appropriate green suppliers.

At present, there are many studies on the supply chain, and scholars at home and abroad have expressed unique views on this. Dan Bin and Liu Fei (2000) defined the green supply chain, and proposed supply chain management technology and green manufacturing theory as its core basis. Li Haiyue (2004) systematically introduced and analyzed some major models and methods for supplier selection, and pointed out their application environment, evaluation criteria, theories and methods, and solutions. Xu Hui (2008) selected five indicators of reputation and popularity, price, technology, quality, and delivery ability in the evaluation of suppliers, and used the TOPSIS method to construct an evaluation model for supplier selection. Zhang Jian (2019) studied a supplier selection model based on the HTFWGBM operator, which fully considers the correlation between attributes, eliminates the influence of redundant information between attributes on decision-making results, and provides a new approach for

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multi-attribute decision-making problems . Yang Ning (2020) studied the use of AHP-TOPSIS evaluation method to select suppliers in the context of green supply chain. He listed product quality, cost control, delivery ability, service ability, corporate performance and environmental factors as evaluation factors. index. In addition, the research methods commonly used by scholars include BP neural network, mutation series method, grey relational analysis method, VIKOR algorithm, etc.

From the current research situation at home and abroad, it is found that there are many literatures on the classification and evaluation of suppliers, but most of them are concentrated in the manufacturing industry, while there are few relevant literatures on the evaluation of medical device suppliers, and the evaluation started late. In the existing literature research, the evaluation index on the selection of medical device suppliers is not enough to measure the green degree, and the green index is often rarely considered in the procurement process. Therefore, this paper considers and adds the green environmental protection index into the supplier index system. When selecting suppliers, some evaluation methods are too affected by subjective factors. In this paper, the entropy weight TOPSIS method is used to evaluate medical device suppliers, and the relevant evaluation indicators are improved and optimized to provide reference for related enterprises.

## 2. Construction of Green Supplier Evaluation Model for Medical Device Enterprises

### 2.1. Improvement of Evaluation Index System

**Table 1.** Improved comprehensive evaluation system for green suppliers of medical devices

| First-level indicators | Secondary indicators |
|---|---|
| Supplier reputation | Enterprise reputation |
| | Enterprise scale |
| | Supply historical performance |
| Product quality | Product pass rate |
| | Quality certification system |
| Service level | Pre-sale and after-sale service |
| | Order Processing Accuracy Rate |
| | On-Time Delivery Rate |
| Cost | Product Price |
| | Logistics Cost |
| | Price stability |
| Green environmental protection | ISO14001 certification |
| | Medical equipment green logistics |
| | Utilization of raw materials and energy for medical devices |
| | Recyclability of medical waste products |
| | Packaging Reduction for Medical Device Components |
| | Discharge of polluting waste |

This paper draws on relevant domestic and foreign literatures to check the green supplier selection method, green supplier evaluation index system, green supplier performance evaluation and corresponding journal papers and dissertations and other related materials, and summarizes the supply of some predecessors and scholars. Commercial green environmental protection indicators, which mainly include a series of indicators such as discharge of polluting

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waste, energy consumption, product recovery rate, ISO certification, green packaging level, environmental management, ecological design, and green logistics.

The traditional comprehensive evaluation system for medical device suppliers mainly includes the top four first-level indicators in Table 1 and the corresponding second-level indicators. Combining the evaluation goal orientation and index selection mechanism of modern green suppliers, this paper improves the original comprehensive evaluation system for medical device suppliers, and introduces a new "green environmental protection" first-level index and its corresponding six second-level indexes , and finally determined the following evaluation index system for medical device suppliers.

## 2.2. Construction of Comprehensive Evaluation Model for Medical Device Suppliers based on Entropy Weight TOPSIS

In spatial statistics, the TOPSIS method is an analytical method based on spatial statistics. This method converts the data into points in a multi-dimensional coordinate system, calculates the ideal reference points in space, that is, the positive and negative ideal solutions, and then calculates the distance between the scheme points and the positive and negative ideal solutions, and finally calculates each scheme and the ideal solution. , and sort the solutions. The solution that is close to the positive ideal solution and far away from the negative ideal solution is the best solution. The TOPSIS method can objectively comprehensively evaluate each scheme in the case of multiple indicators, and is widely used in the field of multi-criteria decision-making research. Since the weight of each indicator is the same by default in the TOPSIS method, this paper uses the entropy weight correction method to determine the weight of each indicator. The advantage of this method is to get rid of the dependence on the knowledge and experience of decision makers, making the result of the weighting more scientific and reasonable.

The specific operation steps are as follows.

(1)Preliminary analysis and processing of data: Assuming that there are m targets and n evaluation indicators, and $x_{ij}$ represents the score of the j-th indicator of the i-th supplier, the supplier's indicator evaluation matrix is:

$$\boldsymbol{X}' = (x_1', x_2', \ldots, x_n') = (x_{ij}')_{m \times n}$$

(2)Unify the index type, convert the inverse index and moderate index into positive index, and get the matrix of index forwardization:

$$\boldsymbol{X} = (x_1, x_2, \ldots, x_n) = (x_{ij})_{m \times n}$$

i=1,2,...,m, j=1,2,...,n

(3)Standardization: The data is dimensionless, and the dimensionless formula is used in the TOPSIS method:

$$R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}}$$

Get a dimensionless matrix:

$$\boldsymbol{Y} = (y_1, y_2, \ldots, y_n) = (y_{ij})_{m \times n}$$

(4)Determine the weights and construct a weighted evaluation matrix. For TOPSIS, the entropy weight correction method is used to determine the weight of each index. Information entropy is a measurement method that uses probability to measure the uncertainty of information. If the distribution of information data is more scattered, the uncertainty will be greater. The decision information of each indicator can be represented by its information entropy value $e_j$:

$$e_j = -\frac{1}{l_n m} \sum_{i=1}^{m} r_{ij} l_n (r_{ij})$$

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In the formula, $r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}$, which represents the proportion of the i-th supplier under the j-th indicator in the indicator. The difference coefficient $d_j$ of the evaluation data of the j-th index is expressed as:

$$d_j=1-e_j$$

For the j-th index, the larger the difference coefficient $d_j$ of the index value $x_{ij}$, the greater the effect of $x_{ij}$ on supplier evaluation.

Calculate the weight of the j-th indicator as:

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$$

After calculating the weight $w_j$ of each indicator, the indicator weighted evaluation matrix of the supplier can be obtained as:

$$Z = \begin{bmatrix} w_1 y_{11} & w_2 y_{12} \cdots & w_n y_{1n} \\ \vdots & \ddots & \vdots \\ w_1 y_{m1} & w_2 y_{m2} \cdots & w_n y_{mn} \end{bmatrix}$$

(5)Determine the positive ideal solution and the negative ideal solution

Positive ideal solution $z^+ = \begin{cases} maxz_{ij} --Benefit\ type \\ minz_{ij} --Cost\ type \end{cases}$

Negative ideal solution $z^- = \begin{cases} minz_{ij} --Benefit\ type \\ maxz_{ij} --Cost\ type \end{cases}$

(6)The distance between the evaluation value of the supplier and the evaluation value set of positive and negative ideal solutions can be expressed by the n-dimensional Euclidean formula:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (z_{ij} - z_j^+)^2}$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (z_{ij} - z_j^-)^2}$$

(7)Calculate the relative posting progress $T_i$ of each supplier:

$$T_i = \frac{d_i^-}{d_i^- + d_i^+}$$

(8)The alternative suppliers are sorted according to the calculated value, the larger the value, the better the overall performance of the supplier. Therefore, just select the cooperative supplier with the largest $T_i$ value.

## 3. A Case Study on the Evaluation Process of Medical Device Suppliers

### 3.1. An Example of an Improved Comprehensive Evaluation System for Green Suppliers of Medical Devices based on Entropy Weight Topsis Model

A total of 4 suppliers have become alternative suppliers, and the 4 suppliers are recorded as Supplier A, Supplier B, Supplier C, and Supplier D respectively. The evaluation indicators are shown in Table 2, and the indicators are based on the full score of 10 points. Standard assessment. The improved comprehensive evaluation system for green suppliers of medical devices was compared with the traditional comprehensive evaluation system using the entropy weight TOPSIS method, and suitable suppliers were selected.

(1)Preliminary analysis and processing of the data, the supplier's initial index evaluation matrix $\boldsymbol{X'}$:

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$$\begin{pmatrix} 6 & 7 & 6 & 9 & 8 & 8 & 9 & 9 & 7 & 6 & 9 & 7 & 9 & 7 & 9 & 6 & 8 \\ 5 & 9 & 4 & 8 & 8 & 7 & 9 & 8 & 8 & 4 & 8 & 6 & 8 & 8 & 9 & 4 & 9 \\ 8 & 7 & 5 & 9 & 7 & 9 & 8 & 8 & 6 & 7 & 7 & 8 & 6 & 7 & 7 & 8 & 7 \\ 6 & 8 & 3 & 9 & 9 & 7 & 9 & 9 & 5 & 6 & 9 & 5 & 7 & 6 & 8 & 5 & 8 \end{pmatrix}$$

**Table 2.** Scoring of the Comprehensive Evaluation System for Green Suppliers of Medical Devices

| Metric | Metric Type | A | B | C | D |
|---|---|---|---|---|---|
| Enterprise reputation | Traditional comprehensive evaluation indicators of medical device suppliers | 6 | 5 | 8 | 6 |
| Enterprise scale | | 7 | 9 | 7 | 8 |
| Supply historical performance | | 6 | 4 | 5 | 3 |
| Product pass rate | | 9 | 8 | 9 | 9 |
| Quality certification system | | 8 | 8 | 7 | 9 |
| Pre-sale and after-sale service | | 8 | 7 | 9 | 7 |
| Order Processing Accuracy Rate | | 9 | 9 | 8 | 9 |
| On-Time Delivery Rate | | 9 | 8 | 8 | 9 |
| Product Price | | 7 | 8 | 6 | 5 |
| Logistics Cost | | 6 | 4 | 7 | 6 |
| Price stability | | 9 | 8 | 7 | 9 |
| ISO14001 certification | Improved Evaluation Indicators for Green Suppliers of Medical Devices | 7 | 6 | 8 | 5 |
| Medical equipment green logistics | | 9 | 8 | 6 | 7 |
| Utilization of raw materials and energy for medical devices | | 7 | 8 | 7 | 6 |
| Recyclability of medical waste products | | 9 | 9 | 7 | 8 |
| Packaging Reduction for Medical Device Components | | 6 | 4 | 8 | 5 |
| Discharge of polluting waste | | 8 | 9 | 7 | 8 |

(2)The data is dimensionless, and the dimensionless matrix $\boldsymbol{Y}$ is obtained:

$$\begin{pmatrix} 0.473 & 0.449 & 0.647 & 0.514 & 0.498 & 0.513 & 0.514 & 0.528 & 0.531 & 0.513 & 0.543 & 0.531 & 0.593 & 0.497 & 0.543 & 0.505 & 0.498 \\ 0.394 & 0.577 & 0.431 & 0.457 & 0.498 & 0.449 & 0.514 & 0.470 & 0.606 & 0.342 & 0.482 & 0.455 & 0.528 & 0.569 & 0.543 & 0.337 & 0.560 \\ 0.630 & 0.449 & 0.539 & 0.514 & 0.436 & 0.577 & 0.457 & 0.470 & 0.455 & 0.598 & 0.422 & 0.606 & 0.396 & 0.497 & 0.422 & 0.674 & 0.436 \\ 0.473 & 0.513 & 0.323 & 0.514 & 0.560 & 0.449 & 0.514 & 0.528 & 0.379 & 0.513 & 0.543 & 0.379 & 0.462 & 0.426 & 0.482 & 0.421 & 0.498 \end{pmatrix}$$

(3)According to the entropy method, the weight of each index is determined, so as to construct a weighted decision matrix.

$$e_j = -\frac{1}{l_n m}\sum_{i=1}^{m} r_{ij} l_n\,(r_{ij})$$

$e_j$ = (0.989,0.996,0.977,0.999,0.997,0.996,0.999,0.999,0.989,0.986,0.996,0.989,0.992,0.996,0.996,0.977,0.997)

$d_j$=1-$e_j$= (0.010656, 0.004068, 0.022657, 0.000901, 0.002825, 0.004068, 0.000901, 0.001249, 0.010759,0.013676,0.003714,0.010759,0.008064,0.003693,0.003714,0.023424,0.002825)

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$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$ = (0.083278,0. 031792, 0.177073, 0.007042, 0.022080, 0.031792, 0.007042, 0.009759,0.084085,0.106885,0.029027,0.084085,0.063027,0.028862,0.029027,0.183065,0.022080)

The index weighted evaluation matrix Z of the available suppliers is:

$$\begin{pmatrix} 0.039 & 0.014 & 0.115 & 0.004 & 0.011 & 0.016 & 0.004 & 0.005 & 0.045 & 0.055 & 0.016 & 0.045 & 0.037 & 0.014 & 0.016 & 0.093 & 0.011 \\ 0.033 & 0.018 & 0.076 & 0.003 & 0.011 & 0.014 & 0.004 & 0.005 & 0.051 & 0.037 & 0.014 & 0.038 & 0.033 & 0.016 & 0.016 & 0.062 & 0.012 \\ 0.053 & 0.014 & 0.095 & 0.004 & 0.010 & 0.018 & 0.003 & 0.005 & 0.038 & 0.064 & 0.012 & 0.051 & 0.025 & 0.014 & 0.012 & 0.123 & 0.010 \\ 0.039 & 0.016 & 0.057 & 0.004 & 0.012 & 0.014 & 0.004 & 0.005 & 0.032 & 0.055 & 0.016 & 0.032 & 0.029 & 0.012 & 0.014 & 0.077 & 0.011 \end{pmatrix}$$

(4)Determine the positive and negative ideal solutions:

Positive ideal solution $z^+$= (0.053, 0.018,0.115, 0.004, 0.012, 0.018, 0.004, 0.005, 0.051, 0.064, 0.016, 0.051,0.037,0.016,0.016,0.123,0.012)

Negative ideal solution $z^-$ =(0.033, 0.014, 0.057, 0.003, 0.010, 0.014, 0.003, 0.005, 0.032, 0.037, 0.012, 0.032,0.025,0.012,0.012,0.062,0.010)

(5)The distance between the evaluation value of the supplier and the evaluation value set of positive and negative ideal solutions:

$$d_i^+ = (0.036, 0.081, 0.027, 0.081)$$
$$d_i^- = (0.072, 0.030, 0.083, 0.026)$$

(6) Calculate the relative posting progress $T_i$ of each supplier:

$$T_i = (0.664, 0.269, 0.752, 0.242)$$

(7)The alternative suppliers are sorted according to the calculated value, the larger the value, the better the overall performance of the supplier.

**Table 3.** Comprehensive evaluation results of improved green suppliers of medical devices

| | Supplier A | Supplier B | Supplier C | Supplier D |
|---|---|---|---|---|
| $d_i^+$ | 0.036 | 0.081 | 0.027 | 0.081 |
| $d_i^-$ | 0.072 | 0.030 | 0.083 | 0.026 |
| $T_i$ | 0.664 | 0.269 | 0.752 | 0.242 |

The comprehensive evaluation of the four suppliers is in order of supplier C, supplier A, supplier B, and supplier D. Therefore, supplier C should be selected under the improved comprehensive evaluation system for green suppliers of medical devices.

## 3.2. Calculation Example of Traditional Comprehensive Evaluation System for Medical Device Suppliers based on Entropy Weight TOPSIS Model

Calculated in the same way under the comprehensive evaluation system of traditional medical device suppliers without considering green environmental protection indicators, the relative progress of each supplier is as follows.

The comprehensive evaluation of the four suppliers is supplier A, supplier C, supplier B, and supplier D. It can be seen that supplier A should be selected under the traditional comprehensive evaluation system for medical device suppliers.

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**Table 4.** Comprehensive evaluation results of traditional medical device suppliers

| | Supplier A | Supplier B | Supplier C | Supplier D |
|---|---|---|---|---|
| $d_i^+$ | 0.030 | 0.087 | 0.040 | 0.106 |
| $d_i^-$ | 0.105 | 0.046 | 0.087 | 0.034 |
| $T_i$ | 0.776 | 0.349 | 0.684 | 0.242 |

## 4. Research and Evaluation Conclusion

This paper improves the traditional comprehensive evaluation system of medical device suppliers, adds six second-level indicators under the first-level indicators of enterprise green environmental protection, and applies the entropy weight TOPSIS method to the evaluation of medical device suppliers, and draws the following conclusions:

Based on the entropy weight TOPSIS method, under the improved comprehensive evaluation system for green suppliers of medical devices, the evaluation result is to select supplier C, while under the traditional comprehensive evaluation system for medical device suppliers, the evaluation result is to select supplier A . Compared with the previous supplier evaluation system, 6 green secondary indicators have been added to the improved system, which makes the selection of indicators more comprehensive, more in line with the characteristics of green supply chain, and more reasonable and scientific. The reason why the selection of suppliers has changed is that after adding green environmental protection indicators, the comprehensive score of C suppliers is higher, and the newly improved indicator system is more conducive to suppliers who are relatively good in green environmental protection. In terms of the practical application of green supplier selection, ISO14001 certification is a qualitative indicator, which is assessed by a third-party certification body to pass the certification or not to pass the certification; the green logistics of medical devices in this article mainly refers to green transportation, and green transportation mainly reduces emissions from exhaust gas. Considering the use of vehicles and new energy vehicles, green transportation = (the number of vehicles with low exhaust emissions + the number of new energy vehicles) / the total number of vehicles used; the utilization rate of medical equipment raw materials and energy is used to measure the supplier's resource utilization degree , which can be quantified by raw material consumption and energy consumption per unit product, raw material utilization rate = (net weight of materials contained in unit product/weight of material consumed per unit product) × 100%; energy utilization efficiency = (effectively utilized energy per unit product /Actual energy consumption per unit product) × 100%; Recyclable rate of medical waste products = (recycling amount of waste products in a certain period of time / total amount of waste products in a certain period of time) × 100%; Packaging reduction of medical device parts It refers to the packaging that conforms to the concept of sustainable development. On the premise of ensuring product safety, the outer packaging should be used as little as possible. This indicator can be assessed by professionals; the discharge of polluting waste refers to the negative impact of the supplier on the environment during the production process. The impact can be quantified by the amount of toxic waste emitted per unit of product.

In the entropy weight TOPSIS method used in this paper, the application of the "entropy value method" eliminates the influence of subjective factors in the process of weight calculation, and its weight score is based on the actual dispersion of supplier index data. The comparative analysis between evaluation indicators is relatively more objective and reflects the actual characteristics of supplier selection in the new era, making the evaluation process more intuitive and rigorous. Through the conclusion analysis, the newly improved green supplier index system of medical device enterprises is more conducive to selecting high-quality suppliers who have done more prominently in the field of green environmental protection. At the same time, the entropy weight TOPSIS evaluation method is suitable for the green supply

of medical device enterprises. business choice. The evaluation indicators of green suppliers of medical devices and the evaluation methods provided in this paper provide a reference for the selection of suppliers of medical device-related enterprises, and have certain application significance.

## References

[1] Zhang Hongyan, Li Bin, Wang Lijun, He Dehua. Establishment of evaluation index set for medical equipment suppliers [J]. Medical Equipment Information, 2006(06): 63-64.

[2] Zhang Jian. Based on HTFWGBM operator Research on the Supplier Selection Model of China [J]. China Management Science, 2019, 27(03): 137-143.

[3] Liu Xiao, Li Haiyue, Wang Chengen, Chu Chengbin. Review of Supplier Selection Models and Methods [J]. China Management Science, 2004(01):140-149.

[4] Wu Jian, Cao Qingwei, Li Hui. Green supplier selection method based on COWA operator in fuzzy decision-making environment [J]. Chinese Journal of Management Engineering, 2010, 24(03) :61-65.

[5] Xie Xuemei, Luo Dan, Gao Yanru. Empirical Research on the Collaboration Mechanism of Supply Chain Enterprises Based on Green Innovation [J]. Chinese Journal of Management Engineering, 2019,33(03):116-124.

[6] Zou Ping, Yuan Yinan. Supplier selection based on EAHP and GRAP [J]. Systems Engineering Theory and Practice, 2009, 29(03): 69-75.

[7] Ye Hua, Xie Weihua, Bu Xianglei, Huang Erliang. Balanced Scorecard-based Medical Discussion on Performance Management of Consumables Suppliers [J]. China Medical Equipment, 2019, 34(07): 153-156.

[8] Yue Yimeng, Lu Shan. Medical equipment suppliers based on improved rough set theory and AHP Selection [J]. China Medical Equipment, 2016, 31(10): 138-139+151.

[9] Wang Daoping, Wang Xu. Research on the index weight of green supplier selection in iron and steel enterprises based on AHP/entropy method [J]. Soft Science, 2010, 24(08): 117-122.

[10] Hou Mao. Research on the evaluation and selection of suppliers in the medical device industry [D]. Shanghai Jiaotong University, 2009.

[11] Luo Xinxing, Peng Suhua. Green Supply Research on supplier evaluation and selection based on AHP and TOPSIS in the chain [J]. Soft Science, 2011, 25(02): 53-56.

[12] Zhang Juncai, Zhao Lijuan, Zhao Yi. Supplier selection in hospital equipment purchase [J]. Medical Equipment Information, 2004(04): 53-55.

[13] Xu Hui. Research on supplier evaluation index system and selection method [D]. Hefei University of Technology, 2008.

[14] Dan Bin, Liu Fei .Research on Green Supply Chain and Its System Structure[J].China Mechanical Engineering, 2000(11):40-42+4.

[15] Wang Xiangjie, Ying Yue, Wang Zhikang, Lou Haifang. Evaluation system for medical device suppliers based on AHP method [J].China Medical Equipment, 2016,31(03):144-145+148.

[16] Han Li,Mei Qiang,Lu Yumei,Ji Min.Analysis and research on AHP-fuzzy comprehensive evaluation method[J].China Journal of Safety Science, 2004(07):89-92+3.

[17] Yang Ning. Based on AHP-TOP An empirical study on the selection of green suppliers for furniture manufacturing in SIS [J]. Logistics Technology, 2020, 43(08): 17-20.

[18] Bin Hou, Wang Yanrong. Supplier evaluation based on improved TOPSIS method in green supply chain and Selection [J]. Journal of Hunan University of Technology, 2014, 28(02): 81-86.

[19] Wang Shuo. Research on the fuzzy selection of suppliers for green supply chain [D]. Zhejiang University of Finance and Economics, 2017.

[20] Wang Xingxing. Research on supplier evaluation and selection under green supply chain management [D]. Shanxi University, 2017.

ISSN: 2688-9323

[21] Dai Peiyan. Research and application of green supplier evaluation and selection in electronic manufacturing enterprises [D]. Chongqing University, 2019.

[22] Liu Junjun. Analysis and Performance Improvement of Active Green Supply Chain Management of Manufacturing Enterprises [D]. Shanghai Jiaotong University, 2020.

[23] Wang Tuorong. Research on Fuzzy Evaluation of Suppliers Based on Green Supply Chain Management [D]. Capital Economy and Trade University, 2019.

[24] Li Shucheng, Hu Fang. Green supplier selection based on fuzzy multi-level comprehensive evaluation [J]. Journal of Hunan University (Natural Science Edition), 2006(03):137-140.