Research on Risk Identification and Response Strategies of PPP Contracts Based on Risk Management

Shyng, Jyh-Harng *

* Corresponding author: hidosing@outlook.com

Department of Landscape Architecture, School of Life Sciences, Zhaoqing University, Zhaoqing, Guangdong, China

Abstract. In the competitive environment of government and social capital cooperation (PPP) projects, contract management plays a pivotal role. It outlines the framework for monitoring and managing the risks associated with the rights and obligations of both parties, ensuring the project's long-term success. Without effective contract management, PPP projects are prone to various risks that can derail the project and impact its outcomes. To identify, assess, and respond to these risks, scientific and technological data monitoring is essential in risk project management. For instance, the "Risk Matrix Method" is commonly used in landscape architecture PPP projects. This method involves classifying risk factors based on their likelihood of occurrence and impact level, creating a risk matrix. The evaluation principle assesses the probability and impact level of risk occurrence to prioritize management and response strategies. Based on the Severity (SEV) and Occurrence (OCC) factors, these strategies can be categorized into four distinct categories: "Avoidance," "Transfer," "Reduction," and "Acceptance." Each category suggests a different approach to manage the risk associated with a specific project. Comprehensive empirical research methods, combined with qualitative and quantitative assessments, provide valuable insights into reducing risks in PPP project bidding contracts.

Keywords: Public-Private Partnership (PPP); Risk Identification; Risk Prevention; Bidding; Risk Priority Matrix (RPN)

1 Introduction

Public-private partnerships (PPP) involve the cooperation between the government and the private sector in the construction and management of public facilities. These partnerships emphasize partnership, resource sharing, mutual benefit, and risk management. Engineering bidding contracts are crucial legal documents in the PPP model, defining the rights and obligations between the government and private sector, and specifying key elements such as project scope, quality standards, prices, and construction timelines. The importance of engineering bidding contracts lies in several aspects: they clarify the rights and obligations of the government and private sector, standardize project management, reduce risks, and ensure fairness and justice. The contracts specify key elements such as project scope, quality standards, prices, and construction timelines, providing a basis and guideline for project management. Additionally, risk-sharing clauses are usually included in the contracts, with the government and private sector sharing risks as agreed upon, effectively mitigating project

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risks. Furthermore, the clauses in the contract should be fair and equitable, taking into account the interests of both the government and private sector to avoid any unfair outcomes.

2 Research Literature on the Risk of Project Bidding Contracts under the PPP Model

2.1 Risk Identification and Management in PPP Projects

Numerous scholarly investigations have extensively explored the discernment and governance of contractual perils within the context of Public-Private Partnerships (PPPs). These investigations have scrutinized various potential risk factors and proposed effective strategies for risk identification and management.[1][2] Another analysis explored the efficient management of contract risks in public-private cooperation projects, presenting an integrated approach that encompasses risk identification, assessment, and mitigation. [3] Mahdi, A., & Rezgui, Y. (2019) conducted on risk identification and assessment in public-private cooperation projects, comparing the pros and cons of different methods and suggesting new research directions. [4] Huang, M., Liu, L., & Zhang, H. (2021) for these challenges, a set of preventive measures and mitigation strategies were proposed for contract risks in public-private cooperation projects, providing practical guidance for project managers in these fields. [5]

2.2 Contract risk management in PPP projects:

The main objective is to leverage private sector expertise, efficiency, and innovation while protecting public interests. However, managing contract risks can be challenging due to various factors.[6] Wang, Q., & Chen, Y. (2020) proposed a framework for identifying and evaluating contract risks in PPP projects, introducing various risk identification and evaluation methods such as qualitative analysis, quantitative analysis, risk matrix, etc. They suggested a method based on flowcharts and risk matrices to improve the accuracy and efficiency of risk identification.[7] Li, M., & Wang, L. (2019) study explored preventative measures and mitigation strategies for contract risks in PPP projects, presenting existing preventative measures and mitigation strategies such as risk avoidance, risk transference, risk reduction, etc. They proposed a method based on risk matrix for selecting appropriate preventative measures and mitigation strategies for PPP project contract risks.[8] Finally, Yang, Z., & Zhang, X. (2021) a comparative study was conducted on contract risk management in PPP projects, analysing different risk management approaches and their effectiveness in reducing contract risks in PPP projects.[9] Guo and Xu (2020) proposed an application framework for identifying and evaluating contract risks in PPP projects. They discussed how to use this framework for identifying and evaluating contract risks and demonstrated its application effect through a specific case study. They proposed a method based on risk matrix for identifying and evaluating contract risks, aiming to improve the accuracy and efficiency of risk identification. [10]

2.3 Contract Risk Identification, Assessment and Management in PPP Projects:

The above-mentioned literature provides a comprehensive overview of PPP project contract risk management. Multiple research efforts have been conducted to comprehensively explore

the identification and management of contractual risks within Public-Private Partnerships (PPPs). Li, W., & Zhang, H. (2021) study reviewed existing research and suggested future research directions[11]. Wang, P., & Liang, Y. (2020) study used data mining methods to classify and predict PPP project contract risks, showing their effectiveness.[12] A multi-perspective decision support framework was proposed by Xu, Z., & Liang, L. (2021) study to help managers better understand and manage PPP project contract risks.[13] Yang, L., & Wang, Z. (2019) study was conducted on the prevention measures and mitigation strategies of PPP project contract risks in Chinese railway construction projects.[14] Finally, fuzzy set theory was used by another study to classify and prioritize PPP project contract risks, providing an effective tool for risk management.[15]

2.4 Summary

The extant research literature accentuates the paramountcy of discerning and regulating contractual hazards in Public-Private Partnership (PPP) ventures. It proffers some efficacious methodologies and tactics, albeit with certain discrepancies. For instance, certain investigations concentrate more on risk appraisal, whereas others concentrate more on risk abatement. Consequently, for PPP project managers, it is imperative to select the most appropriate risk identification and management methodology in accordance with specific project circumstances and risk milieu. The literature furnishes a profound comprehension of PPP project contractual risk management and offers valuable guidance and recommendations for practitioners. This study summarizes the relevance of each stage of PPP project management to risk management in the planning stage, execution stage, and control stage. It draws a flowchart of risk management (Figure 1).

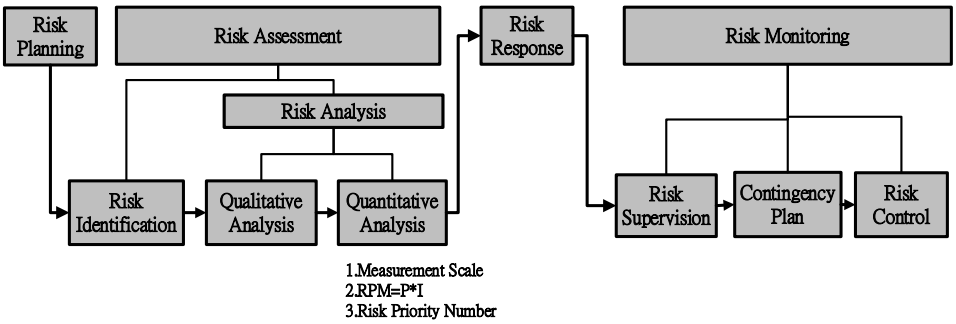

Figure 1 Risk management process of PPP projects

3 Risk identification of PPP model project bidding contract

3.1 Contract Risk Identification in PPP Mode

Contract risk in the PPP model refers to the possibility of losses faced by contractual parties during the process of signing and performing the contract due to various uncertainty factors. The types of contract risks mainly include default risk, liability risk, intellectual property risk, and financial risk, which may lead to the possibility of failing to perform contractual obligations as agreed.

(1) Special Risk Points Analysis of Engineering Bidding Contracts in the PPP Model

The special risk points of engineering bidding contracts in the PPP model mainly include partner selection risk, project execution risk, policy and regulatory risk, market risk, and technical risk. If effective management and control are not implemented, these risks may have serious impacts and consequences on the project, such as project delays, increased project costs, decreased project quality, and broken relationships, which may lead to partner breakdown and affect project cooperation and execution.

(2) Risk Identification in Engineering Bidding Contracts under the PPP Model

Due to the involvement of many stakeholders and the complexity of contracts in the PPP model, more systematic and targeted risk identification methods need to be adopted. The specific steps include establishing a risk identification team, collecting information, preliminary risk identification, developing a risk inventory, in-depth risk analysis, and developing response strategies.

(3) Common Risk Identification Techniques in Engineering Bidding Contract Management

Common risk identification techniques in engineering bidding contract management include Environmental Analysis Method, Brainstorming Method, Cause-and-Effect Analysis Method, Risk Matrix Method.

3.2 Risk Priority Number Matrix

In this study, a risk matrix approach is adopted for PPP model landscape architecture construction projects to identify and mitigate risks. The risk factors are classified and ranked according to their likelihood of occurrence and impact severity, forming a risk matrix for better management and risk response.

The evaluation principle is to assess the likelihood of risk occurrence and impact severity, and calculate the product of the two, which is called the "Risk Priority Number" (RPN) (Table 1). The RPN is then sorted, with higher values indicating higher risks that should be addressed first.

Table 1: Risk Priority Matrix (RPN)

		Occurrence (OCC)(P)				
		0.2	0.4	0.6	0.8	1.0
Severity (SEV) (I)	0.2	0.04	0.08	0.12	0.16	0.2
	0.4	0.08	0.16	0.24	0.32	0.4
	0.6	0.12	0.24	0.36	0.48	0.6
	0.8	0.16	0.32	0.48	0.64	0.8
	1.0	0.2	0.4	0.6	0.8	1.0

The following definitions of the RPN matrix, Occurrence (OCC)(P) (Table 2) and Severity (SEV) (I) (Table 3), are inserted into the PPP model project:

By multiplying P and I, the RPN provides a numerical measure of the priority of each risk, allowing for quick and effective decision-making in risk management. The RPN value is used to identify the scope to be prioritized. There is no fixed rule to determine the high RPN value threshold.

$$RPN = (P) \times (I \tag{1}$$

(1) RPN matrix: A matrix that ranks risks based on their priority Risk Priority.

(2) Occurrence (OCC)(P): The probability of a risk event occurring, on a scale of 1 (low) to 10 (high). With higher values given for higher occurrence.

(3) Severity (SEV) (I): The severity of the impact if a risk event occurs, on a scale of 1 (low) to 10 (high). With higher values given for higher severity.

Table 2: Occurrence (OCC)in PPP Project Risk Hierarchy and Causes

Level	Potential Causes
High(1.0)	- Inadequate project design, particularly in terms of commercial facilities' proportion - Communication, organizational, and coordination issues - Technical risks - Force majeure events (e.g., natural disasters)
Moderate-High(0.8)	- Construction risks, including quality and safety issues - Operating risks, such as insufficient market demand - Revenue risks, when project revenues fall short of expectations - Financing risks, including difficulties in fundraising - Political risks, including policy changes - Legal risks, including contract disputes - Market risks, such as increasing competition or demand decreases
Moderate(0.6)	- Financial risks, including liquidity issues
Moderate-Low(0.4)	- Credit risks
Low(0.2)	- Extremely rare events or natural disasters with very low probability

Table 3 Severity (SEV) in PPP Project Risk Hierarchy and Causes

Level	Potential Causes
Strong (1.0)	War, terrorism, global epidemic, etc.
Moderate- Strong (0.8)	Political conflicts, economic crises, social unrest, etc.
Moderate (0.6)	Natural disasters, policy changes, contract disputes, etc.
Moderate- weak (0.4)	Government turnover leading to policy adjustments, investment party's financial condition deterioration, etc.
weak (0.2)	Market competition, policy changes, etc.

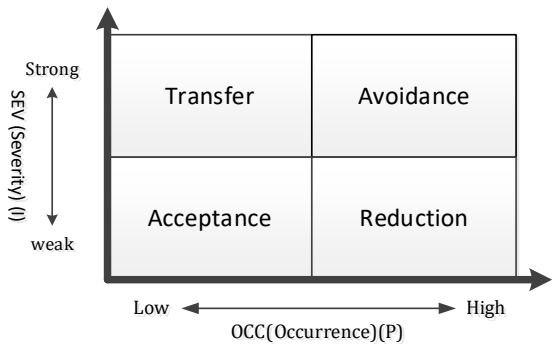

Figure 2: Risk Response Matrix

3.3 Risk Response

The risk response matrix consists of four quadrants, sorted by impact severity and likelihood of occurrence, and can be categorized as "Avoidance," "Transfer," "Reduction," and "Acceptance" (Figure 2). Based on the risk response matrix and the SEV (Severity) (I) and OCC (Occurrence)(P) assessments, specific action plans for risk response are developed. The evaluation criteria and specific risk response actions (Table 4) are as follows:

(1) Avoidance: Priority range is above 0.8 but below 1.0.

(2) Transfer: Priority range is above 0.6 but below 0.8.

(3) Reduction: Priority range is above 0.4 but below 0.6.

(4) Acceptance: Priority range is below 0.4.

Note: The specific actions for each risk response category may vary depending on the nature of the risk and the project's needs and resources. It is essential to carefully consider and evaluate the various options before making a decision on how to respond to a given risk.

Table 4: Risk Response Levels Strategy, Processing Principles, and Specific Actions

Strategy	Processing Principle	Specific Action
Avoidance	Anticipatory Planning and Remedial Measures	Conduct meticulous planning in advance.
Transfer	Contingency for Unforeseeable Factors	1. Seek advice from professional bidding units. 2. Enhance understanding of the rights and obligations of both parties in the PPP project.
Reduction	Regular Inspections and Preventive Measures	1.Strengthen knowledge of bidding, tendering, and contract management. 2.Intensify on-the-job training. 3.Establish standard operating procedures (SOPs).
Acceptance	Natural disasters are unforeseeable factors.	Increase attention and information gathering.

4 Risk Prevention and Control Strategies for PPP Model Engineering Tendering and Bidding Contracts

4.1 Basic Concepts and Principles of Risk Prevention and Control

In the context of PPP models, risk prevention and control for engineering tendering and bidding contracts requires adherence to certain basic concepts and principles. Firstly, it is essential to fully recognize the importance of risk prevention and control and implement effective measures for risk management and control. Secondly, the principle of "prevention first, combination of prevention and control" should be followed, starting from the source,

actively preventing potential risks from occurring, while also taking response measures to prevent the expansion and spread of risks. Finally, a comprehensive risk prevention and control mechanism should be established, including risk assessment, risk warning, risk response, and other aspects, to achieve standardization, systematization, and scientification of risk prevention and control.

4.2 Risk Management Measures for Engineering Tendering and Bidding Contracts under PPP Models

The risk management measures for engineering tendering and bidding contracts under PPP models mainly include the following aspects: establishing a sound contract management system, strengthening the review and approval of contract terms, establishing a supervision mechanism during the performance of contracts, and properly handling contract disputes.

4.3 Analyze effective risk prevention and control measures through case study.

To illustrate the development and execution of PPP-based project bidding contract risk prevention strategies, an example is provided below.

Assume a municipal government plans to construct a landscape architecture project through the PPP model and conduct bidding to select a construction unit. During the bidding process, the government has established strict risk prevention measures, which mainly include the following aspects:

(1) The risk factors are clearly listed in the bidding documents, including requirements for duration, quality, safety, environmental protection, etc. At the same time, the responsible party and punishment measures are also specified.

(2) A strict qualification review is conducted on the bidding parties, including enterprise qualifications, performance, technical strength, etc., to ensure that the bidding party has the ability and creditworthiness to bear risks.

(3) In the bid evaluation process, in addition to considering price factors, the technical scheme and construction organization design of the bidder are also evaluated in detail to ensure that the winning bidder has reasonable technical strength and construction capabilities.

(4) Before the contract is signed, detailed negotiations and consultations are conducted with the winning bidder to ensure the fairness and rationality of the contract terms and avoid risks caused by contract loopholes.

(5) During the contract implementation process, a regular inspection and evaluation mechanism is established to detect and resolve potential risks in a timely manner. At the same time, an effective monitoring mechanism is established to comprehensively monitor the construction progress, quality, safety, etc. of the winning bidder.

For possible risk factors, emergency plans and response measures are developed to ensure that effective measures can be taken in case of emergencies.

Through the development and execution of these measures, the municipal government successfully selects a suitable construction unit, ensuring that various risks in the construction process of the landscape architecture project are effectively prevented and managed. This case

also demonstrates the importance of PPP-based project bidding contract risk prevention strategies.

In summary, project bidding contract risk management in PPP projects is a complex and crucial task. Through successful cases both domestically and internationally, it has become evident that effective risk management requires more than just clear contract terms. It necessitates the establishment of a comprehensive risk management system and the introduction of third-party guaranteed mechanisms. In China's actual situation, we can draw on and apply best practices such as establishing a sound risk management organizational structure, refining risk management practices, and introducing third-party guarantee mechanisms. Only by doing so can we ensure the smooth progress of PPP projects, reduce contract risks, safeguard the interests of all stakeholders, and provide valuable experience and insights for future PPP projects.

5 Conclusions

This study has conducted an in-depth investigation into the risk types, characteristics, identification methods, and prevention strategies associated with engineering bidding contracts under the Public-Private Partnership (PPP) model. Through a comprehensive analysis, it has been revealed that PPP-modeled engineering bidding contracts possess unique attributes and risk points that necessitate targeted risk prevention and control measures.

The research also delved into the risk management process system for PPP-modeled engineering bidding contracts. By employing empirical research methods comprehensively, it was discovered that risk prevention measures can only be effectively tailored through qualitative identification and quantitative assessment. As a result, in real project management, it is crucial to focus on strengthening contract management and supervision, improving risk assessment technology levels, and enhancing management capabilities to ensure smooth project implementation and maximize public interests.

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