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A Study on the Risk Assessment of Water Conservancy Scenic Spot PPP Projects

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Abstract: The water conservancy scenic spot is an important part of China's water ecological civilization construction and is an important way to transform "clear water and green mountains" into "mountains of gold and silver". The current development of the water conservancy scenic spot is limited by the conditions of capital, management, and technology. The PPP model, as a means of introducing these elements, is an effective way to realize the marketization, characterization, and high-quality development of water conservancy scenic spots. Due to the particularity and complexity of water conservancy scenic spots, the PPP model, and their combination, the risks in water conservancy scenic spot PPP projects are more complicated. Identification and assessment, as well as response, are necessary ways to reduce project risks. In this paper, the risk evaluation index system and the DEMATEL-ANP-FUZZY risk evaluation model of the water conservancy scenic spot PPP project are put forward and, then, the key risk factors, causal relationship between the factors, and risk level of the project are obtained in combination with case analysis. The results show that risks in construction and operation, as well as political and economic risks, are the key risk factors in the water conservancy scenic spot PPP project, and the natural, economic and political risk factors are the main causes of project risk. Risks in construction and operation, as well as organizational and social risks, are the main affected factors. Further analysis shows that the political and economic factors are the key points to focus on when attempting to reduce the project risk, and suggestions are provided, such as improving the legal and regulatory framework, establishing a reasonable risk-sharing and social capital withdrawal mechanism, unblocking social capital participation channels, and strengthening financial support. This could provide a reference for the risk management of water conservancy scenic spot PPP projects.

Keywords: water conservancy scenic spot; PPP model; indicator system; DEMATEL-ANP-FUZZY model; risk assessment

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1. Introduction

A water conservancy scenic spot refers to an area with scenic resources and environmental conditions of a certain scale and quality based on water (water bodies) or water conservancy projects, where sightseeing, entertainment, leisure, vacation, science, culture, education, and other activities can be carried out [1]. As a support for developing water conservancy tourism, the water conservancy scenic spot is a mode of resource development and conservation [2]. It has six main functions: maintaining water engineering, protecting water resources, improving the water environment, restoring water ecology, promoting water culture, and developing the water economy [3]. The water conservancy scenic spot is an important part of China's water ecological civilization construction, and is an important way to transform "clear water and green mountains" into "mountains of gold and silver". However, water conservancy scenic spots lack the support of special funds and professional operation and management, and the comprehensive capacity of the construction and development subject is relatively insufficient. These problems limit the construction of water conservancy scenic spots and the development and utilization of water conservancy scenic resources. In recent years, the construction of an ecological civilization in China has been strengthened, and more attention has been paid to water conservancy scenic spots. Many relevant supporting documents have been issued, mainly focusing on the introduction of social capital and the development of a public–private partnership (PPP) model of water conservancy scenic spots.

A PPP is an institutionalized form of cooperation between the public and private sectors through which participants develop mutual products and services [4]. In 2013, the China Ministry of Water Conservancy proposed innovating the investment and financing model, further introducing a market mechanism, opening up a wide range of funding channels, and encouraging and guiding social capital to participate in the construction of water conservancy scenic spots in "Several Opinions on Further Improving the Work of Water Conservancy Scenic Spots". The 2014 "Guidance of the National Development and Reform Commission on the Development of Government-Social Capital Cooperation" identifies the scope of application of the PPP model to include water conservancy, resource environment, and ecological protection projects. In March 2022, the "Measures for the Administration of Water Conservancy Scenic Spots" proposed to "encourage social capital to participate in the construction and operation of water conservancy scenic spots". In May 2022, the "Guiding Opinions on Promoting the Development of the PPP Model of Water Infrastructure" aimed to "standardize and actively guide social capital to participate in the construction and operation of water infrastructure, better adapt to the financing needs and broaden long-term financing channels for water infrastructure construction, and provide financial security for accelerating the construction of a modern water infrastructure system". The "Guiding Opinions" (XII) suggest "expanding the market financing channels and attracting social capital to participate in the construction and management of water conservancy scenic spots". Water conservancy scenic spots combine water conservancy, resource environment, and ecological protection. According to sociohydrology, human activities have an impact on the water environment. With climate change and human activities, the relationship between the human social system and the hydrological system is becoming closer. Different groups, such as the government, social capital, and the public, play different roles in water conservancy scenic spots to jointly promote the construction and development of the water conservancy scenic spot [5].

The PPP mode of water conservancy scenic spots, that is, the local government with jurisdiction, will grant the management and operation rights regarding state-owned water conservancy scenic resources to the water conservancy scenic spot investment and operation company established by the social capital subject, either through a franchise or as entrusted by the management, and the investment and operation company are responsible for the construction, management, and operation of the scenic spot regarding the matters that were agreed on in the contract, while the water conservancy, tourism, environment, and other departments exercise the supervision power according to law and regulations [6]. The introduction of the PPP mode to the construction of water conservancy scenic spot projects can innovate the investment mode, broaden financing channels, reduce the government's financial burden, introduce advanced technology and management experience to the project, and improve the efficiency and quality of the project. However, there are many participants in PPP projects, representing different interests, with asymmetric information. This can lead to a lack of flexibility in cooperation. Water conservancy scenic spot PPP projects should consider the impact on water conservancy projects, which makes the project risk factors multiple, complex and changeable, and more difficult in risk management. Therefore, identifying the risk factors, establishing a risk evaluation index system, building a risk evaluation model for risk evaluation, and conducting risk response or control according to the evaluation results can effectively reduce the risks inherent in water conservancy scenic spot PPP projects, which is very important for the application of PPP models in water conservancy scenic spots and the risk management and sustainable development of water conservancy scenic spots.

2. Literature Review

The risks of water conservancy scenic spot PPP projects include the commonness of PPP project risks and the specific risks of water conservancy scenic spots. At present, there is no research on the risks of water conservancy scenic spot PPP projects. Therefore, this paper analyzes the risks from two aspects: PPP project risks and water conservancy scenic spot project risks.

2.1. PPP Project Risk Factors and Risk Assessment Methods

The risk factors of PPP projects are interrelated and mutually affect each other. The correlation between risk factors of PPP projects is shown as the occurrence of each risk that will worsen the impact of other risks [7]. Legal and policy risks are the most influential and interdependent risks in China's PPP projects, and the interest rate risk is the most essential risk [8]. Legal risks are also considered to be one of the most serious risks in international PPP projects. There are legal risks at each stage, and these are interrelated [9]. For PPP projects with risk factors that influence and interact with each other, it is important to analyze the interdependence between factors and identify key risks, as well as study the risk transmission path and preventive measures for such PPP projects [4,10].

Different types of projects have different risk factors. PPP projects regarding transportation facilities mainly face political, legal, and financial risks [7,11–13]; power and energy PPP projects mainly have legal, contractor, and operator risks [14]. The key risk factors for China's water environment governance PPP projects are political risks, construction and operation risks, as well as ecological risks and economic risks; the key risks in sponge city PPP projects in China are an imperfect regulatory system, government intervention, immature laws and regulations, fragmented projects, and unclear watershed boundaries [15,16]. The main risks in PPP projects are political, legal, economic, social, environmental, construction, and operational risks.

In addition, risks also vary according to the different countries or regions in which PPP projects are located. The experience of PPP projects in developed and developing countries varies according to the existing legal, economic, social, and political environment. The main risks of PPP projects in developing countries include inflation, political situation, law and order, corruption, end-user income risks, and foreign exchange fluctuations [17]. The main risk factors of PPP projects in China are government intervention, poor public decision-making processes, and legal risks [8,16,18] due to a poor legal and regulatory system and ineffective public decision-making processes [19]. Analyses of successful PPP projects in developed countries, such as the United States, the United Kingdom, and Japan, revealed that economic feasibility, appropriate risk allocation, sound financial solutions, and a favorable investment environment are key factors for the success of PPP projects [20]. The reasons for PPP's implementation in developed and underdeveloped regions are different. Developed regions focus on efficiency and quality services while developing regions focus on economic and social benefits [9,21].

In terms of PPP project risk-assessment methods, the Technique for Order Preference by Similarity to an Ideal Solution [22], Decision-Making Trial and Evaluation Laboratory [16], Interpretive Structural Model [10,23], Structural Equation Model [24], Analytic Hierarchy Process [7,14], and the Fuzzy comprehensive evaluation method [19] are widely used. In general, the risk assessment methods of PPP projects are mainly qualitative [25,26] and quantitative analysis [9,27]; among them, the Fuzzy assessment [13,25,26,28], the Analytic Network Process [7,8] and the Cloud Model [15,29,30] are most frequently applied. PPP project risk assessment methods are very mature but, when used in water conservancy scenic spot PPP projects, it is difficult for a single method to reflect the complex risk situation. Most risk assessment models either ignore the correlation between risk factors [11] or quantify some concepts with unclear boundaries. It is difficult to quantify in a "one-size-fits-all" manner [31]; this leads to the fuzziness of factors being ignored, and the results not being in line with the actual situation of the project.

2.2. Sustainable Development and Risks of Water Conservancy Scenic Spots

There are five aspects of sustainable development in water tourism: economic sustainability, social sustainability, environmental sustainability, management sustainability, development conditions, and potential [32]. The deterioration of natural attractions, historical relics, infrastructure, artifacts, and the environment are the main problems faced by tourist destinations around the world [33]. Deterioration is the result of a series of human and natural forces, including tourism activities, weather events, policies, inadequate planning and management, and political unrest. Although tourist visits are not the only source of deterioration, over-tourism is an important factor. In fact, tourism is based on consumption rather than production. Evidence suggests that the excessive use of water resources by tourism is at least twice as much as that used by permanent residents, which may lead to water shortages, water supply degradation, and increased wastewater production [34]. While developing economic and social benefits, water conservancy tourism may overload the environmental carrying capacity [35], especially the consumption of water resources and the pollution of the water environment [36]. Many tourist destinations are implementing various water management programs to reduce the environmental impact of tourism and improve sustainability [37]. Water conservancy scenic spots face great difficulties in resource development and management in the important task of water resource management [38].

Water conservancy tourism resources have rich landscape types, profound cultural heritage, and precious spiritual wealth, showing the comprehensive value of water conservancy scenic area development. The development of resources in water conservancy scenic spots includes the development of material, cultural, and spiritual resources [39]. The development of water conservancy tourism resources and water conservancy scenic spots is inseparable from the construction and improvement of supporting infrastructure. Fewer studies have been conducted on resource development, such as the supporting infrastructure, roads, scenic climate, and maintenance of water conservancy projects. Other risk factors during project construction have also not been addressed. Studies have shown that roads and the transportation infrastructure support the development of tourism [40], can change the spatial distribution and accessibility of water conservancy scenic spots [2,41] and facilitate access to tourist destinations, increasing commercial activities in the region and enhancing not only existing tourism activities, but also the development of new tourist attractions in the region [42,43].

In the management of water conservancy scenic spots, it is important for tourism management to improve tourist satisfaction and scenic influence. Factors affecting tourists' satisfaction with water tourism include tourism resource perception, cultural landscape, hydrological landscape, thematic features, and location conditions [44]. It is necessary to promote the influence of water conservancy scenic spots. For natural and cultural attractions, video ads are similar to, or better than, virtual reality ads, with print ads being the least effective [45]. The most difficult aspect of water conservancy scenic spots' management is risk management. At present, water conservancy scenic spots still face problems in attaching importance to the declaration, construction, and development, but not to planning, protection, and management [39]. Due to COVID-19, risk management has become a hot topic in tourism management, as the global tourism industry has suffered tremendous losses [46]. Water conservancy scenic spot projects, especially after the introduction of the PPP model, have many participants and stakeholders. The project situation is special and complex, and easily affected by natural and human factors. The biggest difference between water conservancy scenic spots and other types of scenic spots is that water conservancy scenic spots are based on water conservancy projects, and their operation and management should be coordinated according to the seasonal operation of these water conservancy projects. There are no studies on the risk management of water conservancy scenic spots, only on the application of PPP models in water conservancy scenic spots [6,47] and the coordination of governmental and social capital interests [48].

According to the above literature research, the risk factors of PPP projects differ according to type or region, but generally include political, economic, social, environmental, construction, and operational aspects, and there are correlations between the risk factors. Some risk factors, such as interest rate risk, are easy to quantify, while some risk factors, such as government credit, are difficult to quantify. The key to risk assessment is in comparing various risks using a unified scale. However, the previous research methods either failed to quantify the impact of risks and compare the importance of various risk factors, failed to express the fuzzy relationship between risk factors, or ignored the correlation between risk factors and regarded each risk as independent, which is not in line with the actual situation. The risks of water conservancy scenic spot PPP projects include the risks in the development of water conservancy tourism resources and project management, which requires an analysis of the characteristics of the water conservancy scenic spot PPP project itself and the environment in which it is located. A risk assessment index system should be established, and a risk assessment model should be built by combining Analytic Network Process (ANP) with the Decision-Making Trial and Evaluation Laboratory (DEMATEL) and Fuzzy comprehensive (FUZZY), which can not only quantitatively describe and compare the risks, but also express the correlation between the factors. This is more scientific and operable than the previous methods, and is groundbreaking for the risk assessment of water conservancy scenic spot PPP projects.

3. Methods

This paper constructed a risk analysis framework for water conservancy scenic spot PPP projects, as shown in Figure 1. The framework is divided into three steps, including risk identification, risk assessment, and risk response. In risk identification, the risk evaluation index system is determined through literature research, classic case analyses, a questionnaire survey, and an expert interview. Using risk assessment, the DEMATEL-ANP-FUZZY risk assessment model was developed. Firstly, DEMATEL was applied to determine the causal relationship between risk factors; then, the ANP was applied to determine the weight of each risk factor according to the correlation. Finally, the FUZZY method was applied to determine the project risk level by combining the index weights. In risk response, risk response measures were formulated according to the assessment results, focusing on controlling the incidence, severity, and propagation of key risk factors, clarifying the causal relationship between risk factors, finding the root risk, reducing the risk level of the project, and making suggestions for the risk management of water conservancy scenic spot PPP projects.

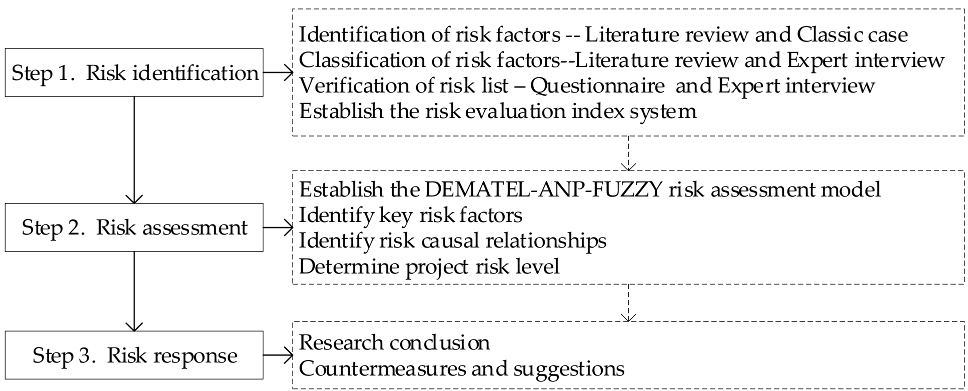


Figure 1. Research framework.

3.1. Risk Identification

The list of risks in water conservancy scenic spot PPP projects is determined by referring to a large number of classic cases and the literature. Six risk factors were established: politics, economy, society, nature, construction, and operation. Then, the feasibility of risk factor selection and the scientificity of the groupings were verified through field investigation, questionnaires, and expert interviews, and key risk factors were selected to determine the final risk evaluation indexes in Table 1.

Table 1. PPP project risk evaluation index system of water conservancy scenic spots.

Risk Groups	Types of Risks	Factor Interpretation	Literature Source
Political	Government credit	The rejection or delays in implementing the responsibilities agreed on in the contract cause direct or indirect damages.	[8,11,12,16,18,19,23,49]
	Government intervention	The public sector unreasonably interferes with privatized facilities or services.	[11,12,16–19,30,49]
	Government corruption	Corruption increases the cost of maintaining the relationship between the government and the project company, and increases the risk of the contract being broken by the government.	[11,12,17–19,30,49]
	Poor political decision-making process risk	Nonstandard procedures, bureaucracy, lacking PPP or experience and ability in water conservancy scenic spot projects, insufficient preparation, and information asymmetry lead to poor decision-making.	[8,12,17–19,23,30,49]
	Delay in project approvals/permits	Complicated procedures are required for project approval, with high costs and a long duration.	[11,12,16–19,49]
	Expropriation and nationalization	The central or local government seizes the projects.	[8,11,12,17–19]
	Inadequate law and supervision system	The damage arising from the water tourism or PPP legislation is low level, has low effectiveness, and leads to conflict and poor operability.	[11,12,16–19]
	Changes in laws and policies	Changes in laws, regulations, and other government macroscopic economic policies will increase project costs and decrease revenue, etc.	[8,11,12,17–19,23,49]
Financial and Economical	Inflation risk	The devaluation of currency or price rises lead to increases in project cost and declines in consumption power lead to tourism depression.	[8,11,12,16,17,19,30]
	Interest rate risk	The loss of projects arising from a volatile interest rate.	[8,11,12,17–19,30]
	Exchange rate fluctuations	The risk of the variability in foreign currencies and the foreign currencies' exchangeability.	[11,16–19,30]
	Financing risk	The risk arising from the irrational financing structure, unsound financial market, and difficulties financing.	[8,18,19,23]
	Market competition	Actual market competition is caused by the new project or rebuilding project, between the government and other investors, and the uniqueness and exclusivity of the project itself.	[11,12,17–19,32,39,49]
Social	Industry influence	The popularity of the scenic spot, the public's understanding and inheritance of the water culture, and whether there is a cultural conflict regarding multi-cultural integration.	[11]
	Security risk	Safety of scenic activities and their impact on social security and stability.	[8]
	Risk of disease transmission	Neglect in the management of the scenic spot and control of the spread of diseases causing adverse effects, especially since the outbreak of COVID-19.	
	Public support	The public and residents around the project love and accept the water conservancy scenic spot.	[8,23,30,32]

Table 1. *Cont.*

Risk Groups	Types of Risks	Factor Interpretation	Literature Source
Environmental	Unforeseen weather/ geotechnical conditions	Due to the bad natural conditions at the project site, for example, climate conditions, special geographical environment, poor site conditions, etc.	[8,11,12,17–19]
	Ecological sensitivity	The solid, liquid, and gas wastes and noise generated by human activities during scenic spot construction and tourism cause changes in environmental capacity and ecological sensitivity.	[32,38]
Construction	Delay in project	Construction delays caused by approval or other reasons.	[8,11,12,16,30]
	Overrun of construction costs	Increases in price and labor wages, backward technology, low resource utilization efficiency, unregulated management, and equipment damage.	[8,16,30]
	Project quality	Engineering quality problems caused by technology, materials, etc.	[8,30]
	Technical and design risk	Immature technology, design defects, equipment failures, professional inconsistency of operation and maintenance personnel, lack of management experience, etc.	[8,11,12,16–19,23,30,32,39]
	Construction completion risk	Project delays and cost overruns, etc., which cause insufficient cash flow and the inability to pay off debts on time.	[11,12,17–19,23]
	Lack of material/labor	Inadequate or late supply of labor, resources, energy, equipment, and unreasonable equipment procurement systems and models.	[11,17–19,30]
	Contract risk	The risk of inaccurate, vague, inflexible, and inconsistent contracts, as well as inequitable risk-sharing, an unclear division of responsibility, etc.	[8,11,12,17–19,23,30]
	Project/operation changes	Poor constructability in the design phase, design error or vagueness, variations in standards and contracts, and variations in owners lead to changes in the project or its operation.	[12,17–19,23]
	Protection of historical and heritage objects	The impact of the consideration and protection of water conservancy projects and historical buildings on project construction.	[11]
	Force majeure	Before signing the contract, the contracting party cannot reasonably control or prevent this. When the events occur, the situation cannot be escaped or conquered, such as a worker strike, or other unforeseen items that are not “natural” risks.	[8,11,12,16–19,23,30,49]

Table 1. *Cont.*

Risk Groups	Types of Risks	Factor Interpretation	Literature Source
Operation	Operating and maintenance costs overruns	Improper measurement, schedule, or low operating efficiency. The government raises the standard of the products or services leading to cost overrun due to noncommercial factors, such as an increase in interest rates, exchange rates or force majeure, or poor operation management. Maintenance costs are higher than expected and repairs are too frequent.	[8,11,12,17–19,30]
	Operation revenue risk	Lower than expected demand, prices, and operating efficiency.	[8,11,16,17,23,30,32,39,49]
	Expense payment risk	The project infrastructure or process of the service provider is affected by other factors, which prevent the timely payment of the client's (or government's) fees.	[12,16,18,19]
	Risk of tourism service	Water conservancy tourism consulting the service level, scale, and completeness of tourism facilities, the supply and maintenance of recreational resources, the perfection of accommodation and catering, a suitable travel period, etc.	[32,38,50]
	Tourism management risk	Lack of management talent, imperfect organization and leadership, low management level, imperfect management system, and lack of authoritative management organization.	[32,39]
	Publicity risk	Insufficient marketing efforts and poor promotional channels for water conservancy tourism.	[39]
	Traffic location conditions	The traffic and location conditions of the scenic spot are poor, and the spatial relevance of the scenic spot is not strong.	[32,38,41,50]
	Organization and coordination risk	Due to the insufficient coordination ability of the project company, the cost of communication among project participants increases, and conflicts occur.	[8,11,12,17–19,23]
	Risk of tourism resources	Serious homogenization or insufficient attraction of water, water conservancy, ecology, humanities, and other resources.	[1,32,38,39,41,50,51]
	Market risk	The influence of the market radiation of scenic spots, the economy of tourist source areas, population density, tourist growth rate, tourist consumption power, and other factors.	[38]
	Third-party risk	The credibility and reliability of third parties and their willingness to fulfill their obligations in the future.	[8,11,12,18,19,30]

3.2. Proposed Model

3.2.1. Related Method

(1) The DEMATEL method calculates the influence degree and affected the degree of each element on the others according to the logical relationship and direct influence matrix between the elements in the system. This can be used to calculate the degree of centrality and causality of each element and used as the basis for constructing the model. The causal relationship between the elements and the position of each element in the system is determined. The centrality indicates the importance of risk factors. The higher the centrality value, the more important the corresponding risk factor is, and the more important it needs to be taken into account. The correlation indicates the degree to which the risk factor influences or is influenced by other factors. If the correlation degree is >0, it indicates that the risk factor mainly affects other factors,

and if the correlation degree is <0, it indicates that the risk factor is mainly affected by other factors.

(2) The Analytic Hierarchy Process (AHP) aims to divide the complex problem into individual constituents and cluster them according to the dominance relationship to form an ordered recursive hierarchy, in which there is no dominance and subordination relationship between any two elements at the same level. The levels are internally independent and only the upper-level elements have dominance over the lower-level elements. Then, through judgment and a two-by-two comparison according to the proportional scale, the relative importance of each element is determined relative to each criterion of the previous level to form a judgment matrix. Then, through comprehensive judgment, the weight ranking of the importance of each decision element is determined relative to the total goal. In the actual situation, the sets of elements in the system may influence each other; not only is there a dominant effect of the upper-level elements compared to the lower-level elements, there may also be dependency and feedback between and within the sets of elements. Both a recursive hierarchy and a network hierarchy exist. Therefore, the Analytic Network Process (ANP) is proposed to accommodate this complex structure in decision science.

(3) The FUZZY method is a comprehensive evaluation method based on fuzzy mathematics, applying the principle of fuzzy relationship synthesis, quantifying some factors with unclear boundaries that are not easy to quantify, and conducting a comprehensive evaluation of the subordination level status of the evaluated item by looking at multiple factors.

3.2.2. The DEMATEL-ANP-FUZZY Model

The DEMATEL-ANP-FUZZY model, shown in Figure 2, is an evaluation model combining the DEMATEL, ANP, and FUZZY methods. This model not only qualitatively analyzes the correlation between indicator factors, it also quantifies indicators that are difficult to quantify, finds the key risk factors, identifies the correlation between factors, and determines the risk level, making the evaluation more scientific and operable.

Step 2.1. According to the risk evaluation index system constructed in step 1, the DEMATEL method is used to determine the importance of the risk factors and the correlation between factors.

Firstly, the direct relation matrix A is determined by the evaluation index system.

Secondly, the comprehensive influence matrix T is obtained by standardizing A, where $i, j = 1, 2, \cdots, n$, E is the identity matrix.

$$X = kA \tag{1}$$

$$k = min\left\{ \frac{1}{\underset{1 \le i \le n}{max} \sum_{j=1}^{n} |a_{ij}|}, \frac{1}{\underset{1 \le j \le n}{max} \sum_{i=1}^{n} |a_{ij}|} \right\} \tag{2}$$

$$T = \sum_{i=1}^{+\infty} X^i = X(E - X)^{-1} \tag{3}$$

T_D is obtained by setting the influence value in T, which is less than the threshold value, to 0. The influence degree β is obtained by adding each line of T_D and the γ obtained by adding each column of T_D.

Finally, the centrality $(\beta + \gamma)$ and causality $(\beta - \gamma)$ degrees are obtained. The causality diagram is drawn and the correlation between factors is analyzed according to the degree of centrality and causality.

Step 2.2. According to the importance and correlation of the risk factors obtained in step 2.2, the ANP method is used in combination with a questionnaire survey and expert interview to obtain the correlation model of each risk factor and factor group, as well as the weight of each indicator.

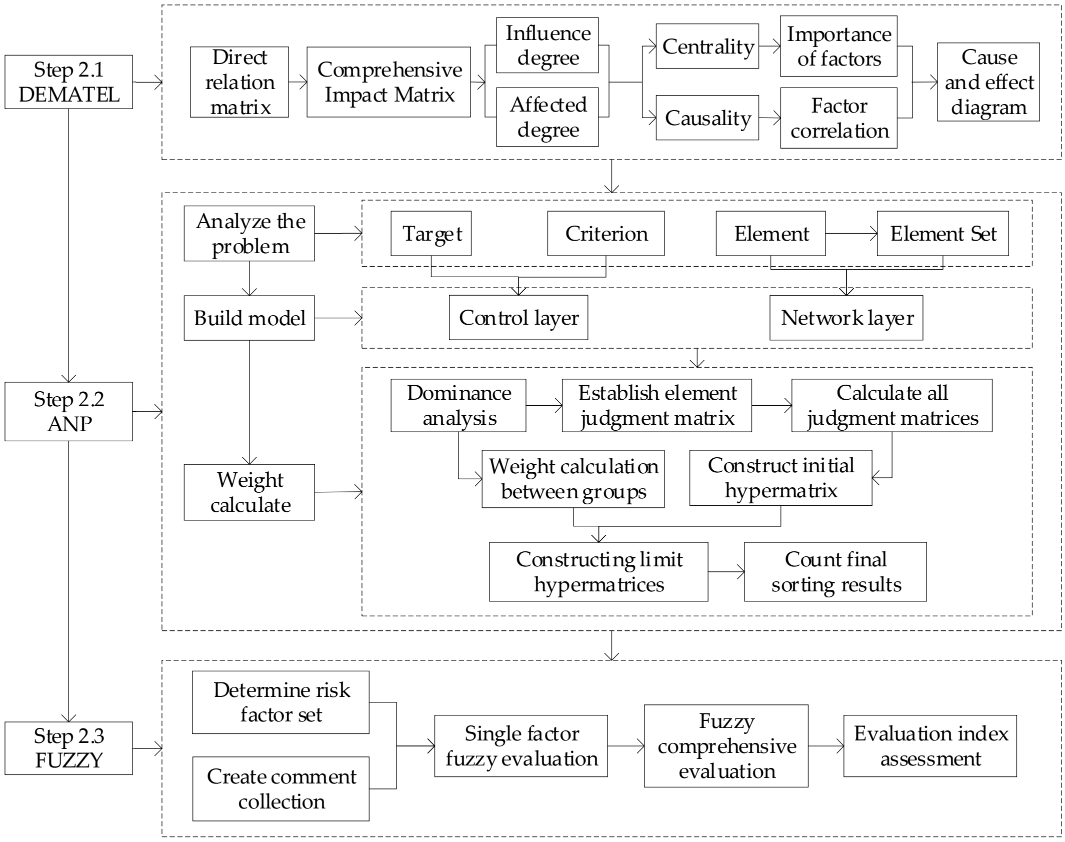


Figure 2. The DEMATEL-ANP-FUZZY risk assessment model.

Firstly, the decision problem is systematically analyzed, the objectives, criteria, and elements are determined, and the sets of elements are determined according to the principle of "things are clustered together".

Secondly, the control and network layer are determined and the ANP structure model is constructed, as shown in Figure 3.

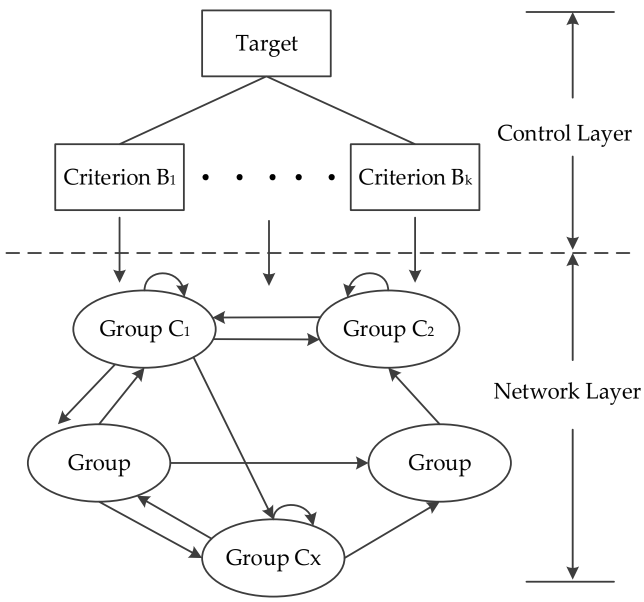


Figure 3. The ANP basic structure model.

Finally, the weight of each index is calculated by establishing the element judgment matrix, supermatrix, weighted supe matrix, and limit matrix using dominance analysis. The elemental judgment matrix, supermatrix W, weighted supermatrix W', and limit matrix Z^{∞} are as follows. The judgment matrix is as Table 2.

$$W = \begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1j} \\ w_{21} & w_{22} & \cdots & w_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ w_{i1} & w_{i2} & \cdots & w_{ij} \end{bmatrix} \quad (4)$$

$$w_{ij} = \begin{bmatrix} w_{i1}^{(j1)} & w_{i1}^{(j2)} & \cdots & w_{i1}^{(jm)} \\ w_{i2}^{(j1)} & w_{i2}^{(j2)} & \cdots & w_{i2}^{(jm)} \\ \vdots & \vdots & \ddots & \vdots \\ w_{in}^{(j1)} & w_{in}^{(j2)} & \cdots & w_{in}^{(jm)} \end{bmatrix} \quad (5)$$

$$W' = \begin{bmatrix} d_{11}w_{11} & d_{12}w_{12} & \cdots & d_{1j}w_{1j} \\ d_{21}w_{21} & d_{22}w_{22} & \cdots & d_{2j}w_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ d_{i1}w_{i1} & d_{i2}w_{i2} & \cdots & d_{ij}w_{ij} \end{bmatrix} \quad (6)$$

$$Z^{\infty} = W'^{\infty} Z^{(0)} = \lim_{l \to \infty} W'^{l} Z^{(0)} \quad (7)$$

where m and n are the numbers of element groups and elements in the groups, i and j are arbitrary element groups, t is any element in the group, and d_{ij} is the weighted matrix element. The 1–9 scale method was used $(p,\ q,\ r = 1,\ 2,\ 3,\ \ldots,\ 9)$.

Table 2. The judgment matrix.

c_{jt}	c_{i1}	c_{i2}	$\cdots$	c_{in}	**Normalized Eigenvector**
c_{i1}	1	p	$\cdots$	q	$w_{i1}^{(jt)}$
c_{i2}	$1/p$	1	$\cdots$	r	$w_{i2}^{(jt)}$
	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$
c_{in}	$1/q$	$1/r$	$\cdots$	1	$w_{in}^{(jt)}$

Step 2.3. The FUZZY method is applied to calculate the overall risk level of the project and the risk level of each first-level index, in combination with the weight of each index obtained in step 2.2.

Firstly, determine the set of risk factors U and the commentary V (n is the number of risk sets and l the number of risk levels).

$$U = \{U_1, U_2, \cdots, U_n\} \quad (8)$$

$$V = \{V_1, V_2, \cdots, V_l\} \quad (9)$$

Secondly, carry out a single-factor fuzzy evaluation. Determine the evaluation object's degree of membership in each element in the evaluation set r_{ij}. The evaluation result of the U_i can be expressed by the fuzzy set as follows (R_i is the single-factor evaluation set):

$$R_i = (r_{i1}, r_{i2}, \cdots, r_{im}) \quad (10)$$

Then, the fuzzy comprehensive evaluation of the first-level index H_i is obtained and expressed as follows:

$$H_i = G_i \cdot R_i = (g_1, g_2, \ldots, g_n) \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} = (h_1, h_2, \cdots h_m) \tag{11}$$

where G_i is the weight of each group of secondary indexes and is calculated using the ANP method. Then, the overall risk evaluation vector B is obtained and defined as follows:

$$B = GH \tag{12}$$

G is the total sorting weight set and H is the fuzzy comprehensive evaluation set. This can be expressed as $H = (H_1, H_2, \cdots, H_i)^T$.

Finally, the overall risk level of the project S and the risk level of each first-level indexes S_i is ($i = 1, 2, \cdots, 6$):

$$S = BV^T \tag{13}$$

$$S_i = H_i V^T \tag{14}$$

4. Case Analysis

The proposed research framework is applied to the PPP project of the Lianyungang Linhong River water conservancy scenic spot in Lianyungang, Jiangsu. The project belongs to the environmental protection industry, focusing on the implementation of wetland protection and restoration projects, protecting the rich flora and fauna resources, and carrying out various forms of wetland science education, ecological tourism and leisure activities, promoting wetland culture, and looking at the ecological, social, and economic benefits of the water conservancy scenic spot.

The total investment of the project is CNY 324 million. It adopted the operation mode of Design-Build-Operate-Transfer (DBOT), with the return mechanism of a feasibility gap subsidy. The project is funded by the state-owned asset financier designated by the government and the social capital party. This was selected through a statutory means to form the project company, which is responsible for the design, investment, construction, operation, maintenance management, and transfer of the project.

4.1. Risk Identification

According to the risk evaluation index system of the water conservancy scenic spot PPP projects constructed in Table 1, and combined with the actual situation of the project, the risk factors with relatively high occurrence, severity, and propagation rates are identified, screened, and grouped by category. The selected index factors should be typical, representative, and operable, and revised according to the results of questionnaires and expert interviews to form a risk evaluation index system, as shown in Table 3. The questionnaire was distributed online to the managers and employees of the Lianyungang Linhong River wetland park and the expert interview was conducted online. The basic information of the experts who were interviewed is shown in Appendix A, Table A1.

Table 3. Centrality and causality of indexes.

First-Level Indexes	Centrality	Causality	Second-Level Indexes	Centrality	Causality
C_1: Political	10.78369	0.58192	C_{11}: Government credit	12.26858	−1.22723
			C_{12}: Changes in laws and policies	10.98223	1.81191
			C_{13}: Poor political decision-making	12.10028	1.26088
C_2: Financial and Economical	9.52152	1.20677	C_{21}: Inflation risk	6.84185	4.94418
			C_{22}: Financing risk	13.05821	−2.42759
C_3: Social	8.86365	−0.94367	C_{31}: Industry influence	11.06164	−1.00332
			C_{32}: Public support	11.25926	0.49944
C_4: Environmental	6.03801	1.87374	C_{41}: Unforeseen weather/ geotechnical conditions	7.04019	2.74863
			C_{42}: Ecological sensitivity	9.35694	0.53310
C_5: Construction and Operation	11.77884	−1.76240	C_{51}: Delay in project	15.01180	−3.63650
			C_{52}: Overrun of construction and operation costs	13.39386	−3.46701
			C_{53}: Project quality	14.36252	−1.10797
			C_{54}: Technical and design risk	11.63109	0.41201
			C_{55}: Force majeure	8.83671	3.37339
C_6: Organizational	5.50916	−0.95637	C_{61}: Third-party risk	12.87667	−1.65502
			C_{62}: Organization and coordination risk	11.35525	−1.05888

4.2. Risk Assessment

Step 2.1. This aimed to analyze the importance and causality of the risk factors in the case project. The DEMATEL method and the MATLAB 2016 software were applied to analyze the risk factors and derive the centrality and causality of each indicator, as shown in Table 3. A cause-and-effect diagram of first-level indicators is shown in Figure 4.

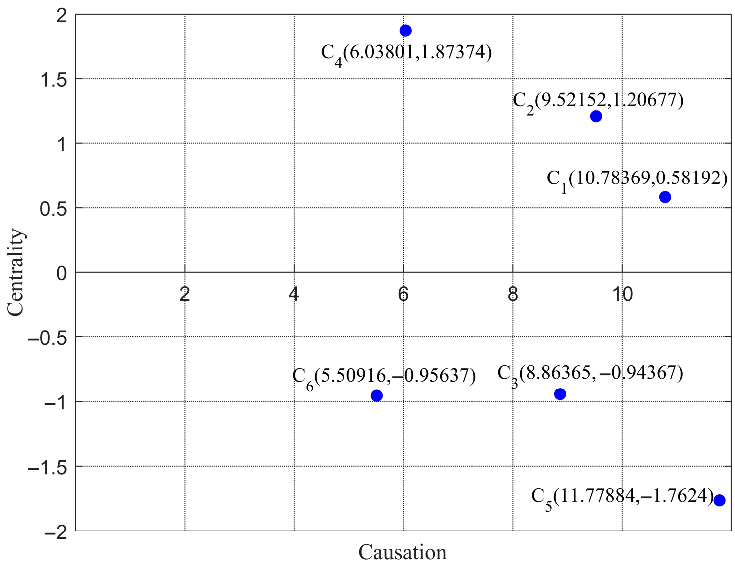


Figure 4. Cause-and-effect diagram of first-level indicators.

Step 2.2. There are dependency and feedback relationships between many factors in the project. According to the risk evaluation index system of the project, the ANP network model shown in Figure 5 was constructed and the index weight was calculated using the ANP method and Super Decisions (SD) software.

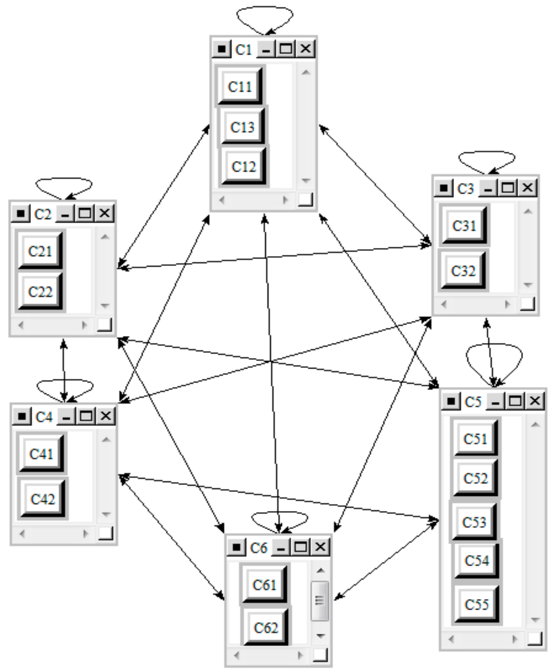
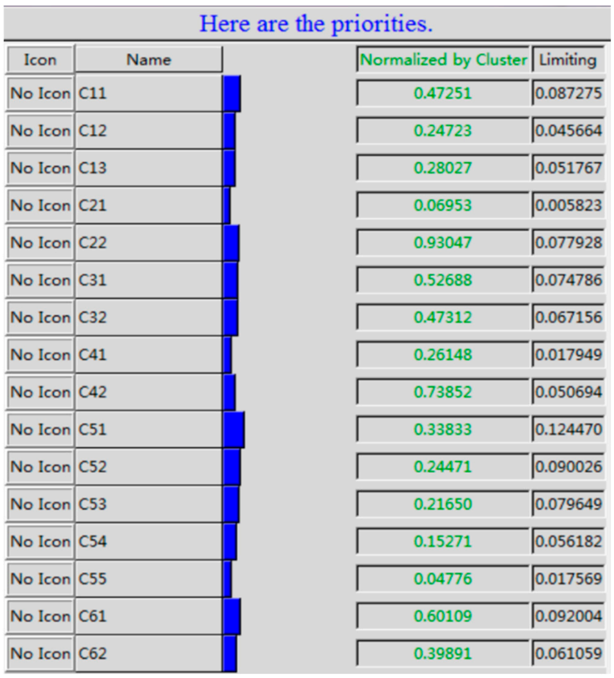


Figure 5. The ANP network model.

The comparative judgment matrix and the supermatrix were constructed for the project after the scoring of 15 experts. Seven of the fifteen experts are from universities, five are from government units, and three are from consulting institutions. Their professional backgrounds include water economy, urban and rural planning, project management, technical economy and management, landscape architecture, water conservancy heritage protection, and architectural design.

The calculation of the supermatrix, weighted supermatrix, and limit weighted supermatrix were completed using the SD software to derive the weights of each secondary indicator in Figure 6, and the results of each index weight calculation are shown in Table 4.



Here are the priorities.

Icon	Name		Normalized by Cluster	Limiting
No Icon	C11		0.47251	0.087275
No Icon	C12		0.24723	0.045664
No Icon	C13		0.28027	0.051767
No Icon	C21		0.06953	0.005823
No Icon	C22		0.93047	0.077928
No Icon	C31		0.52688	0.074786
No Icon	C32		0.47312	0.067156
No Icon	C41		0.26148	0.017949
No Icon	C42		0.73852	0.050694
No Icon	C51		0.33833	0.124470
No Icon	C52		0.24471	0.090026
No Icon	C53		0.21650	0.079649
No Icon	C54		0.15271	0.056182
No Icon	C55		0.04776	0.017569
No Icon	C61		0.60109	0.092004
No Icon	C62		0.39891	0.061059

Figure 6. SD calculation results.

Table 4. Weight of risk factors.

First-Level Indexes	Weight of First-Level Indexes	Second-Level Indexes	Weight of Second-Level Indexes	Comprehensive Weight
C_1: Political	0.18470	C_{11}: Government credit	0.47251	0.08728
		C_{12}: Changes in laws and policies	0.24723	0.04566
		C_{13}: Poor political decision-making	0.28027	0.05177
C_2: Financial and Economical	0.08375	C_{21}: Inflation risk	0.06953	0.00582
		C_{22}: Financing risk	0.93047	0.07793
C_3: Social	0.14194	C_{31}: Industry influence	0.52688	0.07479
		C_{32}: Public support	0.47312	0.06716
C_4: Environmental	0.06864	C_{41}: Unforeseen weather/ geotechnical conditions	0.26148	0.01795
		C_{42}: Ecological sensitivity	0.73852	0.05069
C_5: Construction and Operation	0.36790	C_{51}: Delay in project	0.33833	0.12447
		C_{52}: Overrun of construction and operation costs	0.24471	0.09003
		C_{53}: Project quality	0.2165	0.07965
		C_{54}: Technical and design risk	0.15271	0.05618
		C_{55}: Force majeure	0.04776	0.01757
C_6: Organizational	0.15306	C_{61}: Third-party risk	0.60109	0.09200
		C_{62}: Organization and coordination risk	0.39891	0.06106

Step 2.3 The FUZZY method is used to determine the risk level of the project and each first-level risk factor based on the index weights.

Firstly, the risk factor set and the commentary are obtained by Equations (8) and (9):

$$\begin{aligned} V &= \{v_1, v_2, v_3, v_4, v_5\} \\ &= \{\text{high risk level},\ \text{higher risk level},\ \text{general risk level},\ \text{lower risk level},\ \text{low risk level}\} \end{aligned} \tag{15}$$

The corresponding score is as follows:

$$V = \{5, 4, 3, 2, 1\} \tag{16}$$

Secondly, according to Equation (10), each grade, as scored by all experts, is summed up in Table A2 (in Appendix A). The fuzzy linear transformation method was used to construct the secondary index evaluation matrix $R_i (i = 1, 2, 3, \ldots, 6)$ to obtain the following evaluation matrix:

$$R_1 = \begin{bmatrix} 0.00000 & 0.26667 & 0.40000 & 0.20000 & 0.13333 \\ 0.00000 & 0.40000 & 0.26667 & 0.20000 & 0.13333 \\ 0.26667 & 0.40000 & 0.20000 & 0.06667 & 0.06667 \end{bmatrix} \tag{17}$$

We can derive R_2, R_3, R_4, R_5, and R_6 in the same way.

Then, evaluation vectors are obtained by Equation (11):

$$H_1 = G_1 R_1 \tag{18}$$

$$= \begin{pmatrix} 0.47251 & 0.24723 & 0.28027 \end{pmatrix} \begin{bmatrix} 0.00000 & 0.26667 & 0.40000 & 0.20000 & 0.13333 \\ 0.00000 & 0.40000 & 0.26667 & 0.20000 & 0.13333 \\ 0.26667 & 0.40000 & 0.20000 & 0.06667 & 0.06667 \end{bmatrix} \tag{19}$$

$$= (0.07474,\ 0.33700,\ 0.31099,\ 0.16263,\ 0.11465) \tag{20}$$

In the same way, we can derive H_1, H_2, H_3, H_4, H_5, and H_6.

$$H = \begin{pmatrix} H_1 & H_2 & \cdots & H_i \end{pmatrix}^T = \begin{pmatrix} H_1 & H_2 & \cdots & H_6 \end{pmatrix}^T \tag{21}$$

$$H = \begin{bmatrix} 0.07474 & 0.33700 & 0.31099 & 0.16263 & 0.11465 \\ 0.00000 & 0.01391 & 0.22318 & 0.63422 & 0.12870 \\ 0.09462 & 0.22437 & 0.40717 & 0.27383 & 0.00000 \\ 0.00000 & 0.22049 & 0.61437 & 0.16514 & 0.00000 \\ 0.02229 & 0.08065 & 0.24646 & 0.43612 & 0.21449 \\ 0.00000 & 0.12022 & 0.34681 & 0.53297 & 0.00000 \end{bmatrix} \tag{22}$$

The overall evaluation vector of risk is as follows:

$$B = GH = (0.03543,\ 0.15846,\ 0.31985,\ 0.37538,\ 0.11087) \tag{23}$$

Finally, the risk level of the project and each first-level risk factor are obtained by Equations (13) and (14):

$$\mathrm{S} = \mathrm{BV}^{\mathrm{T}} = 3.36777 \tag{24}$$

$$S_1 = 2.90548, S_2 = 3.87771, S_3 = 2.86021, S_4 = 2.94464, S_5 = 3.73991, S_6 = 3.41275 \tag{25}$$

4.3. Analysis of Evaluation Results

As shown in Table 2 and Figure 4, the top two first-level indexes of the centrality are construction and operation risks and political risks, and the top five second-level indexes are project delays, project quality, construction and operation overruns, third-party risks, and financing risks. This shows that construction operation and maintenance and political risks are key risk factors, among which project delays, project quality, project overspending, third-party risk, and financing risk are the most prominent. This is because there are many participants in the PPP project in the water conservancy scenic spot, the project situation is relatively complex, the relevant laws and regulations are not sound, and the government lacks relevant management experience. In terms of causation, the natural risks, economic risks, and political risks are >0, and the construction and operation risks, organizational risks and social risks are <0. Natural risks' causation is the highest in the positive direction, while the causation of construction and operation risks is the highest in the negative direction. This shows that natural risks, economic risks, and political risks mainly act as influencing factors, and construction and operation risks, organizational risks, and social risks mainly act as the factors that were influenced in the project. Natural conditions are generally difficult to be directly affected by political and economic factors, and natural environmental sensitivity is affected by social and human factors is also a slow process. However, changes in the natural environment directly affect the construction and management of the water conservancy scenic spots and the formulation of relevant policies. The construction and operation of the project are determined by many external factors and are easily affected by other factors.

As shown in Table 3, the top two first-level indexes of weight in the ANP analysis are construction and operation risk and political risk, and the top five second-level indexes are project delay, third-party risk, construction and operation overrun, government credit, and project quality risk. This is basically consistent with the DEMATEL analysis results and also indicates the importance of construction, operation, and political factors in the project, which should focus on prevention and control. Project delays are a very common but serious problem in water conservancy scenic spot PPP projects, which directly lead to a series of problems, such as project cost overruns and financing difficulties, etc. Implementing the project according to the construction organization plan is key to ensuring the success of the project.

From the FUZZY analysis, the overall risk score of the project is 3.36777, which is the general risk level. Economic risks and construction and operation risks are higher, close to 4, which is the higher risk level. As the capital problem is the main problem affecting the development of water conservancy scenic spots, difficulties in financing are also the key problem in water conservancy scenic spot PPP projects. The social risk score is 2.86021, which is the lowest, and belongs to the general risk level. As people in modern society have a strong desire for a better quality of life, the surrounding residents are willing to accept such scenic areas. The COVID-19 outbreak has also changed people's views on tourism and tourism patterns, and water conservancy scenic spots are more popular with the public.

The results of the above analysis show that the key risks in water conservancy scenic spot PPP projects are construction and operation risks, as well as political risks, with project delays, cost overruns, and government credit risks being particularly prominent. Natural risks, economic risks, and political risks are the main causes of project risks, while construction and operation risks, organizational risks, and social risks are the influencing factors. Therefore, reducing political and economic risks is the first priority in reducing the risk level of the project.

5. Discussion and Management Insights

5.1. Discussion

The construction of water conservancy scenic spot projects is more complex than traditional tourism projects. After the introduction of the PPP model, there are many participants in the construction and operation. These represent different interests, asymmetric information, and a lack of flexibility in cooperation. The project has large problems in terms of management and organization coordination. However, many aspects of the construction and development of water conservancy scenic spots are still in the exploratory stage. The government lacks relevant experience and laws, regulations, and regulatory frameworks are not sound, the responsibilities and powers of the government and social capital in the PPP project of water conservancy scenic spots are not clearly defined, and the default handling is not clear. Social capital is at a particular disadvantage in terms of project cooperation with the public sector, and lacks a voice in project decision-making and management, reducing public enthusiasm to participate. At the same time, when the government is building, in operation, or changing its terms of office, it may break its promise, which increases the investment risk of social capital. Human activities, including the construction and tourism of water conservancy scenic spots, will burden the natural environment on which the scenic spots depend for survival, contradicting the sustainable development of the scenic spots, which is also the key risk of the development of water conservancy scenic spots.

In water conservancy scenic spot PPP projects, risk factors vary according to subject and activities. The previous review shows that the construction and operation risks, political risks, and economic risks are the key risks in water conservancy scenic spot PPP projects. The dereliction of duty by government staff, changes in policies and regulations, improvements in water environment governance standards, changes in taxes and tax rates, and the failure to obtain construction land on time affect the project's construction progress and increase the project cost. These factors are mainly caused by the government, or the government has the strongest control over them. Social capital, along with capital, technology and management experience, can obtain more control over the unsystematic risks in construction and operation, such as financing failing to arrive on time, high financing costs, construction delays, quality problems, and cost overruns. Due to the ability and advantages of the government and social capital, as well as their different levels of control over different risks, it is possible to reasonably allocate risks.

In addition, capital is an important factor restricting the development of water conservancy scenic spots. At present, most construction funds for water conservancy scenic spots come from government support. As these construction projects are public welfare projects and diversified, the stock of resource assets is small, and the structure is singular, it is difficult to attract social capital for participation. In addition, water conservancy scenic spots have strong relevance to public welfare, and their management and operation lack the support of special funds. For public welfare scenic spots, management and operation are mostly in charge of the water management unit, which does not have an operating income, and the funds for the scenic spot's maintenance and ecological governance are large. Without special fund support, the project mainly depends on the water project maintenance fund. However, the construction and maintenance of water conservancy projects in water conservancy scenic spots are expensive and tight, relying on national allocation and earmarking. The construction of water conservancy scenic spots has increased the capital burden of water management units. Therefore, the lack of support from special funds has greatly weakened the enthusiasm of scenic area management subjects regarding the construction and management of scenic areas. For quasi-public welfare or commercial water conservancy scenic spots, the maintenance can be supported by operating income, but the public welfare management and protection aspect of the scenic spot generally lacks special funds, placing some financial pressure on the scenic spot. Since the COVID-19 outbreak, many operational scenic spots have been struggling to operate. As the public welfare management and protection of the scenic spots have not been strengthened, financial support urgently needs to be increased.

5.2. Management Insights

Based on the above research, construction, operation, political, and economic risks are the key risks in water conservancy scenic spot PPP projects, and natural, economic, and political risks are the main causes of project risk. Therefore, political and economic risks should be the focus of risk control. This could effectively reduce other risks and reduce the project's risk level. The following political and economic management insights are proposed.

(1) On the political side, a relevant legal and regulatory framework should be improved, and a reasonable risk-sharing mechanism and social capital exit mechanism should be established. Firstly, the government should improve the relevant legal system, clarify the rights and obligations of the public sector and social capital regarding project cooperation, avoid government or public sector intervention, delays and other issues, and ensure the smooth progress of the project and the basic rights and interests of social capital. Supervision and punishment should be improved, and the rights and obligations of both parties should be strictly defined. The method of handling violations should be defined according to the project contract, on-site review, and expert review, and the behaviors of both parties should be standardized. Secondly, a reasonable risk-sharing mechanism should be established according to the capabilities and advantages of the government and social capital. Only when the risks undertaken in terms of social capital are equal to the benefits obtained can they be encouraged to focus on long-term goals and create greater value for the project. A reasonable risk-sharing mechanism is conducive to the allocation and avoidance of risks, reducing the losses caused by policy changes, or force majeure. The introduction of an insurance factoring system into water conservancy scenic spots PPP projects is an important means of transferring and resolving risks. When user fees and government subsidies are insufficient, the factoring agent provides social capital, along with financing and risk guarantee services, which can transfer and resolve project risks and effectively reduce the loss of social capital. In addition, the phased nature of social capital and the participation of financial institutions causes the social capital to exit the project. However, at present, this is limited to passive factors, such as policy changes, default events, or force majeure, which will hinder social capital's enthusiasm to participate in such projects. Therefore, it is beneficial to the management and development of water conservancy scenic spot PPP projects to improve the social capital exit mechanism and unblock the social capital exit channels. In addition, the main shareholders should repurchase equity in the project within a certain period after the expiration of the construction period, as agreed in the investment cooperation agreement. Dynamic management of the scenic spots should be established.

(2) In terms of the economy, the channels of social capital participation should be opened up and financial support should be strengthened. First of all, social capital can bring capital, technology, and management experience to the construction and development of water conservancy scenic spots. The channels of social capital participation should be unblocked, and social capital should be encouraged to participate in the construction of water conservancy scenic spots. The construction projects of water conservancy scenic spots are commonweal and diverse, the stock of resource assets is small and the structure is singular. To attract social capital, it is necessary to expand the industrial chain in multiple ways while developing and managing water conservancy landscape resources, to drive the comprehensive development of a water-conservancy diversified business. Public welfare, quasi-operational, and operational projects should be implemented to ensure the comprehensive, packaged implementation and integrated promotion of the proposed project. The project's operation mode, implementation mode, investment and financing plans, transaction structure, and return mechanism should be designed; then, market-oriented operation, industrialization, and enterprise operation should be implemented to finance and land the project. For public welfare or quasi-public-welfare water conservancy scenic spot PPP projects, to ensure that the functionality of the water conservancy project (or water body) is not affected and that the state-owned assets are safe, the management and operation content and profitability of the scenic spot should be considered. In addition, the principles of mutual benefit and win–win situations for government and enterprises should be followed. Risk-sharing and rights and responsibility matching should also occur, the operation mechanisms of interest distribution, risk-sharing, and government security should be reasonably determined, and social capital should be invited to participate in the operation of the scenic spot. This will relieve the pressure to fund scenic spot management and operation, and can also promote the market-oriented operation of scenic spots and improve the efficiency of scenic spot management and operation.

Capital is an important factor that restricts the development of water conservancy scenic spots. Financial support for water conservancy scenic spots should be strengthened. Regarding the lack of special funds for the construction and development of water conservancy scenic spots, the investment and financing mechanisms for scenic spot management and operation should be further improved. For public welfare water conservancy scenic spots or the public welfare aspects of quasi-operational scenic spots, such as environmental sanitation, water environment protection, and water ecological restoration, it is recommended that the Scenic Area Office recognize the necessity and feasibility of allocating special funds to management and maintenance. The Ministry of Water Resources should receive a report, communication with the Ministry of Finance and other relevant departments should be strengthened, and these institutions should be coordinated to establish special funds for public welfare management and the protection of water conservancy scenic spots. In addition, it is suggested that the water management unit should include the scenic area management content in water-conservancy project-related planning to form a basis for subsequent applications for funds. This could, to some extent, avoid the problem of there being no special funds for the subsequent reconstruction process. The management and operation costs of the scenic spot can also be included in the budget of the supported water conservancy projects, such as risk elimination and reinforcement, and operation and maintenance reconstruction, to provide a guarantee for the management and operation funds of the scenic spot. Special funds and project funds for the cultural construction of water conservancy scenic spots can be set up and measures can be taken, such as increasing the operating income of scenic spots to feed back into their construction and upgrading.

6. Conclusions

Water conservancy scenic spots are an important part of China's water ecological civilization construction. The introduction of the PPP mode can bring financial, technical, and management support to water conservancy scenic spots, which is conducive to their construction and development. However, at present, there is no research on the risks of water conservancy scenic spot PPP projects, only a discussion regarding the application of PPP models in water conservancy scenic spots and the coordination of government and social capital interests. By reviewing the research on PPP project risks and water conservancy scenic spots, it is concluded that the risk factors of different types of PPP projects, or projects in regions, are different and interrelated, and there are various risks in the development and management of water conservancy scenic resources.

Therefore, this paper establishes a risk assessment framework for risk analysis, evaluation, and response to reduce the risks in water conservancy scenic spot PPP projects. Firstly, through risk identification, a risk evaluation index system is established for water conservancy scenic spot PPP projects, including six first-level indicators of political, economic, social, natural, construction and operation, and organizational risks, and 41 second-level indicators, such as government credit and government intervention. Then, through risk assessment, the DEMATEL-ANP-FUZZY risk assessment model is established, and it is concluded that the key risks in PPP projects in the water conservancy scenic spots are construction and operation, political, and economic risks. The specific risk factors are project delay, project quality, construction and operation overspending, third-party risks, financing risks, and government credit risks. Natural, economic, and political risks are the main causes of project risk. Construction and operation, and organizational and social risks are the main affected factors. Finally, based on an analysis of the evaluation results, the paper puts forward suggestions to improve the relevant legal and regulatory framework, establish a reasonable risk-sharing and social capital withdrawal mechanism, unblock the channels of social capital participation, and strengthen financial support of the political and economic aspects. This study fills the gap in the risk assessment of water conservancy scenic spot PPP projects, and the DEMATEL-ANP-FUZZY risk assessment model can effectively assess the risks in water conservancy scenic spot PPP projects, making up for previous defects, which were caused by ignoring the correlation and fuzzy relationship between risk factors.

Although this study has achieved effective results, it still has some limitations. First, the cases and data in this paper are from China. Different countries have different political, economic, social, and natural environments, and specific situations should be analyzed individually. In addition, although this paper identified a causal relationship between risk factors and the main influencing and influenced factors of risk, it does not portray the specific risk propagation path. Therefore, the next research plan is to find the source of the risks, map the detailed risk propagation path, and develop a risk control plan to cut off risk propagation.

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Appendix A

Table A1. Basic information of interviewed experts.

NO.	Education	Professional Background	Work
1	Undergraduate	Water Conservancy Economics	Government sector
2	Master	Urban Planning	Government sector
3	Doctor	Urban Planning	Government sector
4	Master	Urban Planning	Advisory body
5	Master	Landscape Architecture	University
6	Doctor	Urban and Rural Planning	University
7	Doctor	Technical Economy and Management	University
8	Master	Engineering Management	Advisory body
9	Master	Water Conservancy Economics	University
10	Master	Water Conservancy Heritage Protection	Advisory body
11	Doctor	Engineering Management	University
12	Master	Hydraulic Engineering	Government sector
13	Master	Water Conservancy Economics	Government sector
14	Doctor	Architectural Design	University
15	Doctor	Engineering Management	University

Table A2. The sums of risk grade scores to each indicator.

First-Level Indicators	Second-Level Indicators	Risk Grade				
		1	2	3	4	5
C_1: Political	C_{11}: Government credit	0	4	6	3	2
	C_{12}: Changes in laws and policies	0	6	4	3	2
	C_{13}: Poor political decision-making	4	6	3	1	1
C_2: Financial and Economical	C_{21}: Inflation risk	0	3	8	3	1
	C_{22}: Financing risk	0	0	3	10	2
C_3: Social	C_{31}: Industry influence	0	1	8	6	0
	C_{32}: Public support	3	6	4	2	0
C_4: Environmental	C_{41}: Unforeseen weather/ geotechnical conditions	0	7	7	1	0
	C_{42}: Ecological sensitivity	0	2	10	3	0
C_5: Construction and Operation	C_{51}: Delay in project	0	0	2	10	3
	C_{52}: Overrun of construction and operation costs	0	0	1	5	9
	C_{53}: Project quality	0	4	7	4	0
	C_{54}: Technical and design risk	0	1	7	7	0
	C_{55}: Force majeure	7	4	4	0	0
C_6: Organizational	C_{61}: Third-party risk	0	3	6	6	0
	C_{62}: Organization and coordination risk	0	0	4	11	0

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