Party Discipline Measurement Decision-Making Based on Hesitant Fuzzy and VIKOR Method

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Abstract: Discipline measurement refers to the activity of determining whether and what kind of punishment should be given to the violator based on identifying the facts of the violation and accurately determining the nature of the violation according to the corresponding disciplinary regulations. This kind of action can be regarded as a multicriteria group decision-making problem. At present, the grass-roots discipline inspection and supervision organs mainly use qualitative methods in the process of discussing disciplinary action, which is greatly influenced by subjective or objective factors, and are difficult to fully absorb the opinions from groups, which means it lacks a kind of quantitative decision-making methods. Based on the above reasons, this paper uses linguistic variables for the first time to describe the principles of taking disciplinary action, and on this basis, a multicriteria assisted decision-making method for discussing the disciplinary action is proposed based on hesitant fuzzy theory and VlseKriterijumska optimizacija I kompromisno resenje (VIKOR) method, which provides a new method for discipline measurement. It is an important auxiliary decision-making method. This paper takes a real case as an example to prove the effectiveness of this method.

1 INTRODUCTION

Strengthening the construction of the Party's system is an important measure to implement the strict governance of the Party in an all-around way. Among them, the construction of the Party's discipline, laws, and regulations are the most important contents of the construction of the system (Wan 2017). The implementation of Party disciplinary sanctions is an important means to maintain the authority and seriousness of Party regulations, and also an important link in the supervision and enforcement of discipline by the discipline inspection and supervision organs. According to the statistics informed on the website of the CPC Central Commission for Discipline Inspection, from 2016 to 2021, the number of people subject to party discipline punishment was 347,000, 443,000, 526,000, 502,000, 522,000, and 524,000 respectively, with a total of 2,864,000 people disciplined by the Party in six years.

Due to the characteristics of discipline, the regulations and criteria based on which the party disciplinary sanctions are not as detailed and precise as the legal terms, making it easy for the staff of the grassroots disciplinary inspection and supervision organs to be influenced by a variety of factors, such as inaccurate policies, lack of personal experience, and the rendering of social opinion, etc. At present, grassroots disciplinary inspection and supervision organs mainly use qualitative methods to make disciplinary decisions, which lack quantitative decision-making methods. This is a feature that is more prominent when dealing with issues that do not yet reach the level of expulsion from the party, which accounts for the majority of disciplinary problems. At the same time, the lack of specific provisions in the disciplinary procedures is prone to the problem of irregularities in the process of discipline. In the actual quantity discipline, it is difficult to grasp the scale of quantity discipline, to effectively punish violators, play a warning role, and not seriously attack people's enthusiasm, thus affecting post-case governance. This kind of pressure of measuring discipline actions sometimes will cause discipline inspectors to be less confident in actual work or less independent of superiors and prosecutors.

Most of the existing literature on the study of disciplinary measurement is the qualitative study from the legal or political perspective. For example, the literature (Wang 2012) studied how to standardize the

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disciplinary procedures of disciplinary organs and made recommendations. The literature (Shen 2016) conducted a study on the issue of measuring discipline in the enforcement of discipline by grassroots discipline inspection and supervision organs and analyzed the current situation of the work of measuring discipline, especially the problems and causes. The literature (Liu 2019) conducted a study on how to identify disciplinary violations that do not implement disciplinary decisions by the regulations, and in doing so, illustrated the main basis for qualitative disciplinary measures. The literature (Hu 2020) conducted a study on the problem of precise discipline measurement by grassroots disciplinary organs and put forward the main problems, reasons, and countermeasure suggestions. The literature (Fu 2021) studied the problem of discipline measurement in a provincial grassroots discipline inspection and supervision organ, pointing out the problems in discipline measurement in a provincial grassroots discipline inspection and prosecution organ and proposing solutions. Because of the complexity and ambiguity of the factors to be considered in measuring discipline for party discipline, it is more difficult to describe quantitatively using precise numbers without losing information. Therefore, despite the urgent need for a quantitative scientific decision-making method with strong explanations and a transparent process, little research has been conducted in this area.

To describe and deal with fuzzy information, since Zadeh proposed the concept of fuzzy sets in 1965 (Zadeh 1965), related research has developed rapidly, and interval fuzzy sets (Turksen 1998), intuitionistic fuzzy sets (Atanassov 1986), and interval intuitionistic fuzzy sets (Atanassov and Gargov 1989) have been proposed successively. In 2009, Torra and Narukawa proposed the concept of hesitant fuzzy sets, whose basic composition is hesitant fuzzy elements, each element is a set consisting of several possible values characterizing the degree of hesitation in the evaluation of the multiple evaluations of the solution formed simultaneously by the decision maker (Torra 2010). Therefore, hesitation fuzzy sets can portray hesitation information affecting decision-makers more comprehensively and carefully than other extended forms of fuzzy sets. In 2011, Xu Zeshui et al. proposed a mathematical expression for hesitation fuzzy sets, which defines the mathematical expressions of hesitant fuzzy elements (Xia and Xu 2010). With the development of fuzzy theory, entropy was introduced to describe the degree of fuzziness of information, and Deluca gave the definition of fuzzy entropy around affiliation and non-affiliation in 1972 (Deluca and Termini 1972), and later scholars conducted extensive research on entropy measurement around intuitionistic fuzzy sets and hesitation fuzzy sets. The literature (Szmidt and Kacprzyk 2001) studied affiliation-based and distance-based probabilistic hesitant fuzzy entropy and proposed an axiom of entropy. The literature (Mei and Li 2019) proposed the calculation method of parametric hesitant fuzzy entropy, which effectively avoids the counterintuitive situation. At present, the hesitant fuzzy theory is applied in decision-making research in various fields. In the work of discipline measurement, disciplinary inspectors will take a collective study to discuss the circumstances of disciplinary violations, application of regulations, disciplinary schemes, etc. The linguistic variables can be used to quantify the discipline measurement criteria, and then the hesitation fuzzy set can be used to describe the different opinions so that the group opinion can be described completely.

In 1998, Opricovi proposed the VIKOR method (Opricovic 1998) for selecting the best solution by maximizing group utility and minimizing individual regret in multi-criteria decision problems with conflicting and non-commensurable criteria (Opricovic and Tzeng 2004). Combining fuzzy theory with the VIKOR method has been applied not only to problems in engineering management such as CO2 transmission pipeline failure mode and impact analysis (Narayanamoorthy et al. 2019), industrial robot selection (Guo et al. 2019), offshore tug selection (Balin et al. 2020), marine air compressor selection (Kaya et al. 2022), project investment selection (Wang and Li 2022), and equipment supplier selection (Zhang et al. 2019), but also in sociology and biomedical fields have been widely used (HU et al. 2020; Kirişci et al. 2022; Akram et al. 2022).

Considering the disciplinary measurement problem as a multi-criteria group decision problem, there are two difficulties to be solved, one is how to express the disciplinary discipline criteria described qualitatively in the way of quantitative language. The second is how to build a reasonable decision model that can follow the principle of "punishing before and after, curing the disease and saving the others", fully integrate different opinions, and form a reasonable recommendation for decision makers to choose from. To solve these difficult problems, this paper adopts the linguistic variables corresponding to fuzzy numbers to quantify the disciplinary criteria for party discipline and uses hesitant fuzzy sets to portray the opinions of different people in the decision-making group. Finally, the VIKOR method is used to synthesize the opinions of the decision-making group and rank the disciplinary scheme to form recommendations. This

paper proposes, for the first time, a quantitative decision aid method for party disciplinary measurement, and verifies the effectiveness of the method through a practical example. In Section 2, we present criteria for disciplinary measurement. In Section 3, we introduce the basic theories of hesitation fuzzy and VIKOR methods. In Section 4, we propose a decision model based on hesitation fuzzy and VIKOR methods to assist the discipline measurement. Then we illustrate a numerical example to show the efficiency of the proposed method in Section 5. In Section 6, we summarize the research results of this paper.

2 DISCIPLINARY CRITERIA FOR DISCIPLINARY MEASUREMENT

The results of the disciplinary measurement are not only related to the personal interests of the people concerned, but also to the maintenance of the seriousness and authority of the party discipline, which should be based on the following 6 basic criteria:

(1) Circumstances of violating discipline. The circumstances of disciplinary violations are an important reference basis for measuring discipline and the core reference for measuring the degree of mistakes of people who violate discipline. In analyzing the circumstances of the violation, the nature and severity of the violation should be measured. The focus should be on "three distinctions," that is, distinguishing between mistakes made by lack of experience and deliberate acts of doing. Distinguish between exploratory experiments when the state has not yet expressly provided for them from regulated non-compliance with acts that are expressly prohibited by the state. Distinguish between unintentional negligence in promoting reform and deliberate acts for personal gain.

(2) Harmfulness. Harmfulness is a measure of the degree of influence of disciplinary action and is a specific description of the language of "causing serious influence" as stated in the Regulations on Party Discipline, which is an important reference in the process of discipline. Harmfulness should be measured in three aspects: the degree of economic loss caused, the degree of damage to the Party's image, and the degree of negative effects on the field.

(3) Punishment. The degree of punishment is an important criterion to measure the disciplinary scheme and should follow the principle of "consistency of crime and punishment" in the law, not only to achieve the purpose of discipline but also not to reflect the strict enforcement of discipline and deliberately upgrade the level of punishment. The degree of the subsequent impact on the person disciplined and the result of the discipline against similar violations should be considered.

(4) Deterrence. To achieve the purpose of "dealing with one, governing a filed", the implementation of party discipline must form an appropriate deterrent, so the degree of deterrence is also one of the criteria to measure the effectiveness of the disciplinary measure. Mainly contains the degree of deterrence in a field and the degree of warning to the violator.

(5) Regulatory matching. The Regulations on Party Disciplinary Punishment is the core basis for disciplinary organs to implement disciplinary punishments. Because of the strong generalization of the language, it is necessary to analyze in depth to match the facts with the content of the regulations, and correctly determine the nature of the violation and the punishment scheme.

(6) Other factors. The principle of disciplinary punishment is "to punish the former to prevent the latter and to cure the sick to save the others". To avoid the problem of generalization and simplification of accountability and responsibility, one should consider the violator’s consistent performance, as appropriate.

According to the above principles, a system of disciplinary criteria for party discipline is established, as shown in Table 1.

Table 1: The criteria of the party disciplinary action measure

Disciplinary Criteria	Language Variables	Variable Type	Variable Description
Circumstances of violating discipline (C1)	C11 Matching degree of violation circumstances	Benefit	The matching degree of the punishment and the severity of the violation.
	C12 Matching degree of attitude	Benefit	The matching degree of the punishment and the violator's attitude towards mistakes.
Harmfulness (C2)	C21 Degree of punishment for economic losses	Benefit	The matching degree of the punishment and the economic loss caused.

	C22 Degree of punishment that damages the image of the party	Benefit	The matching degree of the punishment and the negative impact on the image of the party.
	C23 Degree of punishment for negative demonstration effects	Benefit	The matching degree of punishment and negative demonstration effect.
Punishment (C3)	C31 Degree of punishment for subjective intent	Benefit	The degree of punishment to the subjective intent of the violator.
	C32 Subsequent impact degree	Cost	The impact of the punishment on the subsequent career development of the violator.
	C33 Similarity to similar cases	Benefit	The degree of similarity of punishment results compared with similar cases.
Deterrence (C4)	C41 Deterrence to the field	Benefit	The degree to which the punishment is expected to have a warning effect on the industry.
	C42 Warning degree for violators	Benefit	The degree to which the punishment is expected to have a warning effect on the violator.
Regulatory matching (C5)	C51 Degree of matching with regulations	Benefit	The degree to which the punishment matches the provisions of relevant laws and regulations.
Other factors (C6)	C61 Degree of matching with the daily performance	Benefit	The matching degree of the punishment and the consistent daily work performance of the violator.

3 HESITANT FUZZY MULTI-CRITERIA GROUP DECISION MAKING METHOD

In the process of measuring discipline, different disciplinary inspectors tend to hold different opinions on the final disciplinary scheme. In order to absorb the different opinions from the decision-making group completely, we use hesitant fuzzy information to describe different views quantitatively. The following parts will introduce the basic concepts of hesitant fuzzy sets and the method of multi-criteria group decision-making.

3.1 Hesitant Fuzzy Set Theory

Definition 1 (Xia and Xu 2010). If X is a fixed set. Then the hesitant set is a function of each element of X mapped to a subset of $[0,1]$. Mathematically, it is represented by the following expression:

$$A = \{\langle x, h_A(x)\rangle | x \in X\},$$

where $h_A(x)$ is the set of some values in $[0,1]$, indicating some possible affiliations of the element x about the set A. So $h_A(x)$ is called the hesitant fuzzy element. Θ represents the collection of all hesitant fuzzy elements（Xu and Xia 2011）.

Definition 2 (Torra and Narukawa 2009). Let $A = \{h_1, h_2, \dots, h_n\}$ be an n-dimensional set of hesitant fuzzy elements, ϑ is the hesitant fuzzy elements integration function defined on the set A, $\vartheta: [0,1]^n \to [0,1]$, then we have:

$$\vartheta_A = \bigcup_{\gamma \in \{h_1 \times h_2 \times \dots \times h_n\}} \{\vartheta(\gamma)\}.$$

The hesitant fuzzy weighted average (HFWA) operator cited in this paper is the mapping $\Theta^n \to \Theta$, which can be written (Xia and Xu 2010):

$$HFWA(h_1, h_2, \dots, h_n) = \oplus_{i=1}^{n} w_i h_i = \bigcup_{\gamma_1 \in h_1, \gamma_2 \in h_2, \dots, \gamma_n \in h_n} \left\{1 - \prod_{I=1}^{n} (1-\gamma_i)^{w_i}\right\}, \quad (1)$$

where $w = (w_1, w_2, \dots, w_n)^T$ is the weight vector of $h_i (i = 1,2,\dots,n)$, $w \in [0,1]$, $i = 1,2,\dots,n$, and $\sum_{i=1}^{n} w_i = 1$. In particular, if the weights of the criteria are equal, $w = \left(\frac{1}{n}, \frac{1}{n}, \dots, \frac{1}{n}\right)^T$, then the HFWA operator degenerates to the hesitant fuzzy average (HFA) operator:

$$HFA(h_1, h_2, \dots, h_n) = \frac{1}{n} \oplus_{i=1}^{n} h_i = \bigcup_{\gamma_1 \in h_1, \gamma_2 \in h_2, \dots, \gamma_n \in h_n} \left\{1 - \prod_{i=1}^{n} (1-\gamma_i)^{\frac{1}{n}}\right\}. \quad (2)$$

In an anonymous case, suppose the decision-maker provides several evaluation values for scheme A_i under the criterion x_j, then these values can be considered fuzzy elements h_{ij}. When two decision

makers provide the same evaluation value, then the value appears only once in the set consisting of h_{ij}.

Definition 3 (Xu and Xia 2011). Assuming A_1 and A_2 are two hesitant fuzzy sets on X. $l_{h_{A_1}(x_i)}$ and $l_{h_{A_2}(x_i)}$ denote the number of elements contained in $h_{A_1}(x_i)$ and $h_{A_2}(x_i)$ respectively. When $l_{h_{A_1}(x_i)} \neq l_{h_{A_2}(x_i)}$, let $l_{x_i} = max\left\{l_{h_{A_1}(x_i)}, l_{h_{A_2}(x_i)}\right\}$, then its hesitant fuzzy standard Hamming distance can be defined as:

$$d_i(A_1, A_2) = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{1}{l_{x_i}}\sum_{j=1}^{l_{x_i}}\left|h_{A1}^{\sigma(j)}(x_i) - h_{A2}^{\sigma(j)}(x_i)\right|\right), \quad (3)$$

where $h_{A1}^{\sigma(j)}(x_i)$ and $h_{A2}^{\sigma(j)}(x_i)$ are the jth largest values in $h_{A_1}(x_i)$ and $h_{A_2}(x_i)$, respectively.

In the process of calculating the distance, when two sets of fuzzy numbers do not contain the same number of elements, the set with fewer elements should be expanded to make itself equal to the number of elements contained in the other set. The added value can be one or several of the affiliations contained in this hesitant fuzzy number. The specific choice depends on the decision maker's risk preference. If by optimistic principle, the maximum value is added; If by pessimistic principle, the minimum value is added.

3.2 VIKOR Method

The core of the VIKOR method is to find compromise solutions with the two key characteristics of maximum group utility and minimum individual regret. Its main principle is to prioritize each solution based on the positive ideal solution f_j^+ and the negative ideal solution f_j^- according to the approximation of the evaluation value of the alternative to the ideal solution. Multicriteria measure of alternatives is developed from the $L_p - metric$ distance measure of the aggregate function,

$$L_{pj} = \left\{\sum_{i=1}^{n}\left[\frac{w_i(f_i^* - f_{ij})}{(f_i^* - f_i^-)}\right]\right\}^{\frac{1}{p}}, \quad (4)$$

where, $1 \le p \le \infty,\ j = 1,2,\ldots,m.$

When each alternative $A_i(i = 1,2,\ldots,n)$ is evaluated as f_{ij} by evaluation criterion $C_j(j = 1,2,\ldots,m)$, the positive ideal solution f_j^+ and the negative ideal solution f_j^- can be written as follow:

$$\begin{cases} f_j^+ = \max\limits_i f_{ij},\ f_j^- = \min\limits_i f_{ij}, & \text{When } C_i \text{ is the beneficial criterion} \\ f_j^+ = \min\limits_i f_{ij},\ f_j^- = \max\limits_i f_{ij}, & \text{When } C_i \text{ is the cost criterion} \end{cases} \quad (5)$$

Using the values of the group utility S_i and the individual regret R_i for ranking, the solution with the smallest S_i has the maximum group utility. And the solution with the smallest R_i can satisfy the minimum individual regret,

$$S_i = L_{1,i} = \sum_j^n W_j \frac{f_j^+ - f_{ij}}{f_j^+ - f_j^-}, \quad (6)$$

$$R_i = L_{\infty,i} = max_j\left\{W_j \frac{f_j^+ - f_{ij}}{f_j^+ - f_j^-}\right\}, \quad (7)$$

where w_j denotes the weight of the jth indicator, the smaller the value of S_i the larger the group benefit value, and the smaller the value of R_i the smaller the individual regret value. Meanwhile, the benefit ratio value Q_i is obtained for each scheme:

$$Q_i = \frac{v(S_i - S^*)}{S^- - S^*} + \frac{(1-v)(R_i - R^*)}{R^- - R^*}, \quad (8)$$

where $S^* = min\{S_i\}$, $S^- = max\{S_i\}$, $R^* = min\{R_i\}$, $R^- = max\{R_i\}$; v is the weight of the maximum group utility, which in this paper takes the value as 0.5.

Eventually, the best scheme is determined by comparing the values of Q_i, S_i and R_i for each scheme.

3.3 Hesitant Fuzzy Entropy Measure

In the process of disciplinary decision-making, the weight of each criterion is not appropriate to be determined by the subjective assignment method. The hesitation fuzzy entropy is used to describe the degree of the hesitation fuzzy set. The larger the hesitation fuzzy entropy of a criterion, the fuzzier the judgment information provided by the criterion is. And the fuzzier one should be assigned a smaller weight. On the contrary, it should be assigned a larger weight. In this paper, the parameterized hesitation fuzzy information measure is introduced as the entropy measure of the hesitation fuzzy set.

Assuming $\tilde{A} = \{\langle x_i, h_{\tilde{A}}(x_i)\rangle | x_i \in X\}$ is a hesitant fuzzy set on domain $X = \{x_1, x_2, \ldots, x_n\}$ and $h_{\tilde{A}}(x_i) = \{\gamma_i^1, \gamma_i^2, \ldots, \gamma_i^{l_i}\}$, where l_i is the number of elements in $h_{\tilde{A}}(x_i)$, then

$$E_\alpha^\beta(\tilde{A}) = \frac{2-\beta}{n(2-\alpha-\beta)}\sum_{i=1}^{n} log_2\left[\frac{1}{l_i}\sum_{\lambda=1}^{l_i}\left(\left(\gamma_i^\lambda\right)^{\frac{\alpha}{2-\beta}} + \left(1-\gamma_i^\lambda\right)^{\frac{\alpha}{2-\beta}}\right)\right], \quad (9)$$

where $\alpha > 0$, $\beta \in [0,1]$ and $\alpha + \beta \neq 2$. Above formula is the parameterized hesitant fuzzy information measure, also known as, the entropy of the hesitant fuzzy set $\tilde{A}$.

4 THE HESITANT FUZZY MULTI-CRITERIA GROUP DECISION MODEL BASED ON VIKOR METHOD

The core idea of the VIKOR method is to prioritize the items based on the positive ideal solution (PIS) and the negative ideal solution (NIS), and then to determine the closeness of each item to the positive ideal solution based on its preference value. This method takes into account both the maximization of group utility and the minimization of individual regret, which incorporates the subjective preferences of decision-makers. By using this method in the process of discipline measurement, we can better integrate the opinions of the decision-making group and give a more appropriate scheme.

4.1 Quantitative Language Evaluation Information

Qualitative disciplinary criteria are often described in language. The qualitative linguistic evaluation information can be transformed into fuzzy numbers. The language variable evaluation information in the decision matrix is described by a set of linguistic phrase evaluations with 10 language evaluation granularities, and the corresponding fuzzy numbers are shown in Table 2.

Table 2: Language variables and fuzzy numbers.

Language terms	Fuzzy numbers
Extremely High/ Extremely Positive (EH/EY)	1.0
Very High/Very Positive (VH/VY)	0.9
High / Positive (H/Y)	0.8
Middle High / Middle Positive (MH/MY)	0.7
Middle (M)	0.6
Little Middle (LM)	0.5
Middle Little/Middle Negative (ML/MN)	0.4
Little / Negative (L/N)	0.3
Very Little / Very Negative (VL/VN)	0.2
Extremely Little / Extremely Negative (EL/EN)	0.1

4.2 Quantitative Discipline Decision Model Based on VIKOR Method

Considering the fuzzy characteristics of disciplinary criteria, the decision analysis can be carried out with VIKOR method in the following steps:

Step 1: The hesitant fuzzy decision matrix can be constructed by the decision-making group which usually consists of the disciplinary staff, by evaluating the options according to each quantitative disciplinary criterion:

$$R = (r_{ij})_{m\times n} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \vdots & r_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \vdots & r_{mn} \end{bmatrix},$$

where r_{ij} is the set of hesitant fuzzy numbers.

The entropy matrix of the hesitation fuzzy decision matrix is first obtained using the parameter hesitation fuzzy entropy to determine the weight of the quantitative discipline criterion:

$$E = \begin{bmatrix} E_{11} & E_{12} & \cdots & E_{1n} \\ E_{21} & E_{21} & \vdots & E_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ E_{m1} & E_{m1} & \vdots & E_{mn} \end{bmatrix}. \quad (10)$$

Then the decision entropy matrix is normalized by

$$\tilde{E}_{ij} = \frac{E_{ij}}{max\{E_{i1}, E_{i2}, \ldots, E_{in}\}}. \quad (11)$$

The weights w_j for each quantitative discipline criterion are obtained:

$$W_j = \frac{\tilde{E}_{ij}}{\sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{E}_{ij}}, \quad (12)$$

where $\mathrm{i} = 1,2 \ldots, m;\ j = 1,2 \ldots, n$.

Step 2: the positive ideal solution f_i^+ and the negative ideal solution f_i^- are determined based on the decision matrix.

Step 3: Q_i, S_i and R_i values are calculated for each scheme.

$$S_i = L_{1,i} = \sum_{j}^{n} W_j \frac{d(f_j^+ - f_{ij})}{d(f_j^+ - f_j^-)}, \quad (13)$$

$$R_i = L_{\infty,i} = max_j \left\{ W_j \frac{d\left(f_j^+ - f_{ij}\right)}{d\left(f_j^+ - f_j^-\right)} \right\}, \quad (14)$$

Step 4: Determine the ranking of alternatives and trade-offs: The alternatives to be decided are ranked according to the order of Q_i, S_i and R_i values from smallest to largest, and the object to be evaluated is ranked first. The smaller the value of Q_i, the better the solution to be decided.

①Acceptable advantageous conditions:

$$Q(Y_2) - Q(Y_1) \geq 1 / (n-1),$$

where Y_1 is the best evaluation object in Q_i ranking, Y_2 is the second best evaluation object in Q_i ranking, and n is the number of alternatives.

②Acceptable stability condition: Y_1 is the optimal solution in the ranking of S_i and R_i.

If the condition ① is not satisfied, the maximum value of n satisfying $Q(Y_2) - Q(Y_1) < 1 / (n-1)$ is calculated, and the schemes $Y_1, Y_2, \ldots, Y_n$ are all optimal. If the condition ② is not satisfied, then Y_1, Y_2 are optimal solutions, and the overall decision process is shown in Figure 1.

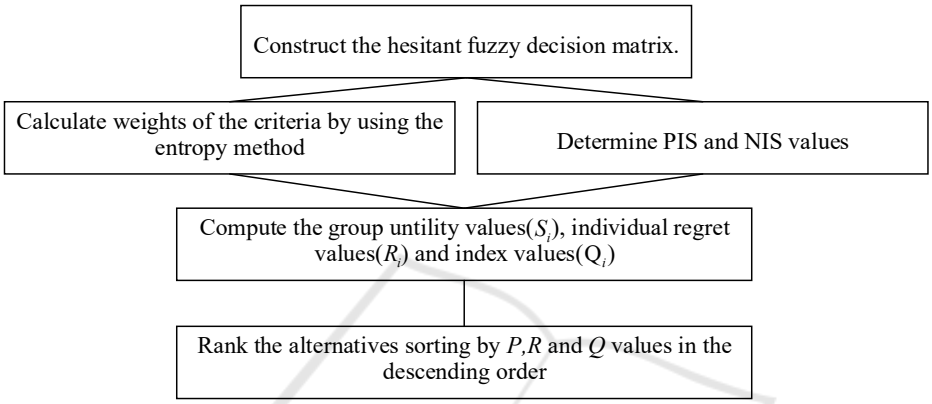

Figure 1: Calculation procedure of the proposed method. (Drawn by author)

5 NUMERICAL EXAMPLE

After review and investigation, a person's disciplinary fact is as follows: violation of the private "small treasury" and the use of "small treasury" money travel issues. A company donated 100,000 yuan of sponsorship money to the village collective set up as a "small treasury", and use 100,000 yuan of "small treasury" money to organize 8 village cadres and their families, a total of 16 people to Hong Kong, Macau and other places to travel. The comrade during the review and investigation, the attitude of admitting mistakes is good.

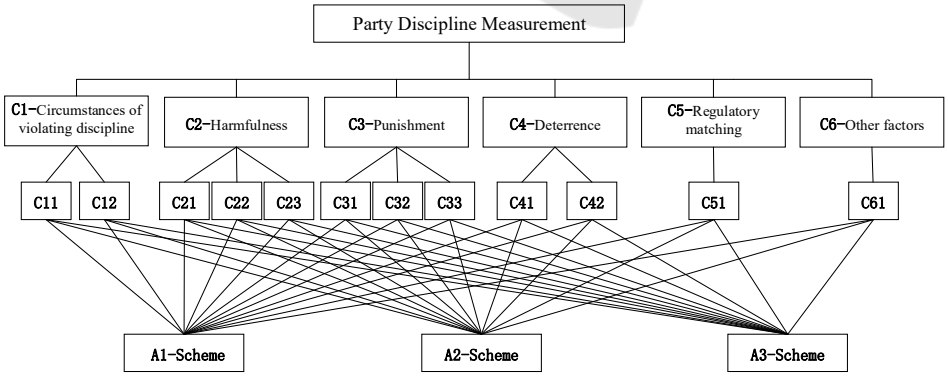

Figure 2: The criteria of the party discipline measurement. (Drawn by author).

In response to the disciplinary facts, the investigation team carefully considered and identified three alternative disciplinary options, namely A1: warning within the Party; A2: serious warning within the Party; and A3: revocation of Party position. Four experts gave the decision matrix as shown in Table 3 - Table 8 below.

Table 3: Options are evaluated according to circumstances of violating discipline.

Circumstances of violating discipline	Matching degree of violation circumstances	Matching degree of Attitude
A1	{0.5,0.6}	{0.3,0.4}
A2	{0.8,0.9}	{0.5,0.7}
A3	{0.3,0.5}	{0.3,0.5}

According to Equation (1) and (2), the fuzzy element $h_i(\mathrm{i}=1,2)$ of $A_i(i=1,2,3)$ is obtained by using HFWA operator.

$$HFWA(c_{11},c_{12}) = HFA(c_{11},c_{12})$$
$$= \frac{1}{2}\oplus_{i=1}^{2} h_i \bigcup_{\gamma_1\in h_1,\gamma_2\in h_2}\left\{1-\prod_{i=1}^{2}(1-\gamma_i)^{\frac{1}{2}}\right\}$$
$$= \{0.4084,0.4523,0.4708,0.5101\}$$

Similarly, the remaining fuzzy element aggregation results are shown in Table 9.

Table 4: Options are evaluated according to the degree of harmfulness.

Harmfulness	Degree of punishment for economic losses	Degree of punishment that damages the image of the Party	Degree of punishment for negative demonstration effects
A1	{0.3,0.6}	{0.2,0.3}	{0.3,0.4}
A2	{0.6,0.8}	{0.7,0.9}	{0.7,0.9}
A3	{0.7,0.9}	{0.8,0.9}	{0.8,0.9}

Table 5: Options are evaluated according to the degree of punishment.

Punishment	Degree of punishment for subjective intent	Subsequent impact degree	Similarity to similar cases
A1	{0.5,0.7}	{0.2,0.3}	{0.1,0.2}
A2	{0.7,0.9}	{0.6,0.8}	{0.5,0.8}
A3	{0.8,0.9}	{0.8,1.0}	{0.4,0.6}

Table 6: Options are evaluated according to the degree of deterrence.

Deterrence	Deterrence to the field	Warning degree for violators
A1	{0.2,0.3}	{0.1,0.2}
A2	{0.6,0.8}	{0.5,0.8}
A3	{0.8,1.0}	{0.4,0.6}

Table 7: Options are evaluated according to the degree of regulatory matching.

Regulatory matching	Degree of matching with regulations
A1	{0.2,0.3}
A2	{0.2,0.3}
A3	{0.2,0.3}

Table 8: Options are evaluated according to other factors.

Other factors	Degree of matching with the daily performance
A1	{0.3,0.4}
A2	{0.6,0.8}
A3	{0.5,0.6}

Step 1: Aggregates the sub-criteria information of each criterion using the hesitation fuzzy HFWA operator, i.e., the hesitation fuzzy decision matrix is obtained, as shown in Table 9.

Table 9: Aggregate values for each scheme under the discipline criterion.

	A1	A2	A3
Circumstances of violating discipline	{0.4084,0.4523, 0.4708,0.5101}	{0.6838,0.7551, 0.7764,0.8268}	{0.3000,0.4084, 0.4084,0.5000}
Harmfulness	{0.5573,0.6571, 0.5901,0.6825, 0.5859,0.6792, 0.6266,0.7030, 0.6653,0.7408, 0.6902,0.7600, 0.6870,0.7575, 0.7102,0.7756}	{0.8961,0.9400, 0.9400,0.9654, 0.9400,0.9654, 0.9800,0.9265, 0.9576,0.9755, 0.9576,0.9755, 0.9576,0.9756, 0.9755,0.9859}	{0.9510,0.9654, 0.9654,0.9755, 0.9654,0.9755, 0.9755,0.9827, 0.9717,0.9800, 0.9800,0.9859, 0.9800,0.9859, 0.9859,0.9900}
Punishment	{0.1515,0.2000, 0.2063,0.2517}	{0.5528,0.7172, 0.6838,0.8000}	{0.6536,0.7172， 1.0000,1.0000}
Deterrence	{0.1515,0.2063, 0.2517,0.3000, 0.3072,0.3519}	{0.6000,0.7172, 0.6536,0.7551}	{0.8268,1.0000, 0.9000,1.0000}
Regulatory matching	{0.2000,0.3000}	{0.6000,0.8000}	{0.6000,0.8000}
Other factors	{0.3000,0.4000}	{0.6000,0.8000}	{0.5000,0.6000}

Step 2: Using Equation (9), the entropy of the decision matrix parameters is calculated. Taking $\alpha = 0.2$， $\beta = 1$, we get:

$$E_1^0(\tilde{A}) = \frac{2}{n}\sum_{i=1}^{n} log_2\left[\frac{1}{l_i}\sum_{\lambda=1}^{l_i}\left(\left(\gamma_i^{\lambda}\right)^{\frac{1}{2}} + \left(1-\gamma_i^{\lambda}\right)^{\frac{1}{2}}\right)\right].$$

The entropy matrix E of the decision matrix is obtained:

$$E = \begin{bmatrix} 0.9983 & 0.9965 & 0.9736 & 0.9577 & 0.9560 & 0.9846 \\ 0.9516 & 0.8495 & 0.8725 & 0.9768 & 0.9657 & 0.9657 \\ 0.9913 & 0.7974 & 0.4918 & 0.4996 & 0.9657 & 0.9971 \end{bmatrix}.$$

Step 3: The weight of each criterions are obtained: $W_1 = 0.18$， $W_2 = 0.16$， $W_3 = 0.14$， $W_4 = 0.15$， $W_5 = 0.18$， $W_6 = 0.18$.

Step 4: Determine the positive ideal solution and negative ideal solution for each indicator:

$$f_i^+ = \{0.9,0.7,0.9,0.9,0.9,0.9,0.2,0.8,0.9,0.9,0.8,0.8\},$$

$$f_i^- = \{0.3,0.3,0.3,0.2,0.3,0.5,1.0,0.1,0.1,0.2,0.2,0.3\}.$$

Step 5: Makes the trade-off coefficient 0.5 and calculates the group benefit value S_i, the individual regret value R_i and the combined evaluation value Q_i, as shown in Table 10.

Table 10. Group benefit value, individual regret value and comprehensive evaluation value

	S_i	R_i	Q_i
A1	1.79	0.52	1.00
A2	0.48	0.09	0
A3	0.67	0.15	0.14

Step 6: Ranking selection of the solutions. By verifying the dominance criterion of acceptability and the stability criterion of acceptability, we get $Q(A_2) - Q(A_3) \leq DQ$， $Q(A_2) - Q(A_1) \geq DQ$, that is, scheme A2 and scheme A3 do not satisfy the dominance criterion of acceptability but scheme A2 satisfies the acceptability stability criterion, then both schemes A2 and A3 are optimal, i.e., the sanctioned person should be given a serious warning within the Party or be given a penalty of revocation of Party position. In the actual processing of the case, the discipline inspection and supervision authority gave the sanctioned person a serious warning within the Party.

6 CONCLUSIONS

This paper proposes an auxiliary decision-making method based on the hesitation fuzzy sum method for party discipline disciplinary measure, which adopts a hesitation fuzzy set to quantify the decision group opinion, adopts an objective weighting method for the weight of each disciplinary measure criterion, combines the method to maximize group utility and minimize individual regret value, and then provides an auxiliary decision-making scheme. The method, as an auxiliary decision-making method, provides quantitative tools for disciplinary measures based on the traditional qualitative method, standardizes the process

of disciplinary measures, and provides a powerful tool for the grassroots discipline inspection and supervision organs in grasping the scale of disciplinary measures, and also provides a more interpretable way for the disciplinary measures of party discipline. At the same time, the use of a hesitation fuzzy set can more comprehensively portray the different opinions of those involved in decision-making, providing a practical tool for giving full play to the role of decision-making groups in the disciplinary work, facilitating further standardization of the procedure of party disciplinary punishment and discipline, which is of great significance for promoting the construction of the rule of law. This paper verifies the effectiveness of the method in the context of actual case processing.

Through the case study, it can be found that this method provides program recommendations for disciplinary decision-making, and decision-makers can then choose among the recommended programs, and the whole process also fully reflects the democratic and centralized decision-making process, which applies to the disciplinary process of party disciplinary punishment.

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