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Research on Investment Management Risks and Control Measures of Engineering Projects

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Abstract. This paper centers on the critical themes of risks and corresponding control measures within project investment management, a domain vital to safeguarding investment returns and ensuring project success. It begins by thoroughly expounding the core aspects of systematic management methods, which serve as the foundational framework—specifically covering risk identification (the initial step to pinpoint potential hazards), scientific risk assessment and in-depth analysis (to quantify risk severity and impact), and targeted response strategies (to formulate proactive plans). On this basis, the study systematically sorts out six key categories of specific risks: those arising in the decision-making stage (e.g., flawed feasibility studies), market fluctuations, capital shortages or misallocation, policy adjustments, unpredictable external environmental changes (such as natural disasters), and inadequate management capabilities. It further analyzes how these risks interact to produce a superposition effect, amplifying potential losses. Finally, it proposes whole-process control measures across three key links—pre-risk prevention, in-process monitoring and control, and post-event response and mitigation—offering practical, actionable ideas to enhance the investment efficiency of engineering projects. Additionally, it looks ahead to the future trend of risk management amid digitalization, hinting at tech-driven advancements like data analytics for risk prediction.

Keywords: Engineering project investment, Risk management, Risk control measures.

1. Introduction

With the accelerated development of urbanization, the scale and complexity of construction projects have also grown and upgraded simultaneously, which is manifested in the long project cycle, many subjects involved, and large fluctuations in the market and environment, which has caused problems such as cost overruns, construction period delays, and substandard quality. If these risks are not controlled, it will affect the normal progress of the project, so the risk management of the project is precisely to ensure its smooth progress and successful completion [1]. At present, a multi-dimensional exploration pattern has been formed for the risk research of engineering investment management. In terms of risk types, scholars classify them into technical risk, economic risk, contract risk and environmental risk.

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At the same time, there ahavealso a variety of risk identification and assessment methods, including qualitative analysis such as expert review method and fault tree analysis, as well as quantitative tools such as sensitivity analysis and probability distribution model, but the application of these research methods in practice also has certain limitations - for example, the assessment of engineering investment risk in Hong Kong's construction industry relies more on the subjective judgment of managers, and because quantitative technology requires high professional level and data acquisition is difficult [2]. Therefore, it is not widely used.

In terms of control measures, the researchers emphasize the dynamic control of the whole process. The whole process refers to the engineering decision-making, design and construction stage. They believe that feasibility demonstration and capital planning should be strengthened in the initial decision-making stage. In the mid-term design stage, the cost is reduced by optimizing the scheme and quota design. Finally, the construction phase focuses on change management, measurement and payment, and material control. However, there are still some fragmentation problems in these existing studies, that is, the lack of comprehensive management framework and the insufficient exploration of the adaptability of risk transmission mechanisms and response measures.

This paper will conduct an in-depth analysis of the investment management risks and control measures of engineering projects based on existing research results, in order to provide reference for improving the investment efficiency of engineering projects.

2. Risks of project investment management

2.1. Methods of investment management

In order to deeply analyze the risks and follow-up control measures of project investment management, it is necessary to first clarify its underlying logic, and the systematic management method is the carrier of this logic and the core of the whole process of risk control. Therefore, this chapter first introduces the method of project investment management, which is the basic framework of risk management and control, covering three key links: risk identification, assessment and analysis, and response strategies, so as to provide analysis paths and tools for subsequent specific risk response strategies. These three links are progressive layer by layer and together form a complete chain of systematic management.

Starting from risk identification, as the basis of management, this paper is committed to investigating potential risk factors through scientific means and anchoring specific objects for follow-up work. Common methods include expert review, which uses the experience and expertise of industry experts to sort out possible risk points at various stages of the project. This method is widely used in various engineering projects due to its simple operation process and efficient identification of potential problems, especially for rapid risk screening of small projects and early risk assessment of large-scale projects [3]. Another commonly used risk identification method is fault tree analysis, which constructs a logical model to trace the risk trigger path backwards, and disassembles the direct or indirect factors that cause the failure layer by layer from the final failure results that may lead to it, and finally forms a "tree-like" risk correlation map [4].

On this basis, risk assessment and analysis have become the key steps in quantifying risks, and provide data support for decision-making by measuring the probability and impact of identified risks. Specifically, you can select tools according to the logic of "from shallow to deep, from part to whole". Starting from the most basic single risk quantification, the simple estimation method can quickly judge the degree of a single risk by calculating the expected value through expert

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assessment or risk factor value. To further analyze the impact of key variables on the project, sensitivity analysis is a suitable tool - it focuses on core elements such as output, cost, and profit, and evaluates the project's risk resistance by measuring the break-even point. When it is necessary to systematically quantify the overall risk, the probability tree method and the Monte Carlo method are more advantageous, and both use mathematical and statistical principles to simulate the probability distribution of the combination of risk factors to achieve accurate assessment of the overall risk level [5]. Finally, the risk response strategy is formulated based on the assessment results, and closed-loop management is formed through risk avoidance, transfer, mitigation and other measures to achieve effective control of risks.

Finally, risk response strategies need to be formulated based on the assessment results, and closed-loop management should be formed through risk avoidance, transfer, and mitigation measures to achieve effective risk control. Specifically, this type of strategy needs to be refined into four core methods based on project characteristics, each with its own focus and complementary to each other: first, risk avoidance directly avoids potential losses by abandoning high-risk solutions, which is a means of cutting off risks from the source; second, loss control focuses on prevention and suppression, reduces the probability or impact of risks through targeted measures, and focuses on active intervention on the risk itself; Third, risk transfer uses contractual agreements or insurance mechanisms to reasonably transfer part of the risk to a third party, and the core is to disperse the pressure through responsibility restructuring; Fourth, risk retention is suitable for risks with low impact, and enterprises bear the corresponding consequences [6], which is a flexible disposal of low-impact risks. In addition, from the perspective of management mode, the project management contracting system, the project supervision system and the general contracting model can also be used as supplementary means to diversify risks [7].

2.2. Risks of investment management

Combined with the above-mentioned whole-process risk management and control logic, the risk in the investment process of engineering projects is the target of the management method. These risks throughout the whole cycle are not only diverse in type, but also need to form closed-loop control through identification, assessment and response strategies, and to implement this control logic, it is necessary to start with the specific performance of the risk - from the perspective of the impact dimension and occurrence scenario of the risk, it can be divided into the following categories:First of all, the risk of the decision-making stage is the primary cause of investment failure, and insufficient feasibility research can easily lead to decision-making bias, such as incomplete market research may cause an imbalance between product supply and demand.

Secondly, market risk has the most direct impact on project returns, which runs through the dynamic changes at both ends of supply and demand. When market demand fluctuates, project output may face unsalable pressure, and fluctuations in raw material prices on the supply side will directly push up production costs. At the same time, insufficient product competitiveness will also exacerbate market risks.

From the perspective of financial security, cost and financing risk are directly related to the stability of the project's capital chain, which are both interrelated and easy to form a superimposed impact with other risks. On the one hand, the problem of overestimation is common in engineering projects, from the omission of the early design to the increase in the price of materials in the construction stage, which may lead to cost breakthroughs beyond expectations; On the other hand, challenges such as capital supply interruption and interest rate fluctuations in the financing process will further exacerbate the tension of the capital chain [8].

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At the same time, there are significant uncertainties between policy and external environmental risks: at the policy level, standard adjustments may directly change the feasibility of projects, such as increased environmental protection requirements may force the suspension of high-pollution projects; At the social level, social risks such as public resistance to the project may also delay the construction period or even lead to the shelving of the project [9]. These two aspects affect the progress of the project from different dimensions, and together constitute the risks and challenges of the external environment.

In addition to external and capital risks such as market and policy, management risks also stem from internal control defects: unreasonable organizational structure will lead to inefficient coordination between departments, such as lengthy cross-departmental approval processes that may delay key nodes; The loss of core talent can create technical or managerial faults. Although such risks do not directly affect the capital chain, they will indirectly affect the project's resilience to various risks by weakening operational efficiency, and intertwine with other risks to form a superimposed impact.

These risks are universal, objective and variable, and form a chain reaction at each stage of the project, and the risk factors at different stages interact with each other through complex correlations and have a comprehensive impact on the implementation of the project. This chain effect makes the occurrence of a single risk may trigger the emergence of a series of related risks, which in turn has an impact on the cost, schedule and quality of the project, which is also the core reason why the above-mentioned risk identification, assessment and response strategies need to form systematic management.

3. Management measures for investment management risks

3.1. Preventive measures before risks arise in investment management

Preventive measures should run through all stages of the project in the early stage, and reduce the probability of risk through system design and scientific planning, as shown in Table 1.

In the process of project implementation, in order to ensure that all links are closely connected and efficiently promoted, the decision-making stage should first examine the actual conditions of the project location, and use this as a basis to combine the planning documents and evaluate the overall feasibility [10]; After entering the design stage, the construction process can be improved through expert review and multi-scheme technical evaluation to reduce the risk of later changes from the source; In contract management, it is necessary to clarify the risk allocation mechanism, especially for variables such as material price fluctuations, and at the same time use digital tools to improve the accuracy of cost estimation and form a full-process risk management and control mechanism.

Table 1. Cost control key points at each stage of the project

Decision-making stage	Conduct feasibility studies and analyze tender documents, government documents, climate and raw materials; Establish a legal person responsibility system and clarify project rights and responsibilities.
Design phase	Excellent design schemes are selected by bidding; Formulate material procurement standards and monitor quality and price in line with budget
Bidding stage	Strictly pre-examine the qualifications and reputation of the bidding units; Standardize quotations and avoid blindly winning bids at low prices.
General measures	set up a professional team and establish a risk early warning system; Improve contract terms, clarify rights, responsibilities and claim mechanisms.

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3.2. Control measures in investment management risks

When a risk occurs, it is necessary to control the spread of losses through dynamic monitoring and emergency response, as presented in Table 2.

The core of this stage is process correction. For example, when the price of materials soars, the price adjustment mechanism is activated according to the contract; Delays in construction due to natural disasters should be timely visas and plans should be adjusted. At the same time, a multi-party communication mechanism is established to ensure that information is synchronized so that risk events can be quickly responded to.

Table 2. Key measures for cost control in different project scenarios

scenario	Keymeasures
Construction phase	Real-time tracking of project quantity and capital expenditure; Regularly check the construction quality and material standards.
Unexpected situations	formulate force majeure plans; Establish an engineering change approval process.
Contract execution	strengthen the supervision of contract performance and rectify violations in a timely manner; Dynamically adjust the strategy to deal with material price fluctuations.

3.3. Measures after investment management risks

Remediate and transfer the risk to make up for the loss to avoid chain reactions, as illustrated in Table 3.

For example, if there is a quality defect in the completion stage of the project, the responsible party can be required to repair it according to the warranty clause; if there are problems such as insufficient funds in the operation process, part of the financial risk can be reasonably allocated to third-party institutions through contractual agreements with the help of risk transfer mechanisms to attract external capital participation. At the same time, it is also necessary to establish a complete risk file and incorporate the disposal experience into the knowledge base to continuously improve the risk response ability of subsequent projects. Attract capital through asset securitization. Establish risk files, incorporate disposal experience into the knowledge base, and improve the ability to respond to subsequent projects.

Table 3. Project risk disposal methods and specific measures table

Disposalmethod	Specificmeasures
Compensation for losses	Initiate insurance claims; claims under contracts; Use the reserved risk reserve
Risk transfer	splitting risk through securitization; Transfer high-risk sub-projects
Summary and optimization	Review event update database; Improve the management system and optimize the follow-up project process

4. Conclusion

By sorting out the investment management risks and control measures of engineering projects, it can be concluded that the investment risks of engineering projects run through the whole life cycle stages such as decision-making, design, and construction, mainly including typical risks such as

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decision-making deviation, market fluctuations, capital chain breakage, and internal management defects, and various risks have superimposed and transmission characteristics. Effective control requires the construction of a full-process system of pre-prevention, in-process control, and post-remediation to achieve risk differentiation and hierarchical resolution through feasibility studies, risk warning, dynamic monitoring, and insurance transfer. Although existing studies have formed multi-dimensional risk identification and assessment methods, they still face problems such as high threshold for the application of quantitative tools and lack of comprehensive management framework in practice.

Looking forward to the future, with the development of smart cities and digital technology, project investment management will show three major trends: first, the popularization of digital risk control tools, the core of which is to use BIM technology and big data analysis to improve the accuracy of risk identification, and thereby reduce the dependence of quantitative assessment on professional experience; The second is the construction of a coordination mechanism for the whole industry chain, which forms a cross-subject risk sharing system by integrating the risk factors and data of owners, construction parties, financial institutions and other entities. The third is the development of a dynamic adaptive management and control model, which establishes a risk transmission path system by combining real-time changes in the market and policies, so as to improve the adaptability of response strategies. Future research can further focus on the quantitative analysis of risk transmission mechanisms, and provide more operational solutions for optimizing project investment benefits by promoting the deep integration of theoretical achievements and engineering practice.

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