

# Research on D&A System Comprehensive Evaluation based on AHP and Fuzzy Comprehensive Evaluation

Ziyu Qu, Yu Yin, Dongtao Tang

Northeast Forestry University, Harbin, Heilongjiang, 150006, China

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## Abstract

In the 21st century, data is an important asset for corporations, and how to effectively manage and analyze data has become a difficult problem for corporations. First, we built multiple indicators of personnel, technology and process based on the company's requirements and related information, and established a comprehensive indicator system of the maturity level of D&A system. Then, we adopt the model of AHP-fuzzy comprehensive evaluation method. AHP method is used to find the weight vectors of all levels of indicators, and combined with the fuzzy comprehensive evaluation method to measure the maturity level of the current D&A system, but also to measure three indicators.

## Keywords

Analytic Hierarchy Process; Fuzzy Comprehensive Evaluation; D&A System.

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## 1. Introduction

The 21st century is an era of data. The booming artificial intelligence relies on data infrastructure. People share countless amounts of information on the Internet in the form of data. The computing, transmission and other capabilities extended from data processing bring benefits to many enterprises. So data is seen by many companies as a strategic asset. However, complete and valuable data is often difficult to obtain due to improper recording and other reasons. Therefore, the enterprise needs to establish a comprehensive data analysis (D&A) system to ensure that it has excellent personnel, high-end technology and clear process to collect, manage, use and protect data, making it a valuable asset of the enterprise.

## 2. D&A System Evaluation Model based on AHP

D&A system is mainly composed of three structures: personnel, technology and process. In the actual operation of the system, the superiority of each structure and function should be considered.

### a) Degree of personnel success ( $B_1$ )

According to ICM's requirements for staff in the data analysis system, combined with previous scholars' setting of talent assessment and evaluation models in the enterprise, [1] talents in the D&A system must have the professional ability to master data and a positive learning attitude, pay attention to their own performance and be able to work in a team. Therefore, the professional skill level, learning attitude, job complete rate and quality, and the degree of team integration of employees are selected as the indicators to measure outstanding personnel.

### b) Degree of Technical success ( $B_2$ )

Instead of choosing software directly, ICM pays more attention to the characteristics that technical software should have. According to the basic functional information required by data analysis software and the setting of previous scholars' evaluation model for technical effectiveness, [2] the technology used in D&A system should have basic data processing functions, while maintaining

stability for long-term use, and be innovative to continuously improve and improve itself. The suitability of technology in the work environment and its cost are also issues that need to be paid attention to in reality. Therefore, technical practicability, stability, innovation and technical compatibility, and cost are selected as the measurement indexes of technology.

c) Degree of process success ( $B_3$ )

Good governance programs aim to provide oversight of data resources, track and approve access to and changes to data, and provide metadata consistency across the organization. The purpose of the process setting in the corporation's D&A system is to supervise and ensure that every part of the data of the port corporation's operation can be recorded in time, so as to realize the sharing and connection between the data for management and analysis. The success or failure of process setting is reflected in the results of data governance, including the integrity of data records, the timeliness of data processing, the security of data protection, the convenience of data circulation and the logic of data association. [3] Use these metrics to measure whether the processes you design are working.

To sum up, the consulting team extracted several indicators sets that could reflect the maturity level of D&A system. After preliminary preparation, the graded index system is shown in the Figure 1:

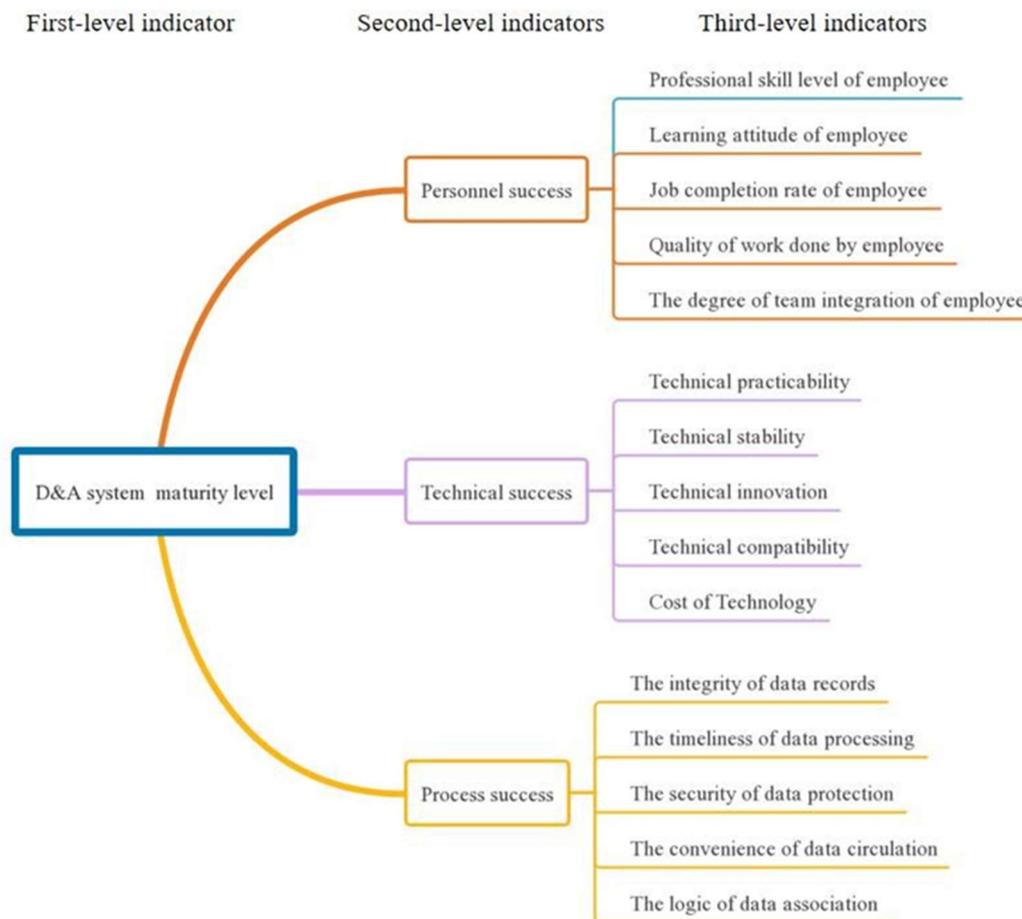


Figure 1. Indicator system diagram

According to the comprehensive indicator system constructed above, the Analytic Hierarchy Process (AHP) was used to rank the relative importance of each indicator at each layer, and the relative weight of each indicator was obtained. MATLAB software was used for weight calculation, and consistency test was carried out.

After the weight is calculated, the fuzzy comprehensive evaluation method is adopted as follows:

Step 1: Determine the set of judgments. The evaluation results of each indicator shall be graded at five levels, namely, “Excellent, Good, General, Bad and Terrible”.

Step 2: Determine membership. Several D&A system research experts were invited to give scores on various indicators of the D&A system. For example, there are 10 experts scoring the calculation results of 1 indicator according to the grade. Among the 10 experts, 4 think excellent, 3 think Good, 1 think General, 1 think Bad and 1 think Terrible. Then the corresponding membership degree of this index is 0.4,0.3,0.1,0.1 and 0.1 respectively, and the corresponding fuzzy membership matrix is [0.4, 0.3, 0.1 , 0.1, 0.1].

Step 3: Determine the membership matrix. The membership matrix is obtained by synthesizing the membership degree of the lowest indicators.

$$R_i = \begin{bmatrix} r_{11} & \cdots & r_{1m} \\ \vdots & \ddots & \vdots \\ r_{n1} & \cdots & r_{nm} \end{bmatrix} \quad (1)$$

Step 4: Single factor evaluation was performed. the following formula is adopted:

$$B_i = W_i \times R_i \quad (2)$$

In Eq.2,  $B_i$  is the first order evaluation matrix of the indicator  $i$  in the second-level index layer  $B$ .  $W_i$  is the weight vector of third-level indicator layer  $C$ .  $R_i$  is the membership matrix of the third-level indicator layer  $C$ .

Step 5: Carry out a multi-factor comprehensive evaluation. The comprehensive fuzzy evaluation matrix is:

$$R = [B_1 \quad B_2 \quad B_3 \quad \cdots \quad B_i]^T \quad (3)$$

Calculate according to the following formula:

$$A = D_i \times R \quad (4)$$

In Eq.4,  $R$  is the comprehensive evaluation matrix, and  $D_i$  is the weight vector of the second-level index layer  $B$ .

According to the principle of maximum membership degree, the second order evaluation matrix  $A$  is analyzed and the evaluation result is obtained. [4].

### 3. Model Solving

Through the collection of experts' opinions, [5][6] the query of historical data and the requirements of the company, the relevant information of the matrix can be obtained to help us build an AHP-fuzzy comprehensive evaluation model for the maturity level of your company's D&A system.

It is convenient to determine the weight of each index of the system evaluation, compare the importance of the indicators through the research data of previous scholars, and construct the judgment matrix. MATLAB software is used to calculate. After the matrix passes the consistency test, the weights of indicators at different levels are calculated, and the results are shown in the Table 1.

**Table 1.** Weight coefficient of each index

1 <sup>st</sup> -Level	2 <sup>nd</sup> -Level	Weight	3 <sup>rd</sup> -Level	Weight	CR
D&A system maturity level (A)	$B_1$	0.7306	$C_1$	0.5041	0.0732
			$C_2$	0.0398	
			$C_3$	0.2549	
			$C_4$	0.1349	
			$C_5$	0.0664	
	$B_2$	0.1884	$C_6$	0.5128	0.0530
			$C_7$	0.2615	
			$C_8$	0.1290	
			$C_9$	0.0634	
			$C_{10}$	0.0333	
	$B_3$	0.0810	$C_{11}$	0.5061	0.0579
			$C_{12}$	0.1321	
			$C_{13}$	0.0669	
			$C_{14}$	0.2602	
			$C_{15}$	0.0348	

Taking D&A system of ICM as the object of investigation, the results of fuzzy comprehensive evaluation can be obtained by referring to the degree to which leaders attach importance to indicators and combining the relevant information queried.

**Table 2.** Index membership degree

Indicators	Excellent	Good	General	Bad	Terrible
$C_1$	0.15	0.32	0.45	0.05	0.03
$C_2$	0.06	0.30	0.54	0.10	0.00
$C_3$	0.10	0.35	0.35	0.12	0.08
$C_4$	0.48	0.32	0.09	0.02	0.09
$C_5$	0.33	0.26	0.21	0.20	0.00
$C_6$	0.12	0.33	0.26	0.19	0.10
$C_7$	0.21	0.23	0.32	0.24	0.00
$C_8$	0.27	0.23	0.39	0.08	0.03
$C_9$	0.11	0.27	0.39	0.16	0.07
$C_{10}$	0.34	0.23	0.26	0.12	0.05
$C_{11}$	0.18	0.24	0.42	0.12	0.04
$C_{12}$	0.09	0.37	0.48	0.06	0.05
$C_{13}$	0.19	0.28	0.35	0.12	0.06
$C_{14}$	0.26	0.29	0.42	0.04	0.00
$C_{15}$	0.22	0.32	0.31	0.13	0.02

According to the algorithm, the result can be obtained:

$$B_1 = W_1 \times R_1 = [0.1902 \quad 0.3229 \quad 0.3636 \quad 0.0758 \quad 0.0477] \quad (5)$$

$$B_2 = W_2 \times R_2 = [0.1696 \quad 0.2838 \quad 0.3007 \quad 0.1847 \quad 0.0613] \quad (6)$$

$$B_3 = W_3 \times R_3 = [0.2406 \quad 0.3478 \quad 0.4893 \quad 0.1209 \quad 0.0361] \quad (7)$$

According to the principle of maximum membership degree, the success degree of the three indicators of personnel, technology and process is analyzed. The maximum membership degree of  $B_1, B_2$  and  $B_3$  are all below the General level, which means that the success degree of personnel, technology and process is all at the general level.

$$R = \begin{bmatrix} 0.1902 & 0.3229 & 0.3636 & 0.0758 & 0.0477 \\ 0.1696 & 0.2838 & 0.3007 & 0.1847 & 0.0613 \\ 0.2406 & 0.3478 & 0.4893 & 0.1209 & 0.0361 \end{bmatrix} \quad (8)$$

The matrix R is multiplied by the weight matrix D to obtain the fuzzy comprehensive evaluation matrix:

$$A = [0.1904 \quad 0.3176 \quad 0.3620 \quad 0.0999 \quad 0.0493] \quad (9)$$

According to the principle of maximum membership degree, the maximum value is 0.3620, corresponding to the "General" in the evaluation level, then the maturity level of the company's D&A system is general, and there is still room for optimization.

## 4. Conclusion

In conclusion, there are various effective indicators to measure the maturity level of ICM's D&A system from the aspects of personnel, technology and process. According to the measurement of the model, the corporation's D&A is not yet fully mature and there is still room for optimization.

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