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# Pre - risk Evaluation of Engineering Project Construction Based on Gray System Theory

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**Abstract.** In the construction of construction projects, the method of risk assessment is mainly affected by human factors, which leads to the accuracy and objectivity of the evaluation results. In order to ensure the accuracy of the evaluation results and scientific factors to reduce the impact of human factors, this paper will be in the project the gray system theory is used to construct the multi - level evaluation model by quantitative calculation and qualitative analysis, and the validity of the model is proved by examples.

## Introduction

The construction of the project has the characteristics of large investment, complex construction, long construction period and more construction units. There are more unforeseeable factors in the construction process. Therefore, the project construction is also high risk and needs to be guarded It is of great practical significance to ensure the smooth implementation of the project construction and to strengthen the risk control and management of the project construction. In the construction of the project in the early work is very important, to a certain extent, the project cost and engineering duration plays a decisive factor, especially the construction site, construction standards, construction technology, project size, construction equipment selection and many other aspects of the project cost And the project duration has a direct impact [1]. Project management is a systematic and complex project, the project construction process will be divided into multiple stages, and each stage has a clear implementation of standards and procedures, because the project is facing a very complex environment, Therefore, there are some difficulties in the project management, often risk events, the project risk identification and evaluation of the work there is a certain degree of difficulty, in fact, in the early construction of the project should be risk management, from a large extent Reduce the risk of the implementation of the project to ensure the smooth implementation of the project construction to achieve the expected social and economic benefits.

## Risk Analysis of Project Construction

**Risk Factors for the Pre-Construction of the Project.** The preliminary construction of the project is an important stage in the overall process of the project construction. The preliminary work is mainly to analyze and evaluate the necessity, feasibility and rationality of the proposed project, so as to provide a reliable basis for the project decision and reduce the project construction of the potential risk of the project to ensure that the construction project of the scientific and economic rationality. In the early stage of the construction of the project mainly includes project proposals, feasibility study report and construction design of these three stages [2]. Among them, the contents of the project proposal stage are mainly the necessity analysis of the project construction, the project market forecast, the product plan and the necessary conditions for the project construction, so as to make strategic decision for the project construction. The main risk factors for this stage are industry-related laws and regulations, design consulting units, engineering duration, industrial policies, owners' units, environmental assessment, investment estimates, financing programs and so on. In the stage of the feasibility study report, it is mainly to compare the construction scale, major technical scheme and standard of the project, so as to select the best construction plan and carry out

the economic feasibility evaluation according to the investment amount. The main risk factors of this stage are industrial policy, social impact, social benefit assessment, regional development planning, resource development and utilization, environmental impact, economic impact, construction land, population distribution, military facilities, transportation, project location, profit rate, communication, project management mode, the need for construction and many other aspects. The design stage is through the implementation of the project demonstration and decision-making, the preparation of construction plans to provide the basis for the construction, from the economic and technical aspects of the proposed project to make planning. In the preliminary design, it is necessary to meet the requirements of land requisition, materials, equipment ordering and project bidding and contracting, and carry out hydrological investigation, scientific research, geological exploration and other engineering tests, in the design of large and medium-sized projects mainly in the design and construction design To determine the project site and technical route, the overall design [3]. In the design phase of the main risk factors are technical parameters, technical programs, tender documents technical requirements, design standards, project investment profiles, civil design, building performance indicators, policies and regulations.

**Risk Characteristics of Construction Projects.** The risk of construction project is mainly caused by objective factors such as social factors and natural factors, and these objective factors have their own development law, not the will of the people for the transfer, so people for the construction project risk cannot be changed, Can only be used and fully understood. Project risk is an objective reality, although people are committed to the control of risk issues, but the current situation, people can only in a limited time and space on the risk of events to change the conditions to reduce the frequency of risk events to reduce the losses caused by the risk events, but cannot completely eliminate the risk.

From a social point of view, the risk of construction projects is objective, but for the construction of specific projects, any risk events are uncertain, that is, the occurrence of risk events are random [4]. Risk is generated by the various types of uncertainty factors under the common effect, so the essential characteristic of risk is uncertainty, but this is not to say that risk is no law, people through the risk of historical data, the regularity of the incident and the size of the risk to predict.

**The Assessment Purpose of Pre-Construction Project Risk.** The purpose of the risk assessment in the early stage of the project construction is threefold: First, the order of the degree of risk is clarified. Second, determine the intrinsic relationship between various types of risk events. In the early stage of the project construction, different risk events, from the overall and detailed analysis found that the risk of various types of risk events are closely linked or even the same, so the project pre-risk assessment is required for the overall project in the relationship between the various types of risk analysis to ensure that the risk of engineering projects to conduct scientific management and control. Third, grasp the relationship between risks, the risk into opportunities, reduce the risk of risk problems, and provide a realistic basis for risk events and management decisions [5]. The countermeasures of risk events are mainly considered from the aspects of effect and cost. The effect of risk events is mainly reflected in the two aspects of reducing the seriousness of the risk and the probability of occurrence of the risk events. Risk response measures are costly, and these costs can usually be accurately measured. In the process of risk response measures, the consequences and applicability of different risk events need to be considered in order to select the best risk response.

**The Risk Evaluation Steps of the Project Construction.** The pre-risk assessment of the project construction is divided into five steps: first, the identification of the risk factors of the evaluation object. First identify and identify the risk factors of the object, to ensure that there is no overlap between the various risk factors. Second, build the risk evaluation index system. The construction of risk evaluation index system needs to be stratified and constructed according to the relationship between primary and secondary risk factors [6]. Third, clear the weight of indicators. Fourth, clear the index value. There are two kinds of methods of qualitative analysis and quantitative analysis, and there are some differences in the quantification method. Fifth, build a comprehensive evaluation model. Through the risk factors and risk index system, the gray level model is selected to

evaluate the risk size, so as to evaluate the risk of the project construction.

## Summary of Gray System Theory

**The Definition of Gray System.** Gray system theory is based on the black system and the white system is concerned, is a kind of incomplete information definition, which is composed of white system factors between the clear relationship, structural clarity, the principle of action clear, and the black system is Refers to the lack of system information state, the gray system theory is between the white system and the black system, according to the definition, gray system theory is essentially refers to some of the information is known, and some information is unknown, through Mathematical method to solve the incomplete information under the uncertainty of the problem analysis of a theoretical method [7].

**The Characteristics of the Gray System.** Gray system theory mainly through fuzzy mathematics and probability statistics solve the gray system of uncertainty factors, through the generation of sequences to find a way between the intrinsic relationship between the sample, the main feature is the establishment of a small data model, focusing on research Connotation is not clear object. Such as "the boy's grade is about 20 years old", which is about 20 years old is the number of gray, epitaxial clear, but which is not a specific value.

## Constructing the Risk Evaluation Model of Project Construction Based on Gray System Theory

**Determine the Evaluation Sample Matrix.** According to the recommendations of the engineering experts, the risk factors of the project construction in the early stage of the project to fully consider the extent of the size of the full consideration to determine the evaluation level V = {high risk, higher risk, medium risk, lower risk, low risk}.

**Determine the Evaluation of Gray Class.** When it is determined that the number of ash whitening weights, gray numbers and gray grades of ash are determined in the pre-construction risk assessment of the project, the gray type of the risk assessment of the project is also determined. The gray matter needs to be evaluated according to the rating level and qualitative analysis, assuming that the ash number is e.

**Calculate the Gray Evaluation Factor.** Assuming that the evaluator scores the index, the secondary indicator $U_{ij}$ belongs to the e evaluation gray class. The evaluation coefficient is expressed as $X_{ije}$: $X_{ije}=\sum_{k=1}^{p} f_e\,(dijk)$

In the early stage of the project construction risk assessment, the secondary index $U_{ij}$ total gray evaluation coefficient expressed as:

$$x_{ij} = \sum_{e=1}^{g} x_{ije}$$

**Calculate the Gray Evaluation Weight Vector and the Weight Matrix.** In the pre-construction project risk assessment, the secondary index belongs to the e-evaluation gray gray evaluation right $X_{ije}$ and $X_{ij}$ ratio to represent, g evaluation of gray class is also used $r_{ije} = X_{ije} / X_{ij}$ to represent the project construction. The gray evaluation weight vector of the pre-risk assessment is expressed as $r_{ij}$=（$r_{ij1}$，$r_{ij2}$，……$r_{ijg}$）, In the pre-risk assessment of the project construction, the first-level index is $U_i$, the secondary index is $u_{ij}$, the gray evaluation weight vector of the gray evaluation right is the comprehensive evaluation of the gray evaluation right.

**Comprehensive Evaluation.** The gray evaluation weight vector of the first-level indicator $U_i$ in the pre-construction risk assessment of the project is Bi = Wi * Ri, and the first-level index belongs to the risk evaluation of the project evaluation. The gray evaluation weight matrix is B = (B1, B2, ... Bi ) T; the gray evaluation weight vector of the primary index evaluation gray class is B1 = W1 * R1, B2 = W2 * R2, ... Bi = Wi * Ri. (B1, B2, ... Bi) T; U's comprehensive evaluation vector is A = W * B, where A mainly reflects the pre-risk assessment of the project construction The degree of

gray, according to the principle of maximum power to clear the project before the construction of the risk of gray, the evaluation results for the A = WTB [9].

## Conclusion

There are risk factors in the whole life cycle of the project construction. If the preventive measures are not taken, the project construction will be affected. The early stage of the project construction is an important part of the construction of the project. Risk control to control is of great significance, can effectively provide the basis for project decision-making. In this paper, the gray system theory is used to analyze the risk assessment of the project construction stage, and the risk factors of the project construction are identified. The risk evaluation model of the project construction is constructed, and the weights of the risk factors are analyzed clearly and lay the foundation for the smooth implementation of the project construction.

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