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Research on Financial Risk Management in the S Water Conservancy Project and Its Implications for Similar Projects

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Abstract: As a vital infrastructure initiative with significant impacts on national development and public welfare, water conservancy projects play an essential role in advancing agricultural development and mitigating losses caused by flooding. However, these projects often require substantial investments and extended construction periods, leading to the inevitable emergence of various financial risks during implementation. This paper aims to explore the current challenges in financial risk management of the S water conservancy project, offering practical management strategies and solutions to address these financial difficulties. Through a detailed assessment and analysis of the S water conservancy project, the study seeks to provide valuable references and insights for similar projects to better manage financial risks, ensuring their smooth progression and successful completion. The proposed control measures are designed not only to effectively mitigate the financial risks specific to the S water conservancy project but also to offer actionable lessons for other similar projects. By promoting and applying these measures, the overall financial management capabilities of the industry can be enhanced, providing robust support for the sustainable development of water conservancy projects.

Keywords: Dual-carbon policy; Financial risk management; S water conservancy project

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1. Introduction

China's water conservancy project management system is undergoing a significant transformation, transitioning from a planned economy to a market-driven economy. This transition has led to the gradual emergence of financial risk issues within water conservancy construction projects. Given the dynamic and uncertain nature of these risks, extensive and in-depth research has been conducted in recent years to address them effectively. By studying and managing the financial risks associated with water conservancy projects, it is possible to optimize project financial structures, minimize unnecessary capital investments, and construct high-quality water conservancy infrastructure with minimal expenditure of manpower and capital.

The primary objective of financial risk management in water conservancy projects is to improve economic efficiency, ensure the safe operation of the projects, and optimize resource allocation. Furthermore, it seeks to provide decision-making support to guarantee the sound operation and long-term sustainability of such projects. Effective financial risk management not only enhances the financial stability of the project but also contributes to the broader goal of improving the overall efficiency and quality of water conservancy initiatives.

2. Literature review

The study conducted by Xiaolan Wang analyzed the underlying causes of financial risks and proposed corresponding management strategies. It highlighted the importance of internal auditing and the construction of a risk-aware culture within enterprises, emphasizing these factors as key to improving the overall risk management capabilities of organizations [1].

Chenxi Lu examined the challenges faced by water conservancy construction enterprises in financial management. The study focused on identifying sources of financial risks, including inadequate cost control, liquidity issues, and erroneous investment decisions. To address these challenges, the study recommended strengthening cost and budget management, optimizing capital structures, and enhancing the efficiency of capital utilization [2].

Xiaodong Wang explored the problems and potential solutions in the financial management of water conservancy projects. The study identified key issues such as lax budget control, inefficient fund utilization, and inaccuracies in financial reporting. To address these problems, Wang proposed strengthening financial systems, improving the professional qualifications of financial personnel, and adopting modern financial management tools and techniques [3].

Shujin Li's study emphasized the significance of pre-project financial risk assessment, advocating for the consideration of potential financial risks during the planning and design stages of projects. The research recommended the establishment of a comprehensive financial risk assessment system, incorporating factors such as market fluctuations, cost overruns, and financing difficulties [4].

The research by Mingxiang Zhang focused on the current risk issues in the financial management of water conservancy projects and proposed targeted countermeasures. The study identified major risks, including fund management risks, cost control risks, and investment decision risks, and provided strategies to mitigate these challenges [5].

Most domestic scholars employ quantitative methods to analyze specific infrastructure projects, but their research scope remains relatively narrow. Furthermore, much of the research on water conservancy projects centers on risk management within government investment models. This indicates a need for broader analyses, particularly those that focus on risk management in water conservancy projects as primary research subjects.

3. Financial risk evaluation of S water conservancy projects

3.1. Hierarchical analysis method and quantitative evaluation model construction

The hierarchical analysis method, a classical approach integrating qualitative and quantitative analysis, is adopted for constructing the financial risk evaluation model of the S water conservancy project. This method effectively addresses the complexity of the factors and their interconnections in decision-making. The process involves breaking down the complex financial risk factors of the S water conservancy project into multiple components and organizing them into a structured hierarchy based on their relationships. Pairwise comparisons are then used to determine the relative importance of factors at each level. Comprehensive calculations produce quantitative results that reflect the relative importance of all factors, enabling a scientific evaluation of the project's financial risks.

3.2. Constructing a judgment matrix

Upon establishing the risk framework, judgment matrices are constructed for each level to determine the relative importance of elements within the same level. These matrices, integral to the hierarchical analysis method, quantify importance by pairwise comparisons of elements using expert scoring. Scores are assigned based on a scale (e.g., 1 indicating equal importance and 9 indicating extreme importance). After assigning and organizing these scores, the maximum eigenvalue and its corresponding eigenvector for each judgment matrix are calculated using the sum-product method. The eigenvectors are normalized to derive weight values, ensuring objectivity and precision.

In evaluating the financial risk of the S water conservancy project, the criteria-level indicators impact the overall risk differently. Therefore, it is essential to analyze and assign weights to these indicators systematically. A judgment matrix is constructed for the criteria layer and individual layers below, facilitating a comprehensive evaluation of the project's financial risks.

The criteria-level indicator judgment matrix for the S water conservancy project is shown in **Table 1**:

Table 1. Criteria-level indicator judgment matrix

A	Policy risk (B1)	Legal and contractual risks (B2)	Project construction risk (B3)	Operational risk (B4)	Accounting risk (B5)
B1	1	1/2	2	1/3	1/2
B2	2	1	3	1/2	1/4
B3	1/2	1/3	1	1/3	1/2
B4	3	2	3	1	1/4
B5	5	4	5	4	1

Subsequent judgment matrices for specific indicators under each criterion layer, shown in **Tables 2–6**, are similarly constructed to assess their relative importance.

Table 2. Policy risk B1 indicator judgment matrix

B1	Government intervention (C1)	Delay in approval (C2)	Government credit (C3)	Investment funds (C4)
C1	1	3	2	1/2
C2	1/3	1	2	1/3
C3	1/2	1/2	1	1/2
C4	2	3	2	1

Table 3. Legal and contractual risk B2 indicator judgment matrix

B2	Default risk (C5)	Regulatory risk (C6)
C5	1	3
C6	1/3	1

Table 4. Project construction risk B3 indicator judgment matrix

B3	Quality compliance (C7)	Project completion (C8)	Availability (C9)
C7	1	2	3
C8	1/2	1	2
C9	1/3	1/2	1

Table 5. Operational risk B4 indicator judgment matrix

B4	Operating cost (C10)	Non-human impact (C11)
C10	1	2
C11	1/2	1

Table 6. Accounting risk B5 indicator judgment matrix

B5	Market price change (C12)	Cost overruns (C13)	Production cost overruns (C14)	Tax rate changes (C15)	Failure to meet expected benefits (C16)
C12	1	1/3	1/4	2	3
C13	3	1	1/2	3	3
C14	4	2	1	3	3
C15	1/2	1/3	1/2	1	2
C16	1/3	1/3	1/3	1/2	1

3.3. Hierarchical single ordering and consistency tests

After constructing the judgment matrices, hierarchical single ordering is performed to calculate the weights of elements in relation to higher-level elements. This involves solving for the maximum eigenvalue of the matrix and its corresponding eigenvector. The eigenvector is then normalized to determine weight values accurately. The results for the criterion-level weights are presented in **Table 7**:

Table 7. Criterion-level judgment matrix and weights

A	B1	B2	B3	B4	B5	W
B1	1	1/2	2	1/3	1/2	0.09
B2	2	1	3	1/2	1/4	0.14
B3	1/2	1/3	1	1/3	1/2	0.06
B4	3	2	3	1	1/4	0.20
B5	5	4	5	4	1	0.51

(1) Calculate the product of the row matrices of B1, B2, B3, etc., and the result of the calculation is expressed in terms of *Kn*. The calculation procedure is shown in **Equation (1)** below:

$$K = \prod_{i=1}^{n} Ui \quad (1)$$

Hence, K1 = 1 × 1/2 × 2 × 1/3 × 1/2 = 1/6; K2 = 2 × 1 × 3 × 1/2 × 1/4 = 3/4; K3 = 1/2 × 1/3 × 1 × 1/3 × 1/2 = 1/36; K4 = 3 × 2 × 3 × 1 × 1/4 = 9/2; and K5 = 5 × 4 × 5 × 4 × 1 = 400.

(2) If $n = 5$ for *Kn*, the vector β can be obtained using **Equation (2)**:

$$\beta = \sqrt[n]{Ki} \quad (2)$$

Hence, β1 = 0.70; β2 = 0.94; β3 = 0.49; β4 = 1.35; and β5 = 3.31.

(3) Regularize the above five vectors to obtain the weights of each indicator in the criterion layer: W1 = 0.09; W2 = 0.14; W3 = 0.06; W4 = 0.20; and W5 = 0.51 (**Table 7**).

(4) After the regularization of the above indicators, combined with the requirements of the hierarchical analysis method, followed by calculating the maximum eigenvalue (λ_{max}) of the criterion layer matrix based on the consistency test, using **Equation (3)**:

$$\lambda_{max} = \overline{A} \times \overline{W} \quad (3)$$

Hence, λ_{max} = 5.188.

(5) Calculate the consistency metrics (consistency index [CI] and consistency ratio [CR]) for the criterion level as well as the target level and test them using **Equations (4)** and **(5)**:

$$CI = \frac{(\lambda_{max} - n)}{(n-1)} \quad (4)$$

$$CR = \frac{CI}{RI} \quad (5)$$

where RI is a random consistency index corresponding to matrix size. If the calculated CR is less than 0.1, the judgment matrix is considered to have passed the consistency test, and the evaluation opinions of the experts or scholars are logically acceptable; if the CR is greater than or equal to 0.1, the judgment matrix needs to be readjusted until it meets the consistency requirements.

Table 8. Consistency indicator RI counterpart

N	1	2	3	4	5	6	7	8	9
RI	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52

For the criterion-level judgment matrix ($n = 5$), λ_{max} = 5.188, yielding CI = 0.047 and CR = 0.042. Since CR < 0.1, the matrix passes the consistency test.

Following this approach, consistency tests are repeated for matrices under the five guideline tiers (policy risk, legal and contractual risk, project construction risk, operational risk, and accounting risk). Each matrix passes the consistency test, confirming the logical acceptability of expert evaluations.

This process reveals that accounting risks account for the largest proportion of financial risks in the S water conservancy project, while project risks have the smallest impact. The hierarchical single ordering and consistency testing results provide a robust basis for evaluating financial risks comprehensively.

4. Analysis of evaluation results

The financial risk evaluation of the S water conservancy project identified several key indicators with significant impact, including production cost overruns, cost overruns, changes in market prices, and operating costs. These factors exert a direct and profound influence on the project's financial risks.

(1) Production cost overruns: Production cost overruns are among the most common risks in water conservancy projects. Due to the large scale, extended construction period, and technical complexity of the S water conservancy project, production costs are highly susceptible to exceeding the budget during actual construction. These overruns may stem from factors such as rising labor costs and increased equipment rental expenses. Production cost overruns not only inflate the total project cost but also risk compromising progress and quality, further intensifying the financial risks associated with the project.

(2) Cost overruns: Cost overrun is another critical financial risk indicator for the S water conservancy project. Previous studies on water conservancy project risks indicate that cost overruns may arise from design modifications, increased construction challenges, and mismanagement during the construction process. If project costs exceed the budget, the construction timeline and successful completion of the S water conservancy project may be jeopardized. To mitigate the risk of cost overruns, project managers should conduct thorough market research and risk assessments at the project's inception and establish scientifically rigorous cost budgets. Furthermore, during project implementation, cost control measures should be continuously reinforced, and robust regulatory mechanisms should be established to ensure project costs remain within budgetary constraints.

(3) Changes in market prices: Market price fluctuations are a major factor influencing the financial risk of the S water conservancy project. Given the project's extended construction period, it is likely to encounter significant changes in market conditions. For instance, variations in the costs of raw materials, labor, and equipment rentals due to supply and demand dynamics can directly affect project expenses and exacerbate financial risks. To effectively address this risk, project managers must maintain heightened vigilance and monitor market trends closely. Based on such observations, procurement strategies and construction plans should be adjusted flexibly to mitigate the impact of price fluctuations, ensuring the financial stability of the project.

(4) Operating costs: Operating costs represent another crucial aspect of financial risks in water conservancy projects. Effective management of operating costs is essential for maintaining the project's financial health. In the S water conservancy project, these costs include routine maintenance expenses, personnel costs, energy consumption, and more. Given the prolonged operational lifecycle of water conservancy projects, the cumulative impact of these costs can be substantial. If operating costs are not adequately controlled, they can directly undermine the project's economic efficiency and return on investment.

By addressing these critical risk factors, the S water conservancy project can mitigate potential financial challenges and ensure the project's overall viability and success.

5. Conclusion

Water conservancy projects are critical livelihood initiatives in China, with their successful implementation and stable operation being of utmost importance. Given the lengthy construction periods and numerous uncertainties associated with such projects, this study employs the hierarchical analysis method to quantitatively assess the risks of the S water conservancy project. By conducting literature reviews and field interviews, complex risk indicators were identified and decomposed to facilitate a comprehensive evaluation and prioritization of risks, thereby determining their magnitude and hierarchy.

Project S faces unique risks, including policy changes, primarily due to its significant dependence on government investment. After identifying these risk factors, causal analysis was conducted to evaluate the influence of both external and internal conditions on these risks and to formulate appropriate mitigation measures. The findings indicate that the S water conservancy project has made considerable progress in financial risk management.

It is recommended that the project team continue to draw on risk management experiences and develop a scientifically informed risk response strategy tailored to the project's specific characteristics. Regular risk assessments and management training should be conducted to enhance the team's capabilities and ensure the project's stable operation. Additionally, a robust risk information-sharing mechanism should be established to ensure the timely and accurate exchange of risk-related information.

Collaboration and communication with government authorities and financial institutions should be emphasized to establish a stable and interconnected risk management network. Risk management measures should be continuously monitored, with strategies adjusted according to prevailing conditions. Establishing a dynamic management mechanism will enable the project to respond flexibly to risks and achieve its ultimate objectives effectively.

Disclosure statement

The authors declare no conflict of interest.

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