Research on the Measurement of Internal Control Effectiveness of Government Departments Based on Fuzzy Comprehensive Evaluation Method

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Abstract—Up to now, with the continuous introduction of internal control related systems, it is unknown whether the internal control system of government departments is standardized and effective. Therefore, from the perspective of urban business environment, this paper constructs the internal control framework system from the five elements of internal control, on this basis, the fuzzy comprehensive evaluation method is used to determine the weight of internal control indicators and calculate the comprehensive score of effectiveness, so as to find the weak links in the internal control process of administrative departments, take corresponding improvement measures to improve the effectiveness of departmental internal control and enhance the ability of standardized operation of administrative departments.

Keywords-business environment; administrative unit; effectiveness of internal control

1 Introduction

The code for internal control of administrative institutions (Trial) issued in November 2012 requires all administrative institutions to formulate and implement effective internal control systems according to the specific conditions of the unit, and requires corresponding personnel to measure the effectiveness level of their internal control to ensure whether the internal control is effective. In order to better adapt to the development of urban business environment, building a self-evaluation system with standardized operation, eliminating fraud and strong supervision is particularly important for testing the administrative efficiency of government departments, people's satisfaction and enhancing the urban business environment index. Therefore, it is necessary to adopt reasonable and effective measurement methods to evaluate the effectiveness of the internal control system of relevant units.

2 Research status of internal control evaluation of administrative institutions and introduction of business environment

2.1 Overview of the development of internal control evaluation and existing problems

Internal control evaluation is the development process from external independent audit to self-evaluation. In the traditional external audit, external auditors mainly check the approval procedures of relevant departments, and their evaluation often contradicts the authenticity of financial reports. In addition, external auditors can not really understand the actual situation of the unit, and the appropriateness of evaluation results is difficult to guarantee. Dong Xiaohong (2008) believes that internal control evaluation should be a special discussion conducted by the internal management and its staff of government departments, mainly from the five aspects of the Department's internal environment, risk assessment, control activities, information and communication and internal supervision [1].

At present, many scholars actively explore the evaluation methods of internal control effectiveness. Chen Hanwen (2008) believes that the basic evaluation method and detailed evaluation method are the main methods for internal control effectiveness evaluation [2]. Li Ding'an (2007) pointed out that the effectiveness evaluation of internal control in China lacks quantitative research at this stage, which is a major disadvantage of internal control evaluation. Luo Liangbin (2008) explored the mapping process of internal control evaluation from qualitative to quantitative, by applying expert scoring method and establishing fuzzy comprehensive evaluation model, using a combination of qualitative and quantitative methods to evaluate the internal control of government departments (Chen Yan, 2015), to make up Insufficient in this regard [3].

2.2 Setting of internal control goals in the urban business environment

The key to investigating the effectiveness of government departments' internal control is to clarify the government's internal control goals. Some researchers believe that whether the government's ruling behavior is standardized and whether the allocation of available resources is reasonable is the core concern of the internal control of government departments (Liu Yuting, 2008). For government departments that master a large number of social public resources and public funds, effective internal control is the first line of defense to ensure the effective use of state-owned assets and strengthen anti-corruption risk prevention and control (Wang Guangyuan, 2009). In terms of building an internal control evaluation system guided by the realization of internal control objectives, liu Yongze (2012) believes that the internal control evaluation system of government departments should include such as internal environment, risk assessment, control activities, information communication and supervision [4]. At present, most scholars in China focus on the process construction of internal control of government departments, ignoring that maximizing the efficiency of government departments is not to maximize the operating benefits, but to improve their public service ability and public satisfaction (Liu Yongze, 2013). At the same time, it also reflects the quality of the business environment in the city to a certain extent (Lou Chengwu, 2018). Therefore, we should take improving the urban business environment as the goal orientation and build an internal control system from the perspective of business environment, so as to evaluate the effectiveness of internal control of government departments.

3 Index system for measuring the effectiveness of internal control in administrative institutions

3.1 Construction principle

3.1.1 Comprehensive construction principle

As a public service department, administrative institutions involve many and complex contents. The established internal control evaluation system should run through the whole process of decision-making, implementation and supervision of economic activities, so as to realize the comprehensive control of economic activities and business processes.

3.1.2 Principle of focused evaluation

Different from other profit-making units, administrative institutions need to evaluate the efficiency of their business activities by evaluating the coverage of their public services and public satisfaction. Therefore, from the perspective of urban business environment, we should grasp the key elements affecting internal control activities and select the most representative indicators.

3.1.3 Principle of effectiveness

The administrative department shall establish an internal control evaluation system suitable for the unit according to the actual needs of the unit. Sort out the business processes of various departments within the unit, and clarify the process links. According to the actual needs of each department, establish a reasonable, effective, scientific and implementable evaluation index system.

3.1.4 The principle of combining qualitative and quantitative

In the past, the evaluation of internal control mainly focused on qualitative evaluation. With the increase of related research, more and more scholars adopt a combination of qualitative and quantitative methods when evaluating the effectiveness of internal control. By calculating the indicators of the internal control system, a specific value is obtained, which makes the results more accurate, and also provides a set of scientific and feasible methods for the evaluation of the effectiveness of internal control.

3.1.5 Specific measurement index system

For administrative institutions, setting up an internal control index system with the goal of improving the efficiency of public services and accelerating urban construction is the focus of evaluating the effectiveness of internal control of administrative departments. Building an index system according to the current situation of internal control of administrative departments in China is the basis for effectiveness evaluation (Zhang Qinglong, 2012). Therefore, from the perspective of urban business environment, this paper will select the most representative index elements for measurement from the level of five elements of internal control. The index system is listed in the form of three-level indicators, the first level indicators are control environment, risk assessment, control activities, information communication, supervision and evaluation. Each primary indicator can be divided into several sub indicators for elaboration. Therefore, the

evaluation system of internal control effectiveness of administrative institutions is shown in Table 1:

Table 1 Construction of internal control effectiveness index system of administrative departments

Target layer	Primary index	Secondary index	Tertiary indicators
Index system (Y)	Control environment (Y1)	management philosophy (Y11)	1. The Department should pay attention to the implementation of internal control; 2. Establish good communication channels both inside and outside the unit; 3. Pay attention to risk prevention
		Administrative department culture (Y12)	1. Whether they have a sense of departmental or social responsibility; 2. Is there cultural system construction
		organization structure (Y13)	1. Whether the employees are clear about the establishment of departments at all levels and have a clear distribution of rights and responsibilities; 2. Whether there is an audit department, Party Committee inspection or internal audit department within the unit; 3. Is the system constructed at all levels scientific and standardized
		human resources (Y14)	1. Whether there is a clear human resources policy and the requirements for the required talents; 2. Whether there is a scientific and standardized process for clearly introducing talents and dismissing employees; 3. Whether there is a clear salary, performance, promotion and punishment system; 4. Is there a clear talent training plan
		internal auditing (Y15)	1. Establish an internal audit department within the unit; 2. Supporting its own internal audit standards; 3. Implement a top-down integrated internal audit system
		Allocation of rights and responsibilities (Y16)	1. Whether the rights and responsibilities of organizations at all levels within the unit are allocated; 2. Whether the post responsibility system of each department is implemented to individuals; 3. All departments shall implement the system of decision-making and service investigation
	risk assessment (Y2)	Goal setting (Y21)	1. Whether the objectives of each department of the unit are consistent with the objectives of the unit; 2. Whether the unit's power operation is legal and compliant; 3. Whether there are risks in unit resource allocation; 4. Is there any risk under the use efficiency of unit funds
		Risk identification (Y22)	1. Whether the internal risk point control of the unit is reasonable and effective; 2. Whether uncontrollable post risks are comprehensively investigated within the unit; 3. Does the unit implement risk point pre control and timely improvement measures
		Risk handling (Y23)	1. Whether the unit has handled the abnormal situation timely and properly; 2. Establish accountability system

		Business process approval control (Y31)	1. Whether the authority and affairs management of the unit are standardized, rapid and effective; 2. The unit shall clarify the business authorization approval procedures and hierarchical authorization mechanism
	Control activities (Y3)	Incompatible post separatio (Y32)	1. The business clerks of the unit are separated from the accounting records personnel; 2. Separation of business handling and audit; 3. Separation of authorization and approval from business handling
		Unit asset management (Y33)	1.Implement the unit asset registration management to the individual; 2. Check the physical assets regularly. 3. The fund control of the company shall be strictly approved; 4. The company seal cannot be managed by one person
		accounting management (Y34)	1. Whether the budget preparation and approval are standardized and reasonable, and establish the budget preparation system and budget responsibility system; 2. Whether the final accounts are true and accurate, and establish the final accounts evaluation mechanism; 3. Revenue and expenditure business control shall be legal and compliant; 4. The procurement management of the unit shall strictly implement relevant procedures and keep relevant files
		contract management (Y35)	1. Implement centralized contract management and clarify the post responsibilities of managers; 2. Regularly monitor the performance of the contract; 3. Set up a special team to solve disputes
	Information communication (Y4)	Information system management (Y41)	1. Scientific and effective management of internal and external information systems and establishment of information communication mechanism; 2. Information system security control and implementation of internal information disclosure system; 3. Pay attention to the management and regular maintenance of the internal financial and accounting information system of the unit
		Establish an effective mechanism of mutual assistance (Y42)	1. Anti fraud mechanism and set up a confidential complaint window; 2. Establish procedures for handling and reviewing fraud cases, strictly ensure the authenticity of information and improve the efficiency of serving the people
	Supervision and evaluation (Y5)	Supervision mechanism (Y51)	1. The unit shall establish a supervision organization; 2. Formulate supervision specifications
		Evaluation mechanism (Y52)	1. Each department shall implement the self-assessment mechanism and issue corresponding reports; 2. Establish a perfect and effective internal control evaluation system; 3. Regularly inspect whether the internal control system is comprehensive, reasonable and effective
		Accountability mechanism (Y53)	1. Establish a supervision and audit system; 2. Establish a balanced assessment system of performance and accountability; 3. Establish a fair and transparent accountability mechanism

4 Application of measurement method of internal control effectiveness in administrative institutions

4.1 Principle of fuzzy comprehensive evaluation method

The fuzzy comprehensive evaluation method can solve the problems restricted by many factors and make a comprehensive evaluation. According to the membership theory of fuzzy mathematics, the problems that are difficult to solve, fuzzy and difficult to quantify are transformed into quantitative evaluation through qualitative evaluation. The measurement range of internal control effectiveness of administrative departments is wide, and there are many factors that are not easy to quantify. The basic steps of constructing the internal control effectiveness evaluation model of public institutions based on fuzzy comprehensive evaluation method are as follows [5].

4.1.1 Calculate comparison matrix

Based on the nine level scaling method and expert opinions, a comparison matrix A is constructed (1):

$$A = \begin{vmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{vmatrix} = \begin{vmatrix} \dfrac{X_1}{X_1} & \dfrac{X_1}{X_2} & \cdots & \dfrac{X_1}{X_n} \\ \dfrac{X_2}{X_1} & \dfrac{X_2}{X_2} & \cdots & \dfrac{X_2}{X_n} \\ \vdots & \vdots & \ddots & \vdots \\ \dfrac{X_n}{X_1} & \dfrac{X_n}{X_2} & \cdots & \dfrac{X_n}{X_n} \end{vmatrix} \tag{1}$$

Where: a_{ij} $(i, j \in n)$ represents the comparison result of the ith index and the jth index based on the comparison scale.

4.1.2 Calculate scale index

The comparison results of the importance of the ith evaluation index of the index layer to an element in the criterion layer are obtained. Multiply the comparison results to the nth power root, where n is the order, that is, the number of indicators at each level (2).

$$u_i = \sqrt[N]{\prod_{j=1}^{n} a_{ij}} \tag{2}$$

4.1.3 Calculate index weight

The scaling exponent obtained above is substituted into this equation to calculate the exponential weight. (3)

$$W_i = \frac{U_i}{\sum\limits_{i=\mathrm{x}}^{\mathrm{X}} U_i} \tag{3}$$

Thus, the index weight vector is obtained (4):

$$\mathbf{W} = \{\mathrm{w}_1, \quad \mathrm{w}_2, \cdots, \quad \mathrm{w}_m\} \tag{4}$$

4.1.4 Establish the comment set and calculate the evaluation matrix R

The comment set refers to the evaluation grade of each factor involved in the evaluation object. After the evaluation grade is given, n experts in the research field are invited to score m indicators, so as to obtain the original data matrix (5).

$$\mathbf{R} = (\mathrm{y}_{ij})_{mn} = \begin{vmatrix} \mathrm{y}_{11} & \cdots & \mathrm{y}_{1n} \\ \vdots & \vdots & \vdots \\ \mathrm{y}_{m1} & \cdots & \mathrm{y}_{mn} \end{vmatrix}_{mn} \tag{5}$$

Where: yij refers to the scoring of the i-th index by the j-th expert.

4.1.5 Fuzzy comprehensive evaluation

After obtaining the evaluation matrix, the fuzzy evaluation set can be calculated (6):

$$\mathbf{A} = \mathbf{WR} = (\mathrm{l}_{i1}, \quad \mathrm{l}_{i2}, \cdots, \quad \mathrm{l}_{in}) \tag{6}$$

According to formula (6), the fuzzy evaluation set can be obtained (7).

$$\mathrm{M} = \mathrm{WM}_j^{\mathrm{T}} \tag{7}$$

4.2 Examples

4.2.1 Determine the set of evaluation factors for the effectiveness of internal control in administrative institutions

Determine the set of internal control effectiveness evaluation factors of administrative institutions under the urban business environment. According to the internal controle ffectiveness evaluation system of administrative institutions established above, the set of internal control effectiveness evaluation factors of administrative institutions is obtained, as shown in Table 2:

Table 2 Set of internal control effectiveness evaluation factors

Target layer	Primary index	Secondary index
Index system (Y)	Control environment (Y1)	management philosophy (Y11)
		Administrative department culture (Y12)
		organization structure (Y13)
		human resources (Y14)
		internal auditing (Y15)
		Allocation of rights and responsibilities (Y16)
	risk assessment (Y2)	Goal setting (Y21)
		Risk identification (Y22)
		Risk handling (Y23)
	Control activities (Y3)	Business process approval control (Y31)
		Incompatible post separatio (Y32)
		Unit asset management (Y33)
		accounting management (Y34)
		contract management (Y35)
	Information communication (Y4)	Information system management (Y41)
		Establish an effective mechanism of mutual assistance (Y42)
	Supervision and evaluation (Y5)	Supervision mechanism (Y51)
		Evaluation mechanism (Y52)
		Accountability mechanism (Y53)

4.2.2 Build comparison matrix

The nine level scaling method is introduced to construct the judgment matrix, and the definition of comparison scale is shown in Table 3.

Table 3 Comparison scale definition

Standard value	definition
1	Xi compared with XJ, one is more important than the other
3	Xi is slightly more important than XJ
5	Xi is obviously more important than XJ
7	Xi compared with XJ, one is more important than the other
9	Xi compared with XJ, one is more important than the other

4.2.3 Building weight sets

The weight calculation formula is (8):

$$W_i = \frac{U_i}{\sum_{i=X}^{X} U_i} \qquad (8)$$

Where u is the nth power root of the product of the scale value of each row, and N is the order.

From equations (1) to (3), the weight calculation results of level I indicators for internal control effectiveness evaluation of administrative institutions can be obtained, as shown in Table 4:

Table 4 Index weight index calculation results

	Y1	Y2	Y3	Y4	Y5	U	W
Y1	1	4	2	2	3	2.1689	0.35
Y2	1/4	1	1/6	1/4	1/2	0.3494	0.06
Y3	1/2	6	1	2	4	1.8882	0.31
Y4	1/2	4	1/2	1	2	1.1487	0.19
Y5	1/3	2	1/4	1/2	1	0.6084	0.10

Similarly, use the same calculation method to calculate the weight set of secondary indicators from equation (4), as follows:

W=[0.35   0.06   0.31   0.19   0.10]

W1=[0.07   0.05   0.18   0.26   0.32   0.13]

W2=[0.30 0.16 0.54]

W3=[0.23 0.14 0.36 0.19 0.07]

W4=[0.67 0.34]

W5=[0.54 0.16 0.30]

4.2.4 Determine the evaluation comment set of the effectiveness of the internal control of the administrative department.

In this paper, the measurement comment set is set as:

B = {very effective, relatively effective, basically effective, generally effective, not effective enough, completely invalid} = {100, 80, 60, 40, 20, 0}

4.2.5 Based on the nine level scaling method, the measure matrix is constructed.

Ten experts in the field of internal control research familiar with the Department are invited to score the 19 indicators of the index system. The scoring matrix is obtained from equation (5), as shown in Table 5. Because this paper is calculated from the perspective of business environment, more attention is paid to the review and supervision of internal control environment, control activities and other process links so as to obtain the original scoring data matrix.

According to equations (5), the evaluation matrices R1, R2, R3, R4 and R5 corresponding to factor sets Y1, Y2, Y3, Y4 and Y5 can be obtained, so the evaluation set can be calculated.

$$R1 = \begin{vmatrix} 0 & \frac{3}{10} & \frac{3}{10} & \frac{1}{5} & \frac{1}{5} & 0 \\ 0 & \frac{1}{10} & \frac{1}{5} & \frac{3}{10} & \frac{2}{5} & 0 \\ \frac{1}{10} & \frac{1}{10} & \frac{1}{5} & \frac{3}{10} & \frac{3}{10} & 0 \\ 0 & \frac{1}{10} & \frac{1}{5} & \frac{1}{5} & \frac{3}{10} & \frac{1}{5} \\ 0 & \frac{1}{5} & \frac{3}{10} & \frac{3}{10} & \frac{1}{10} & \frac{1}{10} \\ 0 & \frac{1}{10} & \frac{1}{5} & \frac{2}{5} & \frac{1}{5} & \frac{1}{10} \end{vmatrix} \quad R2 = \begin{vmatrix} 0 & \frac{1}{5} & \frac{1}{5} & \frac{3}{10} & \frac{1}{5} & \frac{1}{10} \\ \frac{1}{10} & \frac{1}{5} & \frac{1}{5} & \frac{1}{5} & \frac{3}{10} & 0 \\ 0 & \frac{1}{5} & \frac{1}{5} & \frac{1}{5} & \frac{3}{10} & \frac{1}{10} \end{vmatrix}$$

$$R3 = \begin{vmatrix} 0 & \frac{1}{5} & \frac{3}{10} & \frac{3}{10} & \frac{1}{5} & 0 \\ 0 & \frac{1}{10} & \frac{1}{5} & \frac{3}{10} & \frac{3}{10} & \frac{1}{10} \\ 0 & \frac{1}{5} & \frac{2}{5} & \frac{2}{5} & 0 & 0 \\ 0 & \frac{1}{5} & \frac{1}{5} & \frac{2}{5} & \frac{1}{5} & 0 \\ 0 & \frac{1}{10} & \frac{3}{10} & \frac{2}{5} & \frac{1}{5} & 0 \end{vmatrix} \quad R4 = \begin{vmatrix} \frac{1}{10} & \frac{1}{5} & \frac{3}{10} & \frac{3}{10} & \frac{1}{10} & 0 \\ 0 & \frac{1}{5} & \frac{1}{5} & \frac{2}{5} & \frac{1}{5} & 0 \end{vmatrix}$$

$$R5 = \begin{vmatrix} \frac{1}{10} & \frac{1}{5} & \frac{2}{5} & \frac{1}{5} & \frac{1}{10} & 0 \\ 0 & \frac{1}{5} & \frac{3}{10} & \frac{1}{5} & \frac{3}{10} & 0 \\ \frac{1}{10} & \frac{1}{5} & \frac{3}{10} & \frac{3}{10} & \frac{1}{10} & 0 \end{vmatrix}$$

4.2.6 Calculate the evaluation set.

According to the obtained data matrix and weight set, the evaluation set can be obtained by substituting into equation (6):

A1=W1*R1=(0.018,0.147,0.241,0.283,0.224,0.097)

A2=W2*R2=(0.016,0.2,0.2,0.23,0.27,0.084)

A3=W3*R3=(0,0.177,0.3,0.359,0.14,0.014)

A4=W4*R4=(0.067,0.202,0.269,0.337,0.135,0)

A5=W5*R5=(0.084,0.2,0.354,0.23,0.132,0)

4.2.7 The evaluation results are obtained.

According to the comment set calculated above, substitute into equation (7) to obtain the final comprehensive evaluation score:

M_1=A_1*B^T=0.018*100+0.147*80+0.241*60+0.283*40+0.224*20+0.097*0=43.82

M_2=A_2*B^T=0.016*100+0.2*80+0.2*60+0.23*40+0.27*20+0.084*0=44.2

M_3=A_3*B^T=0*100+0.177*80+0.3*60+0.359*40+0.14*20+0.014*0=49.32

M_4=A_4*B^T=0.067*100+0.202*80+0.269*60+0.337*40+0.135*20+0*0=55.18

M_5=A_5*B^T=0.084*100+0.2*80+0.354*60+0.23*40+0.132*20+0*0=57.48

Finally:

M=W* MT=0.35*43.82+ 0.06 *44.2+ 0.31* 49.32+ 0.19 *55.18+ 0.10*57.48=49.51

According to the comment collection, 40 ~ 60 belong to the category of general effectiveness, indicating that the effectiveness of internal control of administrative institutions is general. Especially from the perspective of business environment, the control environment and control activities have an important impact on talent introduction and investment attraction. Therefore, it is still necessary to adopt reasonable methods to modify and improve the internal control of administrative institutions.

Table 5 Original score data matrix

Evaluation factor set	Evaluation factors	Comment collection					
		Very effective	More effective	Basically effective	Generally effective	Not effective enough	Not effective enough
Y1	Y11	0	3	3	2	2	0
	Y12	0	1	2	3	4	0
	Y13	1	1	2	3	3	0
	Y14	0	1	2	2	3	2

	Y15	0	2	3	3	1	1
	Y16	0	1	2	4	2	1
Y2	Y21	0	2	2	3	2	1
	Y22	1	2	2	2	3	0
	Y23	0	2	2	2	3	1
Y3	Y31	0	2	3	3	2	0
	Y32	0	1	2	3	3	1
	Y33	0	2	4	4	0	0
	Y34	0	2	2	4	2	0
	Y35	0	1	3	4	2	0
Y4	Y41	1	2	3	3	1	0
	Y42	0	2	2	4	2	0
Y5	Y51	1	2	4	2	1	0
	Y52	0	2	3	2	3	0
	Y53	1	2	3	3	1	0

5 Conclusion

From the perspective of business environment, this paper studies the application of fuzzy comprehensive evaluation model to the effectiveness of internal control in administrative institutions, and the specific calculation process and results are given in combination with examples. In the process of using the fuzzy comprehensive evaluation method, the method of scoring by experts who know the situation of the Department is adopted. In this way, we can not only better understand the specific situation of the implementation of internal control in each link of the unit, but also measure the effectiveness of the five control factors respectively. Finally measure the overall effectiveness of the internal control of administrative institutions. We can more intuitively understand the weak links in the implementation of internal control of administrative departments from the perspective of business environment. So as to take more effective measures to improve, gradually improve the effectiveness of internal control of administrative departments, and let administrative departments standardize operation, eliminate fraud and avoid risks. Therefore, it is feasible to use the fuzzy comprehensive evaluation model to measure the effectiveness of internal control of administrative institutions from the perspective of business environment.

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