Evaluation on Suppliers Selection in the Context of E-commerce Based on Trapezoidal Fuzzy Order Weighted Average Operator

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***Abstract*—The development of e-commerce has had a significant influence on the index system, methods and process of supplier selection for companies. By considering comprehensively the features of supplier selection in the e-commerce environment as well as the traditional index system, the indices for supplier selection can be determined as supplier flexibility, supplier credit, product quality, information degree and supply ability. Trapezoidal fuzzy order weighted average operator is applied for selecting and evaluating suppliers, and the scientific nature of this decision-making process of selection of suppliers is then verified through empirical studies. It is necessary to further enrich and improve the index system and methods of supplier selection in the future according to features of companies from different industries and with different background.**

***Index Terms*—Supplier selection, e-commerce, trapezoid fuzzy number, order weighted average operator**

I. Introduction

The supplying enterprises now have the opportunity to reach geographically dispersed markets that would otherwise be cost prohibitive to consider. Purchasing enterprises also now have the opportunity to select the best suppliers, by utilizing suppliers' bids, thus averting time consuming and costly outside sources. The current rapid development of e-commerce has brought new challenges to supplier selection. In the context of e-commerce, member companies in the supply chain keep changing the traditional operation way by information integration, coordination and sharing. In 1961 J. Forrester initiated a comprehensive research on the interrelations among member companies in the supply chain, since then, supplier selection has received more and more attention from scholars both at home and abroad, and some achievements have been made in the research on this field. Suppliers serve as the starting point of logistics throughout the whole supply chain of e-commerce. Therefore, how do we evaluate and select suppliers in the context of e-commerce attaches great significance to improvement of the whole supply chain's efficiency.

But supplier selection in the context of e-commerce is a complicated and often difficult process because:

- A list of criteria has to be considered prior to making a decision;
- The criteria used may vary with the buying organization, the buying situation, and the influences involved;
- Multiple participants are involved in the selection process.

Reggie Davidrajuh points out that developing a generic model for the supplier selection is not an easy task, for the following reasons [1].

1) Duration of collaboration. Supplier selection criteria depend on the duration of expected collaboration between the supplier and the purchaser, from short-term commitment to long-term alliance.

2) Type of procurement. Supplier selection procedures vary for procurement of capital equipment and for commodities and MRO (maintenance, repair and operating) items.

3) It's a multiple-person activity. Supplier selection involves persons at several authority levels (vertical involvement) within the purchasing enterprise.

II. Literature Review

At present, there are few references specifically concerning supplier selection in the e-commerce environment, those of which mainly focus on giving separate suggestions from the concept aspect and studying the influence of information sharing and integration in the e-commerce environment on the cooperative relations among the member companies in the supply chain. Paul Hong and Oahn Tran empirically examine the impacts of supplier- and customer-oriented electronic communication technologies (ECTs) (electronic data interchange (EDI) and internet-based) on supply chain integration and manufacturing competitive capabilities (flexibility and quality). The findings of research provide practical management insights on ECTs investment and deployment practices [2]. Matthew L. Smith researches on the impact of e-government on citizens' trust in government remains at the macro-level and misses out on the complexities of the interaction between e-services and citizens' trust in government. He finds within e-services, the most easily perceived and influential trustworthiness cues are those outcomes that

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directly impact the citizen. These cues shape citizens' resultant interpretations of and trust in the public sector agency. Furthermore, the direction of this influence is mediated by individuals' particular circumstances and value positions [3]. Dawn R. Deeter-Schmelz proposes in the environment of business-to-business e-commerce, both buyers and sellers are uncertain about their roles. His findings indicate that the Internet plays almost no role in supplier selection decisions and only a moderate role in ongoing buyer-seller relationships. Additionally, in relationships characterized by high levels of information exchange, trust, cooperation, and/or adaptations, the internet appears to play a less important role [4]. Reggie Davidrajuh points out a methodology, tools and implementation techniques for automation of supplier selection procedures as an e-commerce application. His work could be divided into two main parts. First, the development of a modeling methodology which can be used for automation of supplier selection procedures. By this modeling methodology, supplier selection procedures are divided into pre-selection, selection and the post-selection procedures. The selection procedure is further divided into the following stages: bidder selection, partner selection, and performance evaluation. The second part is about realization of automation. Three modules for automation are identified; they are the data collection system for bidder selection stage, the inference engine for partner selection stage, and the performance evaluation engine for the performance evaluation stage[5]. Yee-Ming Chen seeks to propose a new approach for tackling the uncertainty and imprecision of identifying suitable supplier offers, evaluating these offers and choosing the best alternatives in bi-negotiation. In a build-to-order supply chain, the handling of uncertainties is addressed by real-time information sharing system and appropriate supplier selection [6]. Haesun Park builds an exploratory model to describe buying/sourcing professionals' SRB decision-making process. SRB generally followed a cognitive decision framework and was partly influenced by the decision maker's affective reaction to peer-buying/sourcing professionals' behaviors. The results suggest that changing the organizational environment where employees observe peers and providing standards of what is socially acceptable can improve SRB [7]. Amany Elbanna provides insight into system acceptance and use in mandatory and workplace contexts. It demonstrates that the move from the initial acceptance to actual use is more problematic than TAM suggests. It provides a novel conceptualization of business processes as holders of social and technical networks that constitute actors' performing power [8]. Awasthi et al. develop a supplier selection and order allocation model under uncertain demand where suppliers have restrictions on the minimum and maximum order sizes they can accept. They also propose a heuristic algorithm to solve the model [9]. Chick and Olsen present a multi-attribute model for selection of complex and capital intensive machining tools. According to Chick and Olsen, this model was developed after several interviews with buyers and suppliers of machine tools. The multi-attribute model emphasizes the buyer-supplier relationship that is important for a long-life capital-intensive purchase. One of the aims behind of development of this model is to identify the parts of the supplier selection process that can be supported by decision support systems; in this sense, Chick and Olsen's work has some aims that are similar to the goals of this paper; but our aim is to identify the steps in supplier selection procedures that can be automated as an e-commerce application [10].

Jin Ho Choi & Yong Sik Chang proposes the e-Procurement planning is crucial to reduce purchase cost while selecting the right suppliers and it contributes to improve corporate competitiveness. This e-Procurement planning research describes a framework for the integration of a knowledge-based system capable of identifying a goal model from a Primitive Model. The Primitive Model is screened by the screening factors reflecting the purchase strategy. By using the framework for supplier selection and allocation (SSA), a purchaser is able to reduce the costs and time required to select the right suppliers and to alleviate anxiety for ‘out-of-favor’ suppliers. This approach is based on two-phased semantic optimization model modification that semantically builds a goal model through model identification and candidate supplier screening based on model identification rules and supplier screening rules. This approach contributes significantly to construction of an optimization model from the perspective of model management and it provides a useful environment for efficient e-Procurement from the perspective of a purchaser [11]. Guneri et al. propose an integrated fuzzy and linear programming approach for supplier selection problem. Their approach, firstly, assesses weights and ratings of supplier selection criteria with linguistic values expressed in trapezoidal fuzzy numbers. Then a hierarchy multiple model based on fuzzy set theory is expressed and fuzzy positive and negative ideal solutions are used to find each supplier’s closeness coefficient. Finally, a linear programming model based on the coefficients of suppliers, buyer’s budgeting, suppliers’ quality and capacity constraints is developed and order quantities assigned to each supplier according to the linear programming model[12]. Wu uses grey related analysis and Dempster–Shafer theory to deal supplier selection in a fuzzy group decision making problem. It is to be noted that proposed approach uses both quantitative and qualitative data for international supplier selection [13]. Önüt, Kara & Isik proposed a supplier evaluation approach based on the analytic network process (ANP) and the technique for order performance by similarity to ideal solution (TOPSIS) methods to help a telecommunication company in the GSM sector in Turkey under the fuzzy environment. They used triangular fuzzy numbers in all pairwise comparison matrices in their method to evaluating suppliers by considering six criteria (cost, reference, quality of product, delivery time, institution and execution time) [14].

Ng, Eric adds new insights to the existing literature of B2B supplier selection criteria with the identification of two additional criteria (willingness to cooperate). The exploratory nature of his study and the initial development of a framework of supplier selection within the context of the Taiwan agribusiness industry had constrained the applicability of the findings to other markets and industries. His study is exploratory in nature and involves a two-stage process. In the first stage, in-depth interviews were conducted with 10 agribusiness professionals in Taiwan to determine the relevance of the current literature about the criteria used in the selection of suppliers in the Taiwan agribusiness industry. The second stage involved 16 case studies with 32 interviews, using information gathered from the first stage. The findings revealed that the support of the 22 selection criteria presented in the preliminary framework was important to influence an organization's selection of suppliers in the Taiwan agribusiness industry. The findings suggest that Taiwan agribusiness buyers consider the financial position of the suppliers and the quality of their managerial teams as critically important in the supplier selection process. There was little indication that the desire for business, geographical location, and repair service were regarded as important criteria for selecting suppliers [15].

Zhu Jing proposes a supplier selection decision formula since companies are facing more choices of suppliers because of the fact that the rapid development of e-commerce has led to a widespread rise of purchasing and that more and more companies start to put demand information on electronic exchange market [16]. Song Yiwei thinks that relations among companies in the supply chain are getting much closer because of the rapid development of e-commerce and that it is crucial to carefully select those long-term best suppliers with highly professional technological core ability, instead of just finding those with the lowest cost. Li Xin points out that there are big differences between supplier selection on the platform of e-commerce and that in the situation of one single company [17]. Sun Rui states that there are unique features for the supply chain alliance's performance evaluation in e-commerce age [18]. Xu Hong etc. have done a systematic analysis of the changes of every segment of the value chain in e-commerce age and illustrated the approach and significance of optimizing purchasing process in e-commerce age by analyzing the purchasing part in the value chain [19]. Obviously, the rapid development of the internet-based e-commerce has brought new developing environment and opportunities, and companies both at home and abroad are facing a huge change and so are the indices of supplier selection. Meanwhile, there are few such studies, which is definitely not adapted to the development of supply chain. Therefore, it is worthwhile to research on supplier selection in e-commerce environment.

III. Determination of Index System for the Selection and Evaluation of Suppliers Under the Situation of E-commerce

The traditional index system for selecting and evaluating suppliers pays much attention to those static indices like price, quantity and quality., However, in this age when professional division and fast customized products are valued and e-commerce gets rapidly developed, and competition between companies has come to change into the competition over efficiency of the supply chain system, that is to say those who can deliver the customized products to the customer with the highest speed and the lowest costs win the competition. In this case, companies should be capable of adjusting itself to the constant changes of the market so as to meet the diversified demand of customers. Since electronization has exerted significant influence on the index system, methods and process of supplier selection, the following points need paying attention to:

1) In the environment of e-commerce, enough importance should be attached to supplier flexibility since the demand changes from minute to minute.
2) What internet provides is just a virtual space in which the transactions are fundamentally different from direct transactions. Therefore credit of suppliers is so crucial that without it the delivered products' authenticity and reasonable price cannot be guaranteed.
3) In the IT supporting system based on internet, companies and their key suppliers should share their internal resources to the greatest extent. All the transacting processes (including inquiring, ordering, order processing, payment, etc.) should be digitally controlled through internet, with the information flow, cash flow and logistics being completely smooth. The degree of informationization is a critical issue to be considered by the suppliers.
4) Though e-commerce makes information flow, cash flow and logistics computerized, yet other real goods should be delivered by offline logistics while those computerized goods are delivered through digital control, which is a complicated network of transportation, customs and so on. So it is necessary to take into consideration the strong deliverability of the suppliers when doing the selection.

This paper, by considering the main points of supplier selection in the e-commerce environment as well as the traditional index system, proposes the five indices according to their nature and goal, namely, supplier flexibility, supplier credit, product quality, informationization degree and deliverability.

IV. Trapezoidal Fuzzy Number & FOWA Operator

Definition 1 [20-21]: A fuzzy number is a regular convex fuzzy set above the set of real numbers. For the fuzzy number A, its membership function is shown below:

$$f_A = \begin{cases} f_A^L(x) & a \le x \le b \\ 1 & b \le x \le c \\ f_A^R(x) & c \le x \le d \\ 0 & \text{else} \end{cases}$$

In this function, $f_A^L(x)$ is a continuous monotone increasing function, which is referred to as left benchmark function, and $f_A^R(x)$ is a continuous monotone decreasing function, which is named as right benchmark function. If the left and right benchmark functions of the fuzzy number A are all linear functions, then A can be defined as trapezoidal fuzzy number, $A=[a,b,c,d]$.

Definition 2 [20-21]: There are two trapezoidal fuzzy numbers, $A=[a,b,c,d]$ and $B=[a_1,b_1,c_1,d_1]$, and their operations are as follows:

(1) $A+B=[a+a_1,b+b_1,c+c_1,d+d_1]$

(2) $A-B=[a-d_1,b-c_1,c-b_1,d-a_1]$

(3) $A\times B=[aa_1,bb_1,cc_1,dd_1]$ ($a\ge 0,a_1\ge 0$)

(4) $\frac{A}{B}=[\frac{a}{d_1},\frac{b}{c_1},\frac{c}{b_1},\frac{d}{a_1}]$ ($a>0,a_1>0$)

(5) $rA=[ra,rb,rc,rd]$, here r is a positive real number.

Definition 3 [22-23]: Suppose $A=[a,b,c,d]$ and $B=[a_1,b_1,c_1,d_1]$ are two trapezoidal fuzzy numbers.

1) If $a\ge a_1,b\ge b_1,c\ge c_1,d\ge d_1$, then $A\ge B$.

2) If the condition of $a\ge a_1,b\ge b_1,c\ge c_1,d\ge d_1$ is not met, and

$\frac{a+b+c+d}{4}\ge\frac{a_1+b_1+c_1+d_1}{4}$, then $A\ge B$.

Definition 4: Suppose $f:FN^n\to FN$, if

$$f_\omega(a_1,a_2,\cdots,a_n)=\sum_{j=1}^{n}\omega_j b_j$$

Here $\omega=(\omega_1,\omega_2,\cdots,\omega_n)$ is the weight vector related to function f. If $\omega_i\in[0,1],\sum_{i=1}^{n}\omega_i=1$ and b_j is Element No. j in the trapezoidal fuzzy number $(a_1,a_2,\cdots,a_n)$ (compared according to definition 3), then function f can be defined as fuzzy order weight average operator [24]. The weight vector is determined by the following formula:

$$\omega_i=Q(\frac{i}{n})-Q(\frac{i-1}{n}) \quad (1)$$

Here Q, the function of fuzzy semantic quantization, can be calculated by the method below:

$$Q(r)=\begin{cases}0\,, & r<\alpha\\ \frac{r-\alpha}{\beta-\alpha}\,, & \alpha\le r\le\beta\\ 1, & r>\beta\end{cases} \quad (2)$$

At the same time, $\alpha,\beta,r\in[0,1]$. Parameters in function Q corresponding to the indices of fuzzy semantic quantization “majority”, “at least half” and “as much as possible” are $(\alpha,\beta)=(0.3,0.8)$, $(\alpha,\beta)=(0,0.5)$, $(\alpha,\beta)=(0.5,1.0)$.

V. Method of Evaluation on Suppliers Selection in the Context of E- commerce based on Trapezoidal Fuzzy Order Weighted Average Operator

In practical evaluation, it is both feasible that quantitative index value can be converted into language value and that qualitative index value (i.e. language value) can be converted into fuzzy numbers. Therefore, it is reasonable to adopt the method to evaluate emergency management system in the supply chain based on trapezoidal fuzzy order weighted average operator.

Suppose there are m plans (emergency management systems in the supply chain) to be assessed-- $S=\{s_1,s_2,\cdots,s_m\}$, n decision-makers-- $D=\{D_1,D_2,\cdots,D_n\}$ and q indices-- $C=\{C_1,C_2,\cdots,C_q\}$. And meanwhile, the weight of index C_l given by decision-maker D_p is marked as ω_l^p, and the evaluation matrix is $C^p=(c_{il}^p)_{m\times q}$ in which ω_l^p and c_{il}^p are trapezoidal fuzzy numbers decided by decision-maker D_p according to his knowledge, experience and preference, $\omega_l^p=[\omega_{l1}^p,\omega_{l2}^p,\omega_{l3}^p,\omega_{l4}^p]$, $c_{il}^p=[c_{il}^{p1},c_{il}^{p2},c_{il}^{p3},c_{il}^{p4}]$. The ranks are supposed to be given to each of the systems.

The evaluating process of the above evaluated plans is described as follows:

Step 1: Standardized processing

In order to eliminate the influence caused by different physical dimensions on the results of decision-making, standardized formulas are applied to deal with the trapezoidal fuzzy numbers in a standardized fashion. The methods below are used in this thesis.

For cost index, $\frac{\max_i(c_{il}^{p4})-c_{il}^{pk}}{\max_i(c_{il}^{p4})-\min_i(c_{il}^{p1})}$, $k=1,\cdots,4$

(Note: Elements of every fuzzy number are compared after being standardized and they are then re-ranked in a small-to-big-value way so as to form the standardized fuzzy numbers.)

For benefit index, $\frac{c_{il}^{pk}-\min_i(c_{il}^{p1})}{\max_i(c_{il}^{p4})-\min_i(c_{il}^{p1})}$, $k=1,\cdots,4$

The index weight coefficients given by each evaluator are also processed in this way.

The weights and index values are still recorded as $\omega_l^p=[\omega_{l1}^p,\omega_{l2}^p,\omega_{l3}^p,\omega_{l4}^p]$ and $c_{il}^p=[c_{il}^{p1},c_{il}^{p2},c_{il}^{p3},c_{il}^{p4}]$ for convenience's sake.

Step 2: Group integration of index weight

For every index, group integration is executed according to definition 4, resulting in a group weight, i.e. $\lambda_l=[\lambda_{l1},\lambda_{l2},\lambda_{l3},\lambda_{l4}]$.

Step 3: Group integration of index values of the evaluated plans

For every index of every evaluated plan, group integration is executed according to definition 4, resulting in the group index value for each plan, i.e. $c_{il} = [c_{il}^1, c_{il}^2, c_{il}^3, c_{il}^4]$.

Step 4: Index integration of the evaluated plans

The group synthetic value for each plan can be calculated by the formula below:

$$d_i = \sum_{l=1}^{q} [\lambda_{l1}, \lambda_{l2}, \lambda_{l3}, \lambda_{l4}][c_{il}^1, c_{il}^2, c_{il}^3, c_{il}^4] \quad (3)$$

Step 5: Ranking of the evaluated plans. The ranking of the plans are determined according to definition 3.

VI. Empirical Study

Five indices ($C_1, C_2, \cdots, C_5$) are selected based on theoretical studies and empirical investigations, namely, supplier flexibility, supplier credit, product quality, informationization degree and deliverability. Meanwhile, six supplier ($s_1, s_2, \cdots s_6$) are evaluated and the index values given by three evaluators (D_1, D_2, D_3) of the evaluated plans are referred to as trapezoidal fuzzy numbers. Related values are shown in the following three tables.

TABLE I.
INDEX VALUES GIVEN BY EVALUATOR D_1 OF THE EVALUATED PLANS

	C_1	C_2	C_3	C_4	C_5
s_1	[80, 82, 85, 91]	[86, 87, 90, 91]	[90, 92, 94, 95]	[89, 91, 92, 93]	[93, 96, 97, 99]
s_2	[89, 91, 92, 93]	[89, 92, 93, 95]	[90, 92, 94, 95]	[93, 94, 96, 97]	[90, 93, 94, 95]
s_3	[88, 90, 92, 94]	[84, 88, 91, 92]	[89, 89, 90, 93]	[87, 90, 90, 94]	[91, 92, 93, 96]
s_4	[87, 89, 91, 93]	[86, 90, 91, 93]	[86, 87, 89, 91]	[88, 92, 93, 96]	[90, 91, 91, 92]
s_5	[83, 86, 87, 87]	[85, 88, 90, 90]	[91, 92, 92, 93]	[95, 97, 99, 99]	[91, 92, 93, 94]
s_6	[83, 83, 84, 85]	[90, 90, 91, 92]	[95, 97, 97, 98]	[94, 95, 97, 98]	[92, 93, 93, 96]
Weight	[6, 8, 9, 10]	[8, 9, 11, 15]	[8, 10, 14, 16]	[7, 11, 12, 17]	[10, 11, 14, 17]

TABLE II.
INDEX VALUES GIVEN BY EVALUATOR D_2 OF THE EVALUATED PLANS

	C_1	C_2	C_3	C_4	C_5
s_1	[83, 84, 86, 89]	[80, 82, 86, 88]	[86, 90, 91, 92]	[85, 86, 88, 90]	[90, 90, 91, 92]
s_2	[86, 90, 92, 93]	[83, 84, 88, 90]	[81, 83, 84, 85]	[85, 90, 91, 92]	[88, 92, 93, 94]
s_3	[84, 85, 86, 86]	[81, 82, 83, 87]	[80, 81, 83, 85]	[88, 91, 92, 95]	[80, 82, 83, 87]
s_4	[81, 83, 85, 87]	[85, 89, 90, 92]	[86, 88, 89, 92]	[86, 89, 91, 93]	[90, 91, 91, 92]
s_5	[82, 86, 90, 92]	[86, 88, 90, 90]	[83, 84, 84, 86]	[86, 87, 89, 93]	[91, 93, 93, 96]
s_6	[88, 92, 94, 96]	[83, 84, 89, 90]	[90, 92, 92, 93]	[94, 95, 96, 99]	[90, 91, 92, 92]
Weight	[5, 7, 11, 12]	[6, 8, 10, 13]	[7, 9, 13, 15]	[5, 8, 12, 16]	[8, 11, 12, 15]

TABLE III.
INDEX VALUES GIVEN BY EVALUATOR D_3 OF THE EVALUATED PLANS

	C_1	C_2	C_3	C_4	C_5
s_1	[89, 90, 90, 92]	[81, 88, 89, 89]	[87, 88, 91, 92]	[84, 85, 87, 89]	[84, 86, 87, 88]
s_2	[83, 85, 89, 92]	[84, 85, 85, 88]	[81, 84, 86, 86]	[87, 88, 89, 90]	[85, 86, 86, 89]
s_3	[82, 83, 84, 87]	[82, 85, 86, 87]	[80, 81, 83, 84]	[82, 83, 84, 85]	[80, 83, 84, 88]
s_4	[81, 83, 85, 86]	[85, 88, 90, 92]	[89, 92, 94, 96]	[82, 84, 89, 92]	[87, 90, 90, 94]
s_5	[90, 91, 91, 92]	[85, 91, 91, 92]	[82, 85, 90, 92]	[86, 89, 91, 93]	[90, 92, 92, 93]
s_6	[86, 89, 91, 93]	[90, 91, 91, 92]	[86, 89, 91, 93]	[95, 97, 99, 99]	[91, 92, 93, 94]
Weight	[4, 5, 10, 11]	[6, 10, 14, 18]	[8, 10, 13, 15]	[11, 12, 16, 18]	[10, 14, 16, 18]

Since all the indices are benefit ones with the same dimension, hence the decision-making matrix is not standardized here for convenience's sake.

Step 1: The fuzzy semantic quantization index of "majority" is chosen here and its weight vectors related to function f can be calculated according to definition 4, i.e. $\omega_1 = 0.0667$, $\omega_2 = 0.6667$ and $\omega_3 = 0.2666$. Then the group weights are:

$\lambda_1 = [4.8001, 6.5335, 9.8001, 10.8001]$;

$\lambda_2 = [6.1334, 8.8001, 10.9335, 14.6669]$

$\lambda_3 = [7.7334, 9.7334, 13.0667, 15.0667]$; $\lambda_4 = [6.7336, 10.2669, 12.2668, 16.8001]$

$\lambda_5 = [9.4668, 11.2001, 13.6002, 16.5335]$.

Step 2: The group integrations of the evaluated plans are gained as follows according to definition 4:

$c_{11} = [82.6004, 83.8670, 86.0002, 90.5335]$; $c_{21} = [85.4003, 88.7337, 91.2002, 92.7334]$

$c_{31} = [83.7336, 84.8003, 85.8670, 87.2003]$; $c_{41} = [81.4002, 83.4002, 85.4002, 87.1336]$

$c_{51} = [83.2003, 86.3335, 89.2669, 90.6670]$; $c_{61} = [85.3336, 87.6005, 89.3339, 91.0673]$

$c_{12} = [81.0669, 85.7337, 88.2669, 88.8668]$; $c_{22} = [84.0669, 85.2003, 89.5337, 89.8003]$

$c_{32} = [81.8668, 84.4003, 85.5337, 87.3335]$; $c_{42} = [85.0667, 88.8001, 90.0667, 92.0667]$

$c_{52} = [85.0667, 88.2001, 90.0667, 90.1334]$; $c_{62} = [88.1338, 88.4671, 90.4668, 91.4668]$

$c_{13} = [86.9335, 89.6002, 91.2001, 92.2001]$; $c_{23} = [81.6003, 84.2670, 86.0004, 86.3337]$

$c_{33} = [80.6003, 81.5336, 83.4669, 85.2670]$; $c_{43} = [86.2001, 88.0002, 89.3335, 92.0002]$

$c_{53} = [83.2670, 85.2003, 88.5338, 90.4671]$; $c_{63} = [85.0667, 88.8001, 90.0667, 93.3335]$

$c_{14} = [85.0002, 86.0669, 88.0002, 89.9335]$; $c_{24} = [86.8670, 89.7336, 90.8003, 91.8003]$

$c_{34} = [85.7337, 88.2005, 88.5338, 91.6673]$; $c_{44} = [85.0670, 87.8671, 90.6002, 92.9335]$

$c_{54} = [86.6003, 89.0004, 91.0004, 93.4002]$; $c_{64} = [94.0667, 95.1334, 96.8668, 98.0667]$

$c_{15} = [88.6005, 89.3338, 90.3338, 91.4005]$; $c_{25} = [87.3336, 90.4671, 91.2005, 92.7337]$

$c_{35} = [80.7337, 83.3337, 84.3337, 88.2670]$; $c_{45} = [89.2002, 90.7334, 90.7334, 92.1334]$

$c_{55} = [90.0667, 92.0667, 92.7334, 93.8668]$; $c_{65} = [90.8001, 91.8001, 92.7334, 93.6002]$

Step 3: The group synthetic values based on the above values are:

$d_1 = [2977.1180, 4058.6950, 5307.5705, 6692.3739]$;

$d_2 = [2968.2787, 4014.5436, 5165.8658, 6215.5768]$;

$d_3 = [2892.9414, 4009.4965, 5121.9087, 6079.4398]$;

$d_4 = [2996.3329, 4065.6572, 5265.3286, 6718.4098]$;

$d_5 = [3000.8183, 3911.3168, 5348.2496, 6759.5728]$;

$d_6 = [3101.0089, 4231.3139, 5456.9091, 6837.2148]$.

Then here comes to the order of excellence: $s_6 \succ s_5 \succ s_4 \succ s_1 \succ s_2 \succ s_3$.V. Conclusion

Extensive literature study shows that supplier selection procedures (fully or partially) are not done elsewhere. Therefore, the idea of suppliers' selection in the context of E-commerce is new. The development of e-commerce and internet enables companies to take part in global market competition in a more active way and has made information integration between companies and their suppliers realized, and through cooperation of supply chains, a strong competitive power is then formed in the aspects of product prices, manufacturing costs, leading technology, demand response, customer service, flexibility and so on. With the expansion of the scope of supplier selection and the differences of influencing factors from the traditional supplier selection, it is getting more complicated for companies to make choices among suppliers. This paper, focusing on supplier selection in the context of e-commerce, considering the fuzzy uncertainty of the source of the data, trapezoidal fuzzy order weighted average operators are introduced for the purpose of evaluation, the method of which is visual, simple and easy to calculate. However, in practical operation, with the change of environment and constant development of science and technology, many instant factors need to be considered and companies in different industries and with different background put emphasis on different things when selecting suppliers. Therefore, it is necessary to constantly enrich and improve the index system of supplier selection in light of companies' own situation.

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