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Research on Construction Risk Management of Construction Engineering Projects

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Abstract

The prosperity of construction engineering has experienced more than ten years in China, and there has been considerable development in various fields of engineering construction, among which the construction safety risk management of construction projects has attracted much attention. Construction safety risk management has the characteristics of complex work tasks, volatile safety issues, and weak work system. The construction risk management is difficult and requires special attention from managers. If it is not handled properly, safety accidents will easily occur, and both construction projects and enterprises will face huge losses. The risk management of construction projects in Chinese construction industry is not perfect, mainly because the management methods, ideas and means cannot be coordinated under the market economy conditions, so there are great risks in construction projects. Therefore, we must strengthen risk management, so as to ensure the quality of construction projects, in order to obtain higher economic benefits, so that Chinese construction enterprises can have certain advantages in the fierce international competition.

Keywords

Construction Projects; Construction Safety; Risk Management.

1. Introduction

All Since the reform and opening up, China's development has attracted worldwide attention and achieved remarkable results. The people's material needs have been greatly satisfied, among which, as a necessities of people's life, the growth rate of the construction industry is obvious to all. According to the statistics of the National Bureau of Statistics, the total output value of my country's construction industry has been rising year by year. Although the growth rate has fluctuated as a whole, the growth rate has remained unchanged, as shown in Fig. 1.

The implementation process of architectural projects is constantly changing, and the social and natural environment in which it is located is also very complex, so it will be affected by various factors. Based on these factors that affect construction projects, construction workers often have insufficient awareness of the situation, or from their own perspective, do not have sufficient ability to control, resulting in the deviation of the trajectory of the construction project from the expected target, which is a risk. Construction projects are faced with various risks throughout their life cycle, especially large-scale residential community construction projects with long construction periods and large investments. There are many factors affecting construction, and there will also be certain uncertainties in the future. Due to the influence of the above factors, the occurrence of personal injury, the manager's mistakes in investment decision-making, and repeated delays in the construction period, the construction efficiency of the construction project declines, and the project investment funds are lost and the construction plan deviates from reality, which eventually lead to adverse consequences such as project losses. Therefore, in order to obtain maximum benefits, builders must identify the risks faced in project construction, grasp the characteristics of various risks in construction, and study

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the causes of risks, so as to predict the scope and possibility of risk impact, and at the same time corresponding efficient, convenient and operable risk control measures are proposed.

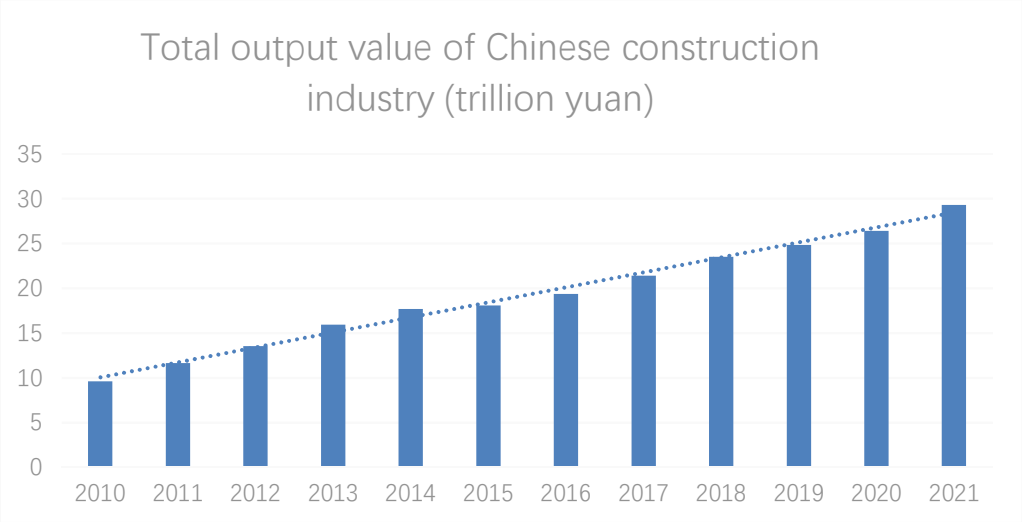

Fig. 1 Total output value of national construction industry

2. Overview of Project Risks

2.1 The Concept of Engineering Project Risk

There are many definitions of risk, but the most basic expression is: the greater the difference between various possible outcomes at a specific time and under a specific situation, the greater the risk. This definition of risk emphasizes the difference between outcomes. Another definition of risk emphasizes the uncertainty of the occurrence of various adverse events. This view holds that risk refers to the uncertainty of the occurrence of undesired events. Other experts think that the definition of project risk refers to the set of uncertain factors that affect the realization of engineering project objectives.

Generally speaking, the event that does not want to change, the uncertainty of the event , the consequences of the event, and the cause of the event risk are the necessary elements of risk Risks exist objectively in the project construction process and will not be transferred by human will. Therefore, risk management is a must. Risk management refers to people's identification and evaluation of various potential losses, and then combined with practical application of effective measures to deal with it, that is to say, to be prepared subjectively, or to be found feasible salvage measures when risk occurs objectively unavoidable, so that accidental losses can be reduced.

Project risk management refers to the risks management including risk identification, risk assessment and the way to treat risk, which is adopted by all participants in the construction of the project, including the contractor, contracting party, and the design, survey, supervision and other units in the process of survey, design, planning, construction and use of the entire project.

2.2 The Importance of Project Risk Management

(1) Risk management of engineering projects is a must for all parties involved in the project, and it is related to life and death. If the enterprise does not carry out risk management, or does not carry out risk management effectively, it is very likely that unexpected losses will occur, resulting in serious consequences. In light cases, the construction period will increase and the expenditure of all parties will increase; in serious cases, the project will not be able to continue to be completed, so that the previously invested funds cannot be recovered. If there is a problem with the quality, it will render the item unusable or cause long-term damage. In contrast, a business that focuses on risk management and manages it effectively will minimize the possibility of unexpected losses and be able to ensure that losses are minimized in the event of an unavoidable accident.

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(2) Risk management of engineering projects has a direct impact on the economic benefits of enterprises. After the enterprise risk management is in place, the materials, funds and manpower can be arranged more reasonably, so that the economic benefits can be improved. For example, in the construction of a project, the contractor will hoard a part of the material to prevent the risk of a sudden increase in the price of the material. However, if the contractor agrees with the developer in the construction contract to settle the actual settlement or adjust it according to market conditions, then the price risk in terms of materials will be borne by the developer, and the contractor does not need to store a large amount of materials. The saved working capital can also bring new profits to the enterprise.

(3) Project risk management ensures the smooth implementation of the project, and can effectively resolve disputes that may occur between all parties involved. Risk management can prevent risks on the one hand, and balance and allocate risks on the other hand. For a risk, the difficulty level of each party in the project is different. By allocating and balancing risks, allocating risks to the most suitable party for prevention and treatment, the possibility of risk occurrence can be greatly reduced, and the losses caused by risks can also be greatly reduced. At the same time, after the risk occurs, all parties involved should clarify their responsibilities and deal with the aftermath in a timely manner, which can reduce the occurrence of disputes.

All in all, project risk management is a work that all parties involved in the project, including contractors, contracting party, and design, survey, supervision and other unit. This is not only for passive risk avoidance, but also for enterprises to seek profits and avoid disadvantages, so as to be able to remain invincible in the fierce competition.

3. The Theories and Methods of Construction Project Risk Management

3.1 The Theory of Construction Project Risk Management

Construction project risk management involves the contents of three disciplines: project management, systems engineering and risk management, and includes many theories. This research mainly uses the following four theories.

(1) Uncertainty Theory

Uncertainty theory is a theory of behavior, which can lead to multiple outcomes, the subject can control the behavior, but not the outcome; if the meaning or extension of a concept only represents an uncertain behavior, then it has uncertainty. In general, randomness refers to the fact that the result of the experiment is known after the experiment, but the result is not known before the experiment, but is expressed by probability, and either or both is its main characteristic. Fuzziness refers to having a clear conceptual connotation but no clear extension, and it also means one and the other; greyness means that some information is known, while other information is unknown, and the extension is clear but the connotation is unclear. This is because information cannot be fully grasped under external interference. The above three are uncertain, they explain the actual situation from different perspectives, have their own characteristics, and will coexist and overlap in application.

(2) Probability Theory

The research object of probability theory is random events, and the research of causal theory is based on many random phenomena, so the meaning of its research object is very clear. However, the conditions and the reasons for the occurrence of things cannot be in one-to-one correspondence because the conditions for the occurrence of random events are not sufficient, that is, the occurrence of events is uncertain. Because the appearance of this uncertainty is a random phenomenon, it is also called random uncertainty. The degree of uncertainty can be determined probabilistically and can be quantified. The possibility of a risk event occurring or not can be predicted by estimating the probability, and the study of such a set of events can clarify the entire process of risk occurrence, development and evolution. Therefore, probability theory is an important tool for risk management,

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and the quality of probability theory's prediction of risk depends on the quality of information used for probability estimation.

(3) Utility Theory

The concept of utility is used to solve the problem of investors' choice of different risk returns and risk levels. "Utility" is an economic concept, which is defined as the relationship between spiritual satisfaction and wealth. It is a measure of psychic gain, that is, how much satisfaction an investment can bring to investors. To a certain extent, the size of the utility is determined by the individual's utility function, which reflects the utility curve of the individual's investment to some extent. By describing the relationship between investment returns and investment utility, it reveals the attitudes of decision makers to risk: risk avoidance, risk preference, and risk neutrality. However, utility theory has certain limitations, especially in the study of bounded rationality phenomena such as "extreme probability" and "extreme interest". The same decision maker, facing the same problem, may get different utility curve, therefore, it is difficult to establish the utility function of the decision maker.

(4) Information Game Theory

Game theory is a related theory that studies how decision-making subjects make decisions and solve the problem of decision-making equilibrium when all parties are interdependent. It is a science that studies the behavior of decision-makers. In risk games, people are often motivated by the duality of risk outcomes to take risks. The game strategy must not only consider strategic factors, but also psychological factors must be considered because the presence of opponents greatly increases the unpredictability of the game state. Game theory uses heuristics to find solutions in a large search space, and its solution model contributes to the pursuit of reward maximization and risk minimization in a competitive environment.

3.2 The Five-dimensional Decomposition Method of Engineering Risk

The five-dimensional decomposition method of engineering risk is to decompose the engineering project according to five different dimensions to understand the actual characteristics of the project.

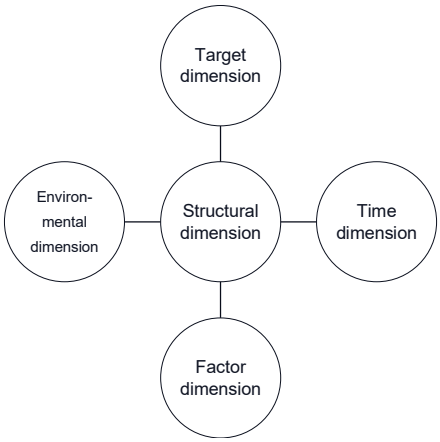

Fig. 2 Five-dimensional decomposition diagram of engineering project risk

The five dimensions are: the target dimension decomposed by project objectives, including cost, progress, quality, and safety goals; the time dimension decomposed by project technical stages, including project planning and design, project procurement, project construction,

trial production, completion acceptance, and project warranty period; structural dimensions decomposed according to the project composition structure, including unit projects, sub-projects; environmental dimensions decomposed according to the relationship between the project and its environment, including natural environment, society, politics, economy; The factor dimension according to the decomposition of project risk factors, including technology, contract, management, and personnel. The five-dimensional decomposition method of engineering risk is shown in Fig. 2.

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4. Construction Risk Identification and Response Principles of Construction Projects

4.1 The Principles of Risk Identification for Construction Projects

The first principle is from coarse to fine and then from fine to coarse. The former refers to comprehensively analyzing risk factors, and then using various methods to refine and decompose engineering risks, so as to achieve an in-depth understanding of engineering risks, and then obtain the original list of engineering risks. The latter refers to the investigation and analysis of the project according to the different risks in the initial list and the actual construction of the project, so as to identify the major risks affecting the construction of the project, and then carry out risk control and management around the major risks.

The second principle is to define the scope of risk on the basis of the association between risks. The scope should be strictly defined according to the definition of different risks to avoid overlapping. In addition, the correlation of different risks should be fully considered in terms of causality, mutual exclusion, and primary and secondary relationships. That is to say, in the stage of risk identification, it is difficult to identify the correlation of various risk factors, but the most basic requirement is to strictly define the scope of risk.

The third principle is to insist on being more skeptical and prudently rule it out. For the risks existing in the construction process of the construction project, the uncertainty of its existence should be fully considered, and these problems cannot be easily denied or excluded. On the basis of careful analysis, corresponding measures must be taken to confirm or exclude them.

The fourth principle is to insist that exclusion and confirmation go hand in hand. If the danger has been proven and can indeed be excluded, it must be carefully analyzed, and timely be eliminated. If the existing risks cannot be identified immediately, further assessment should be made and certain countermeasures should be taken. If it is determined that there is a risk, it cannot be excluded, and the determination shall prevail.

The fifth principle is risk test validation. It is difficult to judge the existence of certain risks with traditional methods, and it is difficult to determine the degree of impact of risks on the purpose of construction projects, especially for technical risks.If conditions permit, test verification can be carried out, and certain countermeasures can be taken according to reliable test conclusions. Of course, this method must pay a certain price.

4.2 The Principles of Risk Response in Construction Projects

(1) Risk avoidance. The role of risk avoidance is to interfere with risk sources, preventing or limiting the occurrence or development of risks. There are two ways to avoid risks. One is to refuse to take risks. For example, when you know that there is a greater risk in the project, you will not participate in the construction of the project; the other is to give up the risks you have taken before. When a project has risks that have not been discovered before, it can avoid the risk by giving up further research. Although risk avoidance can prevent risks, it is a passive means of preventing risks. This is because various types of risks exist widely in modern enterprise management, and it is impossible to completely avoid risks. Risk aversion, on the other hand, does not lose money, but it also loses the opportunity to gain.

(2) Risk prevention. Risk prevention refers to reducing the severity of a risk or being able to reduce the likelihood of it occurring, thereby minimizing the risk. There are two main methods:

The first method is risk prevention, which refers to the use of various measures to reduce the probability of risk occurrence. For example, suppliers use the means of expanding process channels to avoid the risk of unsalable goods; contractors use high standards to control quality to avoid the risk of fines or rework due to unqualified quality; management personnel in engineering construction strengthen safety measures to avoid risks. The contracting party requires the contractor to provide a letter of guarantee to avoid the risk of non-performance by the contractor, and the contractor agrees

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on various claims clauses in the contract to avoid the risk of the owner's breach of contract or other unforeseen events.

The second method is to reduce the risk, which means that when the risk cannot be avoided, various measures are taken to prevent the loss caused by the risk from spreading. For example, when the owner fails to pay the project payment on time, the contractor may stop the work or make a claim or even resort to litigation to reduce the risk; and when the contractor cannot carry out the construction as agreed, the owner immediately replaces the contractor, which can also reduce the risk; first aid is immediated taken after a safety incident in construction process can also reduce the risk.

(3) Risk separation. Separating various risk units to avoid chain reactions or being involved together is risk separation, which can control risks within a certain range, so as to achieve the purpose of reducing losses. Risk separation is often used in the process of purchasing equipment. In order to reduce the exchange rate risk caused by exchange rate fluctuations, equipment can be imported from different countries and paid in multiple currencies. During the construction of the project, the contractor's separate storage of materials is actually a risk separation measure, which can avoid the total loss of materials in the event of an accident due to centralized storage of materials.

(4) Risk diversification. Also known as "risk allocation", that is, by adding different risk-taking units in order to reduce the overall risk, the collective risk can be shared. In engineering projects, the total risk is certain and needs to be shared by all participants. Therefore, each participant should bear a part of the risk. Only in this way can each participant be able to actively control and manage risks. Risk allocation is usually specified in documents such as bidding documents, assignments or contracts, and risk estimation and allocation are carried out during the drafting of these documents.

(5) Risk transfer. After dealing with the above methods, there are still some risks that cannot be effectively controlled, and operators can adopt the method of risk transfer to protect themselves. Risk transfer is not an act of self-serving, and it cannot be simply considered that doing so is to transfer losses. Because there are many risks that can cause losses to some people, and transfer to other people, it will not cause losses. This is because different people have different strengths and, therefore, different risk tolerances. Risk transfer strategies are often widely used in project subcontracting, property leasing and technology transfer. The owner of the contract, technology or property transfers part of the risk that needs to be borne by himself to others through subcontracting projects, transferring technology or contract, renting equipment or houses, etc., so that the pressure of bearing the risk can be relieved.

4.3 The Risk Management Process of Construction Project

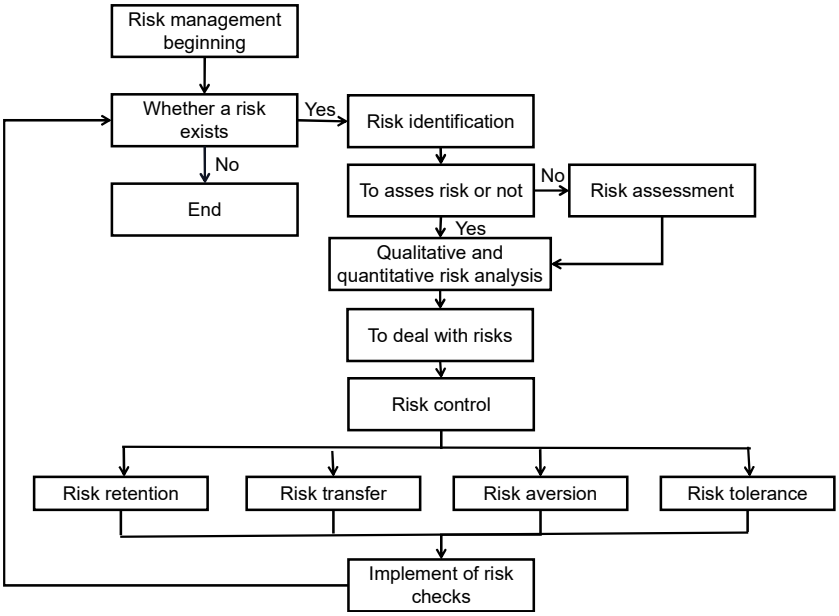

Fig. 3 Risk managment process of construction process

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In view of the high complexity of the construction project itself and the external environment, it is difficult to identify its risks comprehensively and systematically. For this reason, it is necessary to deeply study its risk identification process. The main risk management procedures include: risk management initiation, risk identification, risk assessment, risk analysis, risk control, and execution inspection (see Fig. 3).

5. Conclusion

The risk management of construction projects has made great progress and improvement in China, but with the continuous development and progress of Chinese economy and society, the number of construction projects has continued to increase and the scale has continued to expand. Construction projects are also facing larger risk. Therefore, it is necessary to strictly control and manage the risks of construction projects, so that the construction process is closely integrated with the economy and society, and the investment, construction and quality of construction projects are more effectively controlled. So as to ensure that the investment in construction projects can be more scientific and more reasonable. This is of great theoretical and practical significance for ensuring the long-term, stable, sustainable and coordinated development of our national economy, reducing project costs and improving project benefits.

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