

Research on the Value Analysis and Evaluation of National Defense Scientific and Technological Achievements

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Abstract: Value analysis constitutes the core component in evaluating defense science and technology achievements. A scientific and systematic examination of the value components of such achievements holds significant theoretical and practical importance for refining evaluation frameworks and facilitating their translation into tangible combat capabilities. This paper focuses on defense science and technology achievements, conducts an in-depth analysis of their value essence, and establishes a categorized value analysis indicator system based on key element information for three types-theoretical, technological, and product achievements. Corresponding value assessment models and operational workflows are also developed. The research findings provide systematic analytical tools and methodological support for defense technology management and decision-making.

1. Introduction

National defense scientific and technological achievements serve as the core indicator for measuring a country's military technological capabilities and equipment standards. Their value analysis forms a crucial foundation for evaluating the effectiveness of scientific investments, optimizing resource allocation, and stimulating innovation vitality. Unlike general scientific achievements, defense-related innovations directly contribute to combat effectiveness and possess distinct military applicability, confidentiality requirements, and political significance. Therefore, conducting scientific, systematic, and effective value assessments of defense technologies is not only essential for modern defense management but also a critical basis for identifying technical gaps, enhancing equipment performance, and achieving strategic technological leadership.

Currently, the valuation of defense science and technology achievements still faces challenges such as an incomplete evaluation system, insufficient quantitative indicators, and inadequate reflection of defense-specific characteristics. Based on a review of domestic and international research literature and considering the unique attributes of defense technology achievements, this paper establishes a categorized value analysis indicator system and designs an evaluation framework, aiming to provide theoretical references and practical tools for the management and

decision-making of defense technology value assessment.

2. Research Review and Theoretical Basis

2.1 Current Status of Value Assessment of Scientific and Technological Achievements Worldwide

(1) Current Status of Scientific and Technological Achievement Value Assessment Worldwide

The evaluation of foreign scientific and technological achievements began relatively early. In recent years, as global innovation activities have intensified, developed Western countries-particularly the United States-have continuously established and refined comprehensive assessment systems for such achievements, thereby driving national technological advancement and development.

As the world's most technologically advanced nation, the United States has established a relatively comprehensive system for evaluating scientific and technological achievements. This evaluation process typically involves three stakeholders: government agencies, private evaluation institutions, and academic organizations, though no dedicated department is specifically designated for this purpose. During evaluations, government-funded commissions enable independent assessments conducted by private institutions and academia, ensuring fairness and objectivity. Additionally, legislation such as the Project Evaluation Standards Act and the Government Performance and Results Act reinforces the authority and enforceability of these evaluations. Through decades of practical experience, U.S. evaluation bodies have developed unified industry standards and methodologies that enhance the professionalism and standardization of their work.

Through the introduction of a series of national documents and technological investments, the UK has progressively refined its scientific and technological achievement evaluation system. Since the 1990s, the primary entities conducting such evaluations have shifted from predominantly government agencies to specialized third-party assessment institutions; the focus of evaluation metrics has evolved from emphasizing research publications to prioritizing the commercialization of research outcomes; and the assessment approach has transitioned from primarily qualitative methods to a combination of qualitative and quantitative approaches. In practice, the UK has significantly enhanced the effectiveness and efficiency of its achievement evaluations by supporting and nurturing third-party assessment bodies, refining evaluation criteria, and innovating assessment methodologies.

As early as the 1940s, Japan initiated the evaluation of scientific and technological achievements through its Science and Technology Council system, establishing a relatively comprehensive organizational framework and operational mechanism for such evaluations. The country has developed a three-tier assessment structure comprising the Comprehensive Science and Technology Council, government agencies, and independent evaluation institutions. Each tier establishes relatively independent principles and evaluation criteria within their respective jurisdictions, while overseeing the entire assessment process through a combination of internal and external evaluations. Additionally, Japan has enacted a series of relevant laws and regulations to strengthen legal safeguards for achievement evaluation, including the Basic Act on Science and Technology, the Basic Plan for Science and Technology, and the Guidelines for the Implementation Measures of National Research and Development.

(2) Current Status of Scientific and Technological Achievement Evaluation in China

Since the founding of the People's Republic of China, the country has been conducting evaluations of scientific and technological achievements. With the gradual advancement of reform and opening-up policies and the deepening of reforms in the science and technology system, both the theory and practice of such evaluations have continuously evolved and improved.

China's early evaluation system for scientific and technological achievements was relatively backward, only beginning to develop in a scientific and standardized manner after the 1990s. In 1994, the former State Commission of Science and Technology initiated third-party evaluations of scientific achievements; in 1997, the Ministry of Science and Technology officially established the National Science and Technology Evaluation Center and launched pilot programs for achievement assessments. China's evaluation framework has gradually evolved from the traditional government-funded, assigned, and assessed model to a modern approach guided by government principles with third-party evaluations, enhancing the scientific rigor and objectivity of assessments. Concurrently, China enacted key regulations such as the "Interim Provisions on National Science and Technology Program Management," "Measures for Science and Technology Evaluation," and "Interim Measures for Pilot Science and Technology Achievement Evaluations," progressively improving the fairness and standardization of assessment practices. In June 2016, Ministerial Order No.17 of the Ministry of Science and Technology abolished regulations including the "Measures for the Appraisal of Scientific and Technological Achievements" under the principles of law-based administration, functional transformation, strengthened oversight, and service optimization. Following this abolition, all science and technology administrative departments are prohibited from conducting independent evaluations-such assessments must now be commissioned through professional evaluation institutions as stipulated in the joint decision by five ministries (including the Ministry of Science and Technology and the Ministry of Education) and the subsequent "Measures for Science and Technology Evaluation." On July 16,2021, the "Guiding Opinions on Improving the Evaluation Mechanism for Scientific and Technological Achievements" explicitly stated the need to comprehensively and accurately assess the scientific, technological, economic, social, and cultural value of such achievements, enhance the classification evaluation system for scientific and technological achievements, and innovate evaluation tools and models. This indicates that China's evaluation system for scientific and technological achievements is being progressively refined.

Currently, although China's scientific and technological achievement evaluation efforts have achieved certain results, issues persist, including an inadequate evaluation framework and non-standardized implementation practices. Specific challenges include insufficient legal and regulatory frameworks governing achievement evaluations, unclear qualification standards for evaluation institutions, incomplete and vague quantitative indicators, lack of full independence in evaluation processes, and insufficient depth in evaluation procedures.

2.2 The Connotation and Characteristics of Value Assessment for National Defense Scientific and Technological Achievements

(1) The Concept and Connotation of Evaluation of National Defense Scientific and Technological Achievements

The evaluation of defense science and technology achievements is an assessment activity within the realm of defense technology, serving as the application of scientific evaluation principles in the defense sector. It constitutes a vital component of national scientific evaluation and a key aspect of defense technology management. Currently, there is limited specialized definition for the concept of defense technology achievement evaluation; therefore, this study draws upon relevant concepts from scientific evaluation. Li Youping et al. define technology achievement evaluation as a process that involves conducting comprehensive analysis and assessment-both qualitative and quantitative-of scientific activities and their environments through scientific, impartial, and feasible methods, guided by specific objectives, principles, procedures, and indicators, thereby providing a basis for scientific management and decision-making [1]. Based on the characteristics of defense

technology achievements, Li Zili defines defense technology achievement evaluation as a specialized assessment and consulting activity carried out by defense technology evaluation institutions. These institutions, in accordance with client requirements and objectives, adhere to established principles, procedures, and standards, employing scientific and practical methodologies to evaluate defense technology development, defense technology policies, defense technology programs, defense technology achievements, defense technology institutions, defense technology professionals, and other behaviors, impacts, and outcomes related to defense technology activities [2].

Generally, the evaluation of scientific and technological achievements should prioritize factors such as maturity, value timeliness, and developmental foundations. However, as evidenced by the distinct concepts of defense technology assessment versus general technology evaluation, defense-related assessments must adhere not only to standard evaluation principles but also possess unique characteristics. These distinctive features stem primarily from the military application nature of such achievements. Defense technological achievements encompass all scientific and technological endeavors spanning the entire lifecycle of weapon systems—from preliminary research and development, experimental production, deployment, operational maintenance to decommissioning [3]. Firstly, defense achievements emphasize military applicability, focusing on enhancing weapon system performance or developing novel equipment to boost combat effectiveness and overall military strength. Secondly, they prioritize confidentiality, given their sensitive military implications and significant impact on national security, requiring strict secrecy in specific domains and timelines. Thirdly, these achievements carry strong political dimensions: while applicable to civilian industries, their evaluation prioritizes national security, political, and social benefits over economic considerations. Consequently, defense technology assessments differ fundamentally from conventional evaluations through three key aspects: first, a focused evaluation of their impact on weapon system performance and combat capability enhancement; Second, the evaluation of defense science and technology achievements involves national security; therefore, a proper balance must be struck between security confidentiality and the assessment process. Third, emphasis should be placed on their impact on civil economic development. With the implementation of China's military-civil integration strategy, defense science and technology achievements should now place greater focus on maximizing their civilian applications—not only delivering defense benefits but also generating economic returns. It is important to clarify that all science and technology achievements referred to in this study specifically denote defense-related advancements.

(2) Development of an Evaluation Indicator System for National Defense Scientific and Technological Achievements

Currently, there are relatively few established indicator systems for evaluating the value of defense-related scientific and technological achievements. Therefore, this study conducts a literature review on both the general valuation of scientific achievements and the assessment of defense-related technological innovations. Smith et al. developed an evaluation framework centered on development and design costs, applied research expenditures, and industrialization expenses [4]. Christopher et al. proposed an indicator system based on input-output analysis, focusing on R&D personnel numbers, sales revenue, cost investments, as well as technological advancement and substitutability [5]. Wang Xiang incorporated market demand and commercialization capabilities into the evaluation framework for scientific achievements [6]. Zhang Yuwei, when assessing university-generated technological outcomes, used management costs, risk-return ratios, and transfer convenience as key evaluation metrics [7]. Yang Shuili et al. evaluated research team performance through four dimensions—R&D investment, outcome characteristics, technological impact, and benefit generation—with 13 critical indicators [8]. Wang Jia integrated social benefits,

environmental impacts, and international competitiveness into the assessment framework for scientific achievements [9]. Sun Zongrui prioritized market-oriented indicators for technological outcomes and incorporated lifecycle characteristics into the evaluation system [10].

Regarding the evaluation of defense science and technology achievements themselves, Wang Minfang et al., based on an analysis of their characteristics, developed an evaluation system comprising 25 detailed indicators across four dimensions: technological benefits, political benefits, social benefits, and economic benefits. They recommended employing a multi-objective comprehensive evaluation method to enhance objectivity [11]. Kou Yuanhu et al., considering the independence and significance of indicator selection, established an evaluation framework consisting of seven metrics-including innovation, advancement, maturity, application potential, economic benefits, social benefits, and military effectiveness-and proposed corresponding assessment criteria and expert selection standards [12]. Li Renyi et al. introduced the concept of "production readiness" for defense technology achievements, constructing an evaluation system encompassing three aspects: technical outcomes, dissemination value, and technology holder factors, with secondary indicators covering maturity, advancement, and completeness [13]. Nong Zhiming developed an evaluation framework centered on the defense technology system as the target level, supplemented by criterion layers including policy frameworks, economic factors, military capabilities, and technological proficiency. By integrating methods such as network analysis and uncertainty measurement techniques, he conducted quantitative analyses of indicator relevance and reliability, effectively mitigating evaluation biases arising from subjective experience [14].

(3) Methods for Evaluating Scientific and Technological Achievements

Currently, the primary methods for evaluating scientific and technological achievements include qualitative and quantitative assessments. Qualitative analysis is often highly subjective, abstract, and arbitrary; however, it offers advantages such as intuitiveness and speed. In contrast, quantitative analysis is characterized by objectivity, accuracy, and standardization, though its methodologies are relatively difficult to master and complex to implement. Nowadays, a combination of qualitative and quantitative approaches is commonly employed for achievement evaluation. Indicator-based assessment methods primarily include the Analytic Hierarchy Process (AHP), Principal Component Analysis (PCA), Fuzzy Comprehensive Evaluation, Grey Correlation Analysis, Artificial Neural Network, and Multivariate Statistical Analysis. The strengths and weaknesses of each method are summarized in Table 1.

Table 1. Advantages and disadvantages of several major evaluation methods

method	merit	shortcoming
AHP	A systematic approach combining qualitative and quantitative analysis enables the evaluation of structurally complex systems with multiple decision-making levels.	The evaluation is highly subjective.
principal component analysis	Capable of handling multi-index problems	Large amounts of statistical data are required; the standard is not inheritable.
Fuzzy Synthesis assessment method	Capable of addressing uncertainties that are difficult to quantify	The computational process is complex, and the determination of weights is subjective.
Gray Correlation Coefficient analytical method	No large sample size is required, and the calculation is simple.	The determination of weights and resolution coefficients is subjective and cannot reflect the absolute level of the evaluated object.
Artificial Neural Network Method	The determination of indicator weights is relatively objective.	The required sample size is large, posing practical implementation challenges.
Multivariate Statistical Analysis Method	The evaluation process is simple and maintains objectivity.	A large amount of statistical data is required

3. Framework for the Value Assessment System of National Defense Scientific and Technological Achievements

The evaluation of defense scientific and technological achievements is a series of activities organized and implemented by designated evaluators in accordance with specific objectives and established assessment principles. Building on an analysis of the characteristics of such evaluations, this study initially clarifies the composition of the defense technology assessment framework. It further establishes a three-tiered indicator system encompassing theoretical, technological, and product-based assessments, aiming to provide insights for future academic research and practical applications.

3.1 Technology Achievement Evaluation System

The national defense scientific and technological achievement evaluation system comprises six core elements: evaluation objectives, principles, evaluation institutions, expert panels, evaluation subjects, and evaluation indicators, as illustrated in Figure 1.

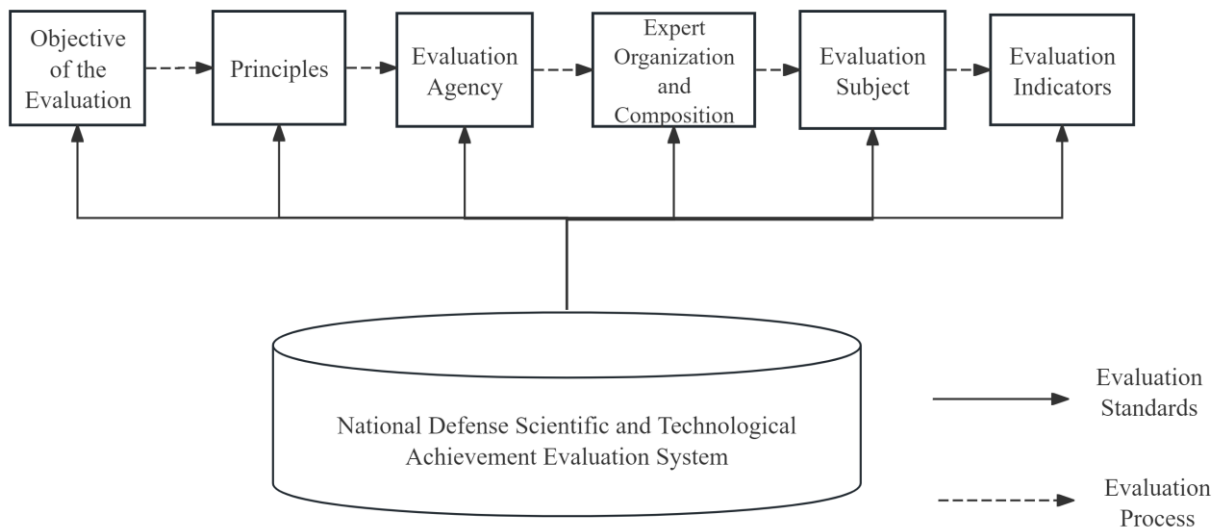


Figure 1. Evaluation System for National Defense Scientific and Technological Achievements

1) The purpose of evaluation serves as the starting point for assessing national defense scientific and technological achievements. Grounded in multiple objectives such as national security, economic development, and social progress, this approach aims to realize the safety benefits, economic returns, and social impacts of these achievements through evaluation. It fundamentally determines the establishment of evaluation principles, the design of organizational frameworks, and the selection of assessment methods and procedures.

2) The evaluation principles refer to the specific implementation guidelines for assessing defense scientific and technological achievements, providing direct guidance throughout the entire assessment process. Generally, the principles of scientific achievement evaluation should include the principles of scientific frontier, critical importance, disruptive impact, and technical feasibility.

3) The evaluation organization is the institutional body responsible for conducting evaluation work in accordance with the objectives and principles of national defense scientific and technological achievement assessment; it constitutes the core component of such assessments. The evaluation organization and responsible agencies shall be established by the corresponding functional departments, with third-party evaluation institutions specifically tasked with organizing

assessments across various fields, coordinating technical matters, and synthesizing comprehensive findings.

4) The evaluation expert panel is generally appointed by the selection organization. It consists of experienced, impartial, and objective technical and management professionals, including experts, scholars, engineering technicians, economists, educators, government policymakers, and human resources strategy specialists. The appointment should balance representation from academia, industry, military, and government sectors while fostering interdisciplinary integration and drawing on established practices; participation from young entrepreneurs and scholars should also be encouraged to provide valuable insights.

5) The evaluation subject primarily refers to various scientific and technological achievements generated during the research process, serving as the object of defense technology achievement assessment. The scope of application is generally determined jointly by the evaluation organization and relevant functional departments.

6) Evaluation indicators serve as the focal point for both qualitative and quantitative analysis in defense technology assessment. Various forms and methods can be employed for evaluating defense technological achievements. Establishing appropriate and rational evaluation indicators based on the specific requirements of achievement assessment and the inherent characteristics of the technological achievements facilitates the generation of standardized and objective evaluation results.

3.2 Design of the Technology Achievement Evaluation Indicator System

Establishing a systematic, scientific, and operational evaluation indicator system serves as the foundation for assessing scientific and technological achievements. The development of a value evaluation indicator system for defense-related scientific and technological achievements should adhere to the following principles.

1) Systematic Principle. The evaluation indicators for scientific and technological achievements should be conceptually clear and mutually independent. Through the value assessment indicator system, they can effectively reflect the future prospects, foundational conditions, and influencing factors for the subsequent transformation and application of defense-related scientific and technological achievements, forming a relatively comprehensive and systematic framework.

2) Principle of Scientificity. The evaluation system for defense scientific and technological achievements must fully and reasonably reflect their defense benefits, economic benefits, and social benefits, and be capable of generating scientifically sound comprehensive evaluation results through the value assessment indicator system for such achievements.

3) Key Principles. The realization of benefits from national defense scientific and technological achievements is a complex and systematic process involving numerous influencing factors that are difficult to exhaustively identify. It is essential to select representative key indicators, ensuring their significance, availability, and comparability.

4) Principle of Dynamism. National defense scientific and technological achievements must undergo real-time dynamic adjustments in accordance with different historical development stages and current strategic priorities in science and technology development, ensuring that their evaluation meets both present and future requirements for national security and technological strategic advancement.

5) Principle of Defense Adaptability. The Principle of Defense Adaptability stands as one of the core criteria for evaluating the value of defense-related scientific and technological achievements, emphasizing that the assessment process and outcomes must closely align with the specific requirements and operational logic of the national defense system. Specifically, this principle

prioritizes military effectiveness by focusing on the direct or indirect contributions of achievements to enhancing combat capabilities-including improvements in weapon systems performance, boosted operational efficiency of military units, and the development of strategic deterrence-rather than solely pursuing economic returns or academic impact. It mandates strategic compatibility, ensuring that achievements serve national defense strategies, military development plans, and joint operational needs, while assessing their alignment with key strategic areas such as intelligent warfare, unmanned systems, and cyber defense, as well as their irreplaceability within the defense technology ecosystem. Additionally, it imposes confidentiality requirements: evaluation activities must be conducted under strict security protocols, with established confidentiality mechanisms throughout indicator design, expert selection, data collection, and result dissemination to balance objectivity with security and prevent leakage of sensitive information.

(1) Indicator System for Evaluating Theoretical Research Achievements

Based on the fundamental characteristics identified in previous analyses and theoretical evaluations, this section establishes an assessment framework for defense science and technology theoretical achievements. The framework comprises 3 primary indicators, 9 secondary indicators, and 23 tertiary indicators, as detailed in Table 2.

Table 2. Evaluation Index System for Theoretical Achievements

Primary Indicator	Secondary Indicator	Third-level indicator
Application of Theoretical Achievements	human input	Number of doctoral supervisors
		Number of Teachers
		Other number of research projects
		The proportion of research personnel among the total full-time staff
	R&D base	Number of national key disciplines
		Number of Key Scientific Research Bases under the Ministry of Education
		Doctoral Points
	project	Number of National Fund Projects
		Number of local fund projects
		Number of military fund projects
	funds	Total expenditure on research funding
	Production of theoretical research outcomes	Works and Application Achievements
Number of research reports submitted to relevant departments		
Number of included papers		Number of papers published in English
		Number of papers translated into Chinese
Paper Quality		Number of top-tier papers accepted for publication
		Number of papers published in English
		Number of papers translated into Chinese
reward		National Award
		Ministerial and Provincial-Level Awards
		Military Reward
Research Efficiency	Research Efficiency	Per capita output rate
		output per ten thousand yuan

(2) Technical Achievement Evaluation Indicator System

Based on the preceding analysis and the fundamental characteristics of technological achievement evaluation, this section establishes an assessment indicator system for defense science and technology achievements. The system comprises 4 primary indicators, 10 secondary indicators, and 35 tertiary indicators, as detailed in Table 3.

Table 3: Technical Achievement Evaluation Indicator System

Primary Indicator	Secondary Indicator	Third-level indicator
Policy Level	development strategy	The degree of civil-military integration
		The extent to which the talent strategy has been implemented
		Amount invested in Scientific and Technological Research and Development
		Impact of National Defense Strategic Development
	Institutional Mechanisms	The Impact of Management Systems
		The impact of the management mechanism
Defense Perspective	Deterrence capability	The deterrent capability against hostile forces
		The ability to change the nature of warfare
	military might	Improvements in the performance of weapons and equipment
		Enhancement of equipment and weapon maintenance capabilities
		The survivability of weapons and equipment has been improved.
		The transportation capacity for weapons and equipment has been improved.
Economic Level	economic cost	Research Cost
		object cost
		opportunity cost
	economic benefits	National Economic Benefit
		Corporate Economic Performance
		socioeconomic performance
	economic risks	risk in investment
		production risk
		Market-oriented risk
technical level	Technology Maturity	Level of technical support
		Project Support Level
		Level of industrialization support
	Technical Risk	engineering reliability
		Technology Diffusivity
		technical stability
		Technical Adaptability
	Technical Forecasts	Technical Strategy
		Technical foresight
		Technical Criticality
		Technological Innovation
		Technological Disruption
		autonomy of technology

(3) Product Outcome Evaluation Indicator System

Based on the preceding analysis and the fundamental characteristics of product achievement technology evaluation, this section establishes an evaluation index system for defense technology product achievements, comprising 2 primary indicators, 6 secondary indicators, and 18 tertiary indicators, as shown in Table 4.

Table 4: Product Outcome Evaluation Indicator System

Primary Indicator	Secondary Indicator	Third-level indicator
application value	Product Practicality	Product National Defense Benefits
		Product Economic Benefits
		Product Social Benefits
	Product Innovation	Innovativeness in Military Applications
		Innovative applications in production
		Innovation in Daily Life Applications
	Product Maturity	Military Application Maturity
		Production Application Maturity
		Life Application Maturity
Support Environment	Military Support Level	The urgency of military needs
		Military expenditure support capacity
		The support capabilities of military industry enterprises
	Government Support Level	Compliance with policies and regulations
		Level of fiscal and tax support
		Support for talent development
	Market Support Level	Market Demand Level
		Market Acceptance Time
		Market Competitiveness

4. Approach and Operational Process for Valuing National Defense Scientific and Technological Achievements

4.1 Preliminary Preparation for the Evaluation of National Defense Scientific and Technological Achievements

(1) Establishing an Organizational Framework for Evaluating National Defense Scientific and Technological Achievements

The organizational management model for evaluating scientific and technological achievements is constructed across three levels-decision-making, execution, and supervision-ensuring mutual coordination and checks and balances. It defines the roles and responsibilities of stakeholders at each stage of the evaluation process, as shown in Figure 2.

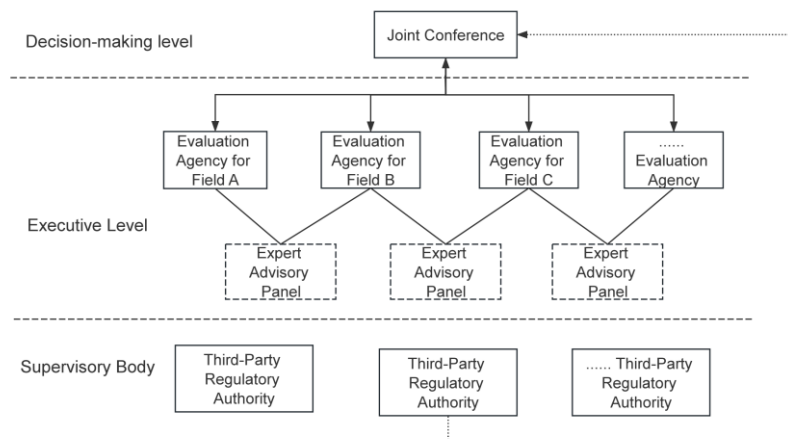


Figure 2: Schematic diagram of the organizational structure for defense scientific and technological achievement evaluation

At the decision-making level, a joint conference on scientific and technological achievement evaluation will be established under the joint leadership of government and military departments. This conference will engage professional assessment institutions to conduct evaluations and ultimately approve the corresponding reports. At the implementation level, specialized evaluation bodies will be formed across various technical fields to undertake assessment tasks, including establishing expert advisory teams, researching and refining evaluation methodologies, optimizing assessment procedures, and developing comprehensive evaluation guidelines. These expert advisory teams operate on a mission-driven basis—they are temporarily assembled for specific evaluation assignments, employ professional methods during assessments, and disband upon task completion. At the oversight level, third-party institutions will supervise and evaluate the standardization and legality of the entire assessment process.

(2) Establish an evaluation index system for national defense scientific and technological achievements

The establishment of an evaluation indicator system for scientific and technological achievements aims to identify whether such achievements will significantly impact national defense security, technological transformation, economic and social development processes, or pose potential risks. Therefore, when developing evaluation indicators for defense-related scientific and technological achievements, it is essential to: understand the role and future trends of these achievements to ensure the forward-looking nature and value of the assessments; assess the timeline for technological implementation within the current international context and conduct comprehensive comparisons of domestic and international technological developments to guarantee scientific rigor and rationality; evaluate the domestic foundation for technological advancement, focusing on key factors such as implementation platforms, primary support systems, R&D costs, and constraints to ensure objectivity and feasibility; explore potential pathways for interdisciplinary integration and convergence to ensure comprehensive application of achievements; and identify and predict potential technical and ethical risks associated with defense-related scientific and technological achievements to safeguard their safety and legitimacy.

(3) Establish an expert database for evaluating national defense scientific and technological achievements

When establishing an expert database for scientific and technological achievement evaluation, comprehensive consideration must be given to factors such as the number of experts, their disciplinary composition, and professional qualifications to ensure both structural diversity and professional competence. In terms of comprehensiveness, the panel should include representatives from government agencies, industry, academia, research institutions, and end-users. While maintaining expert authority, it is essential to widely solicit input from political stakeholders, enterprises, and end-users to guarantee the forward-looking nature, value assessment, and scientific rigor of evaluations. Experts should be selected based on their expertise in relevant fields, typically comprising specialists engaged in specific domains. Participants are categorized into invited experts—technical R&D specialists with deep domain expertise—and general experts—senior technical management professionals specializing in technological foresight and innovation. Additionally, a balanced representation of experts from universities, research institutions, government bodies, and enterprises should be maintained to build a diverse, well-structured, and highly qualified expert team.

4.2 Preliminary Evaluation of Scientific and Technological Achievements

The objective of the preliminary evaluation is to conduct an initial qualitative assessment of the value of scientific and technological achievements.

(1) Technical Grouping

Group the list of scientific and technological achievements according to disciplinary classifications, then design a questionnaire and submit it to the corresponding expert panel for evaluation.

(2) Expert scoring

Through repeated consultations with experts, the first round of written surveys was conducted using the Delphi method across various fields. Grouped materials related to the evaluation of scientific and technological achievements were distributed to experts, collecting their assessment opinions and recommendations. The main steps were as follows: First, 5–7 experts were selected from each technical field to conduct written evaluations, using evaluation forms tailored to the application scenarios, developmental characteristics, and conditions of the achievements for preliminary assessments. Second, the Scientific and Technological Achievements Working Group consolidated the initial results and materials, calculated statistical outcomes based on experts' familiarity with the technical domains, and developed second-round consultation forms. Finally, experts were consulted again with supplementary materials and survey progress updates, while also requesting feedback on peer evaluations to refine and supplement their own selection recommendations. This revision process could be repeated multiple times to continuously refine expert assessments, ultimately yielding more consistent evaluation outcomes.

(3) Statistical Results

After repeated revisions and consolidation, once the evaluation results are consistent, the Scientific and Technological Achievement Evaluation Working Group can conduct data analysis and synthesize opinions to formulate practical preliminary assessment recommendations for new scientific and technological achievements, thereby completing their initial evaluation.

4.3 Re-evaluation of Scientific and Technological Achievements

The re-evaluation phase aims to prioritize scientific and technological achievements that have passed the initial review. Technical experts from various fields are invited to rate their familiarity with the achievements and the project's significance, calculate the priority levels of the evaluation criteria, and rank the achievements accordingly, thereby conducting a second-round assessment of their value.

(1) Importance Ranking

First, the weighting of the scientific and technological achievement evaluation index system is determined based on expert ratings. Second, statistical experts assign scores to each technology, and the statistical data for each item are weighted to derive the comprehensive evaluation score for each technology by the experts. Third, weights are assigned according to experts' familiarity with the technical field, while importance levels are also considered; this process calculates the comprehensive evaluation scores of different experts for the same scientific and technological achievement, enabling a ranking of the indicators' importance.

(2) Evaluation of Scientific and Technological Achievements and Feedback

Based on the ranking results, conduct a re-evaluation of the submitted scientific and technological achievements, and provide preliminary review outcomes to the Chief Scientific and Technological Advisor, the Senior Technical Expert Advisory Panel, and the Scientific and Technological Achievement Evaluation Team. For controversial or non-consensus scientific and technological achievements, an independent list and report may be prepared following panel discussions and retained for deliberation during the on-site evaluation session.

4.4 On-site Evaluation of Scientific and Technological Achievements

By integrating multiple methodologies and employing both qualitative and quantitative analyses, corresponding evaluation models are established to conduct on-site assessments of scientific and technological achievements. The primary steps of the on-site evaluation are as follows.

(1) Report on Scientific and Technological Achievements

The responsible individuals for the scientific and technological achievements elaborated on the practical foundations and anticipated prospects of applying these achievements across dimensions such as technology, industry, economy, society, and military affairs. During the meeting, they presented their reports to experts using PPTs and other formats. Based on the presentations and supporting materials, the experts assessed the potential of the emerging technologies. Throughout the presentations, experts could pose questions and offer suggestions at any time, to which the presenters responded accordingly. Upon completion of all presentations, the responsible individuals could leave the venue and proceed to the next agenda items of the meeting.

(2) Expert Seminar

After reviewing the presentations on scientific and technological achievements, the participating experts exchanged views on the practical foundations and anticipated prospects for their application, discussed the development potential of these achievements, provided insights and evaluations on key issues, and shared perspectives among themselves. Based on this exchange, they formed their respective assessments of the relevant technological advancements.

(3) Data Analysis

Based on a thorough understanding of the strengths and weaknesses of each technological achievement, the experts scored the achievements using an on-site evaluation questionnaire. The process involved four key steps: first, determining the weightings for the technological achievement assessment indicator system; second, having experts assign scores to these weights; third, evaluating each indicator across its respective sub-dimensional categories; and fourth, applying a weighting algorithm that incorporates both invited and regular experts' contributions to calculate the comprehensive score for each technological achievement based on all expert evaluations.

(4) Comprehensive Evaluation

Based on the comprehensive scoring system, the final evaluation report on scientific and technological achievements is prepared. After expert verification confirms its accuracy, the experts sign the materials documenting the selected emerging technologies, and the final evaluation report is subsequently published.

5. Summary

Defense science and technology achievements and their evaluation hold immense significance for implementing the national innovation strategy, promoting economic and social development, and ensuring national security. Centering on the theme of "value assessment of defense science and technology achievements," this study, building upon a literature review and drawing on domestic and international evaluation practices, has developed a three-tiered indicator system for assessing theoretical, technological, and product-based achievements. It outlines a structured evaluation methodology and refines existing assessment processes. A well-designed evaluation system and workflow play a crucial role in identifying emerging and disruptive technologies that will shape the nation's future development. Through further analysis of relevant theories and practices in defense technology assessment, this study aims to provide robust theoretical foundations and practical guidance for evaluating defense science and technology achievements.

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