

A Review of the Research on the Quality Evaluation Method for the Entire Process of Equipment Development Projects

Haiping Zheng^a, Yujia Zhang^b

Naval Aviation University, Yantai 264001, China

^a 15266558855@163.com, ^b 18033824442@163.com

Abstract. With the continuous increase in the technical complexity of equipment development projects and the growing prominence of their systems engineering characteristics, the traditional experience-based management model has become inadequate to meet the high investment, high risk, and low tolerance for errors requirements. This paper systematically reviews the current research status of the quality assessment methods for the entire process of equipment development projects. Starting from the three core dimensions of the assessment index system, weighting methods, and assessment models, it comprehensively sorts out the theoretical basis, practical applications, and advantages and disadvantages of the existing assessment methods. Through in-depth analysis, it reveals the potential problems existing in the current assessment methods in practical applications and proposes the key research directions for the future, aiming to provide more scientific and systematic theoretical references and practical references for the quality assessment of equipment development projects.

Keywords: equipment development project; whole process quality assessment; indicator system; indicator weight; evaluation model.

1. Introduction

With the continuous increase in the technological intensity of equipment development projects and the increasingly prominent characteristics of complex system engineering, their features of long research and development cycle, low quality fault tolerance rate, huge scale of capital investment, and being affected by multiple factors such as technological iteration and environmental adaptability have become more and more prominent. Any minor oversight or execution deviation in any link may lead to the loss of control over the project progress, failure to meet performance indicators, or even total failure, which in turn may cause huge economic losses and national strategic risks. This characteristic of high investment, high risk and low fault tolerance objectively puts forward almost strict control requirements for the quality of equipment development. However, the traditional experience management approach is difficult to effectively deal with these complex situations [1]. Therefore, it is of vital importance to adopt scientific and systematic assessment methods to conduct a full-process measurement and evaluation of the quality implementation status of equipment development projects.

At present, the research on the quality assessment of equipment development projects at home and abroad is relatively limited, and a systematic and complete research system has not yet been formed. However, numerous achievements have been made in the assessment research of equipment quality assessment, engineering project quality assessment and other related fields. These studies have accumulated rich experience in the setting of assessment goals, the selection of assessment methods and the application of assessment results, providing a universal reference framework for the quality assessment work of various projects. Systematically summarizing and generalizing these research results can provide a solid theoretical basis and practical reference for the quality assessment of the entire process of equipment development projects.

This paper systematically sorts out, compares and integrates various existing evaluation methods around three main aspects: the evaluation index system, the weighting method and the evaluation model. Deeply explore the defects and deficiencies existing in the current assessment methods, and explore the potential problems that may arise in practical applications. Combined with the development trend of equipment research and development projects, analyze the weak links in the

current research, propose the key directions for future research, and promote the continuous in-depth improvement of research in this field.

2. The Basic Principle of the Quality Assessment Method for Equipment Development Projects

The equipment development project presents significant characteristics such as complexity, multiple stages and uncertainty due to its wide coverage of technical fields, the integration of disciplines, the spanning of multiple stages in the R&D process and the interference of many internal and external factors. Against this backdrop, the quality assessment of equipment development projects, as a crucial part of project management, plays a decisive role in ensuring that the performance, reliability and safety of equipment meet the expected requirements. Its basic principles mainly include the following core points: First, clarify the quality indicators of the equipment development project to be evaluated and construct a quality assessment index system; The second is to determine the weight values of each quality indicator to provide a quantitative basis for subsequent evaluations; Third, establish a comprehensive quality assessment model for equipment research and development projects, organically integrate each indicator and its weight, and form a systematic assessment framework.

3. The Quality Assessment Index System for the Entire Process of Equipment Development Projects

In the process of constructing the quality assessment index system for equipment research and development projects, the selection of first-level indicators and the choice of construction methods are two core links that cannot be ignored [2]. They directly determine the scientificity and practicality of the index system and play a key role in accurately evaluating the quality of equipment research and development projects.

3.1 Selection of First-Level Indicators

In terms of the selection of first-level indicators, there are two representative research directions. One is to divide by stage, and the other is to classify by elements.

3.1.1 Classify by Stage

When dividing the first-level indicators by stage, emphasis is placed on the concept of phased assessment, and a high degree of attention is paid to the systematicness and dynamics of the overall process. It divides the equipment development project into multiple orderly stages, precisely controls the quality of each stage, and ensures seamless connection between stages, forming an efficient project promotion chain. In the related research of the weapons and equipment development project, Gao Xianzhi [3], Gao Yubing [4], etc. have made detailed stage divisions and relevant introductions for this project. Current research should also closely integrate with the latest regulations on equipment development and optimize the division of weapons and equipment development projects in line with The Times.

In other related studies, Wang Shuai [5] systematically expounded on the management methods and tool applications of quality planning, quality assurance, and quality control in the entire process stage from project initiation and argumentation, design and development, production and manufacturing to test verification for the A aviation weaponry and equipment modification project, providing references for the research and practice of full-process quality management in related fields. Feng Chen [6] et al. focused on anti-ship missiles and other weapons and equipment. Based on the characteristics of each stage of the entire life cycle, they used quality functional Deployment (QFD) to decompose layer by layer to construct the combat applicability mapping matrix, combined with the Analytic Structure Model (ISM) to clarify the hierarchical correlation of indicators, and

systematically constructed a combat applicability index system covering the entire process of equipment research and development, production, and use. Provide a scientific framework for the full-cycle applicability assessment. Cardenas[7] introduced the three stages of process validation. The entire process validation system runs through the entire process of drug production, from design to production and then to continuous monitoring, providing comprehensive guarantees for drug quality.

3.1.2 Classified by Elements

The method of classifying by elements tends to conduct in-depth analysis from the key elements such as people, machines, materials, methods and environment in the theory of total quality management. In relevant research, Yue Jing [8] analyzed the current situation of project quality management and formulated optimization countermeasures for HD road and bridge construction projects by combining the 5M1E analysis method with the fuzzy comprehensive evaluation method. He emphasized the comprehensive application of quality management tools and methods in project quality management to enhance the management level. Zhan Xichen [9] et al. classified the influencing factors of the quality of the key laboratory project of aviation equipment into personnel, airborne experimental equipment, suppliers, technical processes and other factors, and determined the basic framework of the index system to provide a reference for the quality assessment of the project. Li[10] et al. focused on the evaluation of scientific research efficiency in research-oriented hospitals in China, constructed a comprehensive index system, and divided it into two major dimensions of input and output according to the elements.

3.1.3 Summary

Although the classification method by elements can comprehensively cover all kinds of influencing factors in the equipment development process, it has certain limitations in the systematic consideration of the overall process and is prone to ignoring the internal connections and dynamic change characteristics between stages. Especially in the context of emphasizing the "whole-process" quality assessment, the approach of dividing first-level indicators by stages is more accurate and reasonable. It can clearly define the assessment scope and clarify the assessment methods, providing strong support for conducting comprehensive and in-depth quality assessment work.

3.2 Construction Method of the Indicator System

When constructing an indicator system, not only should the selection of first-level indicators be emphasized, but also the choice of construction methods should be paid attention to. Both are of vital importance. In the current related research, for the identification and screening of influencing factors, literature analysis method, expert judgment method, principal component analysis method and factor analysis method are widely applied.

3.2.1 Literature Analysis and Expert Judgment Method

The literature analysis method systematically sorts out a large number of relevant literature materials to dig out the key factors affecting the quality of equipment development projects. The expert judgment rule, drawing on the rich experience and professional knowledge of experts in the field, screens and judges potential influencing factors. Ren Suping [11] aimed at the design and application of the full-process tracking audit and evaluation index system for PPP projects. Through literature analysis, he obtained the specific audit mechanism. By means of expert interviews and other methods, he extracted key factors from relevant documents of PPP projects, designed the index system, and selected actual cases to construct an audit and evaluation model to verify the rationality and feasibility of the index system. Wawak[12] et al. comprehensively analyzed the key factors affecting quality in construction projects through the systematic literature review method, providing valuable insights and suggestions for the quality management of construction projects.

3.2.2 Principal Component Analysis and Factor Analysis

Factor analysis method explores the potential structural relationships among indicators, extracts the common factors that affect the quality of the project, and further optimizes the scientificity and effectiveness of the indicator system. Principal Component Analysis (PCA) converts multiple correlated indicators into a few comprehensive indicators through dimensionality reduction processing, in order to simplify the index system structure and highlight the main influencing factors. Amgen [13] et al. artificially optimized the evaluation work for combat readiness tasks in the assessment of equipment quality status, constructed an index optimization model based on the principal component analysis method, and verified through numerical examples that the principal component analysis method has superiority in index processing and can optimize and distinguish evaluation indicators. When Chang[14] et al. constructed the evaluation index system for the development level of China's green economy, they used the factor analysis method to reduce the dimension of the indicators, thereby evaluating the development level of the green economy more accurately. Yin[15] et al. applied the factor analysis method to the optimization process of the indicator system. Through factor analysis, they screened and classified the indicators to reduce the dimensions of the indicator system. They also combined methods such as principal component analysis to optimize the indicator system in multiple dimensions.

3.2.3 The Combination of Multiple Methods

When constructing an indicator system, many studies will adopt multiple analytical methods simultaneously in order to achieve better results. Yang Zhanjin [16] aimed at the whole-process quality management of substation construction projects. By combining the methods of literature research and expert consultation, and comprehensively considering the stages such as planning, design, and construction, he identified and screened out the influencing factor indicators of the quality management of substation engineering construction projects, and then proposed a control index system for quality management. Provide a theoretical basis for the construction of the quality assurance system of substation engineering construction projects. Miao[17] et al. conducted research on the problem that variables are difficult to measure directly and accurately in the procurement process of equipment scientific research projects. Drawing on expert consultation methods such as the Delphi method, potential evaluation indicators are screened and optimized. By means of factor analysis, path simulation tests, multi-group comparisons, and causal analysis of structural equation models, data analysis and processing of the relationships between variables and between indicators and variables were conducted, providing scientific method support for the bid evaluation of equipment scientific research project procurement.

3.2.4 Summary

In the construction of the quality assessment index system for the entire process of equipment development projects, the selection of first-level indicators needs to comprehensively consider the advantages and disadvantages of stage division and element classification, and make reasonable choices in combination with specific assessment requirements. The selection of construction methods should be based on the research purpose and data characteristics, flexibly applying literature analysis method, expert judgment method, factor analysis method and principal component analysis method, etc., to ensure the construction of a high-quality index system with practical application value, providing a strong guarantee for the quality improvement of equipment development projects.

4. Weighting Method for Quality Assessment Indicators Throughout the Entire Process of Equipment Development Projects

In the entire process quality assessment of equipment development projects, scientific and reasonable index weighting is extremely crucial for accurately reflecting the degree of influence of

each index on the project quality. At present, the methods of indicator weighting are mainly divided into three categories: subjective weighting, objective weighting and combined weighting [18].

4.1 Subjective Empowerment Method

The subjective weighting method determines the index weights based on expert experience, knowledge and subjective judgment, which can fully consider the professional insights and actual needs of the evaluators, but there may be a certain degree of subjectivity. The common ones include the Analytic Hierarchy Process (AHP), the Fuzzy Analytic Hierarchy Process (FAHP), and the optimization graph method.

4.1.1 Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) is a decision-making analysis method that decomposes complex problems into multiple levels and factors. This method quantitatively analyzes each factor in the decision-making problem by constructing a hierarchical structure model, thereby determining the relative importance of each factor.

Wang Linfei [19] aimed at the whole-process quality management of residential projects of Company A real Estate. Based on the analysis of the quality management contents, existing problems and influencing factors at each stage, he used the Analytic hierarchy Process (AHP) to conduct a weight analysis of the influencing factors of quality management, determined the weights of each factor, and then proposed safeguard measures to improve the quality management system. Shen[20] et al. constructed a risk assessment model by using the Analytic Hierarchy Process combined with the entropy weight method. The subjective weights are determined by means of the Analytic Hierarchy Process (AHP), high-risk factors in each link are identified and evaluated, key risks are found, and then risk control measures are proposed to ensure the safety of the food cold chain.

4.1.2 Fuzzy Analytic Hierarchy Process

The fuzzy Analytic Hierarchy Process (AHP) shows significant advantages when dealing with complex multi-criteria decision-making problems. It not only inherits the systematicness and hierarchy of the AHP, but also effectively overcomes the problem of weight calculation errors caused by inconsistent expert scoring in the traditional AHP by introducing the theory of fuzzy mathematics.

Liu Yan [21] et al. constructed an index system for the assessment of the equipment support capacity of the military from five dimensions, and established an assessment model by combining the fuzzy analytic hierarchy Process (AHP) and the approximation to ideal point ranking method. The model algorithm was verified through examples to have high precision and high efficiency. Lai Rongshen [22] et al. aimed at the problem of identifying the priority order of module redesign in the green performance optimization of product families, constructed a green performance evaluation model, and evaluated the green performance of modules by using the fuzzy analytic hierarchy process and the grey relational analysis method. The effectiveness of the method was verified by examples. Zhao[23] et al. aimed at the evaluation problem of the susceptibility of landslides in mountainous areas by using the fuzzy analytic hierarchy process. Combining Shannon entropy theory for variable weight processing, integrating subjective and objective weights, establishing evaluation criteria based on single-factor sensitivity analysis, and selecting eight influencing factors for research to verify the advantages of the method.

4.1.3 The Order Graph Method

The order graph method is a multi-criteria decision-making method based on preference relations. By constructing an order graph, each index in the decision-making problem is quantitatively analyzed to determine the weight of each index.

Zhu Min [24] conducted research on the construction and evaluation of the in-service assessment index system for main battle equipment by using literature review and questionnaire survey

methods. He established an index weight calculation model based on the combination of the improved order graph method for assignment and the correction of assignment differences. The feasibility of the method was confirmed through case analysis. Feng Jiachen [25] et al. established a system structure by setting up first-level and second-level evaluation indicators for the assessment of missile ground equipment support capabilities, calculated the weights of indicators at all levels by using the priority graph method and the expert consultation method, and determined the main factors affecting the construction.

4.1.4 Summary

Subjective weighting methods are widely applied in multiple fields. The Analytic Hierarchy Process (AHP) is suitable for index systems with clear structure and definite hierarchy. The fuzzy Analytic Hierarchy Process (AHP) is suitable for dealing with fuzzy indicators. The order of preference graph method is applicable to scenarios where the priority of indicators is obvious. In research, the selection can be made in combination with the actual situation of the development project to improve the scientificity and rationality of weight determination.

4.2 Objective Empowerment Methods

The objective weighting method determines the weights based on the actual data characteristics of the indicators, avoiding the interference of subjective factors, but it may not fully reflect the intentions and actual needs of the evaluators. The commonly used methods in related research include the entropy method and the CRITIC weight method.

4.2.1 Entropy Value Method

The entropy method objectively determines the weights by analyzing the distribution characteristics of the data, effectively eliminating the interference of subjective factors. This method has been widely applied in the comprehensive evaluation of multiple indicators.

Hu Hao [26] et al. aiming at the problem that the randomness and fuzziness of indicators in the efficiency evaluation of equipment support units affect the evaluation results, proposed an efficiency evaluation method for the mobility capability of a certain type of equipment. They comprehensively evaluated the mobility efficiency of a certain type of equipment by using the entropy weight method, subjective and objective weighting method, and related theories of cloud model, and obtained that the evaluation results of the equipment mobility efficiency belong to the cloud. In the research on the optimization of radar equipment quality assessment indicators, Hou Xiaodong [27] et al. proposed an indicator optimization method based on entropy weight discrimination. Firstly, the entropy value and entropy weight value of each indicator were calculated to obtain the discrimination value, and then the indicators were screened and optimized according to the relevant ranking to achieve the optimization distinction of the indicators in the conventional and combat readiness states. Zhu[28] et al. conducted research on the effectiveness of the entropy method in decision-making. Taking the problem of water source location selection as an example, with the help of Monte Carlo simulation to generate data, it is pointed out that the entropy method allocates weights by measuring the degree of dispersion of index values, highlighting the value of the entropy method in decision-making applications.

4.2.2 CRITIC Weighting Method

The CRITIC weighting method is an objective weighting approach, which determines the weights based on the conflicts and correlations among various indicators. This method quantifies the intrinsic relationships among the indicators by analyzing the differences and information volume among them, and then objectively allocates the weights, effectively reducing the interference of subjective factors.

Yan Xinyu [29] et al. aimed at the weighting problem of evaluation indicators in the combat effectiveness evaluation of air defense early warning equipment systems. They objectively weighted by using the improved conflict-correlation weighting method among standards and obtained the

combined weights through the multiplicative synthesis normalization method, verifying the feasibility of the method. Liu[30] et al. proposed a method for comprehensive evaluation and analysis of the development of renewable energy and regional energy in China. The study calculated the objective weights of each index through the CRITIC method and conducted a comprehensive assessment in combination with other methods.

4.2.3 Summary

In practical applications, appropriate objective weighting methods can be selected based on the characteristics of the evaluated object and the nature of the data. If the data differences are significant and the role of key indicators needs to be emphasized, the entropy method can be selected to determine the objective weights. If there are significant conflicts and differences among the indicators, the CRITIC weight rule is more applicable.

4.3 Combined Weighting Method

The combined weighting method combines the results of subjective weighting and objective weighting to take into account both the subjective will of the evaluator and the objective characteristics of the index data, making the determination of weights more scientific and reasonable. At present, research mostly adopts methods such as game theory, additive composition method, multiplicative composition method and range maximization.

4.3.1 Game Theory Combinatorial Weighting Method

The combined weighting method of game theory, by introducing the idea of game theory and combining the subjective weighting method with the objective weighting method, not only takes into account the empirical judgment of experts, but also fully explores the information contained in the data itself, which can effectively solve the limitations existing in the single weighting method.

Chen Yuguang [31] et al. proposed a method based on game theory - combined weighting for the risk assessment of urban intersections. They improved the evaluation by combining the grey cloud model and comprehensively weighted by using game theory and the fuzzy entropy method. The verification shows that it has high assessment accuracy and can locate risk factors. Yue[32] et al. aimed at the condition evaluation problem of medium and small-span Bridges such as concrete continuous beam Bridges. Based on game theory, an extended model was constructed, and the Analytic Hierarchy Process (AHP) and entropy weight method were combined to construct a combined weighting - fuzzy hierarchical comprehensive evaluation model. Taking the Wuhan bridge as an example, it was verified that this model can take into account both health monitoring and manual detection contents, and coordinate subjective and objective weights.

4.3.2 Other Combined Weighting Methods

In the actual process of multi-attribute decision-making and evaluation, a single weighting method is often difficult to comprehensively and accurately reflect the importance of each indicator. Therefore, in addition to the combined weighting method in game theory, scholars have also explored a variety of other combined weighting methods. By organically combining different subjective weighting methods and objective weighting methods, they aim to give full play to their respective advantages and improve the accuracy and reliability of the evaluation results.

Ding Haojian [33] et al. aimed at the problems of complex indicators and ambiguous results in the human-machine-environment engineering evaluation of wheel equipment. After constructing the evaluation index system, they adopted the Analytic Hierarchy Process (AHP) and Entropy Weight method (EW), introduced correction factors for combined weighting, and established a comprehensive cloud model for evaluation. Deng Hao [34] et al. aimed at the problems existing in the general quality characteristic evaluation system, constructed an evaluation index system covering three dimensions, adopted the AHP-entropy weight method based on the deviation values of subjective and objective weights for weight coupling to complete the index combination weighting, and then conducted fuzzy comprehensive evaluation based on the normal cloud model.

Li Haijun [35] et al. aimed at the problem of missile status assessment and decision-making, constructed a missile status parameter index system. To balance the advantages and disadvantages of subjective and objective weighting, they combined the fuzzy analytic hierarchy process and the entropy weight method, and used the geometric mean method to determine the index weights of the grey correlation analysis, thereby evaluating and making decisions on the missile status.

4.3.3 Summary

The combined weighting method effectively balances the subjective intention of the evaluator and the objective characteristics of the index data by integrating the subjective and objective weighting results. In practical applications, it is necessary to closely combine the characteristics of equipment development projects, assessment objectives and data features, and select the best combined weighting method, so as to provide data support for a comprehensive and accurate assessment of the quality of equipment development projects.

5. The Quality Assessment Model for the Entire Process of Equipment Development Projects

Constructing a scientific and reasonable quality assessment model is the key to accurately measuring project quality, identifying problems and making timely improvements. According to the modeling principles and characteristics, the quality assessment model of the entire process of equipment development projects can be divided into the modeling method based on traditional mathematical theories and the modeling method based on intelligent algorithms and dynamic assessment.

5.1 Modeling Method Based on Traditional Mathematical Theory

The modeling method based on traditional mathematical theory relies on mature mathematical theories and quantitatively evaluates the quality of the entire process of equipment development projects by constructing mathematical models. It has the advantages of rigorous logic and clear calculation process, and is suitable for scenarios where the data is relatively stable and the evaluation goals are clear [36].

Song Yuke [37] et al. sorted out the development history, assessment index system and characteristics of military target threat assessment, summarized the commonly used threat assessment methods, and looked forward to the future direction. Zhang Yanpeng [38] et al. identified the key factors influencing the quality of the aviation equipment laboratory project by using the grey correlation degree screening method and constructed an evaluation index system. He Rong [39] et al. for military equipment construction projects, drawing on the idea of milestone project management, constructed the framework of pre-event, in-event and end-of-event project evaluation models, and adopted the method based on entropy weight TOPSIS for project process evaluation. Li Jiakun [40] et al. established an index system for the evaluation of the optical camouflage effect of air defense missile equipment and conducted a comprehensive evaluation through a grey relational analysis model with combined weighting. Wang[41] et al. proposed a new quality risk assessment framework integrating probabilistic Hesitant Fuzzy Set - Quality Function Expansion (PHFS-QFD) and grey clustering to improve the efficiency of risk identification and control in the development stage of complex equipment. With the help of PHFS-QFD to identify risk factors and grey clustering to deal with risk assessment when quality information is insufficient, And simplify the evaluation by using the expansion function expanded by the quality function.

5.2 Modeling Method Based on Intelligent Algorithms and Dynamic Evaluation

Intelligent algorithms and the concept of dynamic evaluation provide new ideas and methods for the quality assessment of the entire process of equipment development projects, and can better adapt to the complexity and dynamic changes of the projects.

Neural network models are widely used in intelligent algorithms to carry out evaluation work. Kuang Xiaoping [42] et al. in order to improve the inspection quality of finished logistics mobile equipment and avoid the subjectivity of traditional evaluation methods, after establishing the quality evaluation index system and determining its rationality, constructed a quality evaluation model using the BP neural network. Through case analysis, it was proved that this model has high prediction accuracy and good simulation effect. In order to accurately evaluate the quality of machine automatic translation, Liu[43] constructed an evaluation model based on deep learning algorithms. In the unsupervised and supervised learning stages, relevant data were imported to optimize feature extraction and imported into the evaluation model to achieve automatic evaluation.

Cloud models are mostly used for research in dynamic evaluation. Hu Tao [44] et al. addressed the challenge of evaluating the resilience of ship power systems by constructing an index system. They used the Interval Analytic Hierarchy Process (IAHP) and the importance method of the inter-layer correlation criterion to calculate the subjective and objective weights, combined the improved game theory to determine the combined weights, and then evaluated from two dimensions using a two-dimensional cloud model. Wei Bowen [45] et al. proposed a rock mass quality assessment method based on one-dimensional cloud model, which was applied in the rock mass quality assessment of hydropower station dam foundations. The results were intuitive and reliable, providing a new idea for rock mass quality assessment. Li[46] et al. aimed at the problems that the evaluation of the propellant support capacity of the launch power system is affected by multiple factors and links and the accuracy of the evaluation is difficult to guarantee. Based on relevant theories, they constructed an evaluation index system, screened the indicators by the TOPSIS method, and carried out the evaluation in combination with the two-dimensional cloud model.

6. Problems and Challenges

In the process of conducting in-depth discussions and summaries on the evaluation research in related fields, although certain achievements have been made in theoretical and practical studies, many problems and challenges are still faced. To a certain extent, these problems restrict the further development and application of evaluation methods. The following are the main problems and challenges existing in the current evaluation research.

1) Insufficient innovation and systematicness of research methods: Current evaluation research often focuses on one of the three key aspects: the construction of an index system, weight assignment, and the establishment of an evaluation model. Specifically, if a study performs well in the construction of an indicator system but lacks sufficient depth and breadth in weight assignment and the construction of evaluation models, then the overall contribution and application value of the study may be limited. The imbalance of this kind of research leads to insufficient systematicness and comprehensiveness of the overall research, thereby limiting the comprehensive application and effect improvement of quality assessment methods.

2) Difficulty in reflecting the objectivity of combined weighting methods: Although subjective weighting and objective weighting each have their advantages and disadvantages in the selection of weight assignment methods, how to maximize the objectivity of data through combined weighting methods remains a challenge. The existing combined weighting methods have difficulties in balancing the relationship between subjective judgment and objective data, which affects the accuracy and reliability of weight assignment.

3) The intelligence and multi-dimensionality of the assessment model are weak: As weapons and equipment continue to develop towards informatization, intelligence and high-end, the quality assessment work also needs to keep pace with The Times and achieve the intelligence of data processing and analysis. Although research based on big data has made certain progress, on the whole, there are still problems such as an imperfect theoretical system, the need to deepen the evaluation methods, and insufficient practical application. Furthermore, in the dynamic evaluation of cloud models, one-dimensional cloud models are mostly adopted. However, when dealing with

complex projects, it is difficult to comprehensively reflect the actual situation of the project. In contrast, the research on two-dimensional cloud models and multi-dimensional cloud models is relatively scarce, which limits the application effect of the evaluation models in complex environments.

7. Conclusion

The research on the quality assessment method throughout the entire process of equipment development projects is crucial for ensuring the performance, reliability and safety of the equipment. Although certain achievements have been made in the current research, many challenges are still faced. Future research should focus on the following aspects:

1) Enhance the innovation and systematicness of research methods: Balance the depth and breadth of research in the construction of index systems, weight assignment, and evaluation model building to improve the systematicness and comprehensiveness of the overall research.

2) Optimize the combined weighting method: Explore more effective combined weighting strategies to maximize the objectivity of data and enhance the accuracy and reliability of weight assignment.

3) Strengthen the intelligent and multi-dimensional research of evaluation models: By leveraging big data, intelligent algorithms, and dynamic evaluation concepts, build evaluation models that adapt to the complexity and dynamic changes of projects, enhance the accuracy and efficiency of evaluations, and simultaneously promote the research and application of two-dimensional cloud models and multi-dimensional cloud models. For complex projects, two-dimensional cloud models and multi-dimensional cloud models are studied and applied to reflect the actual situation of the project more comprehensively.

Through continuous in-depth research and improvement of assessment methods, more scientific and systematic quality assessment means will be provided for equipment development projects, effectively enhancing the overall quality and efficiency of equipment development projects.

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