Research on Quality Management Evaluation Method of Intelligent Robot Upgrade and R&D Project

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Abstract. In order to promote the high-quality development of intelligent robot upgrade R&D projects, promote the progress of social and economic intelligence, and improve production efficiency, a dynamic weighted evaluation method based on network cohesion of balanced groups is proposed. This method is based on balanced grouping of evaluation groups to ensure the relative homogeneity of evaluation groups. It uses dynamic interactive evaluation to construct a network adjacency matrix based on the consistency of pairwise evaluations within the group. And it collects Horizontal information based on the concept of network cohesion. A stage planning function is constructed to calculate the weights of multiple rounds of evaluation, Finally, a comprehensive evaluation result is obtained after vertical merging. This paper provides a new evaluation method for improving the quality management of intelligent robot upgrade R&D projects.

1 Introduction

As the economy continues to develop, intelligent robots have entered thousands of households, and all walks of life have improved production efficiency thanks to the assistance of intelligent robots. According to different actual needs, the functions of intelligent robots are becoming more and more complex, meanwhile, the requirements for intelligent robot manufacturers are gradually increasing. The upgrading and research and development projects of intelligent robots are independent of intelligent robot manufacturing projects, and they have technology-intensive, many related parties, and people's expectations[1]. Therefore, it is very important for the quality management of intelligent robot upgrade research and development projects.

Group evaluation is an approach commonly used for intelligent robot evaluation, which is mainly based on group homogeneity[2], that is, there is no difference among members participating in the group evaluation, as manifested by uniform scale of experts, consistent knowledge system with the same structure, and similar experiences and backgrounds[3]. Obviously, the assumption of homogeneity will seriously affect the results of evaluation, especially when assessing complicated subjects with a wide range of indicators, where a unified evaluation standard is hardly available. Therefore, it is difficult to ensure homogeneity of groups via simple grouping methods[4].

In view of the above situation, Su Weihua et al.[5] designed a “medium” and a “bridge” to connect subgroups and reduce the gap between chain evaluation values. Yang Lei et al.[6] studied the effect of interaction mechanism on the views of a group, compared and analyzed opinions and comments among groups. Su Weihua et al.[7] improved the consistency of evaluation based on the assessment of conflicts in the evaluation. However, studies like these need to be designed before the evaluation begins, which requires the organizers to be familiar with the attributes of the subjects and experts participating in the evaluation, making it difficult to perform in real scenarios[8]. Based on this, this paper maintained a balance when dividing expert into groups based on dynamic weighted interactive evaluation to ensure accurate and scientific decision-making of groups.

2 Balanced Group Quality Management and Evaluation Based on Dynamic Weighted Network Cohesion

Based on the abovementioned analysis, the traditional group evaluation requires evaluators of homogeneity. However, in actual group evaluation, it is difficult to control factors such as personal experience, cognition and subjective criteria in addition to uncertainties in the results of group evaluation, where homogeneity is hardly available. The balanced grouping method aims at identifying the level and grade of evaluators through evaluation results to place evaluators of homogeneity in the same group and ensure overall consistency of a group. After balanced grouping, the adjacency network matrix was constructed based on evaluation results between two individual evaluators, where the latitudinal weight was determined by network cohesion to generate a stage-planning function that will be used to calculate the meridional weight, thus obtaining the final evaluation results of the balanced groups. The logical process involved in quality management and evaluation of
balanced groups with dynamic weighted network cohesion is shown in Figure 1.

![Flow Diagram](image)

**Figure 1 Flow Diagram**

In Figure 1, a preliminary assessment of indicators used by evaluation groups serves as the first step to identify differences among individuals of the evaluation groups based on initial evaluation results. Then sort the differences and redistribute individuals for balanced grouping, based on which an interactive evaluation of indicators is accomplished. Through balanced grouping, the equivalence and homogeneity of evaluation groups is improved, thus ensuring greater group consistency.

However, there tend to be differences of individual credibility in group evaluation, which could affect the results of group evaluation. At present, there are two main approaches to deal with such problems, namely feedback and adjustment of individual weight. Feedback mechanism, also known as interactive evaluation mechanism, improves overall consistency of evaluation groups by repeatedly asking individual evaluators to adjust their evaluations [9]. The adjustment mechanism of evaluation weights is accomplished by analyzing differences among individual weights to ensure consistency.

In actual evaluation, the repeated evaluations of one indicator can be integrated as the result of overall evaluation, the consistency of which with the group evaluation results would be further improved in each stage of evaluation. The adjustment mechanism of individual weight is based on single round of evaluation, featuring strong individuality. In this paper, the dynamic weighted network cohesion was included in the interactive evaluation mechanism to construct an adjacency matrix based on the pairwise consistency of individual evaluators. Increased network cohesion and the weight of individuals consistent with group decision, coupled with compromised weight of individuals inconsistent with group decision, would reduce disturbance of specific data on the overall evaluation. Balanced grouping and interactive evaluation based on dynamic weighted network cohesion could improve accuracy of the evaluation results and reduce the influence of collective and individual factors on the evaluation.

3 Design and Implementation of Balanced Grouping Evaluation Based on Dynamic Weighted Network Cohesion

3.1 Establishment of an evaluation group for initial evaluation

The evaluation indicator set is \( X = \{x_i \mid x_1, x_2, \ldots, x_n\} \), and the evaluation group is \( E_i (i = 1, 2, \ldots, g) = \{e_1, e_2, \ldots, e_m\} \). The evaluation result of evaluation indicator \( x_r \) by individual evaluator \( e_s \) is \( a_{sr} \).

3.2 Calculate differences between the evaluation results of individuals

On the basis of the initial evaluation results, the difference of individual \( e_s \) and other individuals from indicator \( x_r \) is calculated as: 
\[
d(s, u) = \frac{1}{m \times n} \sum_{s=1}^{m} \sum_{u=1}^{n} |a_{sr} - a_{ur}| \tag{1}
\]
where \( m \) and \( n \) represent the number of individual evaluators and the number of evaluation indicators in the group, \( a_{sr} \) indicates the evaluation of evaluation indicator \( x_r \) by individual evaluator \( e_s \), and likewise \( a_{ur} \) indicates the evaluation of evaluation indicator \( x_r \) by individual evaluator \( e_u \).

4 Balanced grouping

Redistribute the group members based on differences of individual es from others in terms of evaluation indicator \( x_r \). Calculate the differences between evaluation results by individuals to form an evaluation difference matrix, based on which the overall evaluation difference between individuals is calculated. Rank the difference, after which the evaluation individuals are equally divided in a balanced manner and denoted as \( E_i (i = 1, 2, \ldots, h) \).

4.1 Interactive evaluation of evaluation indicators by balanced evaluation groups

After publishing the results of the last round of evaluation, the balanced evaluation group reevaluates the evaluation indicators, after which the consistency between individual \( e_s \) and individual \( e_u \) on indicator \( x_r \) and indicator \( x_o \) is calculated, which was marked by \( C_{ro}^{iu} \) [10]:
\[
C_{ro}^{iu} = \begin{cases} 
1, & \text{if } a_{ro} < a_{so} \quad \text{or} \quad a_{ro} < a_{su} \quad \text{or} \quad a_{so} > a_{iu} \quad \text{and} \quad a_{su} > a_{iu} \; \\
& \text{or} \quad a_{ro} = a_{so} \quad \text{and} \quad a_{su} = a_{iu} \\
0.5, & \text{if } a_{so} = a_{ro} \quad \text{and} \quad a_{su} = a_{iu} \; \text{or} \; a_{so} \neq a_{ro} \quad \text{and} \quad a_{su} = a_{iu} \\
0, & \text{else} 
\end{cases} \tag{2}
\]

In repeated interactive evaluations, the consistency indicator \( C_{ro}^{iu} \) is transformed into the similarity weight
The change of network cohesion \( \phi \) is expressed by the reciprocal of the sum of average weight times average distance [12]:

\[
\phi = \frac{1}{\sum_{s=1}^{m} \sum_{t=1}^{m} w_{st}^{*} d_{st}^{t} - \overline{D}^{t}}.
\]  

4.2 Calculate network cohesion \( \phi \) (WJt)

In the t-th round of interactive evaluation, the importance of individuals participating in the evaluation is determined by the sum of other individual evaluations and their similarity weights [11], that is, \( q_{i}^{t} = \sum_{s=1}^{m} w_{si}^{t} - 1 \), when the average weights of the whole interactive network total

\[
Q^{t} = \sum_{s=1}^{m} \frac{q_{s}^{t}}{m-1}.
\]  

The distance between individuals \( d_{si}^{t} \) is expressed by the reciprocal of similarity weights, that is, \( d_{si}^{t} = (w_{si}^{t})^{-1} \).

The average distance between individuals in the interactive network is calculated by

\[
\overline{D}^{t} = \frac{1}{m(m-1)} \sum_{s=1}^{m} d_{si}^{t} - \frac{m}{m-1}.
\]  

The network cohesion \( \phi \) (WJt) is expressed by the reciprocal of the sum of average weight times average distance [12]:

\[
\phi = \frac{1}{Q^{t} \times \overline{D}^{t}}.
\]  

4.3 Determine the conditions of interactive evaluation termination

The change of network cohesion \( \phi \) (WJt) could determine the stability of evaluation \( \lambda^{t} \). When

\[
\lambda^{t} = \left| 1 - \frac{\phi (WJ_{t})}{\phi (WJ_{t-1})} \right| < \varepsilon, \tag{9}
\]

the result of interactive evaluation is considered stable. The consistency of evaluation \( \theta^{t} \) is determined according to the average distance between individual evaluators and deviation in average distance of the network. When

\[
\theta^{t} = \left[ \frac{1}{m} \sum_{s=1}^{m} \frac{1}{m-1} \sum_{t=1}^{m} (d_{st}^{t} - \overline{D}^{t})^{2} \right]^{2} < \varphi. \tag{10}
\]

the results of interactive evaluation are considered consistent. When and only when the interactive evaluation results are stable and consistent, that is, when \( \lambda^{t} \) and \( \theta^{t} \) meet the conditions, the interaction would be terminated. Both \( \varepsilon \) and \( \varphi \) are preset thresholds.

4.4 Calculate the importance of evaluation result \( I(a_{i}^{t}) \)

The \( \phi \) (WJt) represents the network cohesion of interactive evaluation at the t-th round, and \( \phi \) (WJt \( \cdot \) a\(_{i}^{t} \)) marks the network cohesion of interactive evaluation at the t-th round when evaluations by individual es are removed. The importance of individual evaluation \( I(a_{i}^{t}) \) is calculated by

\[
I(a_{i}^{t}) = 1 - \frac{\phi (WJ_{t})}{\phi (WJ_{t} \cdot a_{i}^{t})}. \tag{11}
\]

4.5 Calculate the overall evaluation results of a single round of evaluation \( a_{i}^{t} \)

After normalizing the importance of the evaluation results of each individual \( I(a_{i}^{t}) \), the evaluation weight of individuals \( w_{si}^{t} \) in this round is obtained by

\[
W_{si}^{t} = \frac{I(a_{i}^{t})}{\sum_{s=1}^{m} I(a_{i}^{t})}. \tag{12}
\]

Then, the overall evaluation result of the n-th evaluation indicator at the t-th round is given by

\[
a_{i}^{t} = w_{si}^{t} \cdot a_{i}^{t}. \tag{13}
\]

The overall evaluation results of each round form the matrix of interactive evaluation results

\[
A^{t} = \begin{bmatrix}
a_{1}^{t*} & a_{2}^{t*} & \cdots & a_{n}^{t*} \\
a_{1}^{t*} & a_{2}^{t*} & \cdots & a_{n}^{t*} \\
\vdots & \vdots & \ddots & \vdots \\
a_{1}^{t*} & a_{2}^{t*} & \cdots & a_{n}^{t*}
\end{bmatrix}.
\]

4.6 Determine the weight at the interactive stage \( \beta^{t} \)

The continuous interactions would gradually reduce fluctuations of evaluation results from individuals while increasing the stage weight. Meanwhile, considering the evaluation results of individuals are closest to the overall evaluation results of the same round, the planning function is constructed as [13]:

\[
\beta^{t} = \frac{1}{m} \sum_{s=1}^{m} \left( \sum_{t=1}^{m} (d_{st}^{t} - \overline{D}^{t})^{2} \right)^{2} < \varphi.
\]
have the stage weight matrix:

\[
\min \sum_{i=1}^{l} \beta^i \sum_{t=1}^{m} (a^i_{t\prime} - a^i_{t\prime+1})^2; \\
\text{s.t. } \beta^i_t - \beta^{i+1}_t \leq 0; \\
\sum_{t=1}^{l} \beta^i_t = 1; \\
\beta^i_1 \geq 0.
\]  

(14)

Solve the stage weight of each individual, then we will have the stage weight matrix:

\[
B^i = \begin{bmatrix}
\beta^1_1 & \beta^1_2 & \cdots & \beta^1_n \\
\beta^2_1 & \beta^2_2 & \cdots & \beta^2_n \\
\vdots & \vdots & \ddots & \vdots \\
\beta^n_1 & \beta^n_2 & \cdots & \beta^n_n
\end{bmatrix}
\]

4.7 Calculate the overall evaluation performance \( P_r \) of balanced groups

\[
p^i_r = a^i_{t\prime} \cdot \beta^i_t
\]

(15)

from which the overall evaluation result of the \( i \)-th balanced group is obtained: \( [p^i_r] = [p^1_r, p^2_r, \ldots, p^n_r] \)

As all groups are divided in a balanced manner, the arithmetic average is used to calculate the overall evaluation performance \( P_r \) of the balanced groups,

\[
P_r = \sum_{i=1}^{r} p^i_r
\]

(16)

5 Application of Balanced Group Evaluation Based on Dynamic Weighted Network Cohesion

To evaluate the quality management maturity of an intelligent robot R&D enterprise through an intelligent robot upgrade and R&D project, a quality evaluation team was set up, consisting of six experts of quality management, six project team members and six clients respectively. The evaluation system is shown in TABLE 1. The evaluation members scored 1-100 points on the indicators, where 20 points, 40 points, 60 points, 80 points and 100 points represented very poor, poor, fair, good, excellent. The closer the score to a specific level, the more likely it would be included in the corresponding category. Due to limitation of space, this paper demonstrated the indicators of quality management expertise as an example.

| Dimension          | Weights | index | Index Weight | Total weight |
|--------------------|---------|-------|--------------|--------------|
| Finance            | 47.07%  | \( X_1 \): Roe        | 17.84% 8.40% |
|                    |         | \( X_2 \): Sales margin | 13.29% 6.26% |
|                    |         | \( X_3 \): Operating profit margin | 10.96% 5.16% |

Table1. Quality Management Maturity Indicators for intelligent robot upgrade and R&D projects

Social responsibility 15.58%

Internal business process 13.15%

Learning and growth 24.30%

| \( X_4 \): Assets and liabilities | 7.36% 3.46% |
| \( X_5 \): Quick ratio | 8.50% 4.00% |
| \( X_6 \): Cash flow debt ratio | 8.53% 4.02% |
| \( X_7 \): Total asset turnover | 5.73% 2.70% |
| \( X_8 \): Inventory turnover | 4.83% 2.27% |
| \( X_9 \): Accounts receivable turnover rate | 5.98% 2.81% |
| \( X_{10} \): Growth rate of total assets | 5.19% 2.44% |
| \( X_{11} \): Main business income growth rate | 7.19% 3.38% |
| \( X_{12} \): Operating profit growth rate | 4.60% 2.16% |

| \( X_{13} \): Customer satisfaction | 33.02% 5.14% |
| \( X_{14} \): Customer acquisition rate | 16.08% 2.50% |
| \( X_{15} \): Sales and advertising expenses as a percentage of sales expenses | 12.47% 1.94% |
| \( X_{16} \): Market share | 17.72% 2.76% |
| \( X_{17} \): Social accumulation rate | 11.65% 1.81% |
| \( X_{18} \): Employment contribution rate | 9.06% 1.41% |

| \( X_{19} \): The proportion of scientific researchers in the total number of employees | 13.84% 1.81% |
| \( X_{20} \): The growth rate of research costs | 9.28% 1.75% |
| \( X_{21} \): Number of new patents | 13.43% 1.75% |
| \( X_{22} \): New product sales as a percentage of total sales | 16.17% 2.11% |
| \( X_{23} \): Rate of qualified products | 14.19% 1.85% |
| \( X_{24} \): Production capacity utilization | 10.45% 1.36% |
| \( X_{25} \): Production cycle rate | 10.32% 1.35% |
| \( X_{26} \): Timely service rate | 6.11% 0.80% |
| \( X_{27} \): Deployment rate of technical service personnel | 6.20% 0.81% |

| \( X_{28} \): Staff training level | 19.58% 4.76% |
| \( X_{29} \): Employee satisfaction | 22.94% 5.57% |
| \( X_{30} \): Employee productivity | 21.83% 5.30% |
| \( X_{31} \): Key employee retention rate | 16.56% 4.02% |
| \( X_{32} \): Information system update speed | 10.00% 2.43% |
| \( X_{33} \): Acceptance rate of reasonable suggestions by employees | 9.09% 2.21% |
5.1 Initial evaluation

The evaluation members were divided into three groups according to their sources, which were named $E_1$, $E_2$ and $E_3$, representing quality management experts, project team members and clients respectively. They were asked to score indicators of Learning and growth, the results of which are shown in TABLE 2.

| Group  | Index member | $X_{28}$ | $X_{29}$ | $X_{30}$ | $X_{31}$ | $X_{32}$ | $X_{33}$ |
|--------|--------------|---------|---------|---------|---------|---------|---------|
| $E_1$  | $e_1$        | 79      | 72      | 53      | 67      | 63      | 72      |
|        | $e_2$        | 81      | 75      | 57      | 66      | 66      | 73      |
|        | $e_3$        | 82      | 84      | 78      | 82      | 86      | 78      |
|        | $e_4$        | 84      | 69      | 61      | 74      | 76      | 82      |
|        | $e_5$        | 89      | 83      | 77      | 82      | 74      | 73      |
|        | $e_6$        | 74      | 77      | 82      | 77      | 81      | 79      |
| $E_2$  | $e_7$        | 93      | 90      | 81      | 85      | 68      | 85      |
|        | $e_8$        | 79      | 74      | 75      | 72      | 57      | 92      |
|        | $e_9$        | 85      | 89      | 88      | 93      | 74      | 95      |
|        | $e_{10}$     | 94      | 93      | 90      | 77      | 65      | 91      |
|        | $e_{11}$     | 93      | 96      | 95      | 90      | 91      | 97      |
|        | $e_{12}$     | 95      | 97      | 89      | 92      | 87      | 95      |
| $E_3$  | $e_{13}$     | 68      | 74      | 83      | 74      | 83      | 82      |
|        | $e_{14}$     | 77      | 84      | 85      | 82      | 87      | 88      |
|        | $e_{15}$     | 80      | 77      | 86      | 73      | 76      | 73      |
|        | $e_{16}$     | 94      | 93      | 74      | 88      | 92      | 83      |
|        | $e_{17}$     | 73      | 74      | 77      | 82      | 88      | 92      |
|        | $e_{18}$     | 74      | 74      | 79      | 73      | 78      | 76      |

5.2 Balanced grouping

According to the results of initial evaluation, the difference between individual evaluations was calculated, as shown in TABLE 3. Then, they were regrouped using balanced grouping method into Major Difference Group $E'_1$ ($e_1$, $e_2$, $e_6$, $e_{10}$, $e_{11}$, $e_{12}$), Medium Difference Group $E'_2$ ($e_4$, $e_7$, $e_9$, $e_{13}$, $e_{16}$, $e_{17}$), and Minor Difference Group $E'_3$ ($e_3$, $e_5$, $e_6$, $e_{14}$, $e_{15}$, $e_{18}$). After regrouping, the balanced groups reevaluated the indicators, and the secondary evaluation results are shown in TABLE 4. By comparing the evaluation results before and after regrouping, it was found that individuals whose result in the first round was highly different with the group evaluation showed much less inconsistency in the second evaluation. The evaluation results of individuals tended to be more consistent, proving the benefits of balanced grouping.

| Group  | Index member | $X_{28}$ | $X_{29}$ | $X_{30}$ | $X_{31}$ | $X_{32}$ | $X_{33}$ |
|--------|--------------|---------|---------|---------|---------|---------|---------|
| $E'_1$ | $e_1$        | 83      | 79      | 72      | 76      | 69      | 82      |
|        | $e_2$        | 84      | 83      | 73      | 74      | 68      | 82      |
|        | $e_3$        | 85      | 82      | 77      | 77      | 67      | 88      |
|        | $e_{10}$     | 88      | 88      | 80      | 77      | 70      | 87      |
|        | $e_{11}$     | 89      | 88      | 83      | 80      | 80      | 88      |
|        | $e_{12}$     | 88      | 88      | 80      | 85      | 80      | 90      |

5.3 Interactive evaluation on evaluation indicators by balanced evaluation group

Given $\varepsilon = 0.001$ and $\varphi = 0.15$, the interactive evaluation by $E'_1$, $E'_2$ and $E'_3$ terminated at round 6,
5 and 3 respectively. The changes of \( \varphi \) and \( \varphi \) are shown in TABLE 5. Take the balanced group of \( E^3 \) as an example, the evaluation result of which at each round is shown in TABLE 6.

| Group | Rounds | \( E^1 \) | \( E^2 \) | \( E^3 \) |
|-------|--------|---------|---------|---------|
|       | \( \varepsilon \) | \( \varphi \) | \( \varepsilon \) | \( \varphi \) | \( \varepsilon \) | \( \varphi \) |
| 0     | 0.000  | 0.030  | 0.000  | 0.057  | 0.000  | 0.088  |
| 1     | 0.023  | 0.033  | -0.002 | 0.061  | 0.027  | 0.064  |
| 2     | -0.006 | 0.040  | 0.005  | 0.059  | 0.015  | 0.060  |
| 3     | 0.052  | 0.039  | -0.009 | 0.057  | 0.001  | 0.060  |
| 4     | -0.002 | 0.036  | -0.003 | 0.038  |        |        |
| 5     | 0.003  | 0.035  | -0.000 | 0.041  |        |        |
| 6     | -0.001 | 0.036  |        |        |        |        |

Table 5. Changes of \( \varepsilon \) and \( \varphi \) in Each Round

Table 6. Interactive Evaluation Results of Each Round of E3 Balanced Group

| Groups       | Index | \( x_{28} \) | \( x_{29} \) | \( x_{30} \) | \( x_{31} \) | \( x_{32} \) | \( x_{33} \) |
|--------------|-------|-------------|-------------|-------------|-------------|-------------|-------------|
| \( E^1 \)    |       | 84.15       | 82.25       | 80.38       | 82.18       | 80.90       | 83.29       |
| \( E^2 \)    |       | 83.65       | 81.56       | 80.31       | 80.96       | 81.02       | 83.11       |
| \( E^3 \)    |       | 82.17       | 81.17       | 80.54       | 80.69       | 81.03       | 83.26       |
| \( E^3 \)    |       | 83.30       | 82.97       | 78.79       | 80.00       | 78.24       | 84.35       |

5.5 Calculate overall evaluation results

Formula (14) is constructed,

\[
B^{E_3} = \begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 \\
0.149 & 0 & 1/2 & 1/2 & 1/3 & 1/2 \\
0.851 & 1 & 1/2 & 1/3 & 1/3 & 1/2 \\
\end{bmatrix}
\]

based on which the weight matrix of \( E^3 \) Balanced Group was obtained for the calculation of the overall evaluation results of the group. The final results were derived by calculating arithmetic mean values of Balanced Group \( E^1 \), \( E^2 \) and \( E^3 \), as shown in TABLE 8.

Table 8. Overall Evaluation Results

5.6 Calculate the overall evaluation values of the indicator system

Calculate the overall evaluation values of all indicators using the abovementioned formula, which, combined with indicator weight, could obtain the overall evaluation of the indicator evaluation system.

6 Conclusion

Based on the quality management system of intelligent robots upgrading and research and development projects, this paper designed a balanced group evaluation method based on dynamic weighted network cohesion with the following characteristics:

Unlike traditional grouping of experts participating in
In interactive evaluation, the evaluation results of the same group were publicized before each round to reduce inconsistency between individuals of the group. The application of network cohesion and similarity weight of experts made the weight adjustment more intuitive and accessible to individuals.

The determination of stage weights added practicality to the evaluation. The incorporation of evaluation results of subjects into the calculation of overall evaluation values improved accuracy and credibility of the evaluation.

Due to limitation of space, this paper simplified procedures involved in the study, and found defects of the investigation as the participants were asked to repeatedly evaluate various indicators of the same subject, thus lowering the credibility of the evaluation. In the meantime, the excessive scale of participants and indicators would hamper the prediction of the evaluation results, imposing challenges to the organization of the evaluation due to increased cost and lower efficiency, which needs further study in the future.

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