A FUZZY MADM METHOD FOR SOLVING A/R COLLECTION INSTRUMENTS SELECTION PROBLEM

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The aim of this paper is to propose a ranking method for solving the account receivable (A/R) collection instrument selection problem in the international trade under the fuzzy multiple attribute decision-making (MADM) environment. The representation of multiplication operation on fuzzy numbers is useful for decision makers who are in the fuzzy multiple attribute decision-making environment to rank all candidate A/R collection instruments and choose the best one. Based on the graded mean integration representation method, this paper proposes the representation of multiplication operation on fuzzy numbers. Finally this representation of multiplication operation on fuzzy numbers is applied to solving an A/R collection instrument selection problem in the international trade. By this representation of multiplication operation on fuzzy numbers, the decision maker can determine quickly the ranking order of all candidate A/R collection instruments and then select easily the best one.

INTRODUCTION

The account receivable (A/R) collection instrument selection is an important issue in the international trade. The selection of a proper A/R collection instrument not only affects the collection behavior of the exporting companies but also the profit potential of banks involved. In general, there are four major alternative instruments for collecting the A/R. The four major alternative instruments include the letter of credit (L/C), telegraphic transfer (T/T), document against payment (D/P) & document against acceptance (D/A), and open account (O/A). The letter of credit has been the preferred instrument in the international trade practice. However, according to the data of the Central Bank of Taiwan, the percentage of the usage of letter of credit (L/C) had declining from 80% in 1980 to 15% in 2000. On the other hand, the total percentage of usages of remittance collection instruments including the telegraphic transfer (T/T) and open account (O/A) had

increased from 10% to 80%.

In the past, some precision-based methods for selection the best alternative have been developed. For example, Dahlberg and May [12] utilized the simplex method to determine the optimal location of energy facilities. Tompkins and White [34] introduced a method that used the preference theory to assign weights to subjective factors by making all possible pairwise comparisons between factors. Spohrer and Kmak [30] proposed a weight factor analysis method to integrate the quantitative data and qualitative rating to choose a plant location from numerous alternatives. Stevenson [31] proposed a cost-volume analysis method to select the best plant location. Multiple criteria decision-making methods were provided to deal with the problem of ranking and selecting locations under multiple criteria [16, 27]. All the methods stated above are based on the concept of accurate measure and crisp evaluation.

In general, the selection of a best A/R collection instrument for exporters from two or more alternatives instruments on the basis of two or more factors is a multiple attribute decision-making problem. Under many situations, the values for the qualitative criteria are often imprecisely defined for the decision maker. It is not easy to precisely quantify the rating of each alternative and the precision-based methods as stated above are not adequate to deal with the multiple attribute decision making selection problem [4, 18]. Since human judgments including preference are often vague and can not estimate his preference with an exact numerical value. A more realistic way may be to use linguistic terms to describe the desired value and important weight of criteria, e.g. "very low", "medium", "high", "fair", "very high", *etc* [1, 15]. Due to this type of existing fuzziness in the selection process, fuzzy set theory is an appropriate method for deal with uncertainty and the subjective evaluation data can be more adequately expressed in fuzzy linguistic variables [4, 7, 18, 37].

The Analytic Hierarchy Process (AHP) method was first proposed by Satty. The AHP method is a popular technique often used to model subjective deci-

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sion making process based on multiple attribute [28, 29]. Many researchers have used AHP method to deal with decision making problems. Further, the fuzzy concept has also been introduced into the AHP method [2]. Fuzzy AHP method was used to solve fuzzy multiple attribute decision making problems [8, 11, 32, 33, 35].

The concept of fuzzy sets, which was introduced by Zadeh [37], led to the definition of the fuzzy number and its implementation in fuzzy control and approximate reasoning problems. The basic arithmetic structure for fuzzy numbers were developed by Mizumoto and Tanaka [22, 23], Nahmias [24], Dubois and Prade [13, 14], and Ma *et al.* [19]. The arithmetic operation was established either by the extension principle [36] or by observing the fuzzy number as a collection of -levels. Chen [5, 6] used the Graded Mean Integration Representation method to obtain the representation of one fuzzy number. Based on the Graded Mean Integration Representation method, Chou [9] further proposed the Graded Multiple Integration Representation method to obtain the representation of fuzzy number and then this representation was applied to solving the transportation demand split model for international ports [10]. In this paper, we further propose the representation of multiplication operation on two trapezoidal fuzzy numbers. This representation of multiplication operation on two fuzzy numbers is useful for decision makers who are in the multiple criteria decision making environment to rank all candidate alternatives and choose the best one.

There existed very little literature concerned on the topic of A/R collection instruments selection problem in the international trade under the multiple attribute decision making environment. Therefore, we will propose a fuzzy MADM method for solving the A/R collection instrument selection problem.

This paper is organized as follows. We first introduce the Graded Mean Integration Representation method in section 2. In section 3 we propose the representation of multiplication operation on two trapezoidal fuzzy numbers. Finally, this representation of multiplication operation on two fuzzy numbers is applied to solving a fuzzy MADM A/R collection instrument selection problem in section 4 followed by conclusions in section 5.

THE GRADED MEAN INTEGRATION REPRESENTATION

First, we introduce the graded mean integration representation method. In 1998, Chen and Hsieh [6] proposed the graded mean integration representation method based on the integral value of graded mean

h-level of fuzzy number. Here we describe the meaning as follows. Let $A = (c, a, b, d)$ be a trapezoidal fuzzy number as Figure 1. Suppose the membership function of A is

$$f_A(x) = \begin{cases} \dfrac{(x-c)}{(a-c)}, & c \leq x \leq a, \\ 1, & a \leq x \leq b, \\ \dfrac{(x-d)}{(b-d)}, & b \leq x \leq d, \\ 0, & \text{otherwise}. \end{cases}$$

$$L_A(x) = \frac{(x-c)}{(a-c)}, \ c \leq x \leq a,$$

$$L^{-1}{}_A(h) = c + (a-c)\,h, \quad 0 \leq h \leq 1.$$

$$R_A(x) = \frac{(x-d)}{(b-d)}, \ b \leq x \leq d,$$

$$R^{-1}{}_A(h) = d + (b-d)\,h, \quad 0 \leq h \leq 1.$$

L_A and R_A are the functions L and R of the trapezoidal fuzzy number A, respectively. $L^{-1}{}_A(h)$ and $R^{-1}{}_A(h)$ are the inverse functions of the function $L_A(x)$ and $R_A(x)$ at h-level, respectively. Then the graded mean h-level value of fuzzy number A is $h\,(L^{-1}(h) + R^{-1}(h))/2$ as Figure 1. Then the graded mean integration representation of A is

$$P(A) = \int_0^1 \frac{h\,(L^{-1}(h) + R^{-1}(h))}{2}\, dh \Big/ \int_0^1 h\,dh$$

$$= \int_0^1 \frac{h\,(c + (a-c)\,h + d + (b-d)\,h)}{2}\, dh \Big/ \int_0^1 h\,dh$$
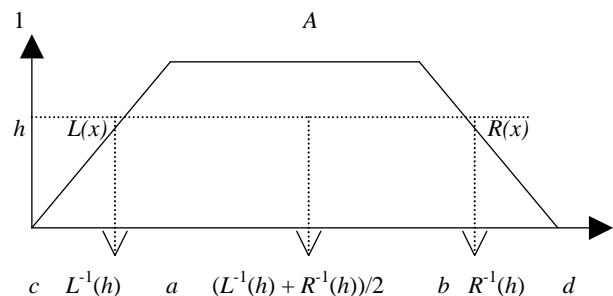
$$= \frac{1}{6}(c + 2a + 2b + d) \tag{1}$$

Fig. 1. The graded mean h-level of A

THE REPRESENTATION OF MULTIPLICATION OPERATION ON TWO FUZZY NUMBERS

Now we define the representation of multiplication operation on two fuzzy numbers as follows. Definition 1. Let $A_1 = (c_1, a_1, b_1, d_1)$ and $A_2 = (c_2, a_2, b_2, d_2)$ be two trapezoidal fuzzy numbers. Let $P(A_1 \otimes A_2)$ be the representation of $A_1 \otimes A_2$.

$$P(A_1 \otimes A_2) = \int_0^1 h \left[\left(\frac{1}{2} L^{-1}{}_{A1}(h) \times \frac{1}{2} L^{-1}{}_{A2}(h) \right) \right.$$

$$+ \left(\frac{1}{2} L^{-1}{}_{A1}(h) \times \frac{1}{2} R^{-1}{}_{A2}(h) \right) + \left(\frac{1}{2} R^{-1}{}_{A1}(h) \times \frac{1}{2} L^{-1}{}_{A2}(h) \right)$$

$$\left. + \left(\frac{1}{2} R^{-1}{}_{A1}(h) \times \frac{1}{2} R^{-1}{}_{A2}(h) \right) \right] dh / \int_0^1 h\, dh$$

$$= \int_0^1 h \left[\left((c_1 + (a_1 - c_1)h)/2 \times (c_2 + (a_2 - c_2)h)/2 \right. \right.$$

$$+ (c_1 + (a_1 - c_1)h)/2 \times (d_2 + (b_2 - d_2)h)/2$$

$$+ (d_1 + (b_1 - d_1)h)/2 \times (c_2 + (a_2 - c_2)h)/2$$

$$\left. + (d_1 + (b_1 - d_1)h)/2 \times (d_2 + (b_2 - d_2)h)/2 \right] dh / \int_0^1 h\, dh$$

$$= \frac{1}{4} \int_0^1 \left[(c_1 c_2 + c_1 d_2 + d_1 c_2 + d_1 d_2)h \right.$$

$$+ (c_1 a_2 - c_1 c_2 + c_2 a_1 - c_1 c_2 + c_1 b_2 - c_1 d_2 + d_2 a_1 - d_2 c_1$$

$$+ d_1 a_2 - d_1 c_2 + c_2 b_1 - c_2 d_1 + d_1 b_2 - d_1 d_2 + d_2 b_1 - d_1 d_2)h^2$$

$$+ (a_1 a_2 - a_1 c_2 - c_1 a_2 + c_1 c_2 + a_1 b_2 - a_1 d_2 - c_1 b_2 + c_1 d_2$$

$$+ b_1 a_2 - b_1 c_2 - d_1 a_2 + d_1 c_2 + b_1 b_2 - b_1 d_2 - d_1 b_2$$

$$\left. + d_1 d_2)h^3 \right] / \int_0^1 h\, dh$$

$$= \frac{1}{4}(c_1 c_2 + c_1 d_2 + d_1 c_2 + d_1 d_2) + \frac{1}{6}[(c_1 + d_1)(a_2 - c_2 + b_2 - d_2)$$

$$+ (c_2 + d_2)(a_1 - c_1 + b_1 - d_1)]$$

$$+ \frac{1}{8}[(a_1 - c_1 + b_1 - d_1)(a_2 - c_2 + b_2 - d_2)]$$

We have that

$$P(A_1 \otimes A_2) = \frac{1}{4}(c_1 c_2 + c_1 d_2 + d_1 c_2 + d_1 d_2)$$

$$+ \frac{1}{6}[(c_1 + d_1)(a_2 - c_2 + b_2 - d_2) + (c_2 + d_2)(a_1 - c_1 + b_1 - d_1)]$$

$$+ \frac{1}{8}[(a_1 - c_1 + b_1 - d_1)(a_2 - c_2 + b_2 - d_2)] \tag{2}$$

Now let's see more examples. Let $A_1 = (1, 1, 1, 1)$ be a real number. $A_2 = (1, 2, 3, 4)$ is a trapezoidal fuzzy number.

Case 1 $A_1 \otimes A_1$

The representation of A_1 is $P(A_1) = 1$. And $P(A_1) \otimes P(A_1) = 1 \times 1 = 1$. On the other hand, by the formula (2) we can obtain that the representation of $A_1 \otimes A_1$ is 1. We have that $P(A_1) \otimes P(A_1) = 1 = P(A_1 \otimes A_1)$.

Case 2 $A_1 \otimes A_2$

Similarly, the representations of A_1 and A_2 are $P(A_1) = 1$, $P(A_2) = 2.5$. $P(A_1) \otimes P(A_2) = 1 \times 2.5 = 2.5$. By the formula (2), the representation of $A_1 \otimes A_2$ is 2.5. We have that $P(A_1) \otimes P(A_2) = 2.5 = P(A_1 \otimes A_2)$.

Case 3 $A_2 \otimes A_1$

$P(A_2) = 2.5$, $P(A_1) = 1$, $P(A_2) \otimes P(A_1) = 2.5 \times 1 = 2.5$ is equal to case 2. That is, $P(A_1) \otimes P(A_2) = P(A_2) \otimes P(A_1)$. On the other hand, by the formula (2), $P(A_2 \otimes A_1) = 2.5$ is also equal to case 2. That is, $P(A_1 \otimes A_2) = P(A_2 \otimes A_1)$. We have that $P(A_2) \otimes P(A_1) = P(A_1) \otimes P(A_2) = P(A_2 \otimes A_1) = P(A_1 \otimes A_2)$

Case 4 $A_2 \otimes A_2$

$P(A_2) = 2.5$, $P(A_2) \otimes P(A_2) = 2.5 \times 2.5 = 6.25$. By the formula (2), $P(A_2 \otimes A_2) = 6.25$. We have that $P(A_2) \otimes P(A_2) = P(A_2 \otimes A_2)$.

According to the above 4 cases, we note that the representation of multiplication operation on two fuzzy numbers proposed in this paper not only can be used to explain the representation of multiplication operation on fuzzy numbers, but also can be used to explain the representation of multiplication operation on the real numbers.

There are two major differences between the method proposed in this paper and those methods proposed in the past papers. The first difference is that there is only one calculation step involved in the method proposed in this paper. The only one calculation step is that we can directly obtain the representation of multiplication operation on two fuzzy numbers $P(A_2 \otimes A_2) = 6.25$ by formula (2) proposed in this paper. There are two calculation steps involved in those methods proposed in the past papers. Step 1 is to calculate the representation of one fuzzy number. Foe example, by those formulas proposed in the past papers, we can obtain the representation of one fuzzy number $P(A_2) = 2.5$. Step 2 is to further calculate the representation of multiplication operation on two fuzzy numbers by the

following Eq. (3).

$$P(A_2) \otimes P(A_2) = 2.5 \times 2.5 = 6.25 \tag{3}$$

Strictly speaking, in the above Eq. (3) $2.5 \times 2.5 = 6.25$ is not a fuzzy arithmetic operation but a mathematic multiplication operation on two real numbers. That is the second major difference between the method proposed in this paper and those methods proposed in the past papers. The method proposed in this paper is a fuzzy arithmetic operation method.

APPLICATION TO A/R COLLECTION INSTRUMEMT SELECTION

1. Descriptions of A/R collection instruments

In general, there are four major alternative instruments for collecting the A/R. The four major alternative instruments include the letter of credit (L/C), telegraphic transfer (T/T), document against payment (D/P) and document against acceptance (D/A), and open account (O/A). The descriptions of the four A/R collection instruments are shown as follows.

The letter of credit (L/C) is a common instrument of "payment on shipment" in the international trade. The seller and the buyer agreed to sell and buy goods by L/C payment when the international trade contract was made. And then the seller is waiting for shipment until he receives the L/C issued by the issuing bank in the buyer's country. The seller has to go to the bank and present the L/C for negotiation after shipment. The negotiation bank must pay the seller money. For the seller, the L/C is a protective but expensive and complicated A/R collection instrument.

The telegraphic transfer (T/T) is the most popular instrument of "payment" in the international trade. In some cases, the seller and the buyer agreed to sell and buy goods by T/T payment in advance when the international trade contract was made. In such situation, the buyer has to go to the bank for telegraphic transfer and forward payment before the seller ships the goods. The T/T is the simplest and cheapest collection instrument for the seller. But for the buyer, the T/T is not a protective instrument because the T/T creates the greatest risk. In some cases, the seller and the buyer agreed to sell and buy goods by T/T deferred payment when the international trade contract was made. In such situation, the seller has to export goods and the buyer paid by T/T after the goods were shipped.

The document against payment (D/P) and the document against acceptance (D/A) belong to the instruments of "deferred payment" in the international trade. The seller and the buyer agreed to sell and buy goods by D/P or D/A payment when the international trade contract was made. The seller must ship the goods. The transportation document will be transmitted through the banking channel to the bank in the buyer's country. The buyer has to go to the bank for document against payment (D/P) or document against acceptance (D/A) to receive the transportation document for goods. The D/P and D/A collection instruments provide a relatively lower secure option than that of the L/C and T/T collection instruments above mentioned. However, The D/P and D/A collection instruments create a relatively lower transaction fee than that of the L/C collection instrument with bank fee typically fixed in 0.5% of total transaction amount.

The open account (O/A) is also a kind of "deferred payment" instrument in the international trade. The seller and the buyer agreed to sell and buy goods by O/A payment when the international trade contract was made. The buyer does not need to forward any payment before the goods be shipped and delivered to the buyer's country. The transportation document will be transmitted directly to the buyer. The transmission of transportation document does not need to transmit through the banking channel. Thus, the O/A collection instrument creates a relatively lowest secure option than the L/C, T/T, D/P and D/A collection instruments above mentioned.

The advantages and the disadvantages of the four A/R collection instruments are compared and listed in Table 1.

2. Constructing the MADM hierarchy structure

An empirical study on A/R collection instrument selection of one hi-tech company which is a computer exporter in the Hsu-Chu Science Park of Taiwan is shown in this section. The evaluation criteria used to selection the A/R collection instrument are from the literature reviews [3, 17, 20, 21, 25, 26] and consultation with one manager who works for this hi-tech company.

The factors affecting the performance of A/R collection instrument can be classified into 12 criteria including the reduction of the transaction partners' credit risk (C_1), reduction of the interest-rate fluctuation risk (C_2), reduction of the exchange-rate fluctuation risk (C_3), reduction of the political and economic risk in partners' countries (C_4), reduction of transaction fee (C_5), convenience of collection procedure (C_6), time period of collection (C_7), reduction of the collection cost (C_8), help for the seller to expand the market share (C_9), financial structure policy (C_{10}), A/R period policy (C_{11}), and the collection way of competitors in the same industry (C_{12}). There are four candidate A/R collection instruments including the letter of credit (Y_1), the tele-

Table 1. The comparision of four A/R collection instruments

Instrument	Advantage	Disadvantage
T/T	1. The lowest transaction risk for the seller 2. The lowest transaction fee 3. The shortest collection time 4. Financial facility 100%	1. The highest transaction risk for the buyer 2. Helpless for the seller to expand the market share
L/C	1. Lower transaction risk for the seller 2. Shorter collection time of sight L/C 3. Financial facility 70%~90%	1. The highest transaction fee (banking fee) 2. The issuing bank takes a risk of non-performance of the buyer 3. Longer collection time of usance L/C 4. Helpless for the seller to expand the market share
D/P, D/A	1. Low risk for the buyer 2. Financial facility 50%~70% 3. Helpful for sellers to expand market shares	1. High risk for the seller 2. Longer collection time than that of L/C
O/A	1. The lowest risk for the buyer 2. The lowest transaction fee 3. Helpful for sellers to expand market shares	1. The highest risk for the seller 2. The highest A/R management cost for the seller 3. Longer collection time

Table 2. Linguistic variables for importance weight of criteria

Very low	(0.3, 0.35, 0.45, 0.5)
Low	(0.4, 0.45, 0.55, 0.6)
Medium low	(0.5, 0.55, 0.65, 0.7)
Fair	(0.6, 0.65, 0.75, 0.8)
Medium high	(0.7, 0.75, 0.85, 0.9)
High	(0.8, 0.85, 0.95, 1.0)
Very high	(1.0, 1.0, 1.0, 1.0)

Table 3. The importance weight of each criteria

C_1	Very high	(1.0, 1.0, 1.0, 1.0)
C_2	Very low	(0.3, 0.35, 0.45, 0.5)
C_3	Medium high	(0.7, 0.75, 0.85, 0.9)
C_4	Very low	(0.3, 0.35, 0.45, 0.5)
C_5	Very low	(0.3, 0.35, 0.45, 0.5)
C_6	Very low	(0.3, 0.35, 0.45, 0.5)
C_7	Very high	(1.0, 1.0, 1.0, 1.0)
C_8	Medium high	(0.7, 0.75, 0.85, 0.9)
C_9	High	(0.8, 0.85, 0.95, 1.0)
C_{10}	Medium high	(0.7, 0.75, 0.85, 0.9)
C_{11}	High	(0.8, 0.85, 0.95, 1.0)
C_{12}	Medium high	(0.7, 0.75, 0.85, 0.9)

graphic transfer (Y_2), the document against payment or document against acceptance (Y_3), and the open account (Y_4) for evaluation in this decision making selection problem. The decision-making hierarchical structure of this A/R collection instrument selection problem is shown as Figure 2.

3. Solution procedure

The proposed representation of multiplication operation on two fuzzy numbers in this paper is currently applied to solving this A/R collection instrument selection problem. The computational procedure is summarized as follows.

Step 1. The decision maker uses the linguistic weighting variables shown in Table 2 to assess the importance of criteria and present it in Table 3.

Step 2. The decision maker uses the linguistic rating variables shown in Table 4 to evaluate the rating of candidate alternatives with respect to each criteria and present it in Table 5.

Step 3. Calculate the total rating of each candidate instrument. Assume there are N candidate instruments

Table 4. Linguistic variables for preference of each alternative

Very poor	(2.0, 2,5, 3.5, 4.0)
Poor	(3.0, 3.5, 4.5, 5.0)
Medium poor	(4.0, 4.5, 5.5, 6.0)
Fair	(5.0, 5.5, 6.5, 7.0)
Medium good	(6.0, 6.5, 7.5, 8.0)
Good	(7.0, 7.5, 8.5, 9.0)
Very good	(8.0, 8.5, 9.5, 10)

(Y_1, Y_2, Y_n..., Y_N), I evaluation criteria (C_1, C_2, C_i ..., C_I). Let $P_{(Y_n, C_i)}$ be the fuzzy rating assigned to the nth candidate instrument by the decision maker under criteria C_i. And W_i is the importance weights of C_i. Let $P_{ni} = P(W_i \otimes P_{(Y_n, C_i)})$ be the representation of $W_i \otimes P_{(Y_n, C_i)}$, where $1 \leq n \leq N$, $1 \leq i \leq I$. And let $TP_n = \sum_{i=1}^{I} P_{ni}$ be the

Goal   Criteria   Alternative

Fig. 2. The decision-making hierarchy structure of A/R collection instrument selection.

total fuzzy rating of the nth candidate instrument. For example, the total rating of candidate instrument Y_1 is

$$TP_1 = \sum_{i=1}^{I} P_{1i} = \sum_{i=1}^{I} P(W_i \otimes P_{(Y1, Ci)})$$

$= [(1.0, 1.0, 1.0, 1.0) \otimes (6.0, 6, 5, 7, 5, 8.0)$
$+ (0.3, 0.35, 0.45, 0.5) \otimes (5.0, 5.5, 6.5, 7.0)$
$+ (0.7, 0.75, 0.85, 0.9) \otimes (5.0, 5.5, 6.5, 7.0)$
$+ (0.3, 0.35, 0.45, 0.5) \otimes (5.0, 5.5, 6.5, 7.0)$
$+ (0.3, 0.35, 0.45, 0.5) \otimes (2.0, 2, 5, 3.5, 4.0)$
$+ (0.3, 0.35, 0.45, 0.5) \otimes (3.0, 3.5, 4.5, 5.0)$
$+ (1.0, 1.0, 1.0, 1.0) \otimes (5.0, 5.5, 6.5, 7.0)$
$+ (0.7, 0.75, 0.85, 0.9) \otimes (4.0, 4.5, 5.5, 6.0)$
$+ (0.8, 0.85, 0.95, 1.0) \otimes (2.0, 2, 5, 3.5, 4.0)$
$+ (0.7, 0.75, 0.85, 0.9) \otimes (2.0, 2, 5, 3.5, 4.0)$
$+ (0.8, 0.85, 0.95, 1.0) \otimes (2.0, 2, 5, 3.5, 4.0)$
$+ (0.7, 0.75, 0.85, 0.9) \otimes (2.0, 2, 5, 3.5, 4.0)]$

Then according to the representation of multiplication operation on two fuzzy numbers proposed in this paper

$$P(A_1 \otimes A_2) = \frac{1}{4}(c_1 c_2 + c_1 d_2 + d_1 c_2 + d_1 d_2)$$

$$+ \frac{1}{6}[(c_1 + d_1)(a_2 - c_2 + b_2 - d_2) + (c_2 + d_2)(a_1 - c_1 + b_1 - d_1)] + \frac{1}{8}[(a_1 - c_1 + b_1 - d_1)(a_2 - c_2 + b_2 - d_2)]$$

The decision maker can obtain quickly the total rating of candidate instrument Y_1. $TP_1 = 7 + 2.4 + 4.8 + 2.4 + 1.2 + 1.6 + 6.0 + 4.0 + 2.7 + 2.4 + 2.7 + 2.4 = 39.6$.

Similarly, we can obtain easily the total rating $TP_2 = 61.7$ for candidate instrument Y_2, the total rating $TP_3 = 31.9$ for candidate instrument Y_3 and the total rating $TP_4 = 41.7$ for candidate instrument Y_4. Thus the decision maker of computer company can rank quickly all candidate collection instruments, $TP_2 = 61.7 > TP_4 = 41.7 > TP_1 = 39.6 > TP_2 = 31.9$, and then select easily the candidate instrument Y_2 (telegraphic transfer, T/T) as the best collection instrument.

Table 5. The rating of each candidate alternative with respect to each criteria

C_1	Y_1	(6.0, 6.5, 7.5, 8.0)
	Y_2	(8.0, 8.5, 9.5, 10)
	Y_3	(3.0, 3.5, 4.5, 5.0)
	Y_4	(2.0, 2, 5, 3.5, 4.0)
C_2	Y_1	(5.0, 5.5, 6.5, 7.0)
	Y_2	(8.0, 8.5, 9.5, 10)
	Y_3	(3.0, 3.5, 4.5, 5.0)
	Y_4	(2.0, 2, 5, 3.5, 4.0)
C_3	Y_1	(5.0, 5.5, 6.5, 7.0)
	Y_2	(8.0, 8.5, 9.5, 10)
	Y_3	(3.0, 3.5, 4.5, 5.0)
	Y_4	(2.0, 2, 5, 3.5, 4.0)
C_4	Y_1	(5.0, 5.5, 6.5, 7.0)
	Y_2	(8.0, 8.5, 9.5, 10)
	Y_3	(3.0, 3.5, 4.5, 5.0)
	Y_4	(2.0, 2, 5, 3.5, 4.0)
C_5	Y_1	(2.0, 2.5, 3.5, 4.0)
	Y_2	(7.0, 7.5, 8.5, 9.0)
	Y_3	(3.0, 3.5, 4.5, 5.0)
	Y_4	(7.0, 7.5, 8.5, 9.0)
C_6	Y_1	(3.0, 3.5, 4.5, 5.0)
	Y_2	(8.0, 8.5, 9.5, 10)
	Y_3	(3.0, 3.5, 4.5, 5.0)
	Y_4	(7.0, 7.5, 8.5, 9.0)
C_7	Y_1	(5.0, 5.5, 6.5, 7.0)
	Y_2	(8.0, 8.5, 9.5, 10)
	Y_3	(3.0, 3.5, 4.5, 5.0)
	Y_4	(2.0, 2,5, 3.5, 4.0)
C_8	Y_1	(4.0, 4.5, 5.5, 6.0)
	Y_2	(8.0, 8.5, 9.5, 10)
	Y_3	(3.0, 3.5, 4.5, 5.0)
	Y_4	(3.0, 3.5, 4.5, 5.0)
C_9	Y_1	(2.0, 2, 5, 3.5, 4.0)
	Y_2	(2.0, 2, 5, 3.5, 4.0)
	Y_3	(2.0, 2, 5, 3.5, 4.0)
	Y_4	(8.0, 8.5, 9.5, 10)
C_{10}	Y_1	(2.0, 2, 5, 3.5, 4.0)
	Y_2	(5.0, 5.5, 6.5, 7.0)
	Y_3	(2.0, 2,5, 3.5, 4.0)
	Y_4	(2.0, 2, 5, 3.5, 4.0)
C_{11}	Y_1	(2.0, 2, 5, 3.5, 4.0)
	Y_2	(5.0, 5.5, 6.5, 7.0)
	Y_3	(3.0, 3.5, 4.5, 5.0)
	Y_4	(3.0, 3.5, 4.5, 5.0)
C_{12}	Y_1	(2.0, 2,5, 3.5, 4.0)
	Y_2	(2.0, 2,5, 3.5, 4.0)
	Y_3	(2.0, 2, 5, 3.5, 4.0)
	Y_4	(8.0, 8.5, 9.5, 10)

CONCLUSION

The representation of multiplication operation on two fuzzy numbers is useful for decision makers who are in the fuzzy multiple attribute decision-making environment to rank all candidate alternatives and choose the best one. In this paper, we propose the representation of multiplication operation on two fuzzy numbers and then this representation is applied to an A/R collection instrument selection problem in the international trade. Based on this representation of multiplication operation on two fuzzy numbers, decision makers can rank quickly the rank ordering of all alternatives and then choose easily the best one in the fuzzy multiple attribute decision making environment. This representation of multiplication operation on two fuzzy numbers proposed in this paper not only can be applied to solving the A/R collection instrument selection problem in the international trade but also can be applied to solving other fuzzy multiple attribute decision-making problems.

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