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Study on determining the weights of risk assessment indexes based on AHP hierarchical analysis for barracks facilities construction units in highland and alpine areas

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ABSTRACT

Under the environment of plateau alpine region, the new model of substitute construction separating government construction and management functions has gained great development in barracks construction, which significantly improves the risk management level of barracks facilities to some extent. From the significance of barracks facilities construction guarantee in highland alpine area, the article proposes a risk identification framework for the substitute construction unit of Someplace facilities in highland alpine area based on the whole life cycle of engineering projects. Combined with the risk identification framework, the risk evaluation index system of the agency construction unit is constructed, and then the AHP hierarchical analysis method is introduced to solve the weight of the indexes, and combined with the fuzzy comprehensive evaluation method, the AHP-FCM evaluation model is constructed. A barracks facilities project in a camp area is selected as a case study, and Company T is used as the research object to carry out data analysis of its risk degree using the AHP-FCM model. In the construction of barracks facilities in highland and alpine areas, the biggest risk faced by the construction unit is the project implementation stage, the weight of which reaches 29.93%, and the fuzzy comprehensive evaluation of Company T's risk score is 3.182, which is between medium and large risks. Therefore, the agency needs to examine and check its own risk factors in time, in order to lay a solid foundation for ensuring the smooth implementation of the agency project of barracks facilities in highland alpine areas.

Keywords: AHP, fuzzy comprehensive evaluation, plateau alpine region, barracks facilities, agency construction unit, risk assessment

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1. Introduction

Base barracks security is based on the military struggle preparation requirements and theater border defense operation plan, in one or more directions of a number of points, pieces of planned construction and management, for officers and soldiers to live, use, travel and other integration of a large-scale security mode [1-3]. The core idea of base barracks security is "to space for time, pre-positioning instead of accompanying". Through the pre-positioning, the field barracks equipment and material reserves can be moved forward, without the need to organize a sudden rush before the war, not only to a large extent to alleviate the tension of the tension of the pro-war capacity, but also alleviate the plateau alpine region of the impact of the road singularity, greatly improving the effectiveness of the guarantee [4-6]. In addition, due to the pre-positioning, infrastructure and housing facilities have a certain period of time to get a higher standard of construction, the overall level of protection has been improved, and can provide high-quality protection for the troops going to the plateau on the verge of war [7-9].

Plateau alpine area base barracks security plateau alpine area average altitude high, harsh climatic conditions, complex social conditions, multifaceted factors intricately intertwined, affecting the smooth implementation of the usual barracks security work, on the plateau alpine area usual barracks security for useful discussion, help to improve the usual barracks security benefits, better play the usual barracks security function, so as to consolidate and improve the combat effectiveness [10-12].

Over the years, the national government has adopted certain policy guidance, the military commission, headquarters and military regions of the plateau alpine region constantly tilt and increase investment, so that the construction level of many barracks on a new level, the housing conditions of the troops have improved, water supply, power supply, heating, sanitary and other aspects of the facilities are also improving, all kinds of equipment is also continuously issued to the troops, barracks protection work is gradually and steadily in the weekdays. Carry out, but from the reality of the requirements and to meet the needs of the troops there is still a big gap, there are still certain problems [13-16]. Among them, the plateau alpine region by its terrain, climate conditions, making the supply of materials is quite difficult to mobilize [17]. And the plateau alpine region due to the influence of various factors, new technologies, new techniques, new materials application level is not high [18]. There are also policy standards, human factors and other management means backward, ineffective measures, affecting and restricting the smooth development of the usual barracks security work in the plateau alpine region [19].

Strengthening the risk assessment and management of barracks construction units in alpine areas is of great practical significance for optimizing resource allocation, integrating the planning of barracks, dealing with construction costs and economic efficiency, and promoting the construction of modern logistics. This paper proposes a risk assessment method based on AHP and fuzzy comprehensive evaluation for barracks facilities construction units in highland alpine area. The risk management of barracks facilities in highland alpine areas is based on the risk management of the whole life cycle, and the risk assessment index system of barracks facilities is constructed based on the four phases of pre-planning, construction preparation, project implementation and completion and delivery. Taking the construction of barracks facilities in a camp area as an example, Company T is chosen as the research object, and the effectiveness of the risk assessment index system is verified by actual data.

2. Overview of the agency for the construction of camp facilities in the high alpine region

With the continuous acceleration of the process of troop construction, the existing troop barracks in the plateau alpine area can no longer meet the needs of troop construction. And the construction of barracks facilities in plateau alpine area contains many types of risks, from the whole life cycle management of engineering projects, combined with the risk assessment of the agency construction unit under the mode of agency construction, it can better realize the construction of barracks facilities in plateau alpine area and ensure the standard construction of barracks facilities in plateau alpine area.

2.1. Construction of barracks facilities in the highland and alpine areas

2.1.1. Significance of securing camp facilities. Base barracks security is based on the requirements of military struggle preparation and theater border defense operation plan, in one or more directions of a number of points, pieces, planned construction and management, for officers and soldiers to live, use, travel and other integration of a large-scale security mode. The core idea of the base camp security is "space for time, pre-positioning instead of accompanying". Through the pre-positioning, the field barracks equipment and material reserves can be moved forward, without the need for pre-war organization of sudden rush, not only to a large extent to ease the tension of the war capacity contradiction, but also alleviate the plateau and alpine areas of the impact of the road singularity, greatly improving the effectiveness of the security. In addition, due to the pre-positioning, infrastructure and housing facilities have a certain period of time to get a higher standard of construction, the overall level of protection has been improved, and can provide high-quality protection for the troops going to the plateau on the verge of war.

2.1.2. Security of camp facilities. Over the years, the national Government has adopted a certain policy orientation, and the Military Commission, headquarters and military regions have continued to tilt and increase their investment in highland and alpine areas, so that the level of construction in many barracks has risen to a new level. The housing conditions of the troops have been greatly improved, and the facilities of water supply, power supply, heating and sanitary facilities are also being continuously improved, and all kinds of equipments are also continuously issued to the troops, and the usual barracks protection work is being carried out gradually and steadily. But from the reality of the requirements and meet the needs of the troops there is still a big gap, there are still certain problems.

1) Difficulty in raising and supplying materials. Plateau alpine region by its terrain, climate conditions, making the supply of materials is quite difficult to raise.

2) The level of scientific and technological applications is not high. Plateau alpine region due to the impact of various factors, new technologies, new techniques, new materials application level is not high.

3) Policy human factors have a great impact. Policy standards, human factors and other management means backward, ineffective measures, affecting and restricting the smooth implementation of the usual barracks protection work in highland alpine areas.

In order to improve the effectiveness of the usual barracks security in the alpine region, we need to start from the details, strengthen the barracks security force construction, increase the application of technology research, the introduction of social security mechanism, targeted efforts to solve the difficult problems in the usual barracks security. The agency units relying on the agency system model can start from the basic needs of barracks facilities in highland and alpine areas, helping to make barracks construction in highland and alpine areas more standardized, and providing a new exploratory program for safeguarding the construction of barracks infrastructures in highland and alpine areas.

2.2. Risk management for the construction agency for camp facilities

2.2.1. Barracks facilities construction unit. On behalf of the construction system refers to the government departments directly bidding or the government authorizes the relevant enterprises to bidding to screen out the appropriate project contractors, the successful enterprise to the government investment project management and construction is responsible for the project completion and acceptance of the project delivered to the government departments. In the process of construction, on behalf of the construction enterprise should be in accordance with the relevant contract on the quality of the project as well as the schedule and other matters responsible. The substitute construction system is a new method of infrastructure project management, which is based on China's national conditions to develop and improve the model. Government investment projects are usually large-scale infrastructure projects, so it is required in the management of the project, there should be a highly skilled, professional degree of high management team, to achieve the purpose of the process of each stakeholder. Whether it is the project's investors, contractors, or the project's user groups, government units, etc. all belong to the interests of the project. Therefore, the project on behalf of the construction unit to consider the core demands of all stakeholders, so as to realize the interests of all parties through management means. In the implementation of the project, the core interests of the investor is to reduce costs, shorten the construction period, improve the quality, the contractor requires the use of efficient management tools to continuously improve the construction efficiency, so as to obtain generous underwriting profits, the user group requirements are in the use of the process to be more convenient to use, lower operating costs.

On behalf of the construction unit on behalf of the construction model mainly contains three modes, mainly based on the signing of the contract for the two-party or three-party to determine the general pattern of the construction system as shown in Figure 1. The straight line in the figure indicates the management relationship, the arrow indicates the direction of financial funds circulation, and the dotted line indicates the coordination relationship. The figure below visualizes several key points and departments in the government investment project, while for the substitute construction unit, it is mainly responsible for several processes, such as project design, decision-making, construction and subsequent protection.

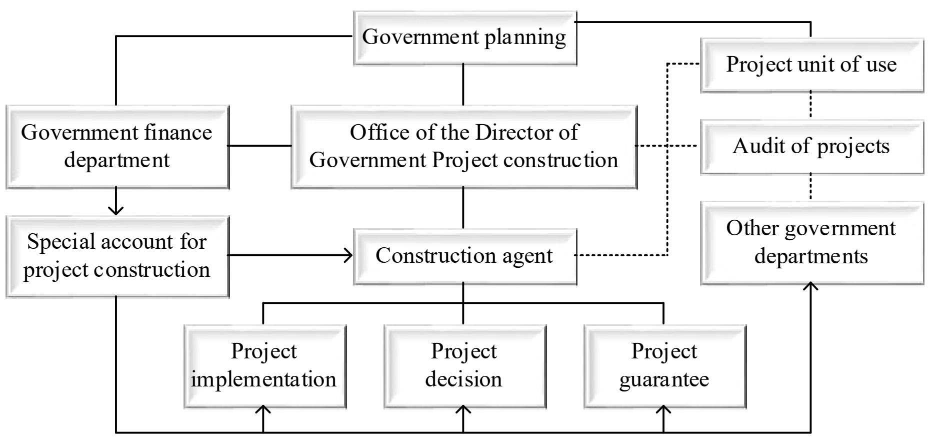

Fig. 1. The general model of construction

2.2.2. Risk management for the construction agency. In the process of construction of barracks facilities in highland and alpine areas, the agency unit's own risk management ability will also affect the effect of barracks facilities construction to a certain extent. In this regard, the agency unit needs to carry out risk management and risk methodology from internal and external perspectives, and enhance its risk management level by strengthening the internal and external management of the agency unit.

Risk management system refers to the decision-making system, method and process to realize certain management objectives and strategies, select and combine various risk management methods on the basis of comprehensive systematic and dynamic risk analysis, and formulate and supervise the implementation of overall risk management program. The process includes risk management planning, risk identification, analysis, response, monitoring and post-evaluation. The emergence of the risk management system has enabled enterprises to abandon the "umbrella approach", "ostrich approach", "intuitive approach" and "brute force approach" to risk in the past, and to identify and prevent risks in a planned and purposeful manner.

According to the characteristics and requirements of the risk management of the agency construction work, the risk management process of the agency construction unit is obtained as shown in Figure 2. It mainly contains the risk management of the whole life cycle of barracks facilities construction in plateau alpine area, and its purpose is to better help the substitute construction unit to realize the risk assessment and ensure the comprehensive risk management of the barracks construction project in plateau alpine area.

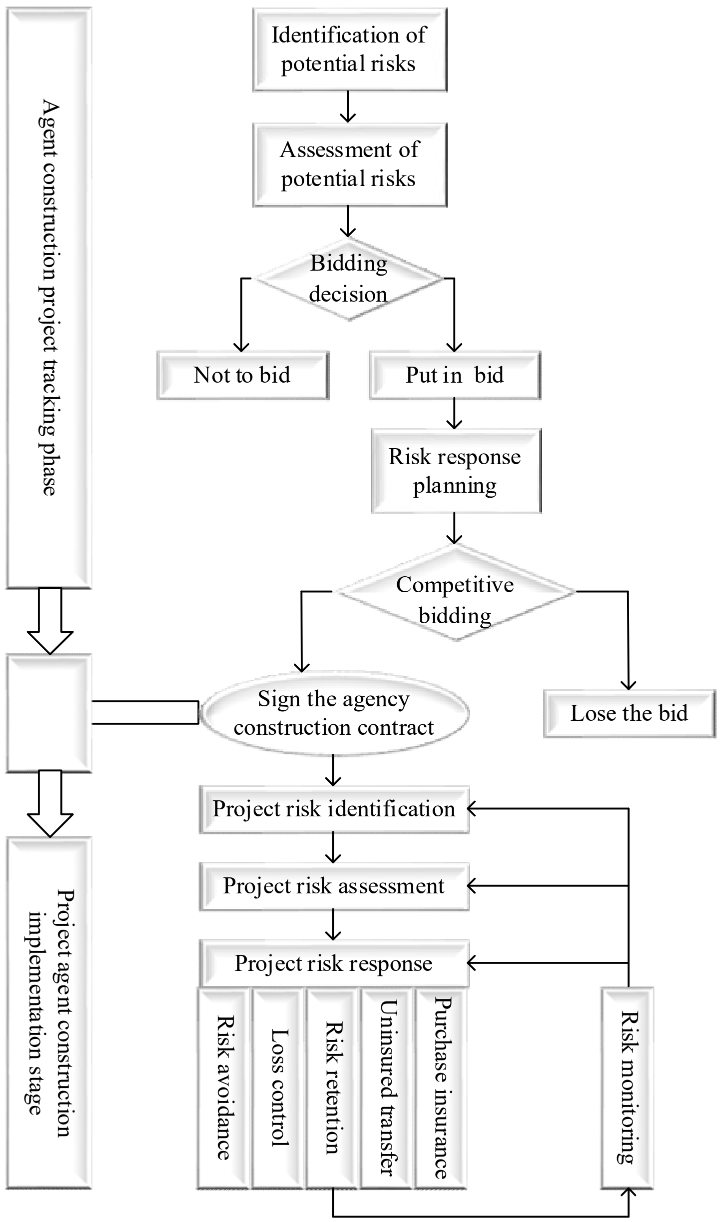

Fig. 2. Construction unit risk management process

3. Risk identification and risk assessment methodology for the agent's construction unit

The project construction mode is an innovative mode based on the optimization of foreign CM mode according to its own situation. China's CM model still has certain defects and needs continuous improvement. Pollution to the environment or the influence of the environment to the project construction, the management level of the agency construction unit, and the safety of the construction process are the main sources of the risk of the agency construction unit. Hierarchical analysis method can be adopted to assess the risk of on behalf of the construction unit. Under the substitute construction management mode, the substitute construction unit manages the whole process of construction, which can effectively control the quality of construction, shorten the construction period, optimize the period and cost, and is conducive to the management effectiveness of the project and the improvement of economic benefits.

3.1. Risk identification framework for camp construction units

The construction of barracks in highland and alpine areas entrusts the project to the agency for project construction management in the form of a commissioning contract, and does not directly manage the construction of the project, thereby transferring part of the risks of project construction to the agency. In accordance with the stage division of the whole life cycle of the construction of the project on behalf of the establishment, the risks faced by the project on behalf of the establishment are divided into four stages, as follows:

3.1.1. Pre-planning and Construction Preparation:

1) Pre-planning stage. In the first stage of the construction of the project on behalf of the pre-planning stage. In the pre-planning stage on behalf of the project on behalf of the construction unit on behalf of the government departments, in the capacity of the agent owner, in the pre-planning stage of the work for the signing of the contract, engineering feasibility study, financing, bidding procedures for approval, etc.. In the pre-planning stage on behalf of the main risks faced by the construction unit has to build the contract brought about by the risk, by the depth of the feasibility study and the accuracy of the risk caused by the pre-processing and approval of the risk caused by the risk of financing risk and bidding risk and so on.

2) Construction preparation stage. The second stage of the construction of the project is the construction preparation stage. The main work in the construction preparation stage is design management, demolition and relocation and supporting management, bidding, contract signing, organization and relationship coordination. Among them, the risks brought by design management work include functional design risk, budgeting risk, schedule risk, design quality risk, etc. Risks brought by demolition and supporting management work include owner, government or social risks, investment control risks, schedule risks, etc. Risks brought by bidding work include construction unit selection risk, supervision unit selection risk, supplier selection risk and so on. Risks brought by the contract include the risk of signing the construction contract, the risk of signing the supervision contract, and so on. Risks brought by organization and relationship coordination work include risks of organization construction of the construction unit, risks of plan making, risks of stakeholder coordination, etc.

3.1.2. Execution of works and delivery on completion:

1) Engineering implementation stage. Risks in the project implementation stage mainly include design management risks, construction management risks, organizational coordination risks, environmental

risks and so on. The construction management risks faced in the project implementation stage are mainly construction cost risk, construction progress risk, construction quality risk and construction safety risk, etc., and the organizational coordination risks are mainly the risk of overstepping the authority of the construction unit and the risk of financial security. The environmental risks faced during the implementation stage of the project are mainly meteorological environmental risks, geological environment and force majeure impacts, environmental pollution risks, and risks of sudden events.

2) Completion and delivery stage. Risks in the completion and delivery stage mainly include completion and acceptance risks and delivery and operation risks. Among them, the completion and acceptance risk is mainly the project settlement risk and maintenance risk. A large number of design changes in the construction process due to changes in the needs of the user units will lead to later settlement issues affecting the design and construction units, while the new volume of work, inflation and other aspects of the project settlement will also have a different degree of impact. In the project delivery after the use of relevant personnel, machinery and materials have left the site, if there is no personnel specifically responsible for on-site maintenance work, once the project quality warranty problems, will affect the progress of the warranty work, will also affect the use of the unit and on behalf of the interests of the construction unit. In the completion of the delivery stage facing the delivery of operational risk is mainly operational safety risk and environmental pollution risk. When the project completion and acceptance of the delivery of the use of units, the entire infrastructure can be safe and smooth operation is the most important, and the corresponding environmental pollution treatment will also cause a certain degree of risk of pollution of the surrounding environment.

3.2. Risk assessment methodology for camp construction units

3.2.1. AHP Hierarchical Analysis. Hierarchical analysis method (AHP) is a widely used method in economics and management, and its advantage lies in the elimination of subjective arbitrariness compared with other evaluation methods. The basic principle of AHP method is to decompose a complex system problem into various constituent factors, and group these factors according to the dominant relationship to form a hierarchical hierarchical structure, and then to determine the relative importance of the factors in the hierarchical structure through the comparison of two-by-two method. The relative importance of each factor in the hierarchy is determined by comparing two by two, and then the comprehensive weight of each factor is determined by integrating the judgment of experts. The whole process reflects the characteristics of "decomposition - judgment - synthesis" and the combination of qualitative and quantitative. Hierarchical analysis programmed and quantified the thinking process of decision makers, this method is suitable for multi-objective decision-making system, and it can find out the factors that have a greater impact on the overall goal from the complicated influencing factors and rank them according to the different degrees of influence [20]. The specific implementation steps of the AHP method are as follows:

1) Construct the recursive hierarchy model.

2) Apply two-by-two comparison method to construct all judgment matrices. That is:

$$B = b_{ij} \tag{1}$$

where b_{ij} denotes the importance scale of risk factor i compared to risk factor j with respect to B, and $0 < b_{ij} \leq 9, b_{ii} = 1, b_{ji} = \frac{1}{b_{ij}}$ i.e., B is a positive inverse matrix. The judgment matrix scales are defined as shown in Table 1.

Table 1. Judgment matrix scale definition

Scale	Meaning
1	The two factors are equally important
3	The former is slightly more important than the latter
5	The former is obvious important than the latter
7	The former is intensity important than the latter
9	The former is extreme important than the latter
2,4,6,8	The middle value of the above adjacent judgment
Reciprocal	The latter is more important than the former

The main reason for choosing the integer between 1 and 9 and its reciprocal as the value of b_{ij} is that it is in line with people's psychological habit of making comparative judgments.

3) Find the weight of each index relative to the upper index. According to the table in the scale rules to establish the judgment matrix, solve the weight can be used to sum method, square root method, characteristic root method, etc., this paper uses the square root method [21]. The calculation process of the weight of a layer indicator relative to the upper layer indicator $w_i^{'}$ can be expressed as follows:

$$w_i^o = \left(\prod_{j=1}^{m} b_{ij}\right)^{\frac{1}{m}} \tag{2}$$

$$w_i^{'} = \frac{w_i^o}{\sum_i w_i^o} \tag{3}$$

4) Calculate the maximum eigenvalues $\lambda_{\max}$ and $C.R.$ of the judgment matrix for consistency test The consistency test of the judgment matrix can be determined by the consistency index $C.R.$, when $C.R. < 0.1$, the judgment matrix is consistent with the consistency test; when $C.R. > 0.1$, the judgment matrix needs to be adjusted to meet the consistency test requirements. $C.R.$ is determined by the following formula:

$$\begin{gathered} \lambda \max = \frac{1}{m}\sum_{i=1}^{m}\lambda_{mi} = \frac{1}{m}\sum_{i=1}^{m}\frac{\sum_{j=1}^{m} b_{ij} w_i^o}{w_i^o} \\ C.I. = \frac{\lambda_{\max} - m}{m-1} \\ C.R. = \frac{CI}{RI} \end{gathered} \tag{4}$$

where $\lambda_{\max}$ is the largest characteristic root of the judgment matrix, m is the matrix order, and $R.I.$ is the correction coefficient, which is called the average stochastic consistency index.

5) Calculate the total weight of the bottom risk factor in the risk evaluation structure.

6) Calculate the comprehensive risk evaluation of each program.

3.2.2. ABC risk classification. The ABC risk classification management method is derived from the management argument of “critical minority and secondary majority”, that is to say, among the many factors determining a thing, there are a few critical factors that play a decisive role in the thing and a majority of secondary factors that have less influence on the thing. Its basic principle is that in the case of limited resources, to distinguish the main and secondary things, the focus of management on the few things that play a decisive role, and carry out differentiated management, so that the given time, funds, human resources, material resources and other resources can be efficiently utilized in a kind of analysis and management methods.

ABC risk classification management method is a method of arranging different categories of data in descending order according to their frequency based on the statistical analysis of target data and drawing a cumulative percentage chart in the same graph [22]. Its basic implementation steps are:

1) Data collection. The technicians collect the data related to target analysis according to the work objectives.

2) Target data processing. Analyze, calculate, process and organize the collected data to make the data of the analysis target more systematic and logical.

3) Drawing ABC form and data classification. Draw the ABC form of the target data and categorize the data analysis of the form according to conventional standards.

4) Determine the categories and draw an ABC analysis chart.

5) Develop appropriate management responses.

4. Risk assessment modeling of the barracks facilities construction unit

The overall level of construction of barracks facilities in highland and alpine areas is relatively good. However, according to the standard requirements for the construction of military barracks in the new period, there are still many hidden safety hazards, incomplete functionality, weakening of military attributes, obsolete infrastructure and other problems. Therefore, the introduction of substitute construction to assist the barracks facilities construction can better ensure the stable operation of barracks facilities in plateau alpine area. Prior to the introduction of the substitute construction unit to carry out the construction of barracks facilities in highland and alpine areas, it is necessary to carry out a comprehensive assessment of the risk management level of the party construction unit, so as to lay a solid foundation for the efficient construction of barracks facilities in highland and alpine areas.

4.1. Risk Evaluation Indicator System for Contractors

4.1.1. Principles for establishing evaluation indicators. For the design of risk evaluation indexes of the barracks construction on behalf of the construction unit in the highland and alpine areas, this paper mainly starts from the following principles to ensure that the risk assessment index system of the construction unit on behalf of the establishment of the scientific nature and comprehensiveness.

1) Scientific principle. Different from the general engineering projects, on behalf of the construction unit involved in the main body and the relationship is complex, the project risk often has a strong hidden nature. Therefore, on behalf of the construction unit risk identification is first established on the principle of science. In the identification process, should use scientific identification methods, adhere to the subjective analysis and objective research, qualitative analysis and quantitative analysis.

2) The principle of comprehensiveness. The identification of the risk of the construction unit on behalf of the construction unit can be carried out from different dimensions, such as the stage dimension, the target dimension and the systemic dimension. However, regardless of the dimension of identification, should adhere to the comprehensiveness and systematic nature of risk identification, through the risk structure decomposition, the establishment of a complete risk identification process, to ensure that there is no omission and repetition.

3) The principle of omnipotence. All-member refers to the mobilization of the construction unit to participate in the project construction of the parties involved in the theme, to participate in the construction unit risk identification. On behalf of the construction unit often has a relatively rich engineering experience, and in the project in different perspectives, from multiple perspectives on the implementation of the project may occur in the process of risk prediction, so as to improve the comprehensiveness of risk identification and scientific.

4) Dynamic continuity. Risk identification is a dynamic process, with the social and economic environment changes, technological process changes and the continuation of the project on behalf of the construction, risk factors are constantly changing. That is, the old risks gradually weakened, new

risks continue to emerge. Therefore, in risk identification should adhere to the dynamic, developmental point of view, on behalf of the construction unit for continuous risk identification.

4.1.2. System of risk evaluation indicators. Based on the previous theoretical basis for the risk identification and management of the construction of barracks facilities in highland alpine areas, it is possible to clarify the various risks and reasons that the construction unit may face in the process of barracks construction in highland alpine areas before carrying out the risk evaluation of the construction unit. As a result, combined with the risk management process of the whole life cycle of the project, the risk evaluation index system of the agency construction unit for barracks facilities in highland alpine areas is established as shown in Table 2. It mainly includes the preliminary planning stage, the construction preparation stage, the engineering implementation stage and the completion and delivery stage.

Table 2. The system of risk evaluation index system for construction units

Dimension	Explanation	Code
Pre-planning stage (PPS)	Contract risk of contract	PPS1
	Risk of feasibility study	PPS2
Construction preparation stage (CPS)	Risk of bidding	CPS1
	Check-in risk	CPS2
	Design management risk	CPS3
	Risk of demolition of land expropriation	CPS4
	Sign the contract risk	CPS5
	Organize the risk of coordination	CPS6
Engineering implementation stage (EIS)	Risk of construction management	EIS1
	Risk of contract management	EIS2
	The risk of demolition	EIS3
	Organizational risk	EIS4
Completion delivery stage (CDS)	Project closure management risk	CDS1
	Physical engineering settlement risk	CDS2
	Project transfer risk	CDS3
	Stakeholder coordination risks	CDS4

4.2. Risk Evaluation Modeling of Substitute Construction Units

4.2.1. Fuzzy integrated evaluation methods. The Fuzzy Comprehensive Evaluation (FCM) method is mainly based on the concept of affiliation degree of fuzzy mathematics to play a role, of which the most noteworthy is the ability to realize the transformation from qualitative to quantitative [23]. The specific approaches are as follows:

1) Clarify the content of the specific indicators to be evaluated. Assumption $U=\{u_1,u_2,\cdots u_n\}$ is also an indicator to be evaluated, which can reflect the specific number of indicators to be evaluated.

2) Determine the level of evaluation. Let $V=\{v_1,v_2,\cdots v_n\}$ be an evaluation level, which can effectively explain the specific number of evaluation contents, and different rubrics will have exclusive subsets.

3) Construction of the evaluation matrix. The most basic work is to make a judgment on the evaluation factors $u_i(i=1,2,\ldots m)$ each single influence factor for the evaluation set $v_j(j=1,2,\ldots n)$, to obtain a judgment matrix for each evaluation factor for the judgment set $r_i=(r_{i1},r_{i2},\cdots r_{in})$. The evaluation matrix so constructed is essentially a fuzzy relationship R from U to V. That is:

$$R=(r_{ij})_{\max}=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m1} & \vdots & r_{mn} \end{bmatrix} \tag{5}$$

In the above equation, r_{ij} means that u_i is considered as the entry point, and the rubric can be rated as the affiliation $v_j(i=1,2,\ldots,m;\ j=1,2,\ldots,n)$ of v. r_{ij} is the frequency distribution of the ith factor u_i on the jth rubric v_j, which must satisfy $\Sigma r_{ij}=1$ after normalization.

4) Fuzzy weight establishment. Let a fuzzy subset of U be A, and call it weight, $A=(a_1,a_2,\cdots a_n)$. where $a_1>0$, and $\Sigma a_i=1$, it is a kind of weighing degree for each evaluation index.

5) Fuzzy synthesized evaluation result vector. To be based on the effective synthesis operator, A is further reconstructed, and the fuzzy comprehensive evaluation result vector B is obtained by synthesizing each evaluated object at R of each evaluated object.

6) Analyze the fuzzy comprehensive evaluation result vector. Use the content produced by B for the whole process of evaluating levels. At this time, it is necessary to set the parameter column vectors relative to each level specified V_j, i.e.:

$$C=(c_1,c_2,\cdots,c_m)^{\text{ú}} \tag{6}$$

This leads to a judgment of the grade parameter as:

$$B\times C=P \tag{7}$$

P reflects the generalized information brought by the hierarchical fuzzy subset B and the hierarchical parameter vector C.

4.2.2. AHP-FCM evaluation model. The AHP-FCM evaluation model is a combination of hierarchical analysis method and fuzzy comprehensive evaluation method, which play their respective advantages to ensure the accuracy of the results. The principle of hierarchical analysis is first used to determine the indicator levels at all levels and calculate the weights of the indicators, and then the principle of fuzzy comprehensive method of subordination is utilized to carry out a comprehensive grade evaluation of the indicators. The specific process is shown in Figure 3.The AHP-FCM evaluation model only requires invited experts or evaluators to qualitatively evaluate the relative importance of the elements in the indicator system, two by two. Then using the hierarchical analysis method, the qualitative evaluation is converted into quantitative calculation, and the weights of each index can be calculated relatively accurately, and then the fuzzy comprehensive evaluation operation is carried out according to the requested weights.

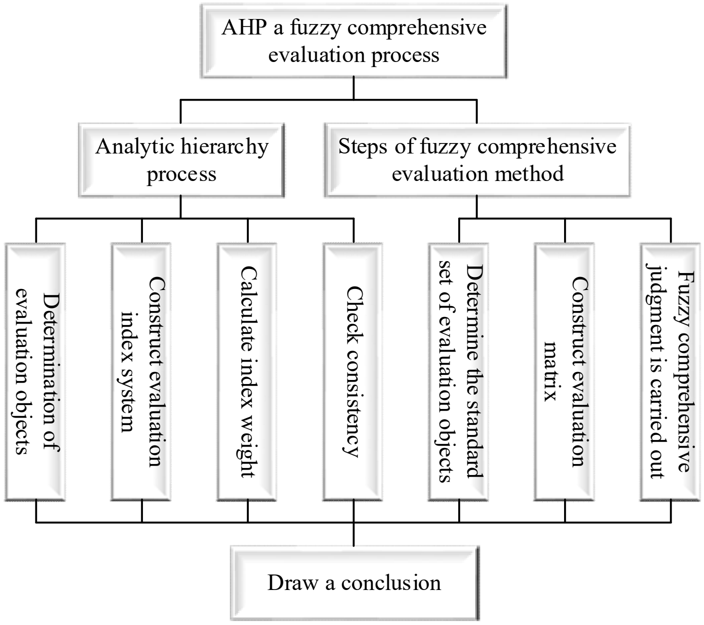

Fig. 3. AHP-FCM evaluation model process

The AHP-FCM evaluation model is used to carry out multilevel fuzzy comprehensive evaluation operation on the risk of the barracks facilities construction unit in the highland alpine area, which not only takes into account the influence of various factors on the study, and considers multiple evaluation opinions comprehensively, but also combines the description of qualitative evaluation with quantitative calculation, which effectively solves the fuzzy problems encountered in the evaluation process.The AHP-FCM evaluation model not only reduces the possible drawbacks of mixing personal subjectivity in evaluation, but also reflects the accuracy of evaluation factors, which is more objective and scientific compared with other evaluation models. The AHP-FCM evaluation model can not only reduce the disadvantages of personal subjectivity, but also reflect the accuracy of the evaluation factors, which is more objective and scientific than other evaluation models.

5. Example of the application of risk evaluation for a barracks facilities construction unit

Under the system of construction on behalf of the construction unit is in the core position of project management, at the same time on behalf of the construction unit of the risks and benefits are coexisting. Then to improve the profit should be on the plateau alpine area barracks facilities construction of the risk of its own impact on the establishment of the corresponding risk control program. Risk assessment is the premise and foundation of risk management, and the assessment method is the key to determine the quality of risk management. In this chapter, the AHP-FCM evaluation model is used to evaluate the risk factors of the agency construction unit of the barracks facilities in the highland alpine region from the perspective of the agency construction unit.

5.1. Hierarchical analysis to determine indicator weights

5.1.1. Selection of Agent and Project. A camp is located in a city in the northeastern region with a flat territory. It has a mid-temperate continental monsoon climate, with long cold winters and cool summers and autumns. Now the camp is located in the low-lying area of the city, and the water in the camp can not be discharged normally during the rainy season, which seriously affects the combat readiness, training and living order of the troops.Company T was qualified to build the camp facilities based on the tender announcement of the camp, and carried out the assessment of the risks that may exist in the process of carrying out the construction of the camp facilities of the camp, in order to ensure the optimization of construction of barracks facilities in the plateau and high-cold area.

5.1.2. Indicator weights for the pre-planning stage. According to the previous risk identification of the agency in the pre-planning stage, the hierarchical analysis method is used to determine the weights of risk evaluation indicators, and the risks faced by the agency are ranked.

1) First determine the weight of the guideline layer relative to the target layer. Through the questionnaires of 30 experts and colleagues, the two-by-two judgment matrix is constructed as shown in Table 3.

Table 3. Two judgment matrices

PPS	PPS1	PPS2
PPS1	1	1/5
PPS2	5	1

The judgment matrix is obtained, and each row of elements in the judgment matrix is multiplied and squared by W^* to obtain a vector of $W^* = (0.2236, 2.2361)$. Normalization is done on 2 to obtain a weight vector of $(0.1452, 0.8548)$. Combined with the formula for calculating the maximum eigenvalue in the previous section, the maximum eigenvalue is obtained to be 2.9461, and then combined with the formula for calculating the dissimilarity index to obtain the value of C.I. as 0.0512, and then followed by the value of consistency ratio C.R. as 0.0728<0.1. Therefore, it can be considered that the consistency of the judgment matrix of PPS1~PPS2 on PSS is acceptable.

2) Next, determine the weight of the program layer relative to the criterion layer. According to the above calculation process, the weight of each program layer to the criterion layer can be calculated in the same way, and the calculation results are shown in Table 4, which will not list the calculation process one by one here. Through the calculation results in the table, it can be seen that the risk weight of the agency in the pre-planning stage accounts for 24.27%, and the risk it faces is mainly the feasibility study risk, which accounts for 75.81%, referring to the ABC classification, this risk constitutes the main risk faced by the unit in the pre-planning stage.

Table 4. The index weight of the pre-planning stage

Dimension	Explanation	Code	Wi	Weight
Pre-planning stage (0.2427)	Contract risk of contract	PPS1	0.2419	0.0587
	Risk of feasibility study	PPS2	0.7581	0.1840

5.1.3. Indicator weights for the construction readiness phase. According to the previous risk identification of this agency in the construction preparation stage, the hierarchical analysis method is applied to determine the weights of its risk evaluation indexes.

1) Through the questionnaire to 30 experts and colleagues, according to the calculation process in section 5.1.1, the weight of each risk factor can be calculated in the same way, and the calculation results are shown in Table 5, which will not list the calculation process one by one here. The calculation results show that C.R.=0.0816<0.1, and it can be considered that the consistency of the judgment matrix of CPS1~CPS6 on CPS is acceptable.

Table 5. Judgment matrix and single sequence and consistency test

CPS	CPS1	CPS2	CPS3	CPS4	CPS5	CPS6	Wi	C.I.	C.R.
CPS1	1	1/3	1/2	1/5	1/3	2	0.0864	0.0984	0.0816
CPS2	3	1	1/6	1/4	1/3	3	0.1326		
CPS3	2	6	1	1/3	1/2	2	0.3158		

CPS4	5	4	3	1	1/2	4	0.2839		
CPS5	3	3	2	2	1	3	0.1162		
CPS6	1/2	1/3	1/2	1/4	1/3	1	0.0651		

2) Calculate the total hierarchical weight of each risk factor and carry out the ranking of the total hierarchical weight, and the calculation results are shown in Table 6. The calculation results show that the risk weight of the agency in the construction preparation stage reaches 21.79%. Among the various risks faced, the proportion of design management risk, land acquisition and relocation risk, and procedure approval risk is 15.96%. With reference to the ABC classification, these three risks constitute the main risks faced by the agency in the construction preparation stage, and corresponding measures should be taken to address these types of risks.

Table 6. The index weight of the preparation stage

Dimension	Explanation	Code	Weight
Construction preparation stage (0.2179)	Risk of bidding	CPS1	0.0197
	Check-in risk	CPS2	0.0289
	Design management risk	CPS3	0.0688
	Risk of demolition of land expropriation	CPS4	0.0619
	Sign the contract risk	CPS5	0.0253
	Organize the risk of coordination	CPS6	0.0142

5.1.4. Indicator weights for the implementation phase of the project. According to the previous risk identification of the engineering implementation stage of the agency, the use of hierarchical analysis to determine the weight of risk evaluation indicators, the risks faced by the agency project is sorted its risk evaluation hierarchy.

1) Through the corresponding processing of the relevant data obtained in this survey, the two-two comparison of the importance of risk factors, the risk assessment judgment matrix under the stage of implementation of the project, through the calculation of the results of the weight, consistency indicators and consistency of the proportion as shown in Table 7. Based on the calculation results in the table, it can be seen that the value of consistency index C.I. is 0.0724 and the value of consistency ratio C.R. is 0.0115<0.1. This indicates that the consistency of the judgment matrix of EIS1~EIS4 for EIS is acceptable.

Table 7. Judgment matrix and single sequence and consistency test

EIS	EIS1	EIS2	EIS3	EIS4	Wi	C.I.	C.R.
EIS1	1	7	1/7	1/6	0.0463	0.0724	0.0115
EIS2	1/6	1	1/2	2	0.4306		
EIS3	3	6	1	1/3	0.3292		
EIS4	2	5	1/2	1	0.1939		

2) Calculate the total hierarchical weight of each risk factor, carry out the total hierarchical weight ranking, and the calculation results are shown in Table 8. As can be seen from the table, the risk weight of the project implementation stage in the plateau alpine region barracks facilities on behalf of the unit accounted for 29.93%, of which the construction management risk, contract management risk, demolition and relocation supporting risk, organizational and operational risk is the A type of risk faced at this stage, of which the contract management risk has the highest percentage of the weight of the risk reached 12.89%. According to the principles of the ABC classification method, this factor

constitutes the main risk of the agency in carrying out the implementation phase of the construction project of barracks facilities in highland alpine areas.

Table 8. Index weight of engineering implementation stage

Dimension	Explanation	Code	Weight
Engineering implementation stage (0.2993)	Risk of construction management	EIS1	0.0139
	Risk of contract management	EIS2	0.1289
	The risk of demolition	EIS3	0.0985
	Organizational risk	EIS4	0.0580

5.1.5. Indicator weights for the completion and delivery phase. According to the risk identification of the completion and delivery stage of the agency construction unit in the previous section, the risks faced by this agency construction unit are ranked and its risk evaluation hierarchy is constructed.

1) Through the corresponding processing of the relevant data and information obtained in this investigation and the two-by-two comparison of the importance of risk factors, the risk assessment judgment matrix under the stage of engineering implementation is obtained, and the index weights, consistency indexes and consistency ratios are obtained through calculation as shown in Table 9. As can be seen from the table, the consistency index of risk assessment judgment of the substitute unit in the stage of engineering implementation C.I.=0.0859, and the consistency ratio C.R.=0.0127<0.1. This indicates that the consistency of the judgment matrix of CDS1~CDS4 for CDS is acceptable.

Table 9. Judgment matrix and single sequence and consistency test

CDS	CDS1	CDS2	CDS3	CDS4	Wi	C.I.	C.R.
CDS1	1	1/4	1/2	1/3	0.1807	0.0859	0.0127
CDS2	4	1	1/3	1/2	0.3673		
CDS3	2	3	1	1/4	0.3081		
CDS4	3	2	4	1	0.1439		

2) Calculate the total hierarchical weight of each risk factor, carry out the total hierarchical weight sorting, and the calculation results are shown in Table 10. From the table, it can be seen that the risk weight value of the completion and delivery stage is 0.2401, in which the entity project settlement risk, project transfer risk is the construction unit in the plateau alpine region barracks facilities construction of the completion and delivery stage of the risk faced by the A class, accounting for 16.22%. According to the basic principle of ABC classification method, these two influencing factors together constitute the main risks of the agency construction unit in the completion and delivery stage.

Table 10. Index weight of engineering implementation stage

Dimension	Explanation	Code	Weight
Completion delivery stage (0.2401)	Project closure management risk	CDS1	0.0434
	Physical engineering settlement risk	CDS2	0.0882
	Project transfer risk	CDS3	0.0740
	Stakeholder coordination risks	CDS4	0.0346

Combined with the relevant analysis in the previous section, the weight summary results of the risk assessment index system of the agency unit for barracks construction in highland alpine areas are shown in Table 11. As can be seen from the table, in the process of risk assessment of the construction of barracks in highland alpine areas, the risk weight value of the project implementation stage is the largest to reach 0.2993, and the risk weight value of the construction preparation stage is the smallest 0.2179. Therefore, when carrying out the risk assessment of the construction of barracks in highland alpine areas on behalf of the construction unit, it is necessary to focus on the risks that may exist in the implementation stage of the project, in order to ensure the efficient construction of barracks facilities in highland alpine areas to provide support.

Table 11. The weighting of the index of risk assessment for the construction unit

Dimension	Explanation	Code	Weight
Pre-planning stage (0.2427)	Contract risk of contract	PPS1	0.0587
	Risk of feasibility study	PPS2	0.1840
Construction preparation stage (0.2179)	Risk of bidding	CPS1	0.0197
	Check-in risk	CPS2	0.0289
	Design management risk	CPS3	0.0688
	Risk of demolition of land expropriation	CPS4	0.0619
	Sign the contract risk	CPS5	0.0253
	Organize the risk of coordination	CPS6	0.0142
Engineering implementation stage (0.2993)	Risk of construction management	EIS1	0.0139
	Risk of contract management	EIS2	0.1289
	The risk of demolition	EIS3	0.0985
	Organizational risk	EIS4	0.0580
Completion delivery stage (0.2401)	Project closure management risk	CDS1	0.0434
	Physical engineering settlement risk	CDS2	0.0882
	Project transfer risk	CDS3	0.0740
	Stakeholder coordination risks	CDS4	0.0346

5.2. *Fuzzy integrated quantitative evaluation of risk*

5.2.1. Single-factor risk evaluation analysis. According to the characteristics of the project and the needs of project management risk evaluation, the risk level of T agency is divided into five risk levels: very small, small, medium, large and very large. Construct the risk degree classification level set V, V = (very small risk, small risk, medium risk, large risk, very large risk) = (1, 2, 3, 4, 5).

For the risk evaluation expert group and project participant managers to organize the project single-factor risk evaluation, the project risk management team to produce questionnaires, questionnaires issued after the results are collected and collated. A total of 50 expert questionnaires were issued and 48 valid questionnaires were returned. The statistical results of the questionnaire survey are shown in Table 12.

Table 12. Statistical results of questionnaire survey

Code	V1	V2	V3	V4	V5	Total
PPS1	5	17	18	6	2	48
PPS2	4	18	15	5	6	48
CPS1	2	19	12	5	10	48
CPS2	3	21	13	8	3	48
CPS3	2	22	12	4	8	48
CPS4	8	19	15	2	4	48
CPS5	7	15	17	1	8	48
CPS6	6	17	16	6	3	48
EIS1	5	18	12	8	5	48
EIS2	11	16	13	4	4	48
EIS3	7	19	17	2	3	48
EIS4	3	20	16	3	6	48
CDS1	2	19	15	7	5	48
CDS2	3	18	15	9	3	48
CDS3	4	26	14	1	3	48
CDS4	5	22	12	6	3	48

For the same risk factor, by comparing the number of investigators who agree with the number of investigators belonging to a certain risk level with the total number of investigations, a table of investigation level affiliation can be obtained. The results are shown in Table 13.

Table 13. Risk level survey results

Code	V1	V2	V3	V4	V5
PPS1	0.0851	0.2234	0.4537	0.1527	0.0851
PPS2	0.1423	0.4018	0.2836	0.1493	0.0230
CPS1	0.0891	0.2836	0.4216	0.1314	0.0743
CPS2	0.0527	0.4524	0.2183	0.2216	0.0550
CPS3	0.0394	0.4236	0.2985	0.2075	0.0310
CPS4	0.0583	0.1459	0.4236	0.2381	0.1341
CPS5	0.1165	0.4658	0.2419	0.1324	0.0434
CPS6	0.1237	0.2751	0.3851	0.1715	0.0446
EIS1	0.0694	0.1426	0.3428	0.2846	0.1606
EIS2	0.0375	0.1769	0.3263	0.2751	0.1842
EIS3	0.0824	0.4224	0.2269	0.1357	0.1326
EIS4	0.0916	0.3469	0.3251	0.2011	0.0353
CDS1	0.0877	0.2824	0.2499	0.3638	0.0162
CDS2	0.0392	0.4219	0.2682	0.1594	0.1113
CDS3	0.0451	0.4538	0.2564	0.1729	0.0718
CDS4	0.0764	0.3637	0.2851	0.2062	0.0686

5.2.2. Fuzzy integrated risk evaluation. This paper takes the construction of a barracks facility in a camp in the highland alpine region as a case study, and takes Formula T as a substitute construction unit as a research object, and carries out an example study on the risk evaluation of the substitute construction unit of the barracks facility in the highland alpine region. Based on the implementation steps of fuzzy comprehensive evaluation model, this paper carries out fuzzy comprehensive risk evaluation as follows:

1) Establish the risk evaluation index set and determine the hierarchical structure model. The risk evaluation of the agency construction unit of the barracks facilities in the highland and alpine region mainly includes four types of risk in the pre-planning, construction preparation, project implementation and completion and delivery stage.

2) Establish the evaluation scale set, i.e., V = (very small risk, small risk, medium risk, large risk, very large risk) = (1, 2, 3, 4, 5) given in Section 5.2.1. Based on the assignment in order to carry out the calculation of the total score of the riskiness of the substitute unit.

3) Based on the AHP method to construct the judgment matrix and calculate the weight of each index, the specific content as the calculation results in section 5.1.

4) Establish the fuzzy comprehensive evaluation matrix. Based on the relevant formula of fuzzy comprehensive evaluation to get the fuzzy evaluation matrix of each risk factor, the fuzzy evaluation vector of each risk factor is obtained as:

$$\begin{cases} PPS = (0.0914, 0.2863, 0.4015, 0.1601, 0.0607) \\ CPS = (0.0519, 0.2037, 0.3342, 0.2668, 0.1434) \\ EIS = (0.0514, 0.2735, 0.2251, 0.2562, 0.1938) \\ CDS = (0.0503, 0.1527, 0.3116, 0.3305, 0.1549) \end{cases} \tag{8}$$

Based on the principle of maximum affiliation, it can be seen that the maximum affiliation of the pre-planning stage, the construction preparation stage, the engineering implementation stage, and the completion and delivery stage are 0.4015, 0.3342, 0.2735, 0.3305, respectively, which are medium risk, medium risk, smaller risk, and larger risk.

5) Based on the fuzzy evaluation vectors of the four phases, the risk fuzzy evaluation matrix of the agency unit is obtained, and then combined with the weights of each risk phase, the comprehensive evaluation set of the agency unit is obtained as:

$$\begin{aligned} B &= W * R \\ &= (0.2427, 0.2179, 0.2993, 0.2401) \\ &* \begin{bmatrix} 0.0914, 0.2863, 0.4015, 0.1601, 0.0607 \\ 0.0519, 0.2037, 0.3342, 0.2668, 0.1434 \\ 0.0514, 0.2735, 0.2251, 0.2562, 0.1938 \\ 0.0503, 0.1527, 0.3116, 0.3305, 0.1549 \end{bmatrix} \\ &= (0.0610, 0.2324, 0.3126, 0.2530, 0.1412) \end{aligned} \tag{9}$$

6) Combined with the evaluation set V = (1, 2, 3, 4, 5) given in the previous section, then the total riskiness score of the substitute construction unit, Company T, in carrying out the construction of barracks facilities in the highland alpine region is obtained:

$$\begin{aligned} P = B * V^T &= (0.0610, 0.2324, 0.3126, 0.2530, 0.1412) * \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{bmatrix} \\ &= [0.0610 * 1 + 0.2324 * 2 + 0.3126 * 3 + 0.2530 * 4 + 0.1412 * 5] \\ &= 3.182 \end{aligned} \tag{10}$$

In this case, the total score of the risk degree of the substitute construction unit, Company T, is 3.182, which is in the range of 3 to 4, and its risk type is medium risk. Therefore, the degree of risk faced by the agency in the course of the agency project for the construction of barracks in the highland alpine region is between medium and large risk, and the agency is facing a certain amount of risk. The agency is faced with certain risks. The agency is required to take into account the various risk factors it faces, identify the key factors, formulate a risk response plan, and take the necessary measures to prevent and control the risks it faces.

6. Conclusion

In this paper, using AHP and fuzzy comprehensive evaluation model, Company T is selected as the substitute construction unit of barracks facilities in highland alpine area, and its risk is comprehensively assessed by data. Among the risk phases of the agency construction unit of barracks facilities in highland alpine area, the weights of the preliminary planning phase, construction preparation phase, project implementation phase and completion delivery phase are 0.2427, 0.2179, 0.2993 and 0.2401 respectively, and the agency construction unit faces the greatest risk in the project implementation phase. Company T's fuzzy comprehensive evaluation risk degree score is 3.182 points, which is between medium and large risk. Therefore, when carrying out the construction of barracks facilities in highland and alpine areas, the agency needs to comprehensively consider its own risk factors as a way to formulate a corresponding risk plan, so as to improve the level of risk control.

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