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Abstract:
The first stage in AHP-weighting in supplier selection is the formation of pairwise comparison matrix. In fact, the matrix is filled by experts or decision makers in the company. If the consistency ratio of this matrix is less than 0.1, then the matrix is inconsistent. If it is not consistent, then the AHP-weighting is invalid, so the first step must be repeated continuously so as to obtain a consistency ratio of less than 0.1. Repetition in making the pairwise comparison matrix requires a lot of time, cost and effort, so this AHP-weighting is not very efficient. This research proposes a new pairwise comparison matrix, which the results of AHP-weighting are always consistent without measurement of consistency ratio. Thus, the proposed method more effective and efficient. Therefore, it will provide the right results in supplier selection more quickly and appropriately.

Keywords: Consistency Ratio, Pairwise Comparison, AHP Weighting, Analytical Hierarchy Process, Supplier Selection, Criteria).

Introduction

Supplier selection is to determine the best supplier from several suppliers based on consideration of several criteria. Thus, supplier selection is multi criteria decision making (MCDM) problem. Analytical Hierarchy Process (AHP) is a widely used MCDM method in supplier selection. Supplier selection can be done using AHP only, or can also use AHP combination with other MCDM methods [1]. The MCDM used in the AHP combination for supplier selection are Data Envelopment Analysis [2], Preference Ranking Organization for Enrichment Evaluation [3], and Technique for Order Preference by Similarity to the Ideal Solution [4]. The use of AHP in such combinations is for weighting criteria.

However, if using AHP only then it can be done to weighting criteria as well as supplier selection. In the last three years, supplier selection research using AHP has been widely applied in many industries, i.e. general automobile industry [5], information technology [6], automotive industry in Pakistan [7], automotive industry in Malaysia [8], Portuguese pharmaceutical company [9], Indian electrical manufacturing [10], Indian iron steel industry [11], information technology in India [12], automotive industry in India [13], gas turbine industry [14], oil and gas industry in United Arab Emirates [15], railway project in Saudi Arabia [16], Italian railway transportation [17], and lubricant industry [18].

The AHP solution is determined by the initial step, i.e. formation of pairwise comparison matrices. Because, the criteria weighting and supplier selection are considered valid if the pairwise comparison matrix is consistent. The problem is that not all pairwise comparison matrices are always consistent. In AHP, the consistency of pairwise comparison matrices using consistency ratio calculation. If this matrix is inconsistent, the AHP result is invalid. If the number of criteria is very large (more than seven criteria), a great opportunity will result in an inconsistent matrix [19]. So, it is recommended always use criteria less or equal to seven [20].

To solve this problem, most research on supplier selection uses a hierarchy model, so there are major-criteria and sub-criteria, i.e. [5]-[10][12][14]. Supplier selection research by [11] uses the Delphi method to reduce the number of criteria in the iron-steel industry, from 13 criteria to seven criteria, and then processed using AHP. Another way is to divide the criteria into two types, namely technical and commercial criteria, as in [15]. However, these methods require a long computational time and do not guarantee the number of criteria to be less than seven in each sub-criteria group or each type of criterion. Thus, these methods are considered less effective and efficient.

Based on the weaknesses mentioned above, this study proposes a new way of ensuring matrix of pairwise comparison is always consistent, regardless of the number of criteria. Thus, the proposed method will have shorter stages, since there is no need to calculate the consistency ratio. Thus, the proposed method will be more effective and efficient than the original AHP.

Analytical Hierarchy Process

In AHP, there are two important groups of stages. The first stage group is the criteria weighting stage, as shown in Figure 1. The second stage group is the calculation of the consistency ratio, as shown in Figure 2. This second stage group as a control tool whether the first stage group has consistent results or not. If the consistency ratio is less than 0.01, then the result of the first stage group is inconsistent. When this condition occurs, the pairwise comparison matrix must be replaced or corrected. In fact, the matrix is filled by experts or decision makers in the company. Replacement and change of the matrix mean asking the experts and decision makers to fill the matrix again. If the result is inconsistent, then it must be repeated and repeated again, and so on. This activity requires a lot of cost, time, and effort. This is the main weakness of AHP. The speed and accuracy of the AHP solution is determined by pairwise comparison matrices. Therefore, it is very important to make pairwise comparison matrices always consistent. Thus, it will eliminate the group of consistency ratio calculation stages.

Proposed Method

If there is a set of criteria ($C_1, C_2, C_3, ..., C_{n-i}, C_i$), then only compare between criteria C_1 to criteria C_2, between criteria C_2 and C_3, between criteria C_3 and C_4, and so on until between C_{n-i} and C_i. Therefore, if $C_1/C_2 = A_{12}$, $C_2/C_3 = A_{23}$, $C_3/C_4 = A_{34}$, ..., $C_{n-i}/C_i = A_{(n-i)i}$; where A_{ij} is the pairwise comparison value between criteria i with criteria j, it will form the equation as follows:

$$\frac{C_1}{C_2} = A_{12} \text{ so } C_1 = A_{12}C_2 \text{ or } C_2 = \frac{C_1}{A_{12}} \quad (1)$$

$$\frac{C_2}{C_3} = A_{23} \text{ so } C_2 = A_{23}C_3 \text{ or } C_3 = \frac{C_2}{A_{23}} \quad (2)$$

$$\frac{C_3}{C_4} = A_{34} \text{ so } C_3 = A_{34}C_4 \text{ or } C_4 = \frac{C_3}{A_{34}} \quad (3)$$

$$\vdots$$

$$\frac{C_{n-i}}{C_i} = A_{(n-i)i} \text{ so } C_{n-i} = A_{(n-i)i}C_i \text{ or } C_i = \frac{C_{n-i}}{A_{(n-i)i}} \quad (4)$$

Thus, it already has enough data to compare between one criterions with another, as follows:

$$\frac{C_1}{C_3} = \frac{A_{12}C_2}{\frac{C_2}{A_{23}}} = A_{12}A_{23} \quad (5)$$

$$\frac{C_1}{C_4} = \frac{A_{12}A_{23}C_3}{\frac{C_3}{A_{34}}} = A_{12}A_{23}A_{34} \quad (6)$$

$$\frac{C_2}{C_4} = \frac{A_{23}C_3}{\frac{C_3}{A_{34}}} = A_{23}A_{34} \quad (7)$$

$$\vdots$$

$$\frac{C_1}{C_i} = A_{12}A_{23}A_{34}...A_{(n-i)i} \quad (8)$$

Based on only a part of the comparison value between the above criteria, a full comparison matrix can be obtained as shown in Table 1.

Table 1 : Proposed pairwise comparison matrix

	C_1	C_2	C_3	C_4	..	C_i
C_1		A_{12}	$A_{12}A_{23}$	$A_{12}A_{23}A_{34}$	..	$A_{12}A_{23}...A_{(n-i)i}$
C_2	$1/A_{12}$		A_{23}	$A_{23}A_{34}$	..	$A_{23}A_{34}...A_{(n-i)i}$
C_3	$1/[A_{12}A_{23}]$	$1/A_{23}$		A_{34}	..	$A_{34}A_{45}...A_{(n-i)i}$
C_4	$1/[A_{12}A_{23}A_{34}]$	$1/[A_{23}A_{34}]$	$1/A_{34}$		..	$A_{45}A_{56}...A_{(n-i)i}$
...	...	...	...	...		...
C_i	$1/[A_{12}A_{23}...A_{(n-i)i}]$	$1/[A_{23}A_{34}...A_{(n-i)i}]$	$1/[A_{34}A_{45}...A_{(n-i)i}]$	$1/[A_{45}A_{56}...A_{(n-i)i}]$	..	

Description: comparative value must be filled are A_{12}, A_{23}, A_{34}, ..., $A_{(n-i)i}$

Result and Discussion

To know the validation of the proposed model, then used some case examples taken from some literature. The consistency ratio of each case example is placed in the *CR* column in Table 2. Whereas, the consistency ratio of the proposed method is derived from a pairwise comparison matrix in each case example, which is filled on only certain cells. As for cells that remain filled in the matrix is the comparison between criteria C_1 with criterion C_2 (A_{12}), the comparison between criterion C_2 with criterion C_3 (A_{23}), comparison between criterion C_3 with criterion C_4 (A_{34}), and so on. The pairwise comparison matrices of each literature can be seen in Table 3, Table 4, Table 5, Table 6, Table 7, Table 8, Table 9, and Table 10. Based on table 2, the proposed method is able to produce a consistent matrix, without considering the number of criteria. In fact, using inconsistent matrices (e.g. number of cases 3 and 6), it still produces a consistent matrix. The proposed method is reliable, because there are 6 case examples of 8 case examples (75%), whose consistency ratio is perfect (CR = 0.000) and all case examples have a consistency ratio of less than 0.1 (100% consistent).

Table 2 : Pairwise comparison matrix from literature

No	Literature	Matrix size	Consistency ratio (CR)	CR using the proposed model
1	Polat and Eray [16]	8 x 8	0.0290	0.0000
2	Polat [3]	11 x 11	0.0089	0.0097
3	Hruska et al. [22]	10 x 10	0.1845	0.0153
4	Jain et al. [4]	8 x 8	0.0161	0.0000
5	Dweiri et al. [7]	4 x 4	0.0116	0.0000
6	Galankashi et al. [8]	4 x 4	0.8185	0.0000
7	Cabrita and Frade [9]	6 x 6	0.0386	0.0000
8	Kar [11]	7 x 7	0.0614	0.0000

Table 3 : Pairwise comparison matrix #1 [16]

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
C_1	1.00	1.48	2.63	0.56	1.46	2.06	1.86	1.41
C_2	0.68	1.00	5.18	0.50	1.73	5.18	2.11	1.28
C_3	0.38	0.19	1.00	0.15	0.33	1.00	1.19	0.31
C_4	1.79	2.00	6.67	1.00	2.63	6.19	3.35	1.41
C_5	0.68	0.58	3.03	0.38	1.00	3.31	1.68	0.31
C_6	0.49	0.19	1.00	0.16	0.30	1.00	0.71	0.27
C_7	0.54	0.47	0.84	0.30	0.60	1.41	1.00	0.36
C_8	0.71	0.78	3.23	0.71	3.23	3.70	2.78	1.00
W_i	0.15	0.17	0.05	0.26	0.10	0.04	0.06	0.17

CR = 0.029 (consistent)

Table 4 : Pairwise comparison matrix #2 [3]

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}
C_1	1.0	1.26	1.44	1.82	2.29	2.15	3.30	2.88	1.65	1.59	3.17
C_2	0.79	1.00	1.44	1.38	1.65	1.59	2.62	2.52	1.44	1.26	2.71
C_3	0.69	0.69	1.00	1.31	1.36	1.55	2.15	1.82	1.26	1.10	2.29
C_4	0.55	0.72	0.76	1.00	1.18	1.14	1.74	1.59	1.05	0.94	1.82
C_5	0.44	0.61	0.74	0.85	1.00	1.10	1.58	1.31	0.87	0.79	1.71
C_6	0.47	0.63	0.65	0.88	0.91	1.00	1.65	1.26	0.85	0.69	1.70
C_7	0.30	0.38	0.47	0.57	0.63	0.61	1.00	0.94	0.72	0.55	0.91
C_8	0.35	0.40	0.55	0.63	0.76	0.79	1.06	1.00	0.63	0.60	1.31
C_9	0.35	0.38	0.47	0.57	1.15	1.18	1.39	1.59	1.00	0.87	1.96
C_{10}	0.63	0.79	0.91	1.06	1.27	1.45	1.82	1.67	1.15	1.00	2.52
C_{11}	0.32	0.37	0.44	0.55	0.58	0.59	1.10	0.76	0.51	0.40	1.00
W_i	0.16	0.13	0.11	0.09	0.08	0.08	0.05	0.06	0.09	0.10	0.05

CR = 0.089 (consistent)

Table 5 : Pairwise comparison matrix #3 [22]

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
C_1	1.0	3.0	5.0	5.0	7.0	8.0	8.0	6.0	5.0	5.0
C_2	0.3	1.0	5.0	5.0	7.0	8.0	8.0	6.0	5.0	5.0
C_3	0.2	0.2	1.0	0.33	5.0	6.0	7.0	5.0	3.0	4.0
C_4	0.2	0.2	3.0	1.0	4.0	3.0	7.0	5.0	1.0	5.0
C_5	0.14	0.14	0.2	0.25	1.0	4.0	0.2	0.14	0.33	3.0
C_6	0.13	0.13	0.17	0.33	0.25	1.0	5.0	0.2	0.33	3.0
C_7	0.13	0.13	0.14	0.14	5.0	0.2	1.0	0.33	0.33	3.0
C_8	0.17	0.17	0.2	0.2	7.0	5.0	3.0	1.0	1.0	3.0
C_9	0.17	0.13	0.14	0.14	3.00	3.0	3.0	1.0	1.0	3.0
C_{10}	0.2	0.2	0.25	0.2	0.33	0.33	0.33	0.33	0.33	1.0
W_i	0.292	0.229	0.114	0.113	0.036	0.037	0.036	0.068	0.051	0.023

CR = 0.1845 (inconsistent)

Table 6 : Pairwise comparison matrix #4 [4]

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
C_1	1.00	1.00	2.00	5.00	3.00	2.00	4.00	3.00
C_2	1.00	1.00	3.00	4.00	2.00	2.00	3.00	2.00
C_3	0.50	0.33	1.00	3.00	1.00	0.50	1.00	1.00
C_4	0.20	0.25	0.33	1.00	0.33	0.25	0.50	0.50
C_5	0.33	0.50	1.00	3.00	1.00	0.50	1.00	1.00
C_6	0.50	0.50	2.00	4.00	2.00	1.00	3.00	3.00
C_7	0.25	0.33	1.00	2.00	1.00	0.33	1.00	1.00
C_8	0.33	0.50	1.00	2.00	1.00	0.33	1.00	1.00
W_i	0.24	0.22	0.09	0.04	0.09	0.17	0.07	0.08

CR = 0.0161 (consistent)

Table 7 : Pairwise comparison matrix #5 [7]

	C_1	C_2	C_3	C_4
C_1	1.00	0.33	0.50	2.00
C_2	3.00	1.00	2.00	4.00
C_3	2.00	0.50	1.00	3.00
C_4	2.00	0.25	0.33	1.00
W_i	0.16	0.47	0.28	0.10

CR = 0.0116 (consistent)

Table 8 : Pairwise comparison matrix #6 [8]

	C_1	C_2	C_3	C_4
C_1	0.50	0.60	0.70	0.90
C_2	0.40	0.50	0.50	0.80
C_3	0.30	0.50	0.50	0.70
C_4	0.10	0.20	0.30	0.50
W_i	0.345	0.279	0.250	0.128

CR = 0.8185 (inconsistent)

Table 9 : Pairwise comparison matrix #7 [9]

	C_1	C_2	C_3	C_4	C_5	C_6
C_1	1.00	1	4	8	7	9
C_2	1	1.00	4	7	5	7
C_3	¼	¼	1.00	5	5	7
C_4	1/8	1/7	1/5	1.00	1	2
C_5	1/7	1/5	1/5	1	1.00	2
C_6	1/9	1/7	1/7	½	½	1.00
W_i	0.15	0.17	0.05	0.26	0.10	0.04

CR = 0.0386 (consistent)

Table 10 : Pairwise comparison matrix #8 [11]

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	1.00	1	3	3	3	5	5
C_2	1	1.00	3	3	3	3	5
C_3	0.3	0.3	1.00	1	3	3	3
C_4	0.3	0.3	1	1.00	3	1	3
C_5	0.3	0.3	0.3	0.3	1.00	0.3	3
C_6	0.2	0.3	0.3	1.0	3	1.00	3
C_7	0.2	0.2	0.3	0.3	0.3	0.3	1.00
W_i	0.284	0.243	0.144	0.119	0.074	0.091	0.045

CR = 0.0614 (consistent)

The pairwise comparison matrix from Hruska et al. [22] is inconsistent, because the value of comparison between criteria C_9 to criteria C_4 and between criteria C_4 and criteria C_8 is inconsistent. From Table 6, it can be seen that the value of comparison between criteria C_4 with criterion C_9 is 1. Similarly, the value of the comparison between criteria C_8 with criteria C_9 also has a value of 1. This means that all three criteria are equally important. However, when compared between criteria C_4 with criteria C_8 then the result is 4 (more important criteria C_4). This means that the criteria C_4 is greater than the criteria C_8 (not equally important). Thus, logically it is inconsistent. This will not happen, if using a proposed matrix. Because, by using a proposed matrix, the experts or decision makers have been directed only to fill certain cells only, so they will not give inconsistent value. This is showed in Table 3, where using the standard method obtained a consistent ratio of 0.1845 (inconsistent), whereas if using a new method obtained a consistency ratio of 0.0153 (consistent).

A very severe case example is a matrix from Galankashi et al. [8]. This is shown from a very large consistency ratio (close to 1). Although the number of criteria is less than the number of criteria from Hruska [22] (the number of criteria is half the number of criteria Hruska [22]), but due to inconsistencies occur in all comparisons between criteria, so its ratio of consistency is greater than Hruska [22]. From table 8 it can be seen that the value of comparison between criteria C_1 with criteria C_2 is 0.6, so criteria C_2 is bigger (more important) than criterion C_1. However, if criteria C_2 is compared to criteria C_1, then its value is 0.4. This means that the criteria C_1 is greater (more important) than the criteria C_2. These two statements are very contradictory, so logically inconsistent. This occurs in all comparisons between the criteria which presented in Table 9. The very inconsistent matrix from Galankashi et al. [8] is crisp data set, which is taken from fuzzy-AHP method. If the proposed method is compared with the fuzzy-AHP method, the results can be seen in Table 12. The fuzzy pairwise comparison matrix for each case example can be seen in Table 13, Table 14, Table 15, Table 16, and Table 17. Based on Table 12, it can be seen that the proposal method is very reliable. Of all the existing case examples, they all yield a perfect consistency ratio, which is 0. In fact, all matrices in case examples are inconsistent matrices, except matrix from Akman and Baynal [24]. Generally, the Fuzzy-AHP method ignores the consistency ratio, when in reality this ratio must remain in pure AHP [28]. There is a possibility that these studies assume not need the consistency ratio if AHP combined with fuzzy logic. However, this logic is not true before they prove the scientific evidence of their hypothesis.

Table 11 : Fuzzy pairwise comparison matrix from literature

No	**Literature**	**Matrix size**	**Consistency ratio (CR)**	**CR using the proposed model**
1	Chen et al. [23]	5 x 5	[0.929, 1.194, 0.644]	[0.0, 0.0, 0.0]
2	Akman and Baynal [24]	7 x 7	[**0.012**, **0.098**, **0.090**]	[0.0, 0.0, 0.0]
3	Kang et al. [25]	3 x 3	[0.574, **0004**, 0.895]	[0.0, 0.0, 0.0]
4	Li et al. [26]	5 x 5	[0.149, **0.085**, 0.189]	[0.0, 0.0, 0.0]
5	Saradhi et al. [27]	4 x 4	[0.544, 0.129, 0.348, 1.344]	[0.0, 0.0, 0.0, 0.0]

Table 12 : Fuzzy pairwise comparison matrix #1 [23]

	C_1	C_2	C_3	C_4	C_5
C_1	(1,1,1)	(1, 3, 5)	(5, 7, 9)	(1, 3, 5)	(1, 1, 3)
C_2	(1/5, 1/3, 1/1)	(1,1,1)	(1/9, 1/7, 1/5)	(1/5, 1/3, 1/1)	(5, 7, 9)
C_3	(1/9, 1/7, 1/5)	(5, 7, 9)	(1,1,1)	(1/7, 1/5, 1/3)	(1/7, 1/5, 1/3)
C_4	(1/5, 1/3, 1/1)	(1, 3, 5)	(3, 5, 7)	(1,1,1)	(1/3, 1/1, 1/1)
C_5	(1/3, 1/1, 1/1)	(1/9, 1/7, 1/5)	(3, 5, 7)	(1, 1, 3)	(1,1,1)

CR = (0.929, 1.194, 0.644) (inconsistent, inconsistent, inconsistent)

Table 13 : Fuzzy pairwise comparison matrix #2 [24]

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
C_1	(1,1,1)	(1,2,3)	(2,3,4)	(3,4,5)	(4,5,6)	(5,6,7)	(6,7,8)	(7,8,9)
C_2		(1,1,1)	(1,2,3)	(2,3,4)	(3,4,5)	(4,5,6)	(5,6,7)	(6,7,8)
C_3			(1,1,1)	(1,2,3)	(2,3,4)	(3,4,5)	(4,5,6)	(5,6,7)
C_4				(1,1,1)	(1,2,3)	(2,3,4)	(3,4,5)	(4,5,6)
C_5					(1,1,1)	(1,2,3)	(2,3,4)	(3,4,5)
C_6						(1,1,1)	(1,2,3)	(2,3,4)
C_7							(1,1,1)	(1,2,3)
C_8								(1,1,1)

CR = (0.012, 0.098, 0.090) (consistent, consistent, consistent)

Table 14 : Fuzzy pairwise comparison matrix #3 [25]

	C_1	C_2	C_3
C_1	(1,1,1)	(1,2,3)	(4,5,6)
C_2	(1/3,1/2,1)	(1,1,1)	(2,3,4)
C_3	(1/6,1/5,1/4)	(1/4,1/3,1/2)	(1,1,1)

CR = (0.574, 0004, 0.895) (inconsistent, consistent, inconsistent)

Table 15 : Fuzzy pairwise comparison matrix #4 [26]

	C_1	C_2	C_3	C_4	C_5
C_1	(1,1,1)	(7/8,5/6,5)	(4,1/3, 1/3)	(7,1,2/7)	(5/2,4,1/8)
C_2	(9/13, 3/4, 1/4)	(1,1,1)	(2,1/6,4)	(4,2/7,5/6)	(1/2,1/2, 1/2)
C_3	(1/6, 2, 2)	(1/3,4,1/6)	(1,1,1)	(3/4,7/8, 2/11)	(6/11,7, 6/11)
C_4	(1/8, 6/11, 5/2)	(2/11, 5/2, 3/4)	(5/6,9/13, 4)	(1,1,1)	(1/4,1/4, 7/8)
C_5	(2/7, 2/11, 7)	(2/3, 2/3, 2/3)	(1,1/8,1)	(3,3,9/13)	(1,1,1)

CR = (0.149, 0.085, 0.189) (inconsistent, consistent, inconsistent)

Table 16 : Fuzy pairwise comparison matrix #5 [27]

	C_1	C_2	C_3	C_4
C_1	(1,1,1,1)	(1,3,5,7)	(3,5,7,9)	(7,9,10,12)
C_2	(1/7,1/5,1/3,1)	(1,1,1,1)	(1,3,5,7)	(3,5,7,9)
C_3	(1/9,1/7,1/5,1/3)	(1/7,1/5,1/3, 1)	(1,1,1,1)	(1,3,5,7)
C_4	(1/12,1/10, 1/9,1/7)	(1/9,1/7,1/5, 1/3)	(1/7,1/5,1/3, 1)	(1,1,1,1)

CR = 0.544, 0.129, 0.348, 1.344 (all inconsistent)

Table 17 : Performance of suppliers for each criteria

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
S_1	8	5	3	1	8	7	8	3	5	3
S_2	10	6	5	2	7	10	5	1	8	1
S_3	10	6	3	3	5	8	6	4	5	5
S_4	9	7	4	2	4	11	2	3	7	0
S_5	12	8	4	2	6	9	4	0	8	2
S_6	10	6	8	4	5	6	3	2	7	1

Inconsistent pairwise comparison matrices have a major impact on errors in the supplier selection process. Inconsistent matrix causes invalid AHP weighting. This invalid weighting will lead to an invalid supplier selection process as well. So, the weighting criteria that are the result of AHP has a direct and major impact on the supplier selection process. This can be explained by using inconsistent case examples, i.e. Hruska et al. [22]. If known there are 6 suppliers and will be evaluated by the company. The decision makers in the company use 10 criteria as consideration in supplier evaluation. The results of this supplier evaluation will determine supplier selection. The results of the decision makers' assessment of each criterion are listed in Table 6. The performance data of each supplier is given in Table 18. By using AHP, it will obtain AHP weighting results for each criterion, as can be seen in Table 6 in the last row. Score in each criterion is obtained from the multiplication of performance data for each criterion (Table 18) with the criterion weight (Table 6 in last row). If the score of each criterion is summed, the final score for each supplier is obtained. This final score determines the rank of each supplier. Supplier ranking is obtained as shown in Figure 1. These results will be different from the solution of the proposed method. The proposed matrix and the criterion weights can be seen in Table 19. The supplier's ranking of the proposed methods is shown in Figure 2. This difference is influenced by the difference of matrix pairwise comparison. If using an inconsistent matrix, then the first sequence is supplier 6 then supplier 5. However, if using a consistent matrix, then the first order is supplier 5 then supplier 6. Inconsistent matrices will result in invalid solutions, and vice versa. Therefore, the error in choosing a supplier is determined by the pairwise comparison matrix.

Table 18 : The proposed matrix of pairwise comparison

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
C_1	1.0	3.0								
C_2		1.0	5.0							
C_3			1.0	0.33						
C_4				1.0	4.0					
C_5					1.0	4.0				
C_6						1.0	5.0			
C_7							1.0	0.33		
C_8								1.0	1.0	
C_9									1.0	3.0
C_{10}										1.0
W_i	0.595	0.198	0.040	0.119	0.030	0.007	0.001	0.004	0.004	0.001

CR = 0.0153 (consistent)

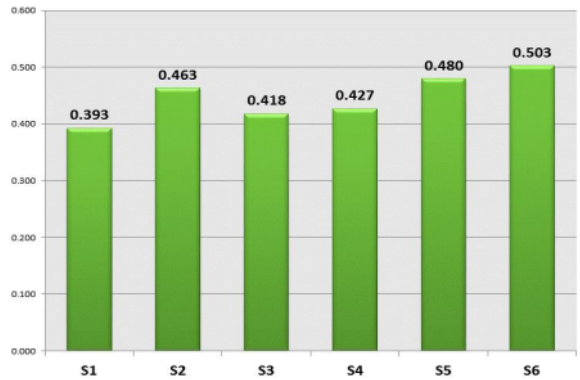

Figure 1: Ranking of suppliers using standard AHP-weighting

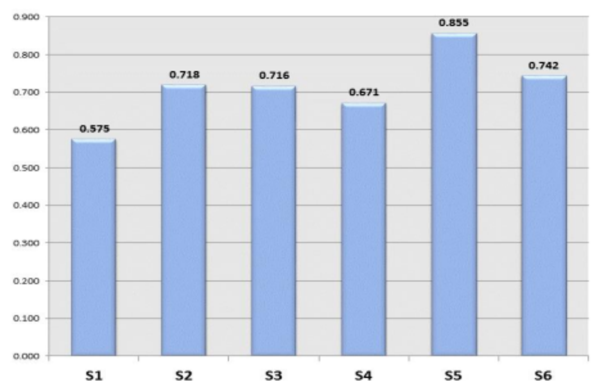

Figure 2: Ranking of suppliers using proposed method

Conclusion

The proposed method introduces a new pairwise comparison matrix, which the results of AHP-weighting are always consistent without measurement of consistency ratio. Thus, it will not require repetition in making the pairwise comparison matrix. So, the proposed method is more effective and efficient. Therefore, the proposed method will give the right results in the selection of suppliers more quickly and precisely.

Conflict of interest

The authors declare that there are no conflicts of interest.

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