





# Research on Comprehensive Evaluation of Performance of Traditional Chinese Medicine Project based on Grey Correlation Analysis

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**Keywords:** Grey Correlation Analysis, Performance Management, Comprehensive Evaluation, TCM Project.

**Abstract:** This paper studied the main factors affecting the execution rate of Traditional Chinese Medicine (TCM) project funds and the comprehensive evaluation result of TCM project performance by grey correlation analysis. During the study, we called the funds evaluation rate and performance evaluation scores of the four categories of TCM projects in 15 cities as performance evaluation data, and used them as the original data for the research. In the study of influencing factors, the funds execution rate was used as the reference sequence, and the project performance evaluation scores were used as the comparison sequences, in the study of the comprehensive evaluation, the performance evaluation data of an ideal city was set as the reference sequence, and the performance data of 15 cities were used as the comparison sequences. Then, the data of the sequences were non-dimensionalized, to calculate the correlation coefficient and correlation degree of the comparison sequences, and sort the correlation degree. The results indicated that the implementation of category D project had the greatest impact on the funds evaluation rate, the comprehensive evaluation of cities D, O, E, N, B, M and I ranked high. The comprehensive evaluation result obtained by grey correlation analysis was consistent with the evaluation result of third-party experts, it could reflect the comprehensive situation of different cities and projects. It is proposed that the competent department of TCM project can improve the performance management level of TCM project from the aspects of optimizing budget allocation, improving the index system, carrying out comprehensive performance evaluation and improving the whole process management of TCM project.

## 1 INTRODUCTION

With the continuous increase of the central government's investment in special funds for TCM projects, government departments have increasingly strict requirements for fund management and performance evaluation of TCM projects. At present, the performance evaluation of TCM projects mainly adopts the performance report formed by the submission of performance data by the evaluated unit, performance self-evaluation and expert sampling on-

site investigation. This study uses grey correlation analysis method to conduct in-depth research on performance data, to help the TCM project department in charge accurately grasp the overall situation of the project performance. This study finds the main factors to improve the execution rate of TCM project funds, finds the weak links in the implementation of TCM projects, puts forward suggestions for improving the management of TCM projects, and provides ideas for performance comprehensive evaluation of TCM project.

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## 2 DATA SOURCES AND RESEARCH METHODS

### 2.1 Data Sources

The data of this study is derived from the performance evaluation data of a province's TCM project in the TCM platform for National Health Insurance Information Engineering in 2020, the data is filled in by the project implementation unit, audited by a third-party accounting firm, which is scientific. We sorted out the funds execution rate and performance evaluation scores data of four categories of projects in 15 cities.

### 2.2 Research Methods

According to the grey system theory (Deng 2002), this paper uses grey correlation analysis method to carry out research, the specific calculation steps are as follows.

1) To determine the reference sequence that reflects the characteristics of the system's behavior and the comparison sequences that affect the system's behavior. Among them, the reference sequence is usually denoted as  $X_0$ , and the comparison sequences are denoted as  $X_1, X_2, \dots, X_k$ .

2) The new sequences are obtained by non-dimensional processing on the reference sequence and the comparison sequences.

3) To calculate the absolute difference between the reference sequence and the comparison sequence, the calculation formula is as follows:

$$\Delta_i(k) = |X_0(k) - X_i(k)| \quad (1)$$

In the formula,  $\Delta_i(k)$  is the absolute difference value,  $X_0(k)$  is the value of the non-dimensional reference sequence, and  $X_i(k)$  is the value of the non-dimensional comparison sequence.

4) To calculate the correlation coefficient of the comparison sequences, the calculation formula is as follows:

$$\xi_i(k) = [\Delta_i(k)_{min} + \rho \Delta_i(k)_{max}] / [\Delta_i(k) + \rho \Delta_i(k)_{max}] \quad (2)$$

In the formula,  $\xi_i(k)$  is the correlation coefficient,  $\Delta_i(k)_{min}$  and  $\Delta_i(k)_{max}$  respectively represent the minimum and maximum difference of the absolute difference, and  $\rho$  represents the resolution coefficient, which is 0.5.

5) To calculate the correlation degree of the comparison sequence and sort it, the calculation formula is as follows:

$$r_i = \frac{1}{n} \sum_{k=1}^n \xi_i(k), k=1,2,3,\dots,n \quad (3)$$

$r_i$  is the grey correlation degree of the comparison sequences  $X_i$  to the reference sequence  $X_0$ . The closer the value of  $r_i$  is to 1, the better the correlation. The degree of relevance is sorted by numerical value. If  $r_1 > r_2$ , the reference sequence  $X_0$  is more similar to the comparison sequence  $X_1$ .

### 2.3 Data Analysis

The research data was processed with Microsoft Excel 2019 and SPSS 21.0 software and analyzed for grey correlation analysis.

## 3 RESULTS AND ANALYSIS

### 3.1 Basic Information

The performance evaluation data of this research is the total funds execution rate of the four categories of projects A, B, C, and D in 15 cities and the performance evaluation scores of each project, the evaluation score is based on a percentage system, as shown in Table 1. From the perspective of project funds execution rate, City C, City I and City L have the top performance rankings, with an execution rate of 100%. While City G, City J, City F and City K rank lower in terms of performance, with lower funds execution rates, they are 78.04%, 74.66%, 67.28% and 30.56% respectively. Judging from the average scores of the cities in the project performance evaluation, the performance of City D, City O, City E and City M are ranked high, with scores of 92.61, 91.63, 91.04 and 90.58 respectively, City C and City F, City H, City A, and City K rank low in performance, with a score of less than 85. The rankings obtained from the two evaluation angles have a large gap, which are not enough to reflect the overall performance level of the cities.

Table 1: Cities performance evaluation data.

cities	Category A (points)	Category B (points)	Category C (points)	Category D (points)	Average score (points)	Funds execution rate (%)
C	78.33	80.00	87.50	83.33	82.29	100.00
I	85.00	83.33	100.00	80.00	87.08	100.00
L	91.00	75.00	85.00	90.00	85.25	100.00
N	79.50	86.00	92.50	97.50	88.88	99.45
A	59.50	81.67	81.50	100.00	80.67	99.19
D	89.20	93.75	100.00	87.50	92.61	98.43
B	85.88	80.00	100.00	90.00	88.97	98.20
M	87.80	87.00	92.50	95.00	90.58	96.33
E	85.00	89.17	100.00	90.00	91.04	95.61
H	86.00	70.00	75.84	93.75	81.40	93.44
O	82.78	83.75	100.00	100.00	91.63	90.53
G	86.88	81.67	91.25	90.00	87.45	78.04
J	97.50	85.00	83.33	89.29	88.78	74.66
F	71.67	80.00	85.00	90.00	81.67	67.28
K	85.00	80.00	85.00	70.00	80.00	30.56

### 3.2 Grey Correlation Analysis of Project Funds Execution Rate and Performance Evaluation Scores

According to the grey system theory, 15 cities are regarded as a grey system, and using grey correlation analysis method to calculate the correlation between the project funds execution rate and the performance evaluation scores (Liu et al. 2021). According to the calculation steps, setting the project funds execution rate as the reference sequence  $X_0$ , and the performance evaluation scores of the four categories of projects A,

B, C, and D as the comparison sequences  $X_i$  ( $i=1,2,3,4$ ). The initial value method is used to non-dimensionally process the data of each sequences, and the results are shown in Table 2. Calculating the absolute difference  $\Delta_i(k)$  of each performance evaluation score according to the data in Table 2, the results are shown in Table 3. It can be seen from the results in Table 3 that  $\Delta_i(k)_{\min}$  is 0 and  $\Delta_i(k)_{\max}$  is 0.5444. Further according to the formulas (2) and (3), the correlation coefficient and correlation degree of the performance evaluation scores to the funds execution rate are calculated, as shown in Table 4.

Table 2: Dimensionless processing of performance evaluation data.

cities	Category A	Category B	Category C	Category D	Funds execution rate
A	0.5950	0.8167	0.8150	1.0000	0.9919
B	0.8588	0.8000	1.0000	0.9000	0.9820
C	0.7833	0.8000	0.8750	0.8333	1.0000
D	0.8920	0.9375	1.0000	0.8750	0.9843
E	0.8500	0.8917	1.0000	0.9000	0.9561
F	0.7167	0.8000	0.8500	0.9000	0.6728
G	0.8688	0.8167	0.9125	0.9000	0.7804
H	0.8600	0.7000	0.7584	0.9375	0.9344
I	0.8500	0.8333	1.0000	0.8000	1.0000
J	0.9750	0.8500	0.8333	0.8929	0.7466
K	0.8500	0.8000	0.8500	0.7000	0.3056
L	0.9100	0.7500	0.8500	0.9000	1.0000
M	0.8780	0.8700	0.9250	0.9500	0.9633
N	0.7950	0.8600	0.9250	0.9750	0.9945
O	0.8278	0.8375	1.0000	1.0000	0.9053
Ideal	1.0000	1.0000	1.0000	1.0000	1.0000

Table 3: Absolute difference table of grey correlation analysis between funds execution rate and performance evaluation scores.

cities	Category A	Category B	Category C	Category D
A	0.3969	0.1752	0.1769	0.0081
B	0.1232	0.1820	0.0180	0.0820
C	0.2167	0.2000	0.1250	0.1667
D	0.0923	0.0468	0.0157	0.1093
E	0.1061	0.0644	0.0439	0.0561
F	0.0439	0.1272	0.1772	0.2272
G	0.0884	0.0363	0.1321	0.1196
H	0.0744	0.2344	0.1760	0.0031
I	0.1500	0.1667	0.0000	0.2000
J	0.2284	0.1034	0.0867	0.1463
K	0.5444	0.4944	0.5444	0.3944
L	0.0900	0.2500	0.1500	0.1000
M	0.0853	0.0933	0.0383	0.0133
N	0.1995	0.1345	0.0695	0.0195
O	0.0775	0.0678	0.0947	0.0947

Table 4: The correlation coefficient and correlation degree of performance evaluation scores to funds execution rate.

cities	Category A	Category B	Category C	Category D
A	0.4068	0.6084	0.6061	0.9711
B	0.6885	0.5993	0.9379	0.7686
C	0.5568	0.5765	0.6853	0.6202
D	0.7468	0.8533	0.9454	0.7135
E	0.7195	0.8086	0.8612	0.8291
F	0.8612	0.6816	0.6057	0.5451
G	0.7549	0.8824	0.6733	0.6948
H	0.7854	0.5374	0.6074	0.9886
I	0.6447	0.6202	1.0000	0.5765
J	0.5437	0.7247	0.7584	0.6504
K	0.3333	0.3551	0.3333	0.4083
L	0.7515	0.5213	0.6447	0.7313
M	0.7614	0.7447	0.8766	0.9534
N	0.5770	0.6692	0.7965	0.9330
O	0.7785	0.8007	0.7418	0.7418
Correlation degree	0.6607	0.6656	0.7382	0.7417
The sorting	4	3	2	1

According to the principle of grey correlation analysis, the correlation degree can represent the importance of the sequence in the grey system, the larger the value, the greater the impact of the

corresponding project performance evaluation score on the funds execution rate. It can be seen from Table 4 that the order of the correlation degree of each project performance evaluation score to the funds execution rate is: Category D > Category C > Category B > Category A, their values are 0.7417, 0.7382, 0.6656, 0.6607. It can be seen that the implementation of Category D project in each city has the greatest impact on the overall funds execution rate.

### 3.3 Grey Correlation Analysis of Project Performance Comprehensive Evaluation

Grey correlation analysis method is used to rank the performance of the projects in each city. First, constructing an ideal city where the performance evaluation scores of each project is 100 points and the project funds execution rate is 100%, and setting it as the reference sequence  $Y_0$ . The performance data of other cities is set as the comparison sequences  $Y_i$  ( $i=1,2,3,\dots,15$ ). Then, the performance evaluation data of each city is non-dimensionally processed, and the results are shown in Table 2. Calculating the absolute difference  $\Delta_i(k)$  of the performance evaluation data of each city according to the formula (1), the results are shown in Table 5. It can be seen that  $\Delta_i(k)_{\min}$  is 0 and  $\Delta_i(k)_{\max}$  is 0.6944. Finally, calculating the correlation coefficient and correlation degree of the corresponding sequences of each city, the results are shown in Table 6.

Table 5: Absolute difference of city performance evaluation data based on grey correlation analysis.

cities	Category A	Category B	Category C	Category D	Funds execution rate
A	0.4050	0.1833	0.1850	0.0000	0.0081
B	0.1412	0.2000	0.0000	0.1000	0.0180
C	0.2167	0.2000	0.1250	0.1667	0.0000
D	0.1080	0.0625	0.0000	0.1250	0.0157
E	0.1500	0.1083	0.0000	0.1000	0.0439
F	0.2833	0.2000	0.1500	0.1000	0.3272
G	0.1312	0.1833	0.0875	0.1000	0.2196
H	0.1400	0.3000	0.2416	0.0625	0.0656
I	0.1500	0.1667	0.0000	0.2000	0.0000
J	0.0250	0.1500	0.1667	0.1071	0.2534
K	0.1500	0.2000	0.1500	0.3000	0.6944
L	0.0900	0.2500	0.1500	0.1000	0.0000
M	0.1220	0.1300	0.0750	0.0500	0.0367
N	0.2050	0.1400	0.0750	0.0250	0.0055
O	0.1722	0.1625	0.0000	0.0000	0.0947

Table 6: Correlation coefficient and correlation degree of performance evaluation data.

cities	Category A	Category B	Category C	Category D	Funds execution rate	Correlation degree
D	0.7627	0.8474	1.0000	0.7353	0.9567	0.8604
O	0.6685	0.6812	1.0000	1.0000	0.7856	0.8271
E	0.6983	0.7622	1.0000	0.7764	0.8878	0.8249
N	0.6288	0.7126	0.8224	0.9328	0.9845	0.8162
B	0.7109	0.6345	1.0000	0.7764	0.9506	0.8145
M	0.7400	0.7276	0.8224	0.8741	0.9044	0.8137
I	0.6983	0.6756	1.0000	0.6345	1.0000	0.8017
L	0.7941	0.5814	0.6983	0.7764	1.0000	0.7700
A	0.4616	0.6545	0.6524	1.0000	0.9772	0.7491
C	0.6157	0.6345	0.7353	0.6756	1.0000	0.7322
J	0.9328	0.6983	0.6756	0.7643	0.5781	0.7298
G	0.7258	0.6545	0.7987	0.7764	0.6126	0.7136
H	0.7126	0.5365	0.5897	0.8474	0.8410	0.7054
F	0.5507	0.6345	0.6983	0.7764	0.5149	0.6349
K	0.6983	0.6345	0.6983	0.5365	0.3333	0.5802

According to the principle of grey correlation analysis, the higher the correlation degree of a city, the closer it is to the performance evaluation result of the ideal city, and the higher its comprehensive evaluation level will be. According to the results in Table 6, the comprehensive evaluation of project performance of the 15 cities is ranked as City D > City O > City E > City N > City B > City M > City I > City L > City A > City C > City J > City G > City H > City F > City K.

## 4 DISCUSSIONS

### 4.1 Factors Influencing Project Funds Execution Rate

According to the results, the order of the degree of influence of the performance evaluation scores of each project on the funds execution rate is: Category D > Category C > Category B > Category A. The four categories of projects are the novel coronavirus Pneumonia prevention and treatment capacity building of TCM, TCM culture and industry, TCM talent training, and TCM medical service capacity building. Therefore, in the process of implementing

TCM projects, cities should focus on improving the performance evaluation score of category D project. Specific measures include improving the infrastructure of relevant business departments and cultivating relevant talents. The correlation degree of category C is 0.7382, which has a higher correlation degree with the funds execution rate. The category C project includes the investigation of citizens' TCM health culture literacy and the promotion of TCM health culture. Cities need to improve the quality of the questionnaire, enrich the survey methods, and improve the professionalism of the investigators, at the same time, actively carry out the cultural dissemination and publicity activities of TCM, to improve the performance evaluation score of category C project.

### 4.2 Comprehensive Performance Evaluation

The results show that City D ranks first comprehensively, and the correlation coefficients of all indicators exceed 0.7, but the Category A and Category D projects he undertakes still need to be strengthened. City O, City E, City N, City B, City M, City I, City L, City A, and City C have a high correlation coefficient in the funds execution rate.



Therefore, they should increase the performance evaluation scores of weak projects to improve the overall ranking. The lower-ranked cities J, G, F, and K have a low correlation coefficient in the funds execution rate. Therefore, they should regulate the use of funds to increase the execution rate, in order to, improve the overall ranking. City H has the lowest correlation coefficient in Category B and Category C projects, so, it is necessary to focus on rectification and reform of these two categories of projects, in order to improve the comprehensive ranking.

## 5 SUGGESTIONS

### 5.1 Optimizing Budget Allocation, and Improving the Index System

A reasonable budget allocation and a comprehensive performance evaluation index system are the basis for improving the funds execution rate and project performance evaluation scores, and are the key factors to improve the quality of performance evaluation. In terms of budget allocation, the department in charge of TCM projects should strictly follow the principles of overall planning, fairness and justice (Huo 2021), and allocate project budgets in accordance with areas and proportions. Local financial departments and business management departments need to strengthen communication in the process of budget formulation (Wu, Tian & Shen 2019), do a good job of investigation and research in the early stage of project implementation. In terms of the performance evaluation index system, the basic principles to be followed by the department in charge of TCM projects are: combination of qualitative and quantitative, combination of theory and practice, combination of completeness and simplicity, and combination of objectivity and orientation. Through the extensive collection of opinions from experts and professional staff, a performance evaluation index system with TCM characteristics and in line with the goals of the TCM project is constructed.

### 5.2 Carrying out Comprehensive Evaluation of the Performance of TCM Projects

At present, TCM projects performance evaluation often uses single indicators such as project performance evaluation score or funds execution rate to evaluate the project implementation unit, which is not enough to reflect the overall level of the

implementation unit and the overall implementation of the project. Therefore, the competent department of TCM projects should actively use grey correlation analysis method, analytic hierarchy process, indirect evaluation method and other scientific evaluation methods when performing performance evaluation. Scientific evaluation results can mobilize the initiative of the competent department and project undertaking units (Huang & Xiao 2017), which is conducive to to comprehensively grasp the implementation of the project, find the weak links, and provide a basis for the competent authority to make reasonable decisions on the project.

### 5.3 Improving the Whole Process Management of TCM Projects

The competent department of TCM projects should improve management system and realize the whole process management from project application, establishment, implementation, interim inspection, acceptance and performance evaluation. First, establishing a database of TCM projects, carrying out ex ante performance evaluation, realizing "project planning first and fund allocation later". Second, forming a standardized and real-time project management and supervision system, dynamically grasping project progress (Xue 2021), in order to, improve performance management. What's more important, the competent department of TCM projects should actively use information technology, and establish a database covering the entire process of budget declaration, review, execution and performance evaluation (Li & Xie 2020). TCM project performance management information system should be constructed to realize the visualization and informatization of project implementation process data, carry out monitoring, early warning and accurate evaluation of project performance operation. It can also support data collection, performance evaluation and scientific research for TCM projects. In the end, the performance evaluation feedback mechanism should be established (Chen, Leng & Jin 2016). The performance evaluation results should be linked to the budget preparation, implementing an accountability system for units to ensure the standardization and rationality of project implementation. As a safeguard measure of performance management, it is necessary to establish a team of performance management talents to ensure the completion of various work with high quality.

## 6 CONCLUSION

This study uses grey correlation analysis method to combine the performance evaluation score and the funds execution rate two major indicators to comprehensively evaluate the performance evaluation data of TCM projects in 15 cities, and find important factors that affect the funds execution rate and comprehensive ranking. On the other hand, due to the limitation of report data, this study does not include other indicators such as the number of completed performance indicators, provinces and years into the study, and the research conclusion has certain limitations. The follow-up research will further increase relevant evaluation indicators and conduct multi-dimensional analysis of performance evaluation data.

## ACKNOWLEDGEMENTS

Research on Performance Evaluation of Traditional Chinese Medicine Projects in Hubei Province in 2021 (Project No: HBZY-2021-Z09).

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