Research on risk identification and control method of construction project management

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Abstract: With the acceleration of urbanization, construction projects are huge in scale and complex in structure, facing unprecedented risks and challenges. This paper discusses the importance of risk identification and control methods in construction project management. Firstly, the steps of risk identification are analyzed, including risk source analysis, risk classification and risk list preparation. Secondly, it expounds the main contents and processes of risk assessment, including risk identification, risk analysis, risk evaluation and risk response. Then, it introduces the common risk types, such as technical risk, economic risk, management risk, legal risk and environmental risk. Finally, the basic logic and objectives of risk control are discussed in detail, as well as the main methods of risk avoidance, risk mitigation, risk transfer and risk retention, and the role of dynamic management and modern technical support in risk control is emphasized.

1. Introduction

With the acceleration of global economic integration and urbanization, construction projects are increasingly characterized by large scale, complex structure and many participants. These characteristics make construction projects face unprecedented risks and challenges. From project planning, design, construction to completion acceptance, every link may be affected by various uncertain factors, which may lead to problems such as project delay, cost overrun, substandard quality and even safety accidents. Therefore, how to effectively identify and control risks in construction projects has become one of the key problems to be solved urgently in the field of project management.

2. Risk identification of construction project

2.1 Risk source analysis

Risk source analysis is the first step of risk identification of construction projects, which involves the identification of all kinds of uncertainties and potential problems that may be encountered in the whole process of the project [1]. These risk sources may come from natural environment, social economy, technology implementation, organization and management, etc. For example, natural risk sources include natural disasters such as earthquakes and floods; The sources of social and economic risks include market fluctuations and policy changes. Technical risk sources include design defects, improper construction technology, etc. The risk sources of organizational management include poor communication between project teams and unreasonable resource allocation.

2.2 Risk classification

Risk classification is to classify the identified risk sources according to certain standards so as to facilitate the subsequent risk assessment and management. Common risk classification methods include risk source, risk manageability, risk influence scope, risk consequence and risk consequence undertaker [2]. According to the source of risk, it can be divided into natural risk, social risk, economic risk, legal risk, political risk, technical risk and organizational management risk; According to whether risks can be managed, they can be divided into manageable risks and

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unmanageable risks.

2.3 Risk list preparation

The establishment of risk list is the process of sorting out the identified and classified risk information into documents, which is the basis of risk management and control. The risk list usually includes risk name, description, source, classification, possible impact, probability of occurrence, countermeasures, etc. When compiling the risk list, we need to consider the specific situation of the project, including the scale, complexity and environment of the project. In addition, the risk list is not static, and it needs to be constantly updated and improved with the progress of the project and the changes of the external environment [3].

3. Risk assessment of construction project

3.1 Main content and process

Risk assessment of construction project refers to the process of systematically identifying, analyzing and evaluating various uncertain factors that may affect the realization of project objectives during the implementation of the project [4]. These risk factors cover many aspects, such as technology, economy, management, law, environment and so on, which may lead to problems such as project schedule delay, cost increase, quality decline or safety accidents. By predicting potential risks in advance and formulating targeted countermeasures, the possibility of risks and their negative effects can be reduced; Optimize the allocation of resources and improve the efficiency of project management; Enhance the risk awareness of decision makers, provide a basis for scientific decision-making, and ultimately ensure the smooth implementation and successful delivery of the project [5].

The risk assessment process of construction project is shown in Figure 1. Risk Identification This is the first step of risk management, aiming at finding out all potential risk sources. Commonly used methods include expert investigation, brainstorming, fault tree analysis and so on. Excavate technical risks such as design defects and difficult construction through collective discussion, or economic risks such as shortage of funds and fluctuation of raw material prices; Historical data and similar project experience can also be used to assist identification. Qualitative or quantitative research on the identified risks [6]. Qualitative analysis focuses on describing the nature and characteristics of risks, such as using risk matrix method to evaluate the combination of possibility and influence degree; In quantitative analysis, probability theory and statistical analysis tools are used to calculate specific values and determine the risk ranking [7]. In addition, it is necessary to analyze the correlation and synergistic effect between risks. Based on the analysis results, the risks are divided into different levels according to the established standards, and the priorities are determined. At this stage, analytic hierarchy process, sensitivity analysis and other tools are often used to make comprehensive judgments in combination with industry standards and regulatory requirements. According to the risk level, formulate corresponding strategies, including avoidance (adjusting plans to avoid high-risk activities), transfer (dispersing responsibilities through insurance or subcontracting), mitigation (strengthening control to reduce probability) and acceptance (taking residual risks within the controllable range). At the same time, a detailed action plan is prepared to clarify the responsible person and time node.

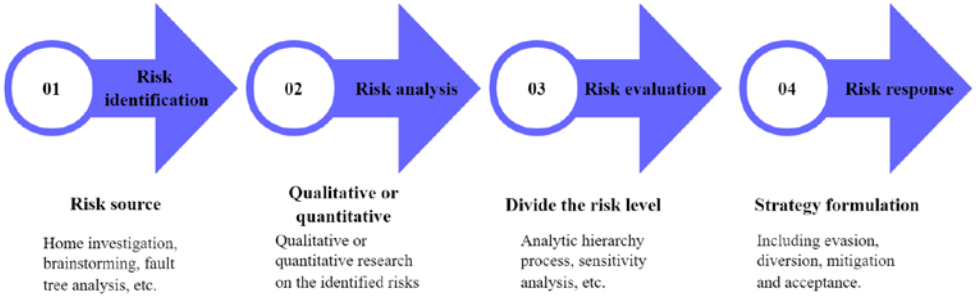

Figure 1 Risk assessment process of construction project

3.2 Common risk types

Common risk types mainly include technical risk, economic risk, management risk, legal risk and environmental risk (Figure 2). Technical risk comes from technical uncertainty in design and construction, which may lead to insufficient structural safety or operational errors; Economic risks involve investment overruns, financing difficulties and market fluctuations, which easily lead to capital chain problems; Management risks are caused by poor organization and coordination, differences in personnel quality or mistakes in decision-making, which are often manifested as schedule delay and waste of resources [8]; Legal risks include compliance challenges such as policy changes, contract disputes and intellectual property disputes; Environmental risk refers to the objective constraints caused by natural disasters such as earthquakes, floods, extreme weather and the impact of the project on the ecological environment.

Figure 2 Common risk types

3.3 Methods and tools

In risk management, traditional methods, such as expert scoring, risk matrix and SWOT analysis, rely on empirical judgment and structural framework to evaluate the possibility and impact of risks and identify internal and external strengths and weaknesses; Modern technology applications realize dynamic monitoring and real-time early warning through big data, integrate information with BIM model to accurately locate risk points, and optimize resource allocation and improve response efficiency with artificial intelligence [9]. The comprehensive application of these methods embodies the concept of "prevention first", effectively reducing the probability of emergencies and ensuring safety; At the same time, it is helpful for rational allocation of resources, avoiding waste and maximizing economic and social benefits; It not only promotes the upgrading of enterprise management system to standardization and refinement, enhances core competitiveness, but also promotes the improvement of industry standards through data accumulation and feedback, which has become an important driving force for sustainable development in the construction field.

4. Risk control method of construction project

4.1 Basic logic and goal of risk control

Risk control is the key link of risk management, and its core is to reduce the probability of risk occurrence or reduce the loss after risk occurrence through active intervention, and finally realize the matching between the overall risk level of the project and the organizational endurance [10]. According to the risk management theory, risk control should follow the principle of "prevention first, hierarchical management and dynamic adjustment", and the specific objectives include:

(1) Prevention in advance. Avoid high-risk events in advance or reduce their occurrence possibility through identification and evaluation;

(2) Control in the matter. Respond quickly to the risks that have occurred and limit the scope and degree of losses;

(3) Improve afterwards. Summarize the experience of risk response and optimize the risk management and control strategy of subsequent projects.

4.2 Main methods of risk control in construction projects

The risk control methods of construction projects can be divided into four strategic types: risk avoidance, risk mitigation, risk transfer and risk retention, which are implemented through specific technical tools and management means.

4.2.1 Risk aversion

Risk aversion is a management strategy to completely avoid taking specific risks by actively changing project plans or decisions, especially for scenarios with high risk probability and serious consequences. In the project selection stage, if faced with adverse geological conditions, strict policy restrictions or owners' credit problems, enterprises can avoid potential losses by refusing to bid or terminating cooperation; In the design process, in view of the construction technology with great technical difficulty and inexperience, such as overbreak of deep foundation pit or long-span cantilever structure, an optimized design scheme can be adopted, such as using shallow foundation or shortening cantilever length to eliminate technical risks; In terms of contract management, we can define the division of responsibilities by rejecting unreasonable terms or negotiating, such as avoiding "unlimited joint liability" or "unequal payment terms" and transferring the risks of professional projects to subcontractors with corresponding capabilities, thus reducing the possibility of risks at the source.

4.2.2 Risk mitigation

Risk mitigation is to reduce the possibility of risk occurrence or the severity of its negative consequences through technical, management or organizational means, and it is the most commonly used active control strategy in engineering. On the technical level, mature and reliable construction technology is adopted, geological survey accuracy is enhanced, and BIM technology is introduced to simulate the construction process. According to the key working procedure, the special construction scheme is formulated and the parameters are optimized through expert argumentation to reduce the risk of quality and safety accidents. The management layer tracks the risk dynamics in real time by setting quality control points, progress milestone nodes and cost early warning lines. Conduct risk awareness training for managers and skill assessment for operators to reduce losses caused by human errors. Establish a multi-sectoral coordination mechanism at the organizational level and clarify the division of risk responsibilities.

4.2.3 Transfer of risks

Risk transfer does not eliminate the risk itself, but transfers the financial or management responsibility of the risk to a more affordable subject through legal means, including engineering insurance, engineering guarantee and contract responsibility division. Engineering insurance covers all risks of construction projects (covering the losses of engineering entities caused by natural disasters and accidents), third-party liability insurance (compensating the damage caused by construction to surrounding residents or property) and industrial injury insurance (protecting the personal safety of workers). For example, the construction of deep foundation pit may lead to the settlement of surrounding buildings, and the potential compensation risk can be transferred by insuring the third party liability insurance. Project guarantee requires subcontractors/suppliers to provide performance guarantee (to ensure that they can complete the work according to the contract), advance payment guarantee (to prevent the owner's advance payment from being misappropriated) and quality guarantee. Contract risk allocation defines the responsibility boundaries of all parties in the bidding documents and contracts, subcontracts specialized sub-projects to professional contractors and signs risk sharing clauses.

4.2.4 Risk self retention

Risk retention is a strategy that enterprises choose to take risks on their own when the probability

of risk occurrence is low, the loss is small, or the transfer cost is too high. It is divided into active retention (reserving resources in advance to deal with it) and passive retention (unidentified or untreated risks are forced to bear). Set "unforeseen expenses" in the project budget to deal with sudden risks. For high-frequency and low-loss risks, the site disposal plan is prepared to ensure rapid recovery when risks occur. It is necessary to analyze the causes of non-transferred risks through after-the-fact resumption and optimize the risk response strategy of future projects.

4.3 Dynamic management and technical support of risk control

The risk of construction projects is dynamic, so risk control should run through the whole life cycle and rely on modern technology to improve efficiency. Dynamic monitoring and feedback Through regular risk reassessment and monitoring of key indicators, control measures can be adjusted in time. For example, if the extension of rainy season leads to the delay of earthwork excavation, it is necessary to dynamically adjust the subsequent process plan and increase the input of drainage equipment. BIM technology is used to realize three-dimensional visual risk preview, real-time field data collection by smart site system, and historical risk case base analysis by big data (identifying high-frequency risk patterns), so as to improve the accuracy of risk identification and the pertinence of control.

5. Conclusion

The risks faced by construction projects are diverse and complex, covering many dimensions such as technology, economy, management, law and environment. Through expert investigation, brainstorming and other tools to effectively identify risks, and combining qualitative and quantitative analysis methods to evaluate risks, it provides a scientific basis for formulating targeted control measures. In terms of risk control, this study puts forward four strategies: risk avoidance, mitigation, transfer and retention, and illustrates the implementation effects of these strategies through specific cases. This study not only provides a comprehensive risk identification and control framework for construction project management, but also emphasizes the importance of continuous monitoring and technological innovation. By implementing these methods, the project risks can be effectively reduced, the smooth implementation of the project can be guaranteed, and the sustainable development of the construction industry can be promoted. Future research can further explore how to integrate more advanced technologies to improve the efficiency and effectiveness of risk management.

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