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Retraction

Retracted: Design of Project Cost Risk Management System Based on Improved Fuzzy Rule Weight Algorithm

Security and Communication Networks

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] C. Huang, Y. Zhu, and X. Shao, "Design of Project Cost Risk Management System Based on Improved Fuzzy Rule Weight Algorithm," *Security and Communication Networks*, vol. 2021, Article ID 4688846, 9 pages, 2021.

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Research Article

Design of Project Cost Risk Management System Based on Improved Fuzzy Rule Weight Algorithm

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Aiming at the low accuracy of index weight calculation and risk type identification in traditional cost risk management systems, this paper proposes a project cost risk management system based on an improved fuzzy rule weight algorithm. We analyzed the types of project cost risks, adopted a three-tier technical architecture to design the system frame structure and functional organization structure of the cost risk management system, and adopted the B/S architecture for network structure deployment. In the software part, an improved fuzzy rule weight algorithm is used to calculate the weight of project cost risk indicators, thereby improving the effectiveness of risk management. Experimental results show that the designed system works well, can accurately calculate the weights of risk indicators, and can effectively identify multiple risk types.

1. Introduction

Under the guidance of the national macropolicy, China's engineering construction has developed rapidly. Although some experience in engineering construction has been accumulated, there are still some problems: engineering construction cost management is not standardized, leading to the problem of high engineering cost which has not been effectively rectified [1]. Engineering construction is a system project with large capital, wide range, and many influencing factors. How to effectively carry out cost risk management in this complex system project, so as to reduce investment, save cost, and maximize economic benefits, is a common concern of project managers. The level of project cost has an important impact on the health of the project. At present, the most critical problem in the project cost risk management system is the scientific and effective management of project cost, which can greatly reduce the cost while improving the project quality [2,3].

Reference [4] proposed a project cost risk management system based on improved cloud model. The system fully considered the randomness, fuzziness, and uncertainty of experts qualitative evaluation, coupled the subjective weight and objective weight of AHP method and entropy weight method with the initial weight of cloud model calculation, and used the combination evaluation method to determine the importance of each risk factor, to realize the management of project cost risk. However, the accuracy of the weight calculated by the system is poor, leading to the final management effect being not ideal. The paper proposes a project cost risk management system based on cloud computing method, which is designed and assembled with high-precision chip, suitable for cloud computing technology, as the equipment foundation of secondary design, and the other hardware is based on the original hardware. Select cloud service to obtain the abnormal part of cost information, and realize the risk level assessment of cost information according to the risk level evaluation index. Based on the risk level assessment results, the risk management and control work is completed by programming language. Combined with hardware and software, the design of financial risk control system based on cloud computing is completed. However, the system has a low accuracy of risk identification. Reference [5] puts forward the project cost risk management system based on BIM. The system takes the whole life cycle process cost management as the research object, analyzes the current situation of cost management in each stage, and studies the comprehensive cost fine management of the project. Through the current situation of highway project cost management, it comprehensively analyzes the development status of different links of project cost management. Combined with the core content of BIM Technology, it is determined that BIM Technology can enhance the efficiency and accuracy of project cost management and achieve the goal of cost data information sharing of collaborative integrated management. In this paper, the specific situation of BIM Technology used in highway engineering cost management process is analyzed in four stages: bidding, design, construction, and completion handover. At the same time, the detailed cost management process is determined to coordinate the synchronous work among various links to effectively manage the project cost. However, the overall management effect of the system is not ideal.

In order to solve the problem of low accuracy of weight calculation and risk identification in the traditional cost risk management system, a project cost risk management system based on improved fuzzy rule weight algorithm is proposed.

The research contributions of this article mainly include three points:

(1) This paper proposes a project cost risk management system based on an improved fuzzy rule weight algorithm.

(2) We analyzed the types of project cost risks, adopted a three-tier technical architecture to design the system frame structure and functional organization structure of the cost risk management system, and adopted the B/S architecture for network structure deployment.

(3) In the software part, an improved fuzzy rule weight algorithm is used to calculate the weight of project cost risk indicators, thereby improving the effectiveness of risk management.

2. Design of Project Cost Risk Management System

The risks of project cost are mainly as follows:

(1) Risk of changes in laws and regulations: the changes of laws and regulations related to project cost, such as the adjustment of tax base and tax rate stipulated by tax law, the change of pricing method, etc., are usually affected by the national macroeconomic regulation and control, and these risks are often unpredictable or uncontrollable risks in the valuation activities of bill of quantities.

(2) Risk of changes in quantities: the more scientific the decision-making of a construction project, the more sufficient the preparatory work, and the more careful the engineering design, the smaller the change of engineering quantity in the process of construction and implementation [6–8].

In the actual project, except for a few small-scale, short construction period and simple functions, there are no projects that do not change the quantities. Therefore, as long as the quantities change, whether it is caused by calculation error or design change, it will bring risks to the valuation of bill of quantities.

This kind of risk is the main content of risk control in the pricing mode of bill of quantities. According to the 2013 code for valuation, when the deviation between the actual quantities and the bill quantities exceeds 15%, the comprehensive unit price shall be adjusted. Therefore, the comprehensive unit price shall include the price risk within 15% of the deviation.

(3) Market price fluctuation risk: the valuation elements of project cost mainly include labor cost, material cost, and machine shift cost. Under the condition of market economy, the prices of these three basic elements will not be stable, but will fluctuate according to the market.

In this way, it brings risks to the activities of valuation with bill of quantities. The higher the frequency and the lower the amplitude of such fluctuations, the greater the risk of valuation with bill of quantities. Therefore, this kind of risk is the main goal of risk management.

(4) Internal management risk: internal management risks mainly include the risks faced in the process of project implementation, such as decision-making, cost, quality, and schedule. These factors run through the whole project management process, which not only influence each other, but also depend on each other. They have the most direct influence reflecting the level of cost management and also an important component of the core competitiveness of engineering projects [9–11].

The risk of decision-making error, deviation of cost control, quality accident, and claim by Party A due to the progress not meeting the requirements of the contract should be considered in bidding activities.

(5) Technical risk: the most important service provided by construction enterprises for owners is actually technical service, which is also the basis for survival and competition of engineering projects. The contractor should reasonably estimate the technical risks faced according to the technical strength of the enterprises and adopt reasonable management and technical means to reduce the technical risks.

(6) Risk of force majeure: force majeure generally refers to the war, turmoil, terrorist activities, and natural disasters such as earthquakes, hurricanes, typhoons, volcanic eruptions, debris flows, landslides, and other events or situations that cannot be controlled, avoided, or overcome by market entities.

2.1. Overall Structure Design of the System. The project cost risk management system designed in this paper adopts three-layer technical framework, and the overall system architecture is shown in Figure 1.

Using object-oriented technology, the presentation layer, business layer, and data layer in the three-tier technical architecture are relatively independent and loosely coupled, and the calls between them are realized through interfaces [12,13]. The architecture mainly depends on the system requirements, adopts B/S architecture, and follows the J2EE platform multilayer architecture, light coupling design principle. Each module in the system is packaged independently, which weakens the interlayer correlation and improves the stability of the system maintenance [14].

2.2. System Technical Architecture. On the basis of the overall framework structure, this paper further expounds the technical architecture of the system. During the design and implementation of the project cost risk management system, the MVC layered theory is adopted. The system code is divided into three parts: view, model, and controller, which are respectively responsible for processing the interface, business logic, and data. Through the layered design, the maintainability and expansibility of the software are improved; it is convenient for program development and management. In the specific implementation process, struts 2 technology is used [15].

The technical architecture of project cost risk management system is shown in Figure 2.

As shown in Figure 2, the workflow of Struts2 MVC is as follows:

(1) Users send requests through JSP pages, and the requests are encapsulated as servlets

(2) The controller servlet dispatcher calls the corresponding action execution business logic according to the request

(3) If the business logic needs to access the database, Bll calls the dbmanage of dal to access the database and obtain the data

(4) After the business logic is executed, it is also returned to JSP in the form of servlet to display the data

In Struts2 MVC, the core of logic control is servlet dispatcher, whose principle is to implement web application by tag definition and complete business logic mapping by user-defined configuration XML file [16].

2.3. System Functional Architecture. The functional organization structure of the cost risk management system is shown in Figure 3.

The functional organization structure of the project cost risk management system is the basic framework structure, the basic project for managing project costs, and the functional organization of the entire project. As shown in Figure 3, the detailed composition of the functional modules of the project cost risk management system is as follows:

(1) Risk identification and ranking: train and manage the classification model, make the identification plan of the classification model, identify the project cost risk, and rank the risks.

(2) Risk task coordination: query the existing risks to be dealt with, formulate risk tasks, and distribute them to the cost management departments involved in the risk tasks.

(3) Risk correspondence: project cost inspection department, query the risk task pushed, assign the task, deal with the risk, and give the evaluation processing.

(4) Risk control evaluation: risk control includes two main functions: risk task processing, review, and query system. The design function includes two specific functions: task allocation and review [17].

2.4. System Network Architecture. The goal of the project cost risk management system is to provide risk management services within the scope of the project. The system adopts B/S architecture, and the implementation of the system network deployment is shown in Figure 4.

As shown in Figure 4, the source node of the project cost risk management system is the client. At present, the system supports PC, notebook, and mobile browser. The target node of the project cost risk management system is the server of the data center. The source node and the target node are connected through the Internet. The main part of the system, including business logic and data, is deployed in the server. At present, the project of the system is the internal network, and the network bandwidth is 100M [18].

2.5. System Software. In the above process, the hardware of the system is designed and studied to meet the hardware operation requirements of the system. In the above sections, the improved fuzzy rule weight algorithm is used to calculate the weight of project cost risk impact factor [19].

Weight calculation of fuzzy rules is an important application of fuzzy set theory. It is a good representation of weight calculation knowledge and has readability and interpretability. In order to obtain the weight calculation criteria of the sample data set to be calculated, a weight calculation model must be established for fuzzy reasoning. Assuming that the weight calculation input variable is $Q = C_1, C_2, \ldots, C_j$, it is composed of different database records, and each record contains different attributes, which together constitute a feature vector. Each record in the data set corresponds to a specific classification label. The fuzzy rules are

$$\begin{aligned}&\text{Rule } R_j\text{: IF } x_1 \text{ is } A_{\mathrm{ji}} \text{ and } x_n \text{ is } A_{\mathrm{jn}},\\&\text{THEN weight is } C_j,\end{aligned} \tag{1}$$

where R_j is the j-th rule, n is the feature number of weight pattern, that is, $x = (x_1, x_2, \ldots, x_n)$, which is the sample of dimension; $x_i\,(A_{ji} = 1, 2, \ldots, n)$ is the i-th attribute of the sample, and $x_i\,(A_{ji} = 1, 2, \ldots, n)$ is the fuzzy set of the antecedent of attribute i in rule j; C_j is the sample category

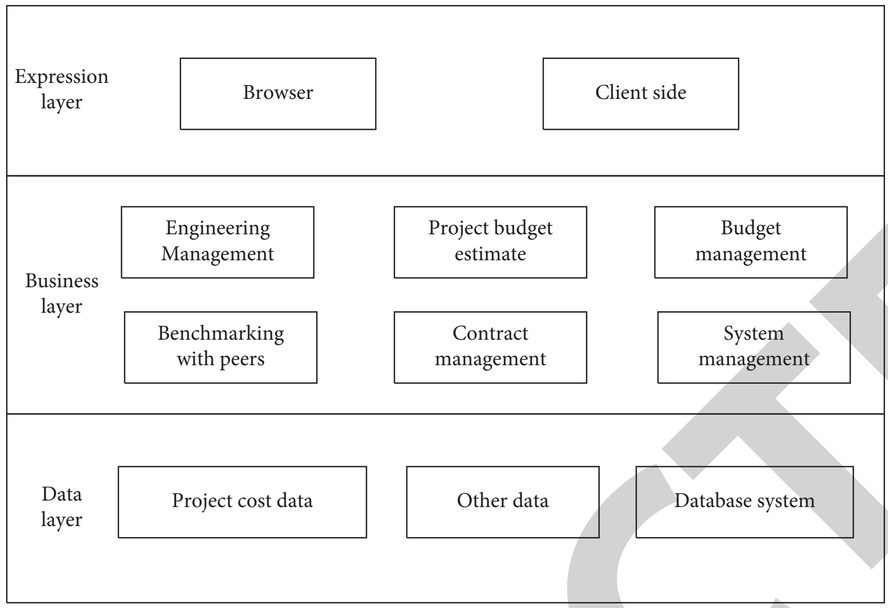

Figure 1: System architecture diagram.

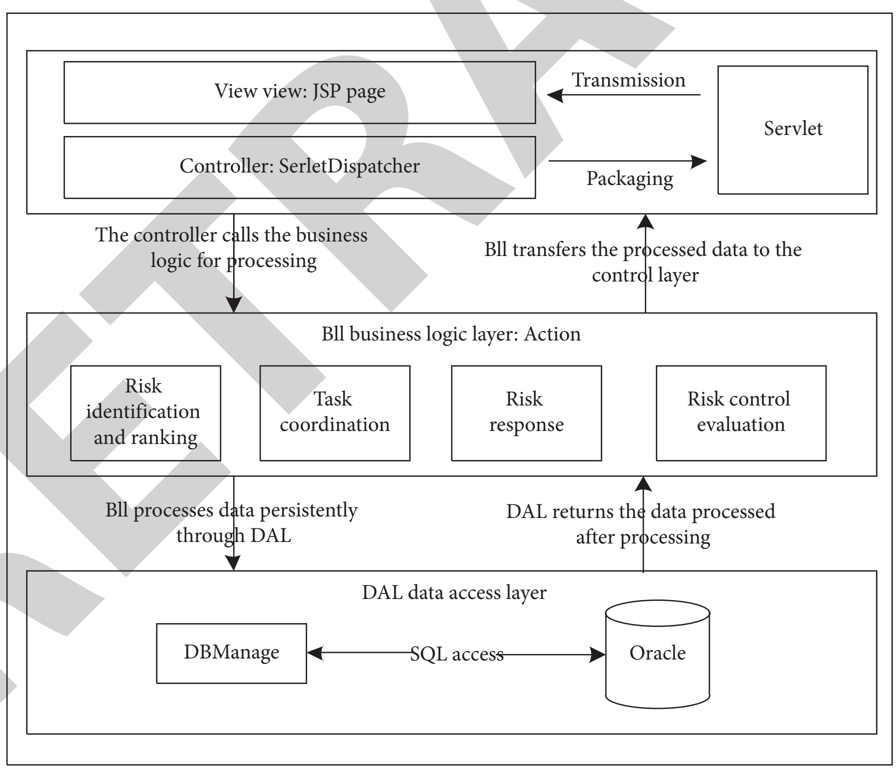

Figure 2: System technical framework.

corresponding to the conclusion of rule j. The membership function of symmetric triangular fuzzy set A_{iji} is as follows:

$$U_{ij} = \max\left(1 - \frac{\left|x - a^{K_{iji}}\right|}{b^{k_i}}, 0\right), j = 1, 2, .., K_i, \quad (2)$$

where $a^{K_{iji}} = (j_i - 1)/(K_i - 1)$, $j_i = 1, 2, ..., K_i$, and $b^{k_i} = 1/(K_i - 1)$.

In the training set, the matching degree of weight h to j rules can be obtained by summing the matching degree of all samples in weight h on rule j, expressed as

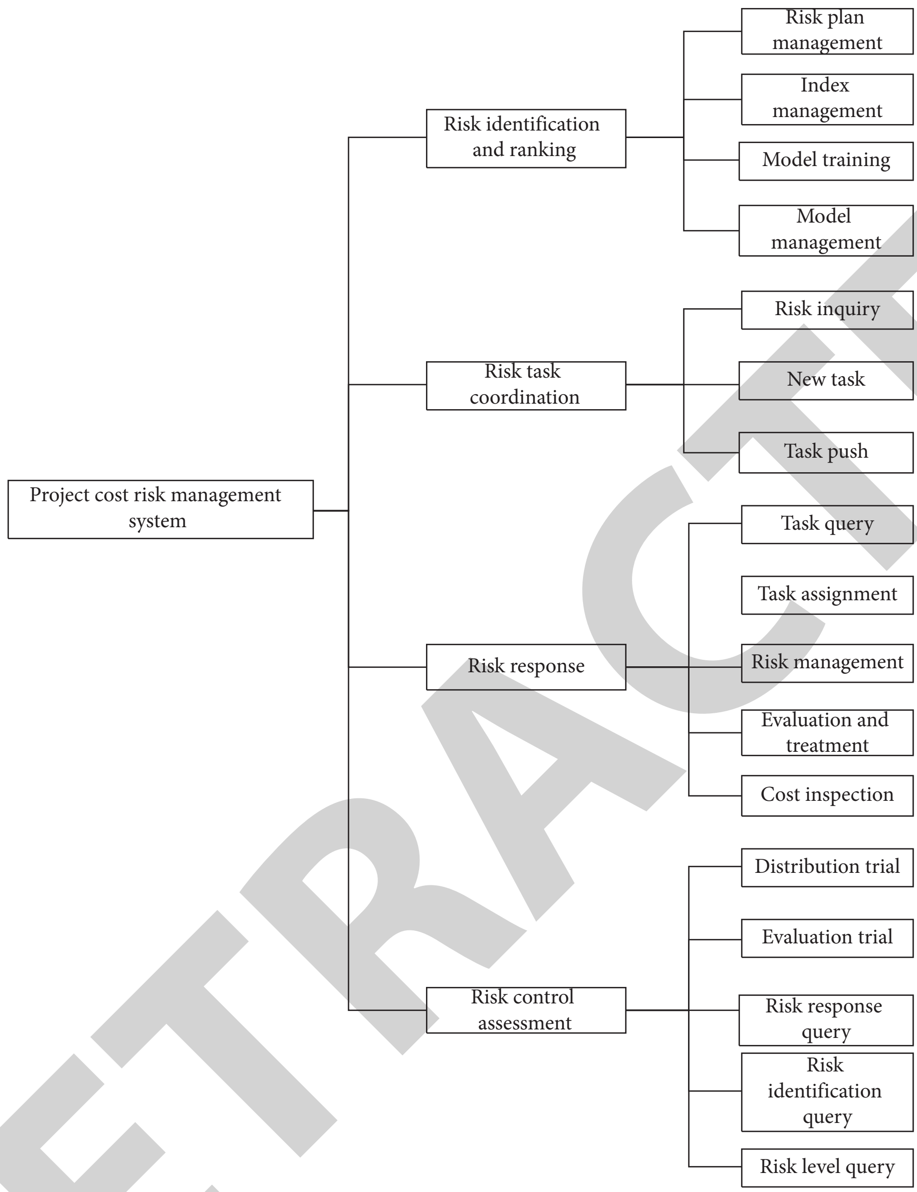

FIGURE 3: Function organization structure of project cost risk management system.

$$\beta_{\text{weighth}}\left(R_j\right) = \sum_{x_p \in \text{weighth}} u_j\left(x_p\right), h = 1, 2, \ldots, M. \tag{3}$$

The matching degree of weight h to rule j is normalized on the matching degree of all weights to rule j to obtain the weight matching degree, which is expressed as

$$H_j^h = \frac{{}_{\text{weighth}}\left(R_j\right)}{\sum_{i=1}^{M}{}_{\text{weighth}}\left(R_j\right)}. \tag{4}$$

The matching degree of the weight h to the rule j is normalized on the matching degree of the weight h to all the rules, and then ρ_j^h can be obtained. Then, the relative matching degree of the rule can be obtained by weighting ρ_j^h according to the proportion of the number of all weight samples, expressed as

$$\varepsilon_j^h = \frac{m_{c_j}\rho_j^h}{m}, \tag{5}$$

where m_{c_j} is the number of samples of each weight, $m = \sum_{c_j=1}^{M} m_{c_j}$,

$$\rho_j^h = \frac{\beta_{\text{weighth}}\left(R_j\right)}{\sum_{i=1}^{N}\beta_{\text{weighth}}\left(R_j\right)^{\circ}}. \tag{6}$$

Because the traditional weight calculation method cannot meet the needs of project cost risk data processing, the project cost risk data is rich and the condition attributes obtained from the analysis of a large number of historical data cannot fully reflect the index attributes of the sample data. Therefore, the improved fuzzy rule weight algorithm is used to reduce the impact of decision environment on the rule decision output [20].

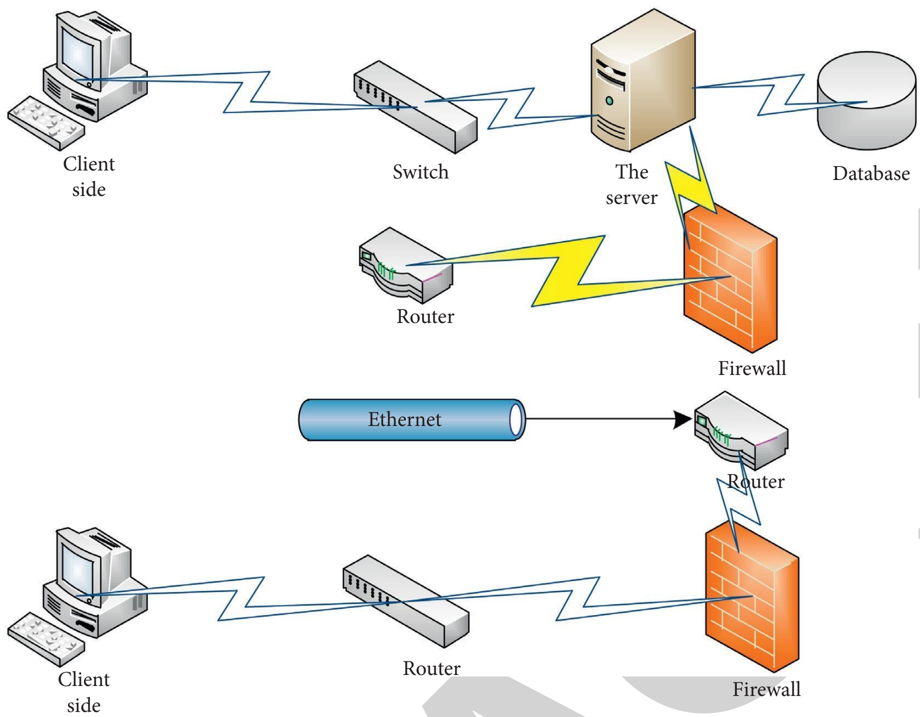

Figure 4: System network deployment.

Fuzzy algorithms are intelligent algorithms. When we do not have a deep understanding of the model of the system, or when we are unable to conduct in-depth research on the control model of the system due to objective reasons, the intelligent algorithm cannot be studied well, and the fuzzy algorithm has good learning ability, to study system control principles in depth. The idea of improving the fuzzy rule weight algorithm is to combine the matching degree of conditional attributes from historical data set with the importance degree of attributes from expert prior knowledge by synthesizing the weight function to calculate the weight value. The weight calculation steps are as follows.

In order to calculate the matching degree of weighted conditional attributes, a weighted index α is introduced to control the compatibility degree of different samples among various kinds of fuzziness.

$$D_j(x_p) = \left[u_j(x_p)\right]^{\alpha} = \left[u_{j1}(x_{p1}) \times \cdots \times u_{\text{jn}}(x_{\text{pn}})\right]^{\alpha}. \quad (7)$$

In the formula, the value range of α is $\alpha = 0$, $0 < \alpha < 1$, and $\alpha > 1$.

Calculate the average weighted condition attribute matching degree, and calculate the comprehensive average of the matching degree of the training samples on the j rules to prevent the weight accuracy from being reduced due to the different degree of weight dispersion. The calculation formula is

$$\beta_{\text{weighth}}(R_j) = \frac{1}{m_{c_j}} \times \sum_{x_p \in \text{weighth}} D_j(x_p), \quad (8)$$

where $h = 1, 2, \ldots, M$, and m_{c_j} represents the number of training samples in sample M.

Find the maximum value of the weighted average condition attribute matching degree of the weight $\hat{h}$; the calculation formula is

$$\beta_{\text{weight}\hat{h}_j}(R_j) = \max\left[\beta_{\text{weight1}}(R_j), \ldots, \beta_{\text{weight}M}(R_j)\right]. \quad (9)$$

The objective rule weight $p(r_j)$ is determined by the following formula:

$$p(r_j) = \frac{\beta_{\text{weight}\hat{h}_j}(R_j) - \bar{\bar{\beta}}}{\sum_{h=1}^{M} \beta_{\text{weight}\hat{h}_j}(R_j)}, \quad (10)$$

where

$$\tilde{\beta} = \frac{1}{M} \sum_{h=1\,(h \neq \hat{h}_j)}^{M} \tilde{\beta}_{\text{weighth}}(R_j). \quad (11)$$

To calculate the comprehensive weight value of the rule, the objective rule weight $p(r_j)$ has been calculated through formula (9), while the supervisor weight is given by experts, assuming that the weight of rule j given by experts is $p(r_j)$. The formula of comprehensive weight is as follows:

$$w(r_j) = K_1 p(r_j) + K_2 p(r_j), K_1 + K_2 = 1, \quad (12)$$

whereK_1 is the weight given to objective weight, K_2 is the weight given to supervisor weight, and K_1 and K_2 can be selected according to different data set types.

Through the above calculation, the calculation of project cost risk weight is completed, which can more accurately realize the management of project cost risk.

3. Experimental Verification

In order to verify the practical application performance of the designed project cost risk management system based on the improved fuzzy rule weight algorithm, the simulation comparison experiment is carried out.

3.1. Test Environment. The system test environment is shown in Tables 1 and 2.

Table 1: Server side system test environment.

Configuration items	Test environment
Operating system	Windows Server 2003 with SP 1 Pack
Database	SQL server 2010
Hard disk space	More than 2T idle
Network speed	LAN 1G
CPU	Pentium quad core 2.5 GHz and above

Table 2: Client system test environment.

Configuration items	Test environment
Browser	Inter Explorer 7.0 and above
Operating system	Windows 7
Broadband	50M

3.2. System Test

3.2.1. System Test Method. After the system is built, according to the development ideas of software engineering, the system development work is completed, and the system needs to be tested to ensure the normal operation of the system. Through understanding, the commonly used system testing methods are divided into two types: one is the white box testing method, and the other is the black box testing method. The advantages of these two methods are described in detail as follows:

(1) White box test: in the white box test method, the tester can accurately check the whole process of the system operation, all the internal program operation, how the system realizes the instruction operation, and whether the programming program is correct when testing the system. These can be seen clearly in the white box test method. Therefore, the white box test method is also known as the internal test method of the system.

(2) Black box test: in the black box test method, the tester tests the system according to the system function operation process. In the test, the tester only needs to pay attention to the correct operation of the system after receiving the instruction. This is the black box test method. Compared with the white box test method, the black box test method is not as detailed as the white box test method, but it is more than enough for the lack of function of the test system.

This experiment uses the black box test method, which is one of the widely used test methods in the current test. This method can determine the system running effect and carry out the relevant control methods, so as to ensure that the data can match the actual application data in the process of test, rather than the more abstract program running internal data.

3.2.2. System Function Test. Before the system is put into operation, the corresponding test must be carried out for the existing functions of the system. It is required that the process of each function can meet the test requirements, the test results of the function should conform to the logic process designed before the program, and the test is completed by a third party, so as to solve the current system test problems fairly.

Table 3 is the system management test case, which includes four parts: function module, input data, expected results, and results. Through this test case, we can verify whether the management function of the system is effective.

The basic functions of the system are verified by Table 3, and then the cost risk management performance of the system is verified by comparative verification experiments.

3.3. System Performance Test. The system performance test includes the accuracy of cost risk index weight calculation and whether it can accurately identify the type of cost risk. The system in this paper is verified with the system based on improved cloud model and the system based on cloud computing.

3.3.1. Calculation Accuracy of Cost Risk Index Weight. The weight of cost risk index has an important impact on the management effect of cost risk, so the calculation accuracy of cost risk weight is selected as the experimental comparison index, and the system in this paper is compared with two traditional systems. The comparison results of the weight calculation accuracy of the three systems are shown in Figure 5.

It can be seen from Figure 5 that the calculation accuracy of the cost risk index weight has a good comparative significance. In the long-term comparison experiment results, the system can accurately calculate the cost risk index weight, and the accuracy of the risk index weight is always higher than 90%. Based on the improved cloud model system and cloud computing system, the weight calculation accuracy fluctuates greatly. Based on the improved cloud model system, the weight calculation accuracy is close to a sine wave, and the upper and lower amplitudes differ greatly. Although the weight calculation accuracy rate based on the cloud computing system has been showing a linear upward trend, the highest accuracy rate is less than 80%.

3.3.2. Can We Accurately Identify the Type of Cost Risk. Accurate identification of risk types is helpful to targeted management of cost risk, so it is necessary to verify that the system can accurately identify cost risk types. The risk type

Table 3: System function test.

Function module	Input data	Expected results	Result
User management	Click the user management function for related operations	It can edit, add, and delete user management	Pass
Log management	Click the log management function for related operations	Can query, modify, and delete other operations on the log	Pass
Basic information management	Click basic information management function to operate related functions	You can set permissions and login passwords for different users	Pass
Function management	Click function management to operate related functions	All functions of the system can be viewed, modified, and added	Pass

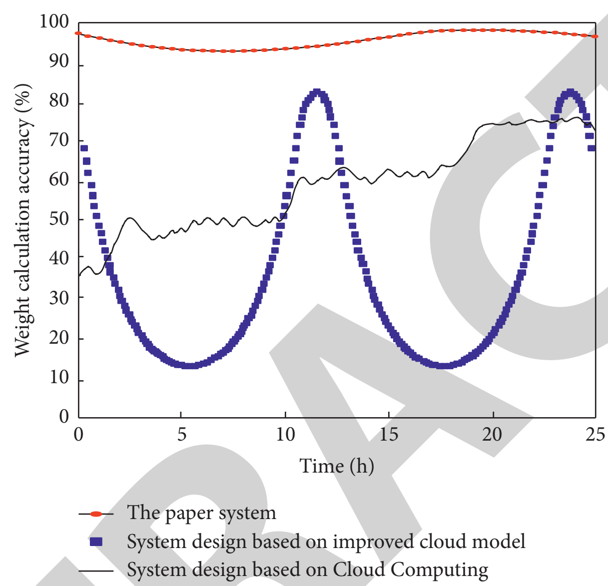

Figure 5: Comparison of weight calculation accuracy of cost risk indicators.

Table 4: Risk type identification results.

Risk type	Can we accurately identify the type of cost risk		
	Text system	System design based on improved cloud model	System design based on cloud computing
Risk of changes in laws and regulations	Yes	No	No
Risk of quantity change	Yes	Yes	Yes
Market price fluctuation risk	Yes	No	No
Internal management risk	Yes	Yes	Yes
Technical risk	Yes	Yes	No
Force majeure risk	Yes	No	Yes

identification results of the three systems are shown in Table 4.

It can be seen from the comparison results in Table 4 that this system can accurately identify six kinds of project cost risks, so it can better manage the project cost risks. However, the results of the two traditional systems are not ideal.

4. Conclusion

In order to improve the effectiveness of project cost risk management, this paper proposes a project cost risk management system based on improved fuzzy rule weight algorithm and verifies the performance of the system from both theoretical and experimental aspects. The system has good performance in project cost risk management and can accurately calculate the weight of risk indicators and identify a variety of risk types. Specifically, compared with the system based on the improved cloud model, the calculation accuracy of risk index weight is significantly improved and basically remains above 90%. Compared with the system based on cloud computing, it can identify the risk types 100%. Therefore, it fully shows that the proposed management system based on improved fuzzy rule weight algorithm can better meet the requirements of project cost risk management [14–20].

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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