Borshch Vyacheslav, Head of Scientific Reserch Department of Metrological Assessments and Expertise of State Scientific Research Institute of Armament and Military Equipment Testing and Certification, Cherkasy, Ukraine, https://orcid.org/0000-0002-8851-4553

METHODOLOGICAL SUPPORT AND EVALUATION OF THE EFFICIENCY OF THE INNOVATION INFRASTRUCTURE SUBJECTS IN UKRAINE'S DEFENSE SPHERE

Abstract

The article is devoted to the study of methodological support and evaluation of the efficiency of the innovation infrastructure subjects in Ukraine's defense sphere. It is substantiated that the effective functioning of the innovation activity system in the defense sphere is impossible without proper methodological support and effective evaluation mechanisms that allow timely identification of «bottlenecks» and adjustment of management decisions. Based on the analysis of current regulatory legal acts of Ukraine (Temporary Regulation on Innovative Activities in the Armed Forces of Ukraine, 2024; Methodology for Assessing the Scientific and Technical Level of a Promising Project, 2022), it is revealed that the current evaluation system is focused primarily on the stage of selecting innovative projects, but does not provide for a comprehensive assessment of the efficiency of the innovation infrastructure subjects themselves - the Innovation Activity Department of the Armed Forces of Ukraine, the Innovation Development Accelerator of the Ministry of Defense, the Brave1 cluster, and the VIP1 integration platform. An analysis of international experience in evaluating the efficiency of defense innovation structures is conducted: the Key Performance Indicators (KPI) system of DARPA (number of successful technology transfers, ratio of project cost to value created), the Balanced Scorecard model for defense

innovation hubs (Canada, Great Britain), and the Technology Readiness Level (TRL) monitoring system (NATO standards). A comprehensive methodology for evaluating efficiency is proposed, which includes four groups of indicators: input flow indicators (number of applications, quality of applications, share of projects corresponding to priority areas); process indicators (speed of passing through stages, share of decisions in compliance with deadlines, cost of supporting one project); outcome indicators (number of samples adopted for service, share of prototypes that reached serial production, economic effect from implementation); impact indicators (combat effectiveness, reduction of losses, increase of capabilities). A method for calculating an integral indicator of the efficiency of an innovation infrastructure subject based on the Analytic Hierarchy Process (AHP) is developed. Recommendations for implementing the proposed methodology in the activities of the Innovation Activity Department of the Armed Forces of Ukraine and other innovation infrastructure subjects are substantiated.

Keywords: methodological support, efficiency evaluation, innovation infrastructure, defense sphere, Key Performance Indicators (KPI), Technology Readiness Level (TRL), Analytic Hierarchy Process, public administration.

Introduction

Formulation of the problem. The effective functioning of the innovation activity system in the defense sphere directly depends on the ability to make timely and sound management decisions based on objective data on the results of the activities of its subjects. As noted in the report on the «Way» operational task (State Scientific Research Institute of Armament and Military Equipment Testing and Certification, 2024), the innovation activity system in the Armed Forces of Ukraine includes six subsystems, including a subsystem for controlling the effectiveness of innovation activities [1, p. 55]. However, the analysis of current regulatory legal acts shows that the methodological support for evaluating

efficiency is limited primarily to the stage of selecting innovative projects and does not provide for a comprehensive assessment of the activities of the infrastructure subjects themselves - the Innovation Activity Department of the Armed Forces of Ukraine, the Innovation Development Accelerator of the Ministry of Defense, the Brave1 cluster, the VIP1 integration platform, etc.

The Defense Innovation Board of the United States, in its March 2026 analysis of Ukraine's potential to develop the technological potential of the Armed Forces of Ukraine, pointed out critical shortcomings in the management system: «the Ministry of Defense of Ukraine (MOU) and the General Staff (GS) do not have a coherent approach to rapid capability development»; «the inability of the Ministry of Defense to properly formulate and convey military requirements and requests to industry or foreign partners» [2]. These conclusions indicate not only organizational but also methodological problems - the lack of adequate evaluation mechanisms that would allow timely detection of «bottlenecks» and correction of management decisions.

Thus, the urgent task is to develop methodological support and evaluation mechanisms for the efficiency of the innovation infrastructure subjects in the defense sphere of Ukraine, which would allow a comprehensive assessment of their activities and the formation of recommendations for improvement.

Literature review. The issue of evaluating the effectiveness of innovation activities in the public sector is covered in the works of J. Bryson (2004) on strategic planning for public organizations, T. Poister (2010) on the relationship between strategic management and performance in the public sector. In the defense sector, the problem of evaluating the effectiveness of innovative structures is being studied by the US Defense Innovation Board, which conducts regular assessments of the effectiveness of DARPA and other innovation structures.

In Ukraine, separate aspects of evaluating the effectiveness of innovation activities were studied by V.V. Khryzhniak (2005) - regarding the implementation

of the NATO military standardization system; I.M. Lappo, M.O. Herashchenko, O.V. Chervotoka (2020) - also regarding the implementation of NATO standards. The report on the «Track-N» operational task (2025) details methods for comparing moving object trajectories using dynamic time warping, Fréchet distance, and Hausdorff distance, which require preliminary data processing (filtering, resampling, interpolation) - these are typical tasks of big data analytics [3, p. 57-62]. The evaluation of the scientific and technical level of an innovative project is currently carried out by an expert commission in accordance with the Methodology approved by Order of the General Staff of the Armed Forces of Ukraine No. 137 of December 14, 2022 [1, p. 57-60]. However, this methodology is focused on evaluating the project, not the activities of the infrastructure subjects.

Therefore, the issue of developing a comprehensive methodology for evaluating the effectiveness of the innovation infrastructure subjects themselves remains insufficiently studied in Ukrainian science.

Purpose of the article - based on the analysis of current regulations, international experience and the conclusions of the US Defense Innovation Board, to develop a comprehensive methodology for evaluating the effectiveness of innovation infrastructure subjects in the defense sphere of Ukraine, including a system of key performance indicators (KPIs), a methodology for calculating an integral indicator based on the Analytic Hierarchy Process (AHP), and recommendations for its implementation.

Main material presentation

1. Analysis of the current state of methodological support for evaluating the effectiveness of innovation activities in the defense sphere of Ukraine. The regulatory framework for innovation activities in the defense sphere of Ukraine includes a number of legal acts, the main of which are:

- Temporary Regulation on Innovative Activities in the Armed Forces of Ukraine (approved by the Commander-in-Chief of the Armed Forces of Ukraine on March 15, 2024);
- Decision of the Commander-in-Chief of the Armed Forces of Ukraine «On Approval of the Temporary Procedure for the Organization and Conduct of Monitoring, Evaluation, and Support of Innovative Projects for the Needs of the Armed Forces of Ukraine» (April 11, 2023);
- Order of the General Staff of the Armed Forces of Ukraine No. 137 of December 14, 2022 «On Approval of Methods for Determining the Priority of Research and Development Works and Assessing the Scientific and Technical Level of a Promising Project».

The analysis shows that the current evaluation system focuses on the following indicators:

- scientific and technical level of the innovative project (high, medium, low);
- degree of compliance with the requirements of current legislation;
- possibilities of scaling up (mass production).

However, these indicators do not allow a full assessment of the efficiency of the infrastructure subjects themselves. For example, the Innovation Activity Department of the Armed Forces of Ukraine does not have approved KPIs. The work of the Innovation Development Accelerator of the Ministry of Defense is not evaluated by quantitative indicators. The efficiency of the VIP1 integration platform is not monitored for the completeness of filling the databases.

As noted in the «Way» report, «the system for collecting, summarizing and analytical processing of information on the results of operation and repair of weapons and military equipment has a three-level hierarchical structure and operates at the strategic, operational and tactical levels» [1, p. 80]. However, the system is largely based on manual submission of daily analytical reports: «in the

context of hostilities, submission of reports in the prescribed form is carried out daily as per subordination» [1, p. 81]. The level of automation of this process remains insufficient, which complicates the implementation of effective evaluation mechanisms.

2. International experience in evaluating the effectiveness of defense innovation structures. The analysis of the practice of leading countries allows us to identify three main models for evaluating the effectiveness of defense innovation structures.

2.1. DARPA KPI system (USA). DARPA uses the following key performance indicators:

- number of successful technology transfers to military branches;
- ratio of project cost to value created (measured in terms of increase in combat capability);
- number of patents obtained;
- number of start-ups created based on DARPA developments;
- share of projects that have reached the prototyping stage.

DARPA specialists note that not all projects can be successful: the risk of failure is deliberately built into the design stage, but the organization is responsible for ensuring that the number of successful transfers of «breakthrough» technologies to the military justifies the cost of unsuccessful ones.

2.2. Balanced Scorecard for defense innovation hubs (Canada, Great Britain). In the Canadian IDEaS program, the following groups of indicators are used:

- input indicators (number of applications, their quality, geographical and sectoral diversity);
- process indicators (speed of application processing, volume of expert support, number of «sandbox» participants);

- outcome indicators (number of technologies that have reached the prototype, number of technologies purchased);
- impact indicators (increasing the combat capabilities of the armed forces).

The Great Britain Defense Innovation Initiative uses a similar methodology with an emphasis on outcome indicators - what specific defense challenges are solved by the implemented developments.

2.3. TRL monitoring system (NATO standards). The Technology Readiness Level (TRL) system, which includes 9 levels: from TRL 1 (basic principles documented) to TRL 9 (technology proven in combat conditions), is widely used in NATO countries. This system allows you to:

- objectively assess the degree of readiness of technology for implementation;
- compare projects of different types according to a single scale;
- plan the resources needed to move to the next level.

Based on TRL, appropriate management decisions can be made: projects with TRL 1-3 require fundamental research funding; TRL 4-6 require prototyping; TRL 7-9 require testing and scaling.

However, TRL focuses on evaluating the technology itself, not the activities of the infrastructure subjects. Therefore, the development of a comprehensive methodology requires a combination of KPI, Balanced Scorecard, and TRL approaches.

3. Comprehensive methodology for evaluating the effectiveness of innovation infrastructure subjects (EIS methodology). Based on the analysis of current practice and international experience, a comprehensive methodology for evaluating the effectiveness of innovation infrastructure subjects (EIS) is proposed, which includes four groups of indicators.

3.1. Input flow indicators. These indicators characterize the «incoming flow» of projects and applications entering the innovation infrastructure subject.

Indicator	Unit	Calculation method
Number of applications received (N_app)	units	direct count
Share of projects corresponding to priority areas (P_prior)	%	N_prior / N_app × 100%
Average expert assessment of application quality (Q_app)	points (1-10)	average of expert assessments
Number of projects with TRL 1-3 (N_TRL_low)	units	direct count
Number of projects with TRL 4-6 (N_TRL_mid)	units	direct count

3.2. Process indicators. These indicators characterize the efficiency of the subject's work on processing applications and supporting projects.

Indicator	Unit	Calculation method
Average time for application processing (T_proc)	days	total processing time / number of applications
Share of decisions made in compliance with deadlines (P_deadline)	%	number of decisions on time / total number of decisions × 100%
Cost of supporting one project (C_project)	thousand UAH	total support costs / number of projects
Number of expert evaluations conducted (N_exp)	units	direct count
Number of events held (N_event)	units	direct count

3.3. Outcome indicators. These indicators characterize the direct results of the activities of the innovation infrastructure subject.

Indicator	Unit	Calculation method
Number of projects that reached the prototyping stage (N_proto)	units	direct count
Number of projects that passed testing (N_test)	units	direct count
Number of prototypes adopted for service (N_adopt)	units	direct count
Share of prototypes that reached serial production (P_scale)	%	N_serial / N_adopt × 100%
Economic effect from implementation (E_eco)	million UAH	calculation based on the methodology of avoided damage/resource savings

3.4. Impact indicators. These indicators characterize the long-term impact of the subject's activities on defense capability and national security.

Indicator	Unit	Calculation method
Increase in combat capability (Δ_combat)	%	expert assessment based on the results of combat use
Reduction of losses (loss)	units	comparison of loss indicators before/after implementation
Number of technologies meeting NATO standards (N_NATO)	units	expert assessment
Level of integration with partner digital systems (L_integ)	%	expert assessment

4. Method of calculating the integral indicator based on the Analytic Hierarchy Process (AHP). To summarize the partial indicators into a general one, it is proposed to use the Analytic Hierarchy Process (AHP) by T. Saaty.

Step 1: structuring the problem. A hierarchy is built: the general goal is «efficiency of the innovation infrastructure subject» - groups (criteria) - sub-criteria (individual indicators).

Step 2: building pairwise comparison matrices. For each level of the hierarchy, square matrices of pairwise comparisons are constructed, in which experts compare the relative importance of elements using the Saaty scale (from 1 - equal importance to 9 - absolute superiority).

Step 3: calculating priority vectors. For each matrix, the priority vector (eigenvector) is calculated, and then normalized to obtain the weights of the criteria and sub-criteria.

Step 4: checking consistency. The consistency index (CI) and the consistency ratio (CR) are calculated. A CR value ≤ 0.1 is considered acceptable.

Step 5: calculating the integral indicator. The integral indicator (I_efficiency) is calculated as the weighted sum of normalized values of partial indicators:

$$I_efficiency = \Sigma\ (w_j \times (x_j / x_norm,j))$$

where w_j - weight of the j-th indicator, x_j - the actual value of the j-th indicator, x_norm,j - the normative (reference) value of the j-th indicator.

Step 6: interpretation of results. Based on the obtained values of the integral indicator and its components, conclusions are drawn about the effectiveness of the subject, «bottlenecks» are identified, and recommendations for improvement are formed.

5. Recommendations for the implementation of the EIS methodology. To implement the proposed methodology in the activities of the

Innovation Activity Department of the Armed Forces of Ukraine and other innovation infrastructure subjects, the following is recommended:

5.1. *Bringing regulatory support into compliance.* Amend the Temporary Regulation on Innovation Activities in the Armed Forces of Ukraine in terms of:

- fixing the list of KPIs for each subject;
- establishing deadlines for submitting reports (quarterly, annually);
- introducing mandatory expert evaluation of impact indicators with the involvement of representatives of the Armed Forces.

5.2. *Automation of data collection.* Create an automated system for collecting and processing indicators based on the VIP1 integration platform, which should provide:

- automatic uploading of data on the number of applications, processing time, number of projects at various stages;
- an interface for entering data on the economic effect and combat effectiveness;
- generating reports on the efficiency of subjects.

5.3. *Conducting training.* Conduct training for employees of innovation infrastructure subjects on the use of the AHP method, filling out pairwise comparison matrices, and interpreting the results.

5.4. *Implementation stages.*

- Stage I (2026-2027): pilot implementation in the Innovation Activity Department of the Armed Forces of Ukraine;
- Stage II (2027-2028): distribution to other subjects (Accelerator, Office, Brave1);
- Stage III (2028-2029): integration with NATO systems for the mutual recognition of efficiency results.

Conclusions

Conducted research allows drawing the following conclusions:

1. The current system of methodological support for evaluating the efficiency of innovation activity in the defense sphere of Ukraine is focused mainly on the stage of selecting innovative projects and does not provide for a comprehensive assessment of the activities of the infrastructure subjects themselves. This creates risks of untimely detection of «bottlenecks» and ineffective management decisions.

2. International experience (DARPA KPI system, Balanced Scorecard, TRL monitoring system) offers effective tools for evaluating efficiency, but requires adaptation to Ukrainian realities (martial law, lack of developed venture capital market, specific structure of the defense-industrial complex).

3. The proposed comprehensive methodology for evaluating the efficiency of innovation infrastructure subjects (EIS) includes four groups of indicators: input flow, process, outcome, and impact. This allows for a comprehensive assessment of the subject's activities - from incoming applications to the long-term impact on defense capability.

4. The method of calculating the integral indicator based on the Analytic Hierarchy Process (AHP) ensures the scientific validity of weighting coefficients taking into account the opinions of experts and allows obtaining a comparable result for different subjects.

5. Implementation of the EIS methodology requires making changes to the Temporary Regulation on Innovative Activities in the Armed Forces of Ukraine, creating an automated data collection system based on the VIP1 platform, and training specialists.

Further research should focus on developing methods for assessing the economic efficiency of defense innovations, adapting the Balanced Scorecard to Ukrainian conditions, and creating a system for monitoring the technology readiness levels (TRL) of innovative projects in accordance with NATO standards.

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