The Application of MDCM with the Optimal Weight Value Consideration for Different Critiria

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Abstract: - During the issue of multiple criteria decision-making (MDCM), not only the weight value of each criterion should be obtained, but the average intension of criterion's importance and common consensus of experts also need to be incorporated into the consideration. As for the performance comparison, we will compare the difference between the actual performance and ideal performance with taking simultaneously all criteria into consideration. As for resolving the problem of MDCM, we will propose a MDCM model with the optimal weight value consideration for different critiria in this study. Besides, we also provide an illustrative example to demonstrate the rationality and feasibility of our proposed model.

Key-Words: - multiple criteria decision-making (MDCM), optimal weight value

1 Introduction

The choice and the summation for the weight values of several criterions, and the difference comparison among several performances with weighted consideration will be the problem for the issue of multiple criterions decision-making (MDCM) (Zeleny, 1982; Zeleny, 1992). As for the choice of weight value, it will be more difficult to be determined during the multiple criterions consideration for those practitioners. Hence, analytic hierarchy process (AHP) (Saaty, 1980; Lai, et al., 1999; Ramanathan & Ganesh, 1995; Ghodsypour & O'Brien, 1998; Tam & Tummala, 2001; Koe, et al., 1999; Ngai, 2003) was developed to overcome such issue by dividing those criterions into the primary and secondary criterions with hierarchy. The feasible weight value can be computed and the test of consistency can also be made via AHP methodology. However, the test of consistency frequently limited the real applications. As for the summation of the weight value, the practitioners will face the problem of how to summarize the weight effect of each criterion with the case of several experts. The average operation was the method frequently been used to compute the weight value of each criterion. However, the variation between different experts will be omitted by using the concept of average to compute the weight value. Restated, it can be viewed as meeting the problem of common consensus during those experts. Generally, the larger degree of importance of criterion will denote the corresponding weight value to be set a larger value. Therefore, we proposed an optimum weight model based on the fuzzy aggregation operator to address such problem, which is the summation of criterion's importance for each criterion. The weight value of each criterion will be obtained based on the average intension of each criterion and the common consensus of experts at the same time. Finally, we also take an example to demonstrate the rationality and feasibility of our proposed model.

2 Literature Review

Generally, the Delphi technique (Noorderhaver, 1995; Schermerhorn, Hunt & Osborn, 1985; Robbins, 1991; Hwang & Lin, 1987) is a known way to obtain the weight value of each criterion based on the questionnaire investigation. The viewpoint of weight value for several experts can be obtained by using Delphi technique. However, the procedures of performing the Delphi need enough time even though that it will be done via e-mail and Internets. The AHP, which was introduced by Saaty (1980), is measurement method to determine the relative importance or preference of a set of activities, in a multiple criteria decision-making (MCDM) problem. It can incorporate judgements on intangible qualitative criteria, as well as tangible quantitative criteria. Using an AHP, an evaluation team is able to systematically evaluate and determine the priorities of the criteria and sub-criteria. Based on this information, the team can then effectively evaluate several potential projects and select the best project. The AHP has been successfully applied to widespread problems, including a multimedia authoring system selection (Lai, et al., 1999), resource allocation problems (Ramanathan & Ganesh, 1995), suppliers selection (Ghodsypour & O'Brien, 1998; Tam & Tummala, 2001), convenience stores location (Koe, et al., 1999), online advertising selection (Ngai, 2003) and so on. The detailed AHP evaluation procedure can be referred to Satty (1980).

3 Proposed approach

In this section, we will clearly explain the proposed MDCM with the optimal weight value. In order to incorporate the average intension of each criterion and the common consensus of experts into our designed weight model, the following steps to derive the optimal weight value will represent the logistic thinking of our approach:

Step 1. Compute the membership degree μ_{ij} according to X_{ij} in an evaluation table

Assume that there are n criteria, m experts, an important evaluation value X_{ij} of i-th criterion for j-th expert, we can construct an evaluated table. Then, the ideal point of each criterion can be obtained by finding the maximum value X_{ij} among those criteria. Next, the membership degree μ_{ij} for each point with respect to the ideal point can be computed via the Equ (1):

$$\mu_{ij} = \frac{X_{ij}}{\max_i \{X_{ij}\}} \tag{1}$$

Step 2. The harmonizing mean of each criterion can be computed as Equ (2).

Where α will denote the degree of importance, and the larger α will represent the enlarger effect of importance.

$$h_i = \frac{1}{m}\sum_{j=1}^{m}\frac{1}{(\mu_{ij})^{\alpha}} \tag{2}$$

Step 3. The average degree of weight value (ei) of i-th criterion can be computed as Equ (3) by using the Equ (2).

$$e_i = \frac{1}{h_i} \tag{3}$$

Step 4. The average weight of i-th criterion (wi) can be computed as Equ (4) by using ei.

$$w_i = \frac{e_i}{\sum_{j=1}^{n} e_i} \tag{4}$$

Step 5. Collect the evaluation score for all candidates and compute the weighted performance score.

The practitioners can obtain the evaluation result by sending the questioniare to the experienced experts or decision-maker. And the performance score can be computed according to the basic concept of weighted value design.

Step 6. Determine the recommended sequence for all candidated options.

Fianlly, the priority or the recommended sequence for the candidates can be determined according the performance values.

4. Illustrative Example

In this section, we apply an example to demonstrate the rationality and feasibility of the proposed procedure. This case address the optimum decision for investment project (totally having seven projects). Herein, five primary dimensions will be chosen according the managers' experience and interestings. Besides, three secondary (or sub-criteria) evluation criteria for each primary domension were included. Two experts for this investment decision were invited to make the comparision recommendation for all criteria including the primary and the secondary criteria. The evaluation result for the primary criteria will be given in Table 1. As for the detailed cmputing process can be referred to the previous section. From Table 1, we can find out that average score for each criteria to be the same. However, the average weight value method can not react the difference on itself. It also limit its applications.

Next, Table 2 will list the final weighted values for all evaluaed item including the primary criteria. Then, we will obtain the evaluation score of the real performance for those ten motels. Herein, we will take Likert scale of 5. The initial scores of all criteria for each project will be listed in Table 3. Next, we will make the weighted computation according to the performance of those projects. The final performance scores under all criteria can be denoted as Table 4. From the result in Table 4, the competence of those ten motels can be expressed as

Porject 6 > Porject 5 > Porject 7 > Porject 2 > Porject 3 > Porject 1 > Porject 4.

Table 1. The weight value for the primary evaluation dimensions.

Criteria	Expert 1	Expert 2	Average Score	Average Weight Value	The Fuzzied Weight Value
A	3	3	3	0.1666	0.202066
B	2.5	3.5	3	0.1666	0.196453
C	2	4	3	0.1666	0.179614
D	1.6	4.4	3	0.1666	0.15806
E	1	5	3	0.1666	0.112259

Table 2.The weight values of the criteria in this study.

Primary criterion (PC)	Weight of PC (M)	Sub-criterion (SC)	Weight of SC (N)	Final Weight (M)x(N)
A	0.202066	A1	0.383600	0.077513
		A2	0.333077	0.067304
		A3	0.283323	0.05725
B	0.196453	B1	0.238640	0.046882
		B2	0.357160	0.070165
		B3	0.404200	0.079406
C	0.179614	C1	0.475052	0.085326
		C2	0.295805	0.053131
		C3	0.229143	0.041157
D	0.15806	D1	0.475052	0.069014
		D2	0.295805	0.089046
		D3	0.229143	0.039371
E	0.112259	E1	0.475052	0.029451
		E2	0.295805	0.029451
		E3	0.229143	0.025394

If there is another evaluation table (it will be given as Table 5), the degrees of importance about five criterions (F, G, H, I, J) from two experts can be represented. Although these two experts have the same evaluation degree about common consensus, they do not have the same average degrees of importance and the most important criterion is denoted as G. The weight values are the same when that experts having the same consensus. And, the result derived from our proposed approach is the same as that derived from the average concept. From the obtained results, the decision-maker can have a reference information for the issue of the resource investment. From the above case, not only the decision can be efficiently made, but the rationality and feasibility of the proposed approach be also demonstrated well. Next, we can make the necessary sensitivity analysis according to the proposed formula. From Figure 1 and Figure 2, we can find out the fact that the degree of sensitivity gradually increase along with a larger α value. The margin of the change for ei will have a significantly effect when the α exceeds 1; and the margin of the change for ei will have a non-significantly effect when the α does not exceed 1.

Table 3. The evaluating score for criteria performance.

criteria	(Score)	Motel 1	2	3	4	5	6	7
A	A1	5	5	5	5	5	5	5
	A2	5	5	4	5	4	5	4
	A3	4	4	4	4	4	4	5
B	B1	4	3	4	4	3	3	4
	B2	4	4	4	4	5	4	5
	B3	4	4	4	5	5	5	5
C	C1	5	5	5	4	5	5	4
	C2	3	3	4	4	5	4	5
	C3	3	3	3	3	3	4	3
D	D1	5	5	4	4	4	5	4
	D2	4	5	5	4	5	5	4
	D3	5	5	5	4	5	4	5
E	E1	5	5	5	5	5	5	5
	E2	4	5	5	5	5	5	5
	E3	5	4	4	4	5	5	5

Table 4.The final performance score for each projects.

Options	1	2	3	4
Score	3.739	3.785	3.748	3.681
Options	5	6	7	
Score	3.930	3.944	3.859	

Table 5. Another evaluation Table

Criterion	Expert 1	Expert 2	Mean	Weight value computed from the average concept	Weight value computed from the optimum weight model
G	5	5	5	0.333333	0.333333
H	4	4	4	0.266667	0.266667
I	3	3	3	0.2	0.2
J	2	2	2	0.133333	0.133333
K	1	1	1	0.066667	0.066667

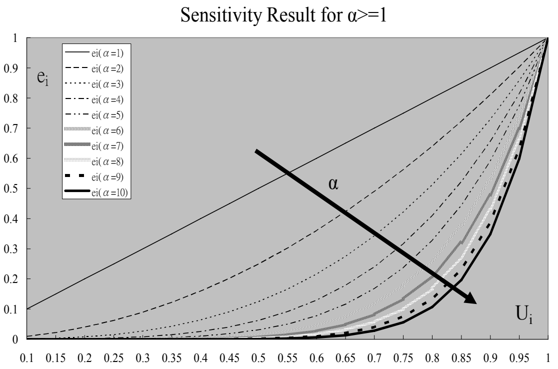

Figure 1. The change diagram of sensitivity analysis for α >= 1.

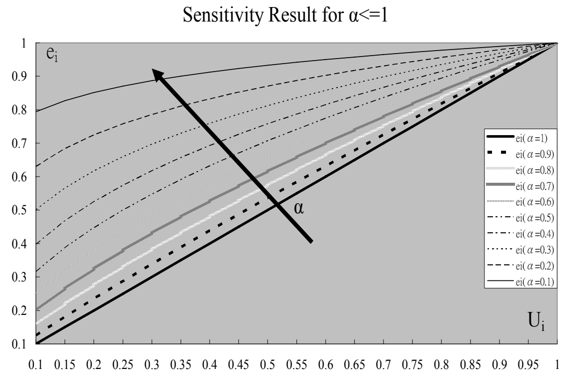

Figure 2. The change diagram of sensitivity analysis for α <= 1.

5 Concluding Remarks

From the deduction procedure and demonstration about the proposed MDCM, no only the weight value of each criterion including the primary and the secondary can be obtained and the average intension of criterion's importance and common consensus of experts also can be incorporate into the considerations of weight summation effect. The weight value derived from the proposed optimal weight model will be more subjective and it also be possibly identified by most practitioners. Besides, we also make the necesaary sensitivity analysis to the proposed weight value. Finally, we also provide an illustrative example to demonstrate the rationality and feasibility of our proposed model.

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