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Research on Evaluation of a Scientific Institution Internal Control Based on Hierarchical Correlation Degree Method

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Abstract: ***Carrying out the construction of internal controls will help scientific research institutes to guarantee the smooth progress of research activities and regulations of operation. The internal control system was analyzed from the four aspects of risk assessment, internal control at the unit level, internal control at the business level, evaluation and supervision, and evaluation indicators were constructed. Using the hierarchical correlation method, the internal control status of one research institute has been assessed. The correlation coefficient, the weight of the factor, and the weight of the correlation coefficient were calculated respectively, and a comprehensive evaluation was conducted. The evaluation results show that the self-evaluation of internal control and the compilation of internal control reports have greatly promoted the construction of internal control of research institutions. However, there is still room for improvement in risk assessment, the construction of internal auditing mechanisms, and the internal control information systems.***

Keywords: Research institution; Internal Control; Hierarchical Correlation; Evaluation; System.

I. INTRODUCTION

Internal control is an effective means and guarantee mechanism for the legal compliance operation of scientific research undertakings, safe and effective use of assets, true and complete financial information, prevention of corruption, and improvement of the efficiency and effectiveness of public services. In 2012, the Ministry of Finance in Chian issued the "Regulations for Internal Control of Administrative Institutions (Trial)", which regulates the internal control and construction activities of public institutions from the aspects of risk assessment and control methods, internal control at the unit level, internal control at the business level, evaluation and supervision [1]. In 2015, the Ministry of Finance in China proposed the overall goal of internal control construction in 2020 and the goal of completing implementation of internal control by the end of 2016. In 2016, the Ministry of Finance in China initiated the basic evaluation of internal control of administrative institutions and began organizing administrative institutions to compile annual reports on internal control. Institute E, as a scientific research institute and an evaluation object, under the guidance of various systems and requirements of the Ministry of Finance in China, has established a unit's internal control system, sorted out business processes, conducted internal control self-evaluation, and prepared annual internal control reports.

In order to objectively reflect the improvement of the internal control system after the internal control self-assessment and the compilation of the internal control report of institute E, this paper uses the hierarchical correlation method to determine the weights of the E-institute's internal control evaluation factors and evaluate the internal control self-assessment of each factor. Comprehensive assessment of the situation before and after the preparation of the internal control report is conducted to find out the direction for further improvement, so as to provide reference for the further construction of an internal control system with

consistent powers and responsibilities, effective checks and balances, smooth operation, strong enforcement, and scientific management.

II. Internal Control Evaluation Elements Weight Determination Institute E

The internal control system of Institute E is divided into three levels of assessment indicators. See Table 1 for details.

Table 1 Evaluation factors system for internal control of Institute E

Factor system	First level factor	Second level factor
Evaluation of internal control of institute E	Risk Evaluation	Creating working group
		Frequency of assessment
		Comprehensive content assessment
		Appropriateness of assessment methods
	Unit level internal control	Leadership responsibilities
		Balance of power
		Working Mechanism
		Information system
	Business-level internal control	Budget , Revenue and Expense Control
		Government Procurement and Contract Control
		Research project control
		Basic construction and asset control
	Evaluation supervision	Internal audit
		Self-evaluation of internal control

The Analytic Hierarchy Process is used to construct the evaluation factor judgment matrix. According to the operation of the internal control system of Institute E and the expert survey questionnaire, the weights of various factors of the internal control system of Institute E were determined [2]. It is shown in table 2.

Table 2 Weighting table of factors for internal control system of Institute E

First level factor	Second level factor	weight	First level factor	Second level factor	weight
Risk Evaluation 0.21	Creating working group	0.27	Business-level internal control 0.37	Budget , Revenue and Expense Control	0.32
	Frequency of assessment	0.16		Government Procurement and Contract Control	0.16
	Comprehensive content assessment	0.25		Research project control	0.25
	Appropriateness of assessment methods	0.32		Basic construction and asset control	0.27
Unit level internal control 0.24	Leadership responsibilities	0.18	Evaluation supervision 0.18	Internal audit	0.70
	Balance of power	0.35		Self-evaluation of internal control	0.30
	Working Mechanism	0.27			
	Information system	0.20			

III. Internal Control Construction Evaluation of Institute E

A. *Evaluation procedure*

The factors involved in the construction of the internal control of Institute E are relatively complicated. Considering comprehensively, choose the hierarchical correlation coefficient algorithm [3], calculate the correlation coefficient and the system function evaluation change value, and then evaluate the improvement status of internal control construction of institute E [4-5]. The internal control construction evaluation factors of institute E refer to Table 1.

(1) Creating evaluation status

There are several elements related to the evaluation of the internal control of Institute E. The assessment status of each element is:

$$Y^{(i)} = \{Y^{(i)}(1), Y^{(i)}(2), \cdots, Y^{(i)}(N)\} \ (i = 0,1,2) \quad (1)$$

First status: No Internal control specification. This status mainly relies on E Institute's own internal management system, self-regulation and restoration. This status is recorded as:

$$Y^{(0)} = \{Y^{(0)}(1), Y^{(0)}(2), \cdots, Y^{(0)}(N)\} \quad (2)$$

Second status: Internal control specification, but no self-evaluation. This status refers to the establishment of internal control standards, but there is no state of self-evaluation, self-improvement of internal control. This status is recorded as:

$$Y^{(1)} = \{Y^{(1)}(1), Y^{(1)}(2), \cdots, Y^{(1)}(N)\} \quad (3)$$

Third status: self-evaluation. In this status, research institute E found out the weaknesses in the internal control system by combing the rules and regulations and business processes, and then improved the system of powers and responsibilities to optimize the status of the internal control operation mechanism. This state helps to improve the efficiency of internal control and improve management capabilities. It is recorded as:

$$Y^{(2)} = \{Y^{(2)}(1), Y^{(2)}(2), \cdots, Y^{(2)}(N)\} \quad (4)$$

(2) Calculate the correlation weight of each assessment factor of internal control construction of Institute E

According to the Analytic Hierarchy Process (AHP), the weights of the evaluation indicators and evaluation factors of the internal control construction of the E Institute are determined. Refer to Table 2.

The associated weight of each sub-element is the product of the weight of the second-level factor and the weight of the corresponding first-level factor.

(3) Evaluation Factor Correlation Coefficient of Institute E Internal Control Construction

The correlation coefficient $k(k = 0,1,2\cdots, N)$ between institute E Internal Control evaluation status $Y^{(i)}(i = 0,1,2)$ and e valuation status $Y^{(0)}$ is $\zeta_i(k)$:

$$\zeta_i(k_i) = \frac{\Delta_m Y + \rho\Delta_M Y}{\Delta Y^{(i)}(k) + \rho\Delta_M Y} = \frac{\min\limits_k \left|Y^{(i)}(k) - Y^{(0)}(k)\right| + \rho \max\limits_k \left|Y^{(i)}(k) - Y^{(0)}(k)\right|}{\left|Y^{(i)}(k) - Y^{(0)}(k)\right| + \rho \max\limits_k \left|Y^{(i)}(k) - Y^{(0)}(k)\right|} \quad (5)$$

In the formula, $\zeta_i(k)$ is the correlation between $Y^{(i)}$ and $Y^{(0)}$, and ρ is the resolution coefficient, $0 < \rho \le 1$, usually, ρ takes 0.5.

(4) Calculate correlation degree values

The correlation degree between evaluation status $Y^{(i)}(i = 0,1,2)$ and $Y^{(0)}$ of institute E is H_i.

$$H_i = \sum_{k=1}^{N} W(k_i)\zeta_i(k)(i = 1,2) \quad (6)$$

(5) System comprehensive evaluation

A comprehensive assessment of the internal control of Institute E will be conducted to assess the status of each of the three conditions: good, bad, and unchanged. The degree of change is:

$$B = \left|\frac{H_{20} - H_{10}}{1 - H_{10}} \times 100\%\right| \quad (7)$$

B. Analysis and Evaluation of Internal Control Construction of the Institute E

On the basis of a comprehensive analysis of various types of status, combined with an expert questionnaire to give assessment scores, the score range is 0 to 100 points, and the assessment status is divided into four levels, respectively, good (80 to 100 points), better (60-80 points), general (40-60 points), and poor (0-40 points). The higher the score, the better the factor state, and vice versa. [2] According to the evaluation status score, calculate the correlation coefficient, $\zeta_{10}(k)$, $\zeta_{20}(k)$, the weight of the association factor W_k, and the weighting correlation coefficient H_1 and H_2. Refer to Table 3 for the specific calculation results.

Table 3 Correlation coefficient table for evaluation elements of internal control system of Institute E

Evaluation factor		Evaluation status			Correlation coefficient of evaluation element				
		No Internal control specification	Internal control specification, but no self-evaluation	self-evaluation	Correlation coefficient	Correlation coefficient	Correlation weight of element	Weight of Correlation coefficient	Correlation coefficient
		$Y^{(0)}(k)$	$Y^{(1)}(k)$	$Y^{(2)}(k)$	$\zeta_{10}(k)$	$\zeta_{20}(k)$	W_k	$W(k)\zeta_{10}(k)$	$W(k)\zeta_{20}(k)$
Risk Evaluation	Creating working group	0	0	60	1.0000	0.6667	0.0567	0.0567	0.0378
	Frequency of assessment	0	0	60	1.0000	0.6667	0.0336	0.0336	0.0224
	Comprehensive content assessment	20	30	70	0.3333	0.7500	0.0525	0.0175	0.0394
	Appropriateness of assessment methods	50	60	80	0.3333	1.0000	0.0672	0.0224	0.0672
Unit level internal control	Leadership responsibilities	60	70	75	0.3333	1.0000	0.0432	0.0144	0.0432
	Balance of power	50	60	70	0.3333	0.8461	0.084	0.0280	0.0711
	Working Mechanism	50	50	70	1.0000	0.8461	0.0648	0.0648	0.0548
	Information system	40	40	65	1.0000	0.7333	0.048	0.0480	0.0352
Business-level internal control	Budget , Revenue and Expense Control	70	**77**	85	0.8333	0.8000	0.1184	0.0987	0.0947
	Government Procurement and Contract Control	55	60	75	1.0000	0.6667	0.0592	0.0592	0.0395
	Research project control	70	**80**	85	0.6667	0.8000	0.0925	0.0617	0.0740
	Basic construction and asset control	70	75	80	1.0000	1.0000	0.0999	0.0999	0.0999
Evaluation supervision	Internal audit	40	50	65	0.3333	1.0000	0.1260	0.0420	0.1260
	Self-evaluation of internal control	0	0	60	1.0000	0.6111	0.0540	0.0540	0.0330

According formula (7), calculate correlation degree between evaluation status $Y^{(i)}(i=0,1,2)$ and $Y^{(0)}$, and find the comprehensive assessment status of internal control of institute E.

$$H_1 = \sum_{k=1}^{14} W_k\zeta_{10}(k) = \mathbf{0.7008}, \quad H_2 = \sum_{k=1}^{14} W_k\zeta_{20}(k) = \mathbf{0.8382}$$

$$B = \left| \frac{H_{20} - H_{10}}{1 - H_{10}} \times 100\% \right| = \left| \frac{0.8382 - 0.7008}{1 - 0.7008} \times 100\% \right| = 45.9\%$$

From the analysis results, after carrying out the internal control self-assessment and report, institute E found the inadequacies of the internal control system, targeted the establishment of a sound system, optimized and implemented the internal control business process. Among them, the internal control risk assessment working group, risk assessment activities, and self-assessment of internal control achieved breakthroughs from scratch. The risk assessment content, methods, focusing on key risk areas, taking into account the frequent risk areas, the qualitative and quantitative assessment methods combined to make the scope and content of the assessment more comprehensive, more scientific and more appropriate. In terms of division of powers, division of posts, establishment of powers, and hierarchical delegation of authority, power balances are further manifested. Coordination and cooperation among various departments and posts also enables the establishment of a smooth internal mechanism. However, the results of the assessment analysis also reflect that there is still room for the improvement of the accuracy of the risk-finding investigation of the internal control risk assessment working group, the supervisory role of internal audit, and the operational support of the information system. Therefore, it is necessary to take further measures in the organization of risk assessment organization operations, the construction of internal auditing mechanisms, and the improvement of internal control information systems, so as to establish effective checks and balances, run smoothly, and implement powerful internal control system services.

IV. Conclusion

This paper uses hierarchical correlation method to assess the internal control construction of a scientific research institute. The conclusions are as follows:

(1) Scientific research institutes should strengthen the construction of internal control to help ensure that the unit's economic operations are legal and legitimate, the assets and interests are safe and complete, the financial information is true and accurate. From the four aspects of risk assessment, internal control at the unit level, internal control at the business level, evaluation and supervision, the analysis of the internal control system and the construction of evaluation indicators can cover all aspects of the internal control system in a comprehensive manner.

(2) Using the correlation coefficient method to carry out the quantitative analysis, the correlation coefficient, the weight of the element of the association, and the weighted correlation coefficient for the self-evaluation status of the internal control report of research institute E is calculated. The self-evaluation and the internal control report status is evaluated. The assessment results show that the self-evaluation of internal control and the compilation of internal control reports have greatly facilitated the construction of internal control. However, there is still room for improvement in the operation of risk assessment organizations, the construction of internal auditing mechanisms, and internal control information systems.

(3) The construction of internal control of scientific institutions cannot be accomplished overnight. It is necessary to follow the law of scientific research, combine the actual operation and management status of the units, and constantly improve internal control so as to better serve the development of scientific research institutions.

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