Supplier selection based on information visualization tools—
—Taking Z agricultural machinery company as an example

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Abstract. The development of economic globalization makes the cooperation relationship between enterprises and suppliers closer. How to optimize suppliers becomes a research hotspot. This paper studies the selection process and selection method of quotient evaluation indicators based on the analysis of supplier data by using information visualization tools. The multi-dimensional data and analytic hierarchy process are used to evaluate the supplier's commercial value and product information. The example of Z agricultural machinery company is used to verify the effectiveness and feasibility of the new scheme.

1. Introduction
With the development of economic globalization, enterprises need to form cooperative relations with upstream and downstream enterprises in the supply chain, among which suppliers become the key targets of enterprise cooperation. In order to cope with the dynamic changes of the market and the data processing of suppliers, it has become a new trend for enterprises to cooperate with excellent suppliers by means of new supplier selection.

In recent years, information visualization technology has developed rapidly. Enterprises can through information visualization tools from multiple data sources of the supplier in real-time data acquisition, and using the multidimensional data and analytic hierarchy process (AHP) to evaluate supplier's business value and product information, by using dynamic feasible and economic applicable supplier selection plan, to meet the market dynamic environment, and reduce the cost of enterprises to select suppliers.

2. Literature review
Dickson (1966) summed up 23 supplier selection criteria and weights through a survey of 273 agents and managers [1]. Weber et al. (1991) focused on basic indicators such as product price and quality when establishing supplier evaluation indicators [2]. Reza Farzipoor Saen (2010) designed the method of selecting suppliers through the DEA model [3]. Chen Zhiping and Yang Wei (2011) proposed a MAGDM method to reduce information inaccuracy [4]. G. Rajesh, P. Malliga (2013) developed a
comprehensive method combining AHP and QFD [5]. Panitas Sureeyatanapas et al. (2018) developed the traditional TOPSIS method [6].

Brief comment:
  (1) The current supplier selection method does not adapt to the market dynamic environment, and it is subjective and computationally intensive.
  (2) The current supplier evaluation index stays at the basic level, and the feasibility of many selection models remains to be studied.

3. Supplier selection process
Power BI is an information visualization software created by Microsoft. Enterprises can import data for visual analysis and processing.

Firstly, the type of suppliers is determined, and the enterprise issues a tender announcement to preliminarily screen the geographical location, product quality and other aspects of the suppliers participating in the bidding. Unqualified suppliers are directly eliminated, and qualified suppliers enter the check link.

Secondly, in the re-election, enterprises can select general suppliers based on basic indicators such as purchase price, delivery date and quality level. If they choose important suppliers, they can add two flexible indicators of business capability and service level and choose the top supplier for cooperation.

| Primary indicator     | Secondary indicator | Type          | Indicator description                                      |
|-----------------------|---------------------|---------------|-----------------------------------------------------------|
| Buying price          | Product unit price  | Quantitative  | Purchasing the price of a single product                  |
| Delivery date         | On-time delivery rate| Quantitative  | The ratio of the number of on-time delivery to the total number of orders |
| Quality level         | Rate of qualified products | Quantitative | Ratio of number of qualified products to total number of products |
| Operational capacity  | Financial ability   | Quantitative  | Supplier registration amount                              |
|                       | Scale of development| Quantitative  | Supplier's business area, number of employees, and operating income |
| Service Level         | Case situation      | Quantitative  | Cause, progress and frequency                             |
|                       | After sales service | Quantitative  | Business rating of suppliers                              |

Finally, companies can include suppliers that are eliminated in the selection process as potential suppliers, save their data, and re-evaluate them on the next selection.
4. Application cases

4.1. Supplier Primary Selection
Jiangsu Z Agricultural Machinery Manufacturing Co., Ltd. (hereinafter referred to as Z Agricultural Machinery Co., Ltd.) ranks among the top 500 Chinese companies and listed companies. It is one of the important enterprises in China to produce engines.

Take the strategic supplier who chooses to provide panel materials as an example. In this bidding, a total of 8 suppliers participated in the bidding. The company developed a preliminary selection standard and surveyed the supplier's data according to the indicators and imported it into Power BI.
Table 2. Supplier Primary Selection Criteria

| Indicator                  | Type          | Indicator description                  |
|----------------------------|---------------|----------------------------------------|
| On-time delivery rate      | Quantitative  | More than 90 percent                   |
| Rate of qualified products | Quantitative  | Above 95 percent                       |
| Unit price                 | Quantitative  | Within 59 yuan                         |
| Geographic location        | Quantitative  | Within 10km from the company           |

Figure 2. Summary of Supplier Primary Selection Data

After preliminary screening, suppliers 1, 2, and 3 entered the re-election.

4.2. Supplier Check
The company combined the analytic hierarchy process to set weights for the five supplier evaluation indicators.

Table 3. Supplier Standard Judgment Matrix

|                 | Buying price | Delivery date | Quality level | Service level | Operational capacity |
|-----------------|--------------|---------------|---------------|---------------|----------------------|
| Buying price    | 1            | 2             | 1             | 3             | 4                    |
| Delivery date   | 1/2          | 1             | 1/2           | 3/2           | 2                    |
| Quality level   | 1            | 2             | 1             | 3             | 4                    |
| Service level   | 1/3          | 2/3           | 1/3           | 1             | 4/3                  |
| Operational capacity | 1/4      | 1/2           | 1/4           | 3/4           | 1                    |

\[
\overrightarrow{W} = \begin{pmatrix} 1.622, 0.811, 1.622, 0.541, 0.405 \end{pmatrix}^T; \\
\overrightarrow{W} = \begin{pmatrix} 0.33, 0.16, 0.32, 0.11, 0.08 \end{pmatrix}^T;
\]
$$\lambda_{max} = \frac{1}{5} * \left( \frac{1.622}{0.33} + \frac{0.811}{0.16} + \frac{1.622}{0.32} + \frac{0.541}{0.11} + \frac{0.405}{0.08} \right) = 5.0067; \quad (3)$$

$$CR = \frac{5 - 1}{1.12} = 0.0015 < 0.1; \quad (4)$$

Since CR=0.0015<0.1, the judgment matrix has consistency.

$$W = \begin{pmatrix} 0.33, 0.16, 0.32, 0.11, 0.08 \end{pmatrix}$$ Was the weights set by the company for the five indicators, as shown in the figure:

Through Power BI, the company collected data from the supplier’s delivery date, quality level, after-sales, registered capital, annual sales, and lawsuits from the website of the Trade and Industry Bureau and the Legal Document Network for visualization.

![Supplier Data Chart](image_url)

**Figure 3. Supplier Data Chart**

Based on the actual situation of suppliers 1, 2, and 3, the company scored the three suppliers based on the evaluation indicators, and the evaluation results were shared with suppliers through Power BI.
4.3. Supplier Determination
Sort suppliers by rating: Supplier 2 > Supplier 1 > Vendor 3. Analysis shows:

1. Although the purchase price of supplier 2 needs to be improved, other indicators are excellent, so supplier 2 is selected as the strategic supplier of the company.
2. The purchase price of supplier 1 is general, and the quality level needs to be improved; the delivery date of supplier 3 is general, and the quality level needs to be improved. Therefore, the company will supply suppliers 1 and 3 as potential suppliers, save the data, and re-evaluate the options in the future.

5. Conclusion
This paper optimized the traditional supplier selection process based on information visualization tools and applied it to Z agricultural machinery company. By using Power BI, the company obtains and analyzes supplier data from multiple channels, formulates supplier evaluation indexes, scores and selects suppliers in combination with AHP, and finally shares the score result and score composition with suppliers to urge them to optimize themselves. The supplier selection process designed in this paper helps enterprises realize the automatic dynamic management of all suppliers with only one employee.

Acknowledgments
This paper is supported by National Key R&D Plan of China under Grant No. 2016YFC0803207 and Fundamental Research Funds for the Central Universities No. ZY1938.

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