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An Extensional Micmac Method to Identify the Key Factors

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ABSTRACT. *The impact matrix cross reference multiplication applied to classification (MICMAC) method can be used to isolate key factors from complex factor sets. Recently, scholars have begun combined fuzzy theory with MICMAC operations to establish the fuzzy MICMAC (FMICMAC) for enhanced evaluation accuracy. A novel fuzzy integration method was developed in the present study to readily integrate expert opinions for combination with the MICMAC.However, traditional MICMAC methods do not account for the dual aspects (e.g., satisfaction/ dissatisfaction, interests/risks) of certain factors. Hence, This study proposed fuzzy integration method and dual-aspect MICMAC process to resolve this shortcoming, then applied to identify the key factors.*

KEYWORDS: *Impact matrix cross reference multiplication applied to classification, Micmac, Fmicmac, Dual-aspect micmac*

1. Introduction

The impact matrix cross reference multiplication applied to classification (MICMAC) method [1] can be used to isolate key factors from complex factor sets. MICMAC is a structural classification method; it is also a systematic factor analysis method which depends on graph theory and matrix tools. MICMAC can be used to calculate the driving power and dependence of various factors as per a matrix of their influence in the system. A “driving-dependence graph” can be used to divide the factors into five categories according to their driving power and dependence: a stakes cluster, input cluster, excluded cluster, output cluster, and regulation cluster. The direct binary relation between factors (0 and 1) is evaluated obtain an adjacency matrix, then a reachable matrix containing the direct and indirect relation between factors is obtained accordingly. However, the adjacency matrix is a binary evaluation which may deviate from the actual evaluation results due to its subjectivity.

Recently, scholars have begun combined fuzzy theory with MICMAC operations to establish the fuzzy MICMAC (FMICMAC) for enhanced evaluation accuracy [2-3]. A novel fuzzy integration method was developed in the present study to readily integrate expert opinions for combination with the MICMAC. However, traditional

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MICMAC and FMICMAC methods do not account for the dual aspects (e.g., satisfaction/dissatisfaction, interests/risks) of certain factors. They are thus not suitable for mixed analysis. The factors of the two aspects should be considered separately and then integrated to better classify relevant factors [4]. Hence, this paper proposes a dual-aspect MICMAC process to resolve this shortcoming. This study proposed fuzzy integration method and dual-aspect MICMAC process were then applied to identify the key factors. Guidelines for managers and/or researchers focused on many practices are proffered according to the results.

2. Micmac Method

The MICMAC method can be used identify and classify key factors. It is operated in the following step-wise process.

2.1 Specify Influences among Factors

If a system is defined as a set consisting of *n* factors, then S_i can be set as a pair-to pair comparison between factors. When a certain factor has a direct influence on another factor, the corresponding elements are given a value of 1; otherwise the elements are given a value of 0. If elements S_i on row *i* are directly influencing element S_j in column *j*, $A=[S_{ij}]$ is defined as the adjacency matrix.

2.2 Construct Reachability Matrix

Adding the adjacency matrix (A) to identity matrix (I) creates an element-connection matrix (N). The matrix N can then be repeatedly multiplexed until its ascending power equals itself via Boolean algebra: $N \neq N^2 \neq N^3 \neq \cdots \neq N^{r-1} = N^r$. N^r is then defined as the reachability matrix (M).

2.3 Plot Driving-Dependence Graph

Define as elements of the i^{th} row and j^{th} column in the reachability matrix (M), then calculate the driving power and dependence. The driving power value (I_i) is equal to: $I_i = \sum_{j=1}^{n} t_{ij}$. The dependence power ($D_j$) is equal to: $D_j = \sum_{i=1}^{n} t_{ij}$.

2.4 Classify Factors

Factors are classified based on their located cluster on the driving-dependence graph (Figure 1), and are defined as follows.

- Stake cluster (I): linkage/relay factors
- Input cluster (II): driver/independent factors
- Excluded cluster (III): autonomous/excluded factors

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- Output cluster (IV): dependent factors
- Regulation cluster: adjustment factors

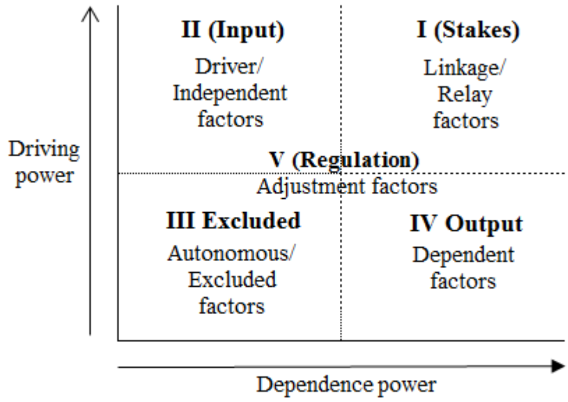

Fig.1 Driving-Dependence Graph

Many previous scholars have explored MICMAC applications [5-8].

3. Extensional Micmac Method

3.1 Fuzzy Integration Method

The fuzzy integration method presented in this paper is not only effective and able to straightforwardly consolidate expert opinion data, but is also easier to use than the traditional FMICMAC method. It is operated in the following step-wise process.

(1)Evaluation in fuzzy linguistic scale

First, define a series of linguistic labels to assign to the linguistic scale for the evaluation of alternatives with triangular fuzzy numbers between factors. The five grades are defined, as mentioned above, as “no influence”, “low influence”, “medium influence”, “high influence”, and “complete influence” and expressed as l_1, l_2, l_3, l_4, and l_5, respectively. The linguistic function is marked as $F(l_i) = \tilde{i}$, i =0, 0.25, 0.5, 0.75, 1. The fuzzy linguistic labels produced in this step are shown as Table 4.

Table 4 Fuzzy Linguistic Labels

Fuzzy number	Linguistic labels
$\tilde{0} = (0, 0, 0.25)$ $\widetilde{0.25} = (0, 0.25, 0.5)$	No influence Low influence

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	Low influence
$\widetilde{0.5} = (0.25, 0.5, 0.75)$	Medium influence
$\widetilde{0.75} = (0.5, 0.75, 1)$	High influence
$\tilde{1} = (0.75, 1, 1)$	Complete influence

(2)Integration of expert opinions

The alternatives between factors can be evaluated based on expert opinions. This data must be integrated with the results of multiple decision-making iterations, as shown in Equation (1), where e_{ijp} denote the evaluation value (triangular fuzzy number) of the p^{th} expert. The integrated fuzzy numbers are obtained after this conversion.

$$\begin{cases} A_{ij} = min(e_{ijp}) \\ B_{ij} = \sum_{p=1}^{n} \frac{e_{ijp}}{p} \\ C_{ij} = max(e_{ijp}) \end{cases} \quad (1)$$

(3)Defuzzication

As mentioned above, defuzzication is needed to convert fuzzy numbers into crisp numbers as the fuzzy number form is not suitable for matrix operations. The graded mean method was used in this study to calculate the property average (PA) to a crisp number:

$$PA_{ij} = \frac{(A_{ij}+4B_{ij}+C_{ij})}{6} \quad (2)$$

(4)Establishment of initial adjacency matrix

Each PA value is compared with the central fuzzy number 0.5 to create an initial adjacency matrix. When PA is greater than 0.5, the value is changed to 1; when it is less than 0.5, it is changed to 0. The resulting initial adjacency matrix can be further analyzed according to the traditional MICMAC method.

3.2 Dual-Aspect Micmac Approach

The traditional MICMAC and FMICMAC methods can only be used to analyze constituent factors of one type, and do not apply to the analysis of two types of factor simultaneously. A dual-aspect MICMAC process was developed in this study. Its implementation flow is as follows.

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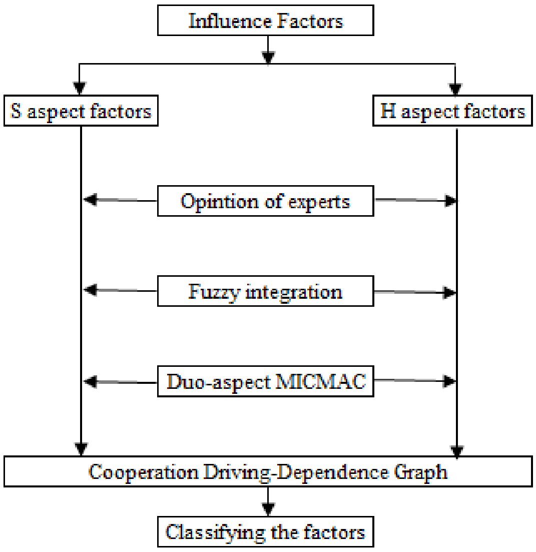

Fig.2 Fuzzy Dual-Aspect Micmac Process Flow

The steps of implementation are described as follow:

(1)Factors are selected from two aspects, respectively. Such as S and H.

(2)Experts provide evaluations of the interactions between respective factors.

(3)The fuzzy integration method is used to obtain an adjacency matrix.

(4)The MICMAC method is operated to obtain the respective driving power and dependence power of the respective types of factors.

(5)The average values of S and H factors' driving power are marked in two straight lines as the distinction lines of the Y-axis. The average S and H factors' dependence power values are marked in two straight lines as the distinction lines of the X-axis. The resulting cooperation driving-dependence graph is as shown in Fig. 3.

(6)Factors are classified based on the cluster (I-IV) in which they are located on the graph under the same definitions as the traditional MICMAC, except that factors which fall between the four dotted lines are classified as adjustment factors.

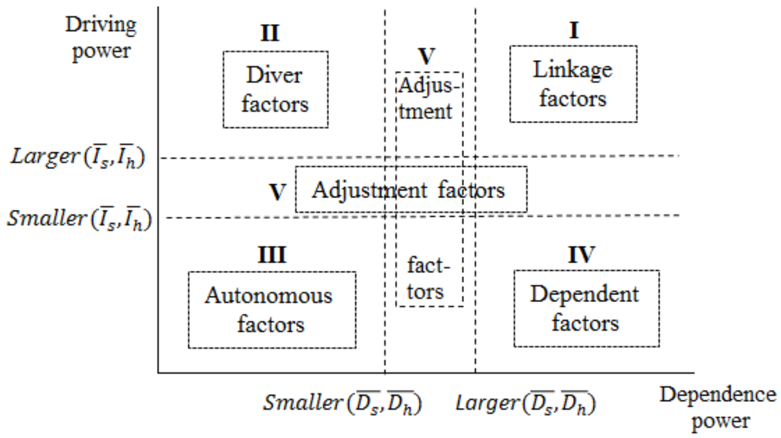

Fig.3 Cooperation Driving-Dependence Graph

4. Conclusion

A novel fuzzy dual-aspect MICMAC approach was developed to identify and classify the key factors. This approach allows factors to be clustered so that decision-makers can prioritize them according to their dependence power and driving power. Practitioners should concentrate on those factors which have higher driving power, as these factors markedly affect the entire system; targeting them is a workable strategy for optimizing the system on the whole. Thus, they represent important guidelines for managers and/or researchers involved in practice.

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