

Risk Evaluation of University Contract Management Based on Rough Set

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Abstract

The internal control system of university has initially taken shape. Contract control runs through the daily management of universities, so the effectiveness of contract control affecting the operation of internal control system has become an important concern of managers and a research hotpot of all social circles. This paper finds that the current research mainly focused on the evaluation of internal control, but the research concerning the effectiveness of contract management is insufficient. And this article establishes the evaluation index system of contract control effectiveness from the organizational and business levels, and evaluates the contract control level of different universities based on rough set, which has achieved good results in weight allocation because of its advantages in processing fuzzy information and revealing potential laws.

Key words: Internal control; Contract management; Rough set

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1. INTRODUCTION

The Ministry of Finance issued the“Regulation for Internal Control of Administrative Institutions (for Trial

Implementation)” in 2012. The regulation is effective nationwide from 1 January 2014, which promoted extensive research on internal control of construction of colleges and universities in China.

During the internal control construction, universities assessed the current state of internal control, sorted out the business process of economic activities and identified business risk points by focusing on budget, fund, asset, procurement, construction project, contract, information and communication. The risk assessment mechanism, university-level control mechanism, business-level control mechanism and internal control supervision and evaluation mechanism have been gradually established or improved, and the internal control system of colleges and universities has initially taken shape. In recently education authorities are paying more and more attention to the effectiveness of internal control.

With the continuous expansion of the university scale, the number and amount of economic contracts signed are increasing year by year. As a link between university with other public institutions or enterprises, contract is a powerful guarantee to safeguard the rights and obligations of university which is a main body of market economy. Contract control runs through the daily management of universities, so the effectiveness of contract control affecting the operation of internal control system has become an important concern of managers and a research hotpot of all social circles.

2. LITERATURE REVIEW

Academic research on the internal control of universities has a long history, but research on the internal control evaluation of universities is more recent and on the rise. At present, the research on the internal control evaluation of universities has mainly occurred in three aspects, which are the determination of the internal control evaluation indicators(Du, 2015), the selection

of evaluation methods, and actual execution of internal control.

The determination of the internal control evaluation indicators in universities mainly include four aspects. First, the main indicators framework is five elements mentioned by COSO, which are internal environment, risk assessment, control activities, information and communication, and internal supervision. Second, Tang(Tang, Ji, & Zhi, 2015) proposed the integrated evaluation framework of internal control of domestic administrative institutions including universities. The framework was designed according to the norms, and divided into two levels. The organizational level reflects the internal control environment, decision-making, authorization and execution mechanism from a macro perspective. The business layer reflects the overall processes and key risk points in the organization's day-to-day operations. Third, the indicators include system evaluation, process evaluation and risk-oriented evaluation (Zhou, 2023). System evaluation is used to verify whether the system can keep pace with the development and safety of the university. The main goal of process evaluation is whether each business process in the university complies with the regulations. Risk-oriented evaluation is mainly used to evaluate the risk control level of universities at the organizational level and operation flow level, as well as test the role of audit. Fourth, the indicators system is similar to the third point, including governance structure, responsibility distribution and business process.

In term of evaluation methods, there are five main aspects. In order to provide scientific, accurate, flexible and applicable technical tools for the effective self-evaluation of internal control in colleges and universities, Chen(Chen & Huang, 2015) determined the weight of internal control indicators and the comprehensive score of effectiveness by AHP. And Liu(Liu, 2016) assessed the effectiveness of internal control base on fuzzy comprehensive evaluation method. In order to make up for the defects of ANP, Qu(Qu, Deng, Han, & Meng, 2022) introduced FCE and constructed integrated method to evaluate the internal control of universities. Dong et al(Dong, Guo, & Ji, 2019) built an analysis model of evaluation results of internal control in universities based on grey clustering theory. Zhao and Pan(Zhao & Pan, 2020) integrated evaluation system of internal control in university from management balance and fund monitoring, risk assessment and process control, information communication and evaluation supervision based on the principle of system dynamics model.

There are four main aspects about actual execution of internal control in universities. First, whether the various processes of business are functioning effectively during the evaluation period. Second, whether the

business controls have been continuously and consistently implemented. Third, whether the relevant internal control mechanism, management system, post responsibility system and internal control measures are effectively implemented. Fourth, whether the relevant personnel who perform business control have the necessary authority, qualification, and capability.

The previous research results have laid a good foundation for later studies. At the same time, this paper finds that the current research mainly focused on the evaluation of internal control, but the research concerning the effectiveness of contract management is insufficient. The literature on contract management has mainly occurred on the following three points, which are the defects of the contract management of universities, the causes of those defects, and suggestions for the optimization of the contract management of universities. Regarding evaluation methods, AHP mainly depends on the knowledge and experience of decision makers. In some cases, the selection of weights is easily affected by the subjective ideas of decision makers, which leads to the biased evaluation results. Also FCE has some defects, such as subjectivity of evaluation index setting, randomness of sample number setting and mechanical data processing. The GCT focuses on making the information from less to more, the SDM is more suitable for complex systems and interaction mechanisms between elements. Therefore, the goal of this paper is to concern the contract management in universities and build a model to assess its effectiveness base on rough set.

3. MODELING

3.1 Contract Risk

This paper analyses contract risk in universities from the organizational level and business level according to "Regulation for Internal Control of Administrative Institutions". Through evaluating specific indicators and observation points at two different levels, the degree of realization of contract risk control in universities can be clarified and measured. Moreover, corresponding risk prevention and control measures can be implemented. On the organizational level, this article emphasizes the effectiveness of organization operation and power restriction, personnel qualification and key positions, information technology use and communication. On the business level, there are seven aspects for evaluating contract management, which are contract management mechanism, contract investigation, contract terms, contract performance, contract changes, contract disputes and contract custody. So there are ten indicators of contract risk control, and this paper uses y_1 – y_{10} to indicate as shown in Table 1.

Table 1
Meaning of indicators of contract management

Index	Meaning	Specification
y1	Organization operation and power restriction	The organizational structure and the decision-making mechanism. Effective separation of decision-making, implementation and supervision of economic activities.
y2	Personnel qualification and key positions	Employee qualification, training, job rotation mechanism, performance evaluation and key position control
y3	IT use and communication	The internal control process is embedded in the information system to achieve effective communication and coordination
y4	Contract management mechanism	Centralized management of contracts is clear, the process management is in order, and the approval is clear.
y5	Contract investigation	Investigate the other party's qualification, credit status and ability to perform the contract.
y6	Contract terms	Check the legality, completeness and tightness of contracts
y7	Contract performance	Discover risks in time and take effective measures.
y8	Contract changes	Carry out relevant management procedures and sign supplementary agreements
y9	Contract disputes	Negotiation, arbitration or litigation
y10	Contract custody	Number, file, keep, borrow and destroy

3.2 Model Construction

In many fields, uncertain factors and incomplete information are dealt with on different degrees. The use of pure mathematical assumptions to eliminate or avoid such uncertainty is often not ideal. On the contrary, dealing with this information properly is helpful to solve practical problems. Similar to fuzzy sets or probabilistic methods, some additional information or prior knowledge of the data is required, but this is not readily available. Rough set theory has achieved good results in weight allocation because of its advantages in processing fuzzy information and revealing potential laws. Also, it provides an effective way to deal with imprecise, uncertain and incomplete data and to mine the necessary knowledge from the data.

In this paper, the rough set method is applied to the evaluation of contract management control in universities, which biggest advantage is not provided any prior information of processing problem and another advantage of this method is that it can effectively eliminate redundancy.

In rough set theory, let $S = (U, R)$ be an information system, and $Q \subseteq R$, then

$U / Ind(Q) = \{X_1, X_2, \dots, X_n\}$, the amount of information Q is defined as

$$I(Q) = \sum_{i=1}^n \frac{|X_i|}{|U|} \left(1 - \frac{|X_i|}{|U|}\right) = 1 - \frac{1}{|U|^2} \sum_{i=1}^n |X_i|^2 \quad (1)$$

In equation (1), $|*|$ is defined as the number of elements in the set. The importance of attribute 'attr' in attribute set Q is defined as

$$sig_Q(attr) = I(Q) - I(Q - attr) \quad (2)$$

The weight of each attribute is obtained by normalizing the significance of each attribute in the set.

4. CASE ANALYSIS

From the business perspective, contract management is directly related to budget, fund, asset, procurement and construction project. As a bridge connecting the university with the outside world, the quality of contract control affects the level of other business control, so the validity of contract management and how to measure its effectiveness have become a concern of university internal governance that managers and supervisors are facing.

4.1 Indicators and Survey

This article selected ten universities in a province to investigate the effectiveness of contract management through field investigation, questionnaire and expert interview. From the above 10 indicators such as "organization operation and power restriction", the questionnaire investigated the respondents' evaluation about the effectiveness of contract control. In the questionnaire, 9 means completely valid and 0 means completely invalid. The initial information table (Table 2) was obtained after the valid questionnaires were collected and processed.

Table 2
Initial information table

	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10
U1	4	7	6	9	6	4	8	7	5	8
U2	7	6	7	8	5	4	6	6	6	7
U3	6	7	6	7	6	6	7	5	4	6
U4	6	6	7	7	5	4	6	7	6	7
U5	7	5	8	8	7	6	7	7	7	9
U6	4	5	5	7	7	7	6	7	8	6
U7	5	7	6	6	6	4	7	6	6	7
U8	4	4	5	6	6	5	6	7	7	6
U9	7	8	7	7	7	7	7	5	5	7
U10	7	7	7	8	5	4	9	7	6	7

4.2 Reduction Approach

The initial information table is first discretized. In the discretization process of this paper, 1 represents the range of 8-9, 2 represents the range of 6-7, and 3 represents the range of 4-5 according to the data characteristics of the case. And the discrete information is shown in Table 3.

Table 3
Discrete information table

	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10
U1	3	2	2	1	2	3	1	2	3	1
U2	2	2	2	1	3	3	2	2	2	2
U3	2	2	2	2	2	2	2	3	3	2
U4	2	2	2	2	3	3	2	2	2	2
U5	2	3	1	1	2	2	2	2	2	1
U6	3	3	3	2	2	2	2	2	1	2
U7	3	2	2	2	2	3	2	2	2	2
U8	3	3	3	2	2	3	2	2	2	2
U9	2	1	2	2	2	2	2	3	3	2
U10	2	2	2	1	3	3	1	2	2	2

Then, the indicators set is reduced through the process of knowledge categorization. The specific approach involves initially classifying the knowledge in Table 3, followed by assessing the impact of removing attribute

The partition of the equivalence relation Q to the discourse domain U is:

$$U / Ind(Q) = \{\{U1\}, \{U2\}, \{U3\}, \{U4\}, \{U5\}, \{U6\}, \{U7\}, \{U8\}, \{U9\}, \{U10\}\}$$

After removing $y2$, the partition of the equivalence relation $U / Ind(Q - \{y2\})$ to the discourse domain U is:

$$\{\{U1\}, \{U2\}, \{U3, U9\}, \{U4, U7, U8\}, \{U5\}, \{U6\}, \{U10\}\}$$

$I(Q)$ can be calculated according to equation (1). After eliminating $y2$, $I(Q - y2)$ can also be obtained by the same equation. The significance of attribute $y2$ can be received in term of equation (2).

$$I(Q) = 1 - \frac{1}{|U|^2} \sum_{i=1}^n |X_i|^2 = 1 - \frac{1}{10^2} (1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2) = 0.9$$

$$I(Q - y2) = 1 - \frac{1}{10^2} (1^2 + 1^2 + 2^2 + 3^2 + 1^2 + 1^2 + 1^2) = 0.82$$

$$sig_Q(y2) = I(Q) - I(Q - y2) = 0.9 - 0.82 = 0.08$$

The significances of attribute $y4$, $y6$, $y7$ and $y9$ also be obtained based on the same method. Then $sig_Q(y4) = 0.06$, $sig_Q(y6) = 0.02$, $sig_Q(y7) = 0.04$, $sig_Q(y9) = 0.04$. The weight of attribute is got after normalizing the attribute significance and the result is shown in Table 4.

Table 4
Reduced attribute significance and weight table

Index	y2	y4	y6	y7	y9
Sig	0.08	0.06	0.02	0.04	0.04
Weight	0.33	0.25	0.08	0.17	0.17

4.4 Comprehensive Valuation Calculation

The linear weighting method is used to evaluate

$y1$ on the original classification ability. If there is a change, attribute $y1$ is deemed necessary; otherwise, it is considered redundant. The attributes $y2$ - $y10$ should also be removed individually to determine their necessity or redundancy. Finally, eliminate all redundant properties, and the remaining necessary properties constitute the reduced index set. The reduction set of the case, $(y2, y4, y6, y7, y9)$, can be obtained according to the aforementioned reduction method. In other words, the index set $Q = \{\text{Personnel qualification and key positions, Contract management mechanism, Contract terms, Contract performance, Contract disputes}\}$.

4.3 Attribute Significance and Weight

After reducing attribute of the index system, the significance of each indicator is calculated based on estimating attribute importance with knowledge information. According to the rule of reduction, when $Q \subseteq R$, then $U / Ind(Q) = U / Ind(R)$.

the effectiveness of contract management in each university(Li & Liu, 2009). By comparing the evaluation results, the order of contract control in universities is obtained. The comprehensive valuation of university 1 (S1) is got according to the Table 1 and Table 4.

$$S1 = 0.33 * 7 + 0.25 * 9 + 0.08 * 4 + 0.17 * 8 + 0.17 * 5 = 7.09$$

Similarly, the scores of universities (U2-U10) can be obtained by calculation. The comprehensive valuations

of contract management are respectively 6.34, 6.41, 6.09, 6.51, 6.34, 6.34, 5.43, 6.99, 7.18. Compared with the overall score, the university 10 did the best job in contract control. On the contrary, there are great shortcomings of the contract management in university 8.

5. CONCLUSIONS AND SUGGESTIONS

Compared with other methods, the biggest advantage of rough set is that it does not need other prior knowledge, and it can directly dig out the potential information from data. This paper establishes the evaluation index system of contract control effectiveness from the organizational and business levels, and evaluates the contract control level of different universities based on the knowledge reduction of rough set, which has certain practical influence. Moreover, it is suggested that, according to the significance of indicators, the contract management of universities must be gradually optimized as follows.

Firstly, establish and improve the contract management mechanism. Economic activities in colleges and universities are divided according to departmental functions when they occur. Therefore, the phenomenon of decentralized management of contracts is easy to appear, coupled with the lack of professional knowledge and weak legal consciousness, leading to the confusion of contract management. Based on the above, clarify the centralized management departments of contracts in university, and strengthen the implementation of legal responsibility of economic matters. Inter-departmental collaboration will be strengthened relying on the integration of information systems. To ensure that the format of the contract is standardized, the content is legal and compliant with the interests of universities, the contract matters shall be examined by classification. Moreover, internal audit plays an important role in contract control, and establish the accountability system and implement it effectively.

Secondly, it is necessary to professionalize contract management. Contract business in university is complicated, involving bidding, law, finance, engineering projects, and so on, but professional talent is insufficient. Even if special positions are set up, it is not equipped with enough strength to undertake a large number of audit business; or the professional contract audit force is insufficient, it is difficult to deal with the complex contract business of the school. Universities need to pay attention to the construction of professional contract talents.

Provide support in staffing, training, key positions, etc., and seek external help when necessary.

Thirdly, strengthen the whole process of contract control. Set up effective key control nodes in each link of contract authorization, performance and follow-up management, and realize the whole process of information management such as approval residue, process tracking, payment control, risk warning, information summary and complete archiving. Pay more attention to checking the legality, completeness and tightness of contracts, discovering risks in time and taking effective measures, focusing on negotiation, arbitration or litigation in case of contract disputes. Make the internal control run through every link of contract management, prevent risks, improve efficiency, and realize the standardization of contract management.

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