Logistics Service Suppliers Evaluation Based on Fuzzy Soft Set

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Keywords: Logistics Service, Fuzzy Soft Set.

Abstract. This paper analyzes the content and scope of logistics service demand of company A, builds the evaluation indicator system of logistics service suppliers of company A, uses the fuzzy soft set to quantify and analyze the evaluation index of logistics service suppliers of company A, Established a Multi-departmental expert model evaluation system, and through the example project suppliers analysis and verification and evaluation, pointed out that company A selects a high-quality logistics service supplier is conducive to enhancing A company's logistics service capabilities, thus enhancing A's core competitiveness.

1. Introduction

Due to the impact of resources and the environment, the strength of each logistics suppliers also has its own length, which brings some difficulties for the selection of enterprise. Under such a background, the evaluation of enterprise logistics service suppliers has attracted great attention from academia. Enterprises are increasingly required to establish good logistics service procurement mechanism and form a benign logistics service procurement decision system.

The problem of evaluation index system is the basis of evaluation and selection of logistics service suppliers. Dickson [1] by the 273 American Association Manager Purchasing Manager and purchasing agent for investigation, analysis of sorting out 23 different criteria to evaluate the supplier's performance. STAMM and GOLHAR [2] through classification and summarizes 43 factors that affect. The supplier evaluation method is another important aspect of supplier selection theory. In the aspect of specific selection evaluation, there are the methods of AHP [3], Data Envelopment Analysis (DEA)[4], Mathematical Programming [5], Analytic Network Process [6] (ANP), Fuzzy Set Theory and so on, applied to the supplier's choice and evaluation. However, the soft set given by Molodtsov [7] has been booming in recent years due to its ability to handle uncertainties, ambiguities and objects that have not been clearly defined.

Company A is a designer and manufacturer of innovative microprocessors for computers, as well as flash and low-power processor solutions. Procurement of logistics services is a guarantee of the entire company's production and plays a crucial role in supporting the normal operation of the entire company. However, the main problems of A's logistics service procurement are ignoring the differences in the demand of different departments for the indicators and subjective model evaluation.

In this paper, to solve the first problem, the fuzzy soft set can be used to adapt to the advantages of different indicators in different departments. According to the opinions of experts from all departments, a reasonable and comprehensive index for all departments is established to improve the rationality of the index system. For the second problem, fuzzy soft set operation and evaluation rules are introduced. Evaluate the uncertain factors in the process of soft set operation. Avoid the problem of membership degree of the traditional fuzzy comprehensive judgment, the judgment result is more scientific and reasonable.

2. Evaluation Indicator

The logistics service content of Company A is relatively simple, but the logistics and transportation requirements are relatively high, which includes not only providing inter city logistics services to the core products of the company, but also putting forward requirements for time and transport safety.

According to the actual situation of company A, and considering many scholars in the selection of logistics suppliers evaluation indicator system. The finalized indicator system includes cost index, quality index, technical index, service index and flexibility indicator. Each indicator is divided into different secondary indicators. Table 1 shows the specific circumstances.

TABLE 1. LOGISTICS SERVICE SUPPLIER EVALUTION INDICATOR SYSTEM

Supplier comprehensive evaluation index system A	Cost Indicator B1	Vendor Quote C1
		Payment method C2
		Payment term C3
	Flexibility Indicator B2	Contingency Planning and Options C4
		Response time C5
		National Transport Support C6
	Specifications B3	Vehicle Characteristics and Global Positioning System Capability C7
		Free Trade Zone warehouse safety facilities C8
		Integrated Information Platform C9
		Construction of logistics network C10
	Quality Index B4	Warehouse Management C11
		ISO9001 certification C12
		Well-known company's recognition of supplier logistics projects C13
	Service(Customer Support) Indicator B5	Project Management Team C14
		Professional Services Team C15
		Corporate culture match degree C16

3. Evaluation Model

Blurry soft collection

Definition 1 Soft collection. Let U be the initial universe of discourse, E be the parameter set, $P(U)$ be the power set of the set U, (F,E) be a soft set on the universe U if and only if F is E to $P(U)$ a map.

For $\forall \varepsilon \in E$, $F(\varepsilon)$ is a set of elements in U with ε-parameter property, that is, $F(\varepsilon) \in U$, and the soft set (F,E) is a set of elements with properties of each parameter in U Constitute the approximate set..

Definition 2 Fuzzy soft collection. Let U be the initial domain, E be a parameter set, $\varphi(U)$ be a fuzzy set of a set U, $C \in E$, (F,C) be a fuzzy soft set on the universe U, if and only if F is C A mapping to $\varphi(U)$.

Definition 3 Fuzzy set "AND" operation. Let (F_1,C) and (F_2,D) be two fuzzy soft sets on U, and if $\forall(\alpha,\beta) \in C \times D$, $H(\alpha,\beta) = F_1(\alpha) \cap F_2(\beta)$,Then $(F_1,C) \wedge (F_2,D) = (F, C \times D)$ is the AND operation of (F_1,C) and (F_2,D).

Service Purchasing Supplier Evaluation Model

Logistics service supplier evaluation of uncertainty in the expression of information

Evaluation of the various indicators of logistics services, the characteristics of the evaluation using the following level to represent that

$$H = \{0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0\} \quad (1)$$

The evaluation value v The larger, indicating that the more suppliers of the indicators meet the requirements.

Logistics service supplier evaluation process

To solve the problem of logistics service procurement supplier evaluation, we first provide the collection of logistics suppliers to be evaluated $U=\{h_1,h_2,\cdots,h_n\}$ and the evaluation index set $C=\{e_1,e_2,\cdots,e_m\}$ The evaluation index set $C_1=\{e_1,e_2,\cdots,e_m\}$ is given and the evaluation matrix V_{N*t} is given. Finally, the fuzzy evaluation set is used to fuse the evaluation values of experts from different departments to get the final evaluation result .

According to the experts in different departments, the evaluation information of their personal index set C_k and evaluation matrix V_{N*k_t} is expressed as fuzzy soft set (F_k,C_k) that

$$(F_k,C_k)=\begin{cases} C_1^k=\{h_1/v_{11}^k,h_2/v_{12}^k,\cdots,h_n/v_{1n}^k\} \\ C_2^k=\{h_1/v_{21}^k,h_2/v_{22}^k,\cdots,h_n/v_{2n}^k\} \\ \cdots \\ C_{k_t}^k=\{h_1/v_{k_t1}^k,h_2/v_{k_t2}^k,\cdots,h_n/v_{k_tn}^k\} \end{cases} \tag{2}$$

After the evaluation information of experts in different departments are merged, the company's comprehensive evaluation matrix for suppliers can be obtained. The fusion method is as follows: ("AND" is performed on the fuzzy soft sets (F_k,C_k) in turn, and the result is represented by (G,E))

$$(G,E)=(G,C_1\times C_2\times\cdots\times C_t)=(F_1,C_1)\wedge(F_2,C_2)\wedge\cdots\wedge(F_t,C_t) \tag{3}$$

For $\forall(c_1^{\bullet},c_2^{\bullet},\cdots,c_s^{\bullet})\in C_1\times C_2\times\cdots\times C_t$, the result is represented that

$$G(c_1^{\bullet},c_2^{\bullet},\cdots,c_s^{\bullet})=F_1(c_1)\cap F_2(c_2)\cap\cdots\cap F_t(c_t) \tag{4}$$

(G,E) is also a fuzzy soft set. From the definition three we can see (G,E) in the parameters by different evaluation experts fuzzy evaluation index set $C_1,C_2,\cdots,C_t$ synthesized. If there is a total of parameters for L synthesis in (G,E) and $E=\{e_1,e_2,\cdots,e_L\}$, (G,E) can be expressed that

$$(G,E)=\begin{cases} e_1=\{h_1/v_{11},h_2/v_{12},\cdots,h_n/v_{1n}\} \\ e_2=\{h_1/v_{21},h_2/v_{22},\cdots,h_n/v_{2n}\} \\ \cdots \\ e_L=\{h_1/v_{L1},h_2/v_{L2},\cdots,h_n/v_{Ln}\} \end{cases} \tag{5}$$

In the formula, v_{ij} represents the degree of conformity of the supplier h_j to the state described by the synthesized parameter $e_i(i=1,2,\cdots,L)$ and $L=l_1*l_2*\cdots*l_t$. However, if the final set of parameters has the same element set, the average of the first set is obtained when the set of indicators are aggregated, and then the minimum value of the different indicators is taken. At this point, the parameter set E is composed of individual indicators from different departments and experts free combination.

Let $c_k\in C_K$, and if v_{c_i} and v_{c_j} are different experts score the same indicator, then

$$v_{c_i}=v_{c_j}=1/2(v_{c_i}+v_{c_j}) \tag{6}$$

After obtaining the average value, the set of indicators is combined for set calculation, that is

$$v_{c_1\cdots c_t}=\min_{k=1\cdots t}\{v_{c_k}\}\quad c_k\in C_K \tag{7}$$

After obtaining (G,E), compare each supplier's score on the post-fusion impact factor to obtain a comparison-table (CT), $CT=(ct_{ij})_{n\times L}$, where

$$ct_{ij}=\sum_x\gamma_{ij}^x \tag{8}$$

$$\gamma_{ij}^x=\begin{cases}1 & v_{ix}\geq v_{ix}\\ 0 & v_{ix}<v_{ix}\end{cases} \tag{9}$$

ct_{ij} means that for all the synthetic evaluation parameters, the supplier h_i comprehensive evaluation value is equal to or higher than the number of suppliers h_j.

Finally, according to CT calculation of the total score $Score(h)$, that is

$$\begin{cases} Score(h_i) = s_i - t_i \\ s_i = \sum_{j=1}^{n} ct_{ij}, t_i = \sum_{j=1}^{n} ct_{ji} \end{cases} \tag{10}$$

s_i denotes the total number of suppliers h_i which is superior to other suppliers in the composite score, t_i denotes that the suppliers h_i are inferior to the total number of other suppliers in the overall score, at this time, $Score(h_i)$ characterizes the suppliers h_i comprehensive competitiveness.

4. Case Analysis

Based on the characteristics of 2.1 logistics service suppliers, the four companies that are bidding are evaluated. In this model, we use the index system in 2.2 as the evaluation index library, and then choose the right supplier.

There are 4 suppliers to be evaluated $U = \{h_1, h_2, h_3, h_4\}$, the indicator set is $C = \{c_1, c_2, \cdots, c_{16}\}$ represents the indicator system in 2.2; Company A's finance, security, procurement and demand Department experts evaluate suppliers, namely: $Ex = \{ex_1, ex_2, ex_3, ex_4\}$.

(1) According to the department's existing knowledge and experience, each expert gives the personal evaluation index set, that is, $C_1 = \{c_1, c_2, c_3\}$ $C_2 = \{c_7, c_8, c_9, c_{10}, c_{11}, c_{12}, c_{13}\}$, $C_3 = \{c_1, c_5, c_{11}, c_{12}, c_{13}, c_{14}, c_{15}, c_{16}\}$, $C_4 = \{c_1, c_4, c_5, c_6, c_7\}$.

(2) The evaluation matrices V_1, V_2, V_3 and V_4 are expressed as fuzzy sets (F_1, C_1), (F_2, C_2), (F_3, C_3) and (F_4, C_4).

(3) Information fusion of V_1, V_2, V_3 and V_4 by fuzzy soft sets, that is, the result of AND of fuzzy sets (F_1, C_1), (F_2, C_2), (F_3, C_3) and (F_4, C_4) Calculate the score of 840 fusion indicators, that is

$$(G, E) = (G, C_1 \times C_2 \times C_3 \times C_4) = (F_1, C_1) \wedge (F_2, C_2) \wedge (F_3, C_3) \wedge (F_4, C_4) \tag{11}$$

The parameters in E are shown in TABLE II:

TABLE II. COMBINATORIAL INDEX SET E IN THE PARAMETER

E	e_1	e_2	e_3	e_4	e_5	e_6	e_7	…
P	$c_1c_7c_1c_1$	$c_1c_4c_1c_4$	$c_1c_7c_1c_5$	$c_1c_7c_1c_6$	$c_1c_7c_1c_7$	$c_1c_7c_5c_1$	$c_1c_7c_5c_4$	…

According to the formula to calculate the fuzzy set (G, E). Taking the fusion index of e_7 and e_6 of supplier h_1 as an example, the calculation process of (G, E) is illustrated that

$$e_7 = \min\left\{v_{11}^1, v_{11}^2, v_{21}^3, v_{21}^4\right\} = \min\{0.9, 0.8, 0.8, 0.9\} = 0.8 \tag{12}$$

$$e_6 = \min\left\{ave\left\{v_{11}^1, v_{11}^4\right\}, v_{11}^2, v_{21}^3\right\} = \min\{0.9, 0.8, 0.9\} = 0.8 \tag{13}$$

By analogy, you get the fuzzy set (G, E), which is shown in the tabular form.

TABLE III. COMBINED INDEX SET E SCORES

	e_1	e_2	e_3	e_4	e_5	e_6	e_7	…
h_1	0.8	0.8	0.8	0.7	0.7	0.8	0.8	…
h_2	0.6	0.6	0.6	0.5	0.6	0.5	0.5	…
h_3	0.7	0.7	0.6	0.6	0.7	0.6	0.6	…
h_4	0.7	0.7	0.7	0.6	0.65	0.7	0.7	…

(4) The final evaluation score is calculated according to fuzzy rules. The comparison matrix is given as follows.

$$CT = \begin{Bmatrix} 840 & 830 & 784 & 751 \\ 204 & 840 & 653 & 169 \\ 153 & 574 & 840 & 190 \\ 512 & 827 & 790 & 840 \end{Bmatrix} \tag{14}$$

Then calculate final evaluation $\mathrm{Score}(H)$, that is

$$Score(H) = \{1496 \quad -1205 \quad -1310 \quad 1019\} \tag{15}$$

Therefore, the supplier h_1 is the best, followed by h_4, h_2, h_3.

As can be seen from the above example, the method of this paper considers that different departments consider different sets of indicators, and experts evaluate suppliers with uncertain information so that evaluation experts can flexibly express personal judgment and introduce fuzzy sets to experts. The evaluation results are integrated to obtain the comprehensive evaluation results.

5. Conclusion

This paper mainly uses the fuzzy soft set logistics service procurement supplier evaluation model, the qualitative analysis and quantitative analysis, according to the established Company A logistics supplier evaluation index system, through the soft set operation, the fuzzy soft set and suppliers in combination, the evaluation of logistics suppliers based on fuzzy soft aggregation is realized, which provides a reference for Company A to face how to choose logistics suppliers.

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