

# EVALUATION OF CIVIL ADMINISTRATION BASED ON FUZZY COMPUTING AND GREY RELATIONAL ANALYTIC PROCESS

Mei-Er Zhuang , Wen-Tsao Pan \*

*School of Business, Guangdong University of Foreign Studies, Guangzhou, 510000, China*

*Email: [teacherp0162@126.com](mailto:teacherp0162@126.com)*

**Abstract:** A scientific performance evaluation system of civil affairs administration based on information technology is of great significance in the society, which exerts positive effects on supervising the government and promoting the development of social management by improving the level of civil affairs work. In order to strengthen the construction of civil administration, this paper established a performance evaluation model fuzzy computing, gray relation analysis (GRA) and analytic hierarchy process (AHP). Specifically, five ethnic minority autonomous regions of China were taken as the example in the study. Quantitative research was carried out from relevant statistical data indicators, and the development and performance of civil affairs work in five regions were analyzed. The performance evaluation model of hierarchical analysis based on fuzzy grey relation was provided to propose some practical suggestions for performance evaluation of civil affairs work.

**Keywords:** Civil Administration; Fuzzy Computing; Grey Relational Analysis (GRA); Analytic Hierarchy Process (AHP)

## 1. INTRODUCTION

Civil affairs are closely related to the interests of the people. The vigorous development of civil affairs can more effectively protect the rights and interests of vulnerable groups, improve the quality of life and perceived happiness of people, and thus promote social harmony. In recent years, with the growing economy and the increasing attention of the government, the civil affairs work in all regions of China has made great progress, and the basic life of the people has been better improved. In the national conference of China held in March 2019, the government work report also put forward new guidelines for civil affairs work, demanding in-depth advancement of poverty alleviation, strengthening poverty alleviation, increasing capital investment, strengthening social assistance, and steadily improve self-development in poverty-stricken areas. Adhere to the protection and improvement of people's livelihood in development, and reform and development results will benefit the people more and more equitably.

When studying civil affairs work, we need to clearly understand the relevant concepts. In the past, some literature distinguished the country and society from the civil affairs work. However, the reality shows that the effective development of civil affairs depends on the joint efforts of both the country and society. Wang Ying (2018) proposed that the concept of "country" refers to a collection of various political powers and administrative forces, while "society" mainly refers to the civil forces that actively participate in and contribute to the process of establishing a professional social work system, including grassroots community organizations and public and private social service organizations, and civil society professional

organizations. Regarding the content of civil affairs work, Yang Lixiong (2019) believes that civil responsibilities should focus on four areas: social assistance, social services, social participation, and social governance. Liu Xitang et al. (2017) pointed out that there are four characteristics of civil affairs work in the new era, namely, openness, pluralism, mass, and sociality. Wang Xiaozhang (2013) emphasizes that civil affairs must achieve its own modern transformation in response to changes in social structure, social relations, and social psychology brought about by China's social transformation from traditional to modern.

Performance appraisal is an important means to understand the implementation of work and promote the quality of work. However, there is little literature on the performance appraisal of civil affairs work. It can be seen that relevant research is not enough. In order to further study this field, this paper will construct a civil behavior performance evaluation model based on the fuzzy analysis method of fuzzy grey relation. The reason why this paper is based on China's minority autonomous regions is mainly because the economic strength and social conditions of minority areas are relatively weak compared with other provinces, and the importance of civil affairs work may not be high enough, so it is more necessary to System performance analysis and evaluation of civil work performance. In addition, this analysis system can also be used to evaluate the performance of civil affairs in other regions.

## 2. RESEARCH METHODS

Analytic hierarchy process (AHP) is an analytical method for making decisions and assessments of

complex problems, which is suitable for analyzing complicated systems composed of many interrelated factors. Analytic hierarchy process is to decompose related elements into goals, criteria, programs and other levels, and conduct qualitative and quantitative analysis on this basis. This research method provides a flexible and simple modeling method for analyzing more complex decision problems. In solving multi-objective decision-making problems, analytic hierarchy process has the advantages of flexibility and is widely used in many fields such as urban planning and economic management. Besides, analytic hierarchy process is one of the most used methods in supply chain evaluation at present. The principle is to decompose complex problems into several levels and several factors, establish a judgment matrix, and use the economic values represented by matrix eigenvalues and eigenvectors to obtain different order of importance of the scheme (Guo Jinyu et al, 2008)

However, in the general analytic hierarchy process, the construction judgment matrix usually does not consider the ambiguity of human judgment, which leads to great complexity and difficulty in verifying the consistency of the judgment matrix and adjusting the comparison judgment matrix. In order to overcome the difference between the consistency of judgment matrix and the consistency of human thinking in analytic hierarchy process, this paper adopts fuzzy calculation and gray correlation analysis.

The results of combination are applied as the the criteria layer and the scheme layer weights in the analytic hierarchy process.

The fuzzy comprehensive evaluation method was first proposed by Chinese scholar Wang Peizhuang (1982) to solve the situation that the relationship between evaluation levels is ambiguous. When a concept and its opposite concept cannot draw a clear dividing line, and as they gradually evolve to qualitative change, the two concepts are said to be blurred. The principle is to evaluate the decision-making unit by constructing the membership matrix and synthesizing the index weight matrix and the membership matrix. There are two main research points. One is the determination of the membership matrix. The membership matrix is composed of membership degrees. The membership degree refers to the degree of membership of a certain evaluation target in a certain index. Another problem is the calculation of the membership. (Li Yulin et al., 2006).

Grey relational analysis is based on the "degree of association" to analyze the problem. The degree of association is essentially the degree of difference in geometry between curves. Therefore, the difference between the curves can be used as a measure of the degree of association. The research object of this method is the non-dimensionalized sequence, which is divided into reference sequence and comparison sequence. The reference sequence is a standard sequence in the gray correlation analysis method, and is a data sequence reflecting the behavior characteristics of the system. The comparison sequence is a sequence of objects in the gray correlation analysis method, and is a data sequence composed of factors

affecting system behavior. Grey correlation analysis can be used to analyze many types of real-world problems. Xu Lin (2018) used gray correlation degree to analyze the pore structure parameters of geotechnical media.

Fuzzy-grey relational analytic hierarchy process (Fuzzy-GRA-AHP) is a comprehensive evaluation method based on fuzzy mathematics and grey relational analysis. The principle of fuzzy relational synthesis and grey correlation coefficient is applied to quantify some unclear and difficult-to-quantify factors for comprehensive evaluation. The comprehensive evaluation method transforms qualitative evaluation into quantitative evaluation according to the membership degree theory of fuzzy mathematics, that is, using fuzzy mathematics to make an overall evaluation of things or objects subject to various factors.

Fuzzy grey relational analytic hierarchy process can effectively overcome the more extreme judgment methods in the general analytic hierarchy process, and more consider the ambiguity of human judgment. Therefore, it has the characteristics of clear results and strong system, which can better solve the fuzzy and difficult to quantify. The problem is suitable for solving various non-deterministic problems. After the data is fuzzy variable, the gray relation analysis is carried out, and the relevance degree is used as the weight of the analytic hierarchy. The decision factor set and the factor weight can be determined, so that the system can be analyzed more systematically and a more scientific performance evaluation system can be constructed

### 3. EMPIRICAL ANALYSIS

#### 3.1 Data Sources

The data of this study are obtained from the official website of the National Bureau of Statistics, and the data source is authentic and reliable. It mainly collects data from civil affairs departments, including data on social work in China's ethnic minority areas in 2018, as well as economic data and population data in recent years. Using R language software, the raw data is processed by fuzzy calculation, which reduces the complexity of the data to better perform hierarchical analysis. After the fuzzy calculation and before the analytic hierarchy process, the correlation degree is determined by the gray correlation analysis, so that the criterion layer and the scheme layer in the analytic hierarchy are weighted.

#### 3.2 Definition of Indicators

(1) Civil fund input Index is calculated by the fuzzy computing of the ratio of social welfare expenditure and social assistance expenditure as follows:

Social welfare expenditure ratio = total annual social welfare expenditure in the district / GDP of the previous year in the district

(2) Social assistance expenditure ratio = total annual social assistance expenditure in the district / GDP of the previous year in the district

Protection coverage index is calculated by the fuzzy computing of old-age care coverage and child adoption

service coverage:

Old people's pension service coverage rate = elderly care service bed in the district / total number of elderly people in the district

Child adoption rescue coverage = child adoption rescue service bed in this district / total children in the district

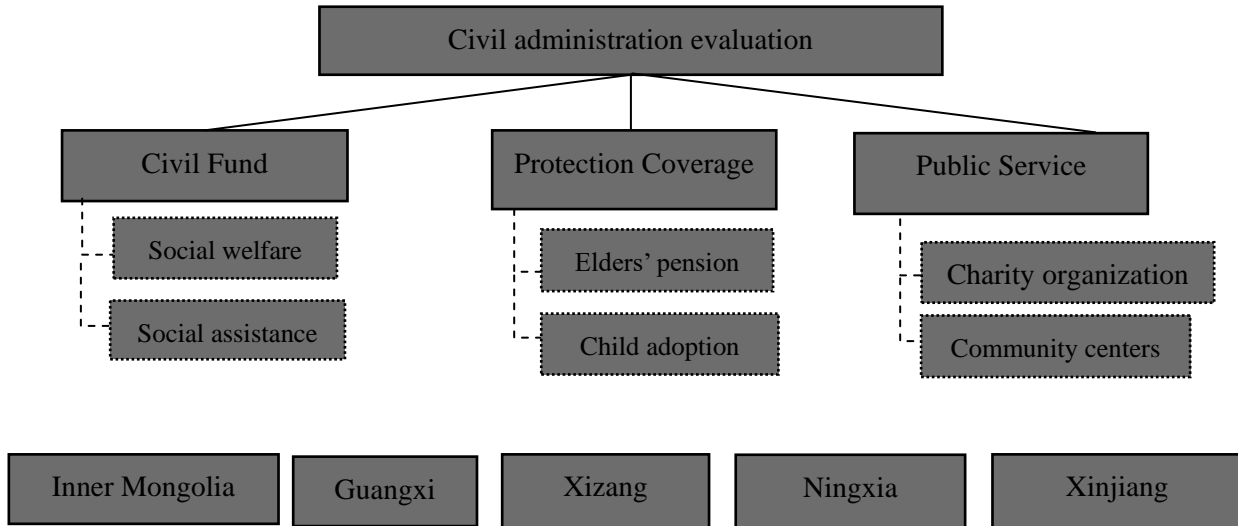
(3) Public service index is calculated by the ratio of charitable charity and community service centers as follows:

Charity of organizations = number of charities in the district / number of aging households in the district

Community service center ratio = number of community service centers in the district / number of aging households in the district

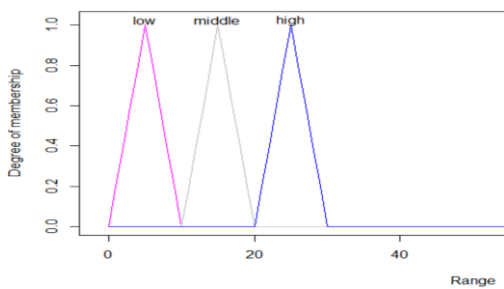
**3.3 Model Establishment**

According to the theory of analytic hierarchy process, the analytic hierarchy evaluation model of fuzzy grey relation is constructed, as shown in **Figure 1**.



**Fig 1.Model based on fuzzy-GRA-AHP**

Take civil fund index as example, the following **Figure 2** shows how the data is calculated by fuzzy computing. The figure of the result is also shown below.



**Fig 2.Screenshot of triangle fuzzy computing process**

```
> evalFIS(data, FIS)
Setting number of points to 101
[ ,1]
[1,] 24.999978
[2,] 16.040267
[3,] 22.077374
[4,] 23.588626
[5,] 7.157676
```

**Fig 3.Result of fuzzy computing**

In the same way, protection coverage and public service can be calculated by fuzzy computing and the results are recorded in **Table 1**.

**Table 1.Criteria layer data results after fuzzy computing**

Civil Fund B1	Protection Coverage B2	Public Service B3
25	10.03	16.61
16.04	7.07	9.58
22.08	5.27	5.4
23.59	5.61	14.07
7.16	5.25	19.06

Then, still taking the civil fund as an example, the grey relational analysis can be conducted in R console and

the grey relational degree can be obtained. (Figure 4)

```

> aita2=(u+r*v)/(Z2+r*v)
> aita3=(u+r*v)/(Z3+r*v)
> aita4=(u+r*v)/(Z4+r*v)
> r12=mean(aita2)
> r13=mean(aita3)
> r14=mean(aita4)
> r12
[1] 0.8739152
> r13
[1] 0.6425367
> r14
[1] 0.6615891
    
```

Fig 4.Screenshot of grey relational analysis process

The gray correlation analysis is carried out on the three indicators of the criterion layer, and the respective gray

correlation degrees are obtained as follows, as the weight of the criterion layer.

Table 2.Grey relational degree of criteria layer

B1	0.8739152
B2	0.6425367
B3	0.6615891

Based on the gray relational degree obtained above, combined with the theoretical rules of the analytic

hierarchy process, the mutual weight of the criterion layer is calculated, as shown in Table 3.

Table 3.Mutual factor weight

A	B1	B2	B3
B1	1	1.36010161	1.320933492
B2	0.735239186	1	0.971202065
B3	0.757040386	1.029651847	1

For the criterion level B, the contrast factors of the influence of the civil fund index, protection coverage

index, and service organization broad index B3 on the plan layer C are shown in the following tables.

Table 4.Contrast factors of the influence of criteria layer B1 on the plan layer C

B1	C1	C2	C3	C4	C5
C1	1	1.5586	1.1322	1.0598	3.4916
C2	0.6416	1	0.7264	0.6799	2.2402
C3	0.8832	1.3766	1	0.9360	3.0838
C4	0.9436	1.4707	1.0684	1	3.2947
C5	0.2864	0.4464	0.3243	0.3035	1

Table 5.Contrast factors of the influence of criteria layer B2 on the plan layer C

B2	C1	C2	C3	C4	C5
C1	1	1.4187	1.9032	1.7879	1.9105
C2	0.7049	1	1.3416	1.2602	1.3467
C3	0.5254	0.7454	1	0.9394	1.0038
C4	0.5593	0.7935	1.0645	1	1.0686
C5	0.5234	0.7426	0.9962	0.9358	1

Table 6.Contrast factors of the influence of criteria layer B2 on the plan layer C

B3	C1	C2	C3	C4	C5
C1	1	1.7338	3.0759	1.1805	0.8715
C2	0.5768	1	1.7741	0.6809	0.5026
C3	0.3251	0.5637	1	0.3838	0.2833
C4	0.8471	1.4687	2.6056	1	0.7382

C5	1.1475	1.9896	3.5296	1.3547	1
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According to the basic principles and steps of the Analytic Hierarchy Process (AHP), the corresponding

program is written and run, and the calculation results are shown in the figure below.

```

R Console
> w1
[1] 0.4012391 0.2950067 0.3037542
> w21
[1] 0.26632537+0i 0.17086995+0i 0.23522153+0i 0.25130646+0i 0.07627669+0i
> w22
[1] 0.3018378+0i 0.2127613+0i 0.1585901+0i 0.1688228+0i 0.1579880+0i
> w23
[1] 0.25664251+0i 0.14802310+0i 0.08343552+0i 0.21739902+0i 0.29449985+0i
>
> w_sum
      [,1]
[1,] 0.2738606+0i
[2,] 0.1762884+0i
[3,] 0.1665091+0i
[4,] 0.2166737+0i
[5,] 0.1666683+0i
    
```

Fig 5.Screenshot of AHP

The final data analysis results are organized as shown in Table 7.

Table 7.Results of evaluation

Criteria layer		Civil fund	Protection coverage	Public service	Total sort weight
Criteria layer weight		0.4012391	0.2950067	0.3037542	
Scheme layer single sort weight	Inner Mongolia	0.26632537	0.3018378	0.25664251	0.2738606
	Guangxi	0.17086995	0.2127613	0.14802310	0.1762884
	Xizang	0.23522153	0.1585901	0.08343552	0.1665091
	Ningxia	0.25130646	0.1688228	0.21739902	0.2166737
	Xinjiang	0.07627669	0.1579880	0.29449985	0.1666683

It can be seen from the above data that after the analytic hierarchy analysis of the fuzzy gray correlation, the ratio of the weight of the finally calculated criterion layer is about 4:3:3. Based on this weight analysis, it is concluded that among the five minority autonomous regions, the Inner Mongolia Autonomous Region has the highest performance in civil affairs, and is much higher than the other four autonomous regions, followed by Ningxia Hui Autonomous Region, and the third is Guangxi. The Zhuang Autonomous Region is slightly higher than the Xinjiang Uygur Autonomous Region and the Tibet Autonomous Region. The performance of civil affairs in Xinjiang and Tibet is similar.

4. CONCLUSIONS

Through fuzzy calculation and grey relational analysis, the statistical data of five autonomous regions are processed, and the fuzzy grey relational hierarchical analysis model is constructed. The specific analysis and conclusions are as follows.

According to the evaluation, we can find that Inner Mongolia Autonomous Region has a balanced performance among the three indicators. It has good performance in all three aspects, and its civil

government investment and old and young coverage are the highest. The service organization is also second only to Xinjiang. In general, the performance of civil affairs in Inner Mongolia Autonomous Region is the best, and all aspects should be maintained.

On the other hand, although the service organization of Xinjiang Uygur Autonomous Region is the highest among the five autonomous regions, it performs best in this single indicator. However, its overall performance is not ideal, mainly because the performance of civil government funds is poor. Lack of adequate financial support, and the coverage of old and young asylum is also low, so the overall performance of civil affairs is not ideal. It is suggested that the government of the Xinjiang Uygur Autonomous Region should increase the input of civil affairs funds and provide sufficient material conditions for the construction of local civil affairs.

The overall performance of the Tibet Autonomous Region is also not ideal, and the reason is roughly the opposite of the Xinjiang Uygur Autonomous Region. Tibet's civil government funding is among the five autonomous regions, at the upper-middle level, but the service organization's wide-ranging is the lowest, indicating that the civil affairs funds have not been fully utilized, and the service organization's settings are not in place. It is suggested that the management and

supervision of civil affairs funds should be strengthened, the civil affairs funds should be used in practice, the protection of vulnerable groups should be strengthened, social service organizations should be increased, and the coverage of old and young asylum and the extensiveness of service institutions should be improved as much as possible.

Ningxia Hui Autonomous Region and Guangxi Zhuang Autonomous Region have performed well in all three indicators, each with advantages and disadvantages. It is suggested that the two places strengthen their advantages and at the same time target the disadvantages. For example, Guangxi Zhuang Autonomous Region should improve social service facilities. And the construction of institutions, improve the breadth of service organizations, fill in shortcomings, and thus improve the performance of civil affairs work as a whole.

In brief, civil administration is increasingly vital in the society and a scientific evaluation model is similarly important. Therefore, the model based on fuzzy grey relational analytic hierarchy process in this paper can exert positive effect on the improvement of the evaluation of civil administration.

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