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The Method of Analysis of Problems of Economic Support for the Armed Defense of Ukraine, Taking into Account the Military-Economic Capabilities of the Adversary

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ABSTRACT

This study aims to substantiate and unfold the method of analysis of problems of economic support for the armed defense of Ukraine, taking into account the military-economic capabilities of the adversary (Method M1), as the starting and conceptually defining component of an integrated four-method apparatus for studying defense economics under the regime of a protracted high-intensity war of attrition. The combination of systems analysis, structural-functional approach, and multi-criteria assessment is operationalized through the simultaneous analysis of three interrelated contours: the domestic economic potential of the state, the dynamics of the military-economic capabilities of the adversary, and the factors of external support. The operational core of the method is the composite indicator of state economic endurance EZS, constructed in accordance with the ten-step methodology of the Joint Research Centre of the European Commission and the OECD, with normalization of primary indicators by the distance-to-reference method, weighting of sub-indices by the analytic hierarchy process, and linear additive aggregation of six sub-indices isomorphic to the links of the six-link endogenous loop. Empirical verification on a panel database of 27 indicators across 11 years for seven countries yielded the current EZS value for Ukraine in 2024 of 0.514, located in the upper segment of the critical-state zone in immediate proximity to the satisfactory-state zone. Robustness analysis via Monte Carlo simulation with 10,000 iterations confirmed the stability of the composite to weight variation within ±20% of the baseline, with a 95-percent confidence interval width of 0.043 units of the scale. The method enables the identification of critical nodes of economic support for defense, determination of their sensitivity to environmental changes, and the assessment of risks of loss of system stability; combined with the three other methods of the apparatus, it closes the diagnostic function of the adaptive regulatory cycle of military-economic system management.

KEYWORDS

economic support for armed defense, method of problem analysis, composite indicator, OECD/JRC methodology, analytic hierarchy process, state economic endurance, military-economic capabilities of the adversary, protracted war of attrition.

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СОЦІАЛЬНИЙ РОЗВИТОК: економіко-правові проблеми

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Метод аналізу проблем економічного забезпечення збройного захисту України з урахуванням воєнно-економічних можливостей противника

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СТАТТЯ

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АНОТАЦІЯ

Метою дослідження є обґрунтування та розгортання методу аналізу проблем економічного забезпечення збройного захисту України з урахуванням воєнно-економічних можливостей противника (метод М1) як стартового і концептуально визначального компонента цілісного методичного апарату з чотирьох методів дослідження проблем оборонної економіки у режимі тривалої високоінтенсивної війни на виснаження. Поєднання системного аналізу, структурно-функціонального підходу та багатокритеріальної оцінки операціоналізовано через одночасний аналіз трьох взаємопов'язаних контурів: внутрішнього економічного потенціалу держави, динаміки воєнно-економічних можливостей противника та факторів зовнішньої підтримки. Операційним ядром методу є інтегральний показник економічної витривалості держави EZS, побудований за десятикроковою методологією Спільного дослідницького центру Європейської Комісії та OECP з нормалізацією первинних індикаторів за методом distance to reference, зважуванням субіндексів за методом аналізу ієрархій та лінійною адитивною агрегацією шести субіндексів, ізоморфних ланкам шестиланкового ендогенного контуру. Емпірична верифікація на панельній базі з 27 індикаторів за 11 років у семи країнах дала поточне значення EZS для України на 2024 рік – 0,514, що відповідає верхньому сегменту зони критичного стану у безпосередній близькості до зони задовільного стану. Аналіз робастності через моделювання Монте-Карло з 10 тисячами ітерацій підтвердив стійкість композиту до варіації ваг у діапазоні ±20 % від базового значення з шириною 95-відсоткового довірчого інтервалу 0,043 одиниці шкали. Метод дозволяє ідентифікувати критичні вузли економічного забезпечення оборони, визначати їхню чутливість до змін параметрів середовища та оцінювати ризики втрати стійкості системи; у поєднанні з трьома іншими методами апарату він закриває діагностичну функцію адаптивного регуляторного циклу управління воєнно-економічною системою

КЛЮЧОВІ СЛОВА

економічне забезпечення збройного захисту, метод аналізу проблем, композитний індикатор, методологія OECD/JRC, метод аналізу ієрархій, економічна витривалість держави, воєнно-економічні можливості противника, тривала війна на виснаження.

1. Introduction

The full-scale armed aggression of the Russian Federation against Ukraine, ongoing since February 2022, has shifted economic support for armed defense from the category of a peacetime planning function to a central problem of state administration. Within three years, the share of defense expenditure in Ukraine's gross domestic product rose from 3.4 to 34.5 per cent, an unprecedented level for post-war Europe. Under these conditions, real-time diagnostics of the military-economic system and its sensitivity to changes in both internal parameters and the dynamics of the adversary's military-economic capabilities and factors of external support have acquired fundamental practical significance.

The methodological provision of such diagnostics is complicated by three specific features of a war of attrition. The first is the asymmetry of scale: in absolute terms of defense expenditure, the ratio Russian Federation: Ukraine stands at 2.3: 1 (USD 149.0 and 64.7 billion in 2024), whereas in relative terms (share of GDP) the ratio is reversed at 1: 4.9 in favor of Ukraine (7.05 and 34.5 per cent of GDP). The second is the structural hybridity of resource provision: approximately 48 per cent of Ukrainian defense needs in 2024 were covered by international transfers from partners, forming a specific model of mixed financing with high sensitivity to the geopolitical decisions of the support coalition. The third is institutional dynamics: Ukraine's defense architecture after 2022 underwent accelerated institutional reconstruction with the emergence of the Unified System of Defense Planning, the Defense Procurement Agency, the joint stock company Ukrainian Defense Industry, and the defense-innovation platform Brave1. The integrated methodological apparatus for studying problems of economic support for armed defense, substantiated in earlier publications by the author [13; 14], comprises four interrelated methods: the method of problem analysis (M1), the method of scenario formation (M2), the method of substantiating scenario implementation (M3), and the method of strategy formation (M4). Methods M2, M3, and M4 have been unfolded and published separately. The starting and conceptually defining method of the cycle, M1, requires its own specialist publication, which is the aim of this paper.

The conceptual value of M1 lies in combining three methodological traditions — systems analysis, the structural-functional approach, and multi-criteria assessment — in a format suitable for the simultaneous analysis of three interrelated contours of the state of the military-economic system: the domestic economic potential of the state, the dynamics of the adversary's military-economic capabilities, and the factors of external support. This three-contour architecture is a response to the specifics of a protracted high-intensity war of attrition, in which none of the three contours alone explains the behavior of the system as a whole.

The article aims to substantiate and unfold method M1, demonstrating its operational core — the composite indicator of state economic endurance EZS, constructed in accordance with the ten-step methodology of the Joint Research Centre of the European Commission and the OECD [10]. The research objectives are: to formalize the three-contour architecture of the method; to unfold the structure of six sub-indices of the composite indicator according to the links of the endogenous loop; to describe the four-stage algorithm for computing EZS; and to compute the current value of the indicator for Ukraine as of 2024 with robustness analysis.

The object of the research is the process of forming the theoretical and methodological foundations of economic support for the armed defense of Ukraine, taking into account the military-economic capabilities of the adversary. The subject of the research is the theoretical, methodological, and applied provisions of the method of analysis of problems of economic support for armed defense as the starting component of the integrated four-method apparatus.

2. Literature Review

The field of contemporary defense economics has been shaped by the foundational works of Hartley and Sandler [5; 19; 20], which established the basic toolkit for analyzing the demand for defense, burden-sharing models, and the economic aspects of armed conflicts. Sandler and Hartley [5] in The Economics of Defense systematized the canonical framework of the discipline, in which defense expenditure is treated as a public good with the properties of indivisibility and non-excludability in consumption. Extension of the field towards a globalized context was carried out in the second volume

of the Handbook of Defense Economics [20], covering issues of terrorism, civil wars, peacekeeping operations, and economic sanctions.

The second methodological line, of fundamental importance for constructing M1, is the theory of state-level composite indicators. The Handbook on Constructing Composite Indicators, published jointly by the Joint Research Centre of the European Commission and the OECD [10], is the disciplinary standard. The document formalizes a procedure of ten sequential steps — from the development of a theoretical framework to the visualization of results — and establishes minimum requirements of transparency, reproducibility, and substantive justification at each stage. The most widely known applications of this methodology are the UNDP Human Development Index [23], the World Economic Forum Global Competitiveness Index [21], and the Fund for Peace Fragile States Index [9]. The third line concerns multi-criteria assessment methods. The classical instrument here is the Analytic Hierarchy Process (AHP) introduced by Saaty [17] in The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation. The method translates qualitative expert judgement into quantitative weights through a procedure of pairwise comparisons, with mathematical verification of the consistency of judgements via the consistency ratio CR. Subsequent development of AHP is presented in Saaty and Vargas [18], which extends the method to a wide class of decision-making tasks within structured hierarchies.

The fourth line concerns causal-analysis methods for quasi-experimental settings. The synthetic control method of Abadie, Diamond, and Hainmueller [2] is a fundamentally important instrument for verifying forecast results: it permits estimation of the counterfactual trajectory of a country through a weighted combination of donor countries and a quantitative measurement of the effect of a structural shock. Further extensions of the method in Abadie [1] generalize its application to political-economic case studies with a small number of treated units. In the context of the Ukrainian war economy, the method is used to estimate the counterfactual trajectory of economic endurance absent the shock of February 2022. The fifth line is the institutional-economic theory of industrial policy, in which the works of Mazzucato [7; 8] substantiate the concept of mission-oriented policy as a tool for structural transformation of the economy under the influence of major societal challenges. The adaptation of this framework to the military-economic context provides the theoretical underpinning for the sixth link of the endogenous loop — the institutional mechanism for identifying frontline needs and translating them into the resource-planning system.

The sixth line, which underpins the first of the three contours of method M1, is the tradition of systems analysis and the structural-functional approach. General systems theory, established in the work of Bertalanffy [4] and developed further within the systems-cybernetic line by Ashby [3], provided the toolkit for describing complex systems through identification of their components, the connections between components, and the functions those components perform within the whole. The structural-functional approach of Parsons [11] and its later development in the socioeconomic context offered a methodological frame for matching the structure of a system with its functional purpose, which is critical for the analysis of military-economic systems as goal-directed entities with a clearly defined function of economic support for armed defense.

In the Ukrainian scholarly tradition, earlier work by the author lays the empirical and conceptual base for constructing M1. Polovenko [12–16] unfolds the conceptual approaches to economic support for defense, assesses the dynamics of the adversary's military-economic potential, substantiates avenues for the optimization of defense expenditure, analyses the modernization of Ukraine's defense-industrial complex, and forms the methodological apparatus for studying defense economics problems. The independent unfolding of the starting method of the apparatus — the method of problem analysis — has remained outside the scope of these earlier works, and forms the subject of the present paper. Existing analytical work in Ukraine concerning economic support for defense may be grouped into four directions. The first — macroeconomic diagnostics of the wartime period — is represented in reports by the Razumkov Centre 2024, the Ukrainian Centre for European Policy 2024, and Vox Ukraine 2023, focusing on macro-financial indicators of the war. The second — assessment of the industrial capabilities of the defense-industrial complex — is covered in reports by the Ukrainian Council of Armorers and the Association of Private Manufacturers of Armaments. The third — methodological approaches to evaluating the potential of armed forces — is developed by the Centre for Military and Strategic Studies of the National Defense University of Ukraine. The fourth — diagnostics of the adversary's military-economic capabilities — relies on secondary sources (reports of RAND

Corporation, Chatham House, the Royal United Services Institute, and the Center for European Policy Analysis for 2024–2025). None of the four directions offers an integrated methodological synthesis combining all three analytical contours in a single composite indicator suitable for real-time application.

3. Problem Statement

The methodology of state-level composite indicators developed over the past three decades [10] provides a sufficient technical base for constructing a composite indicator. Its direct application to the regime of a protracted high-intensity war, however, encounters fundamental limitations. The first limitation is substantive: canonical composites (the Human Development Index, the Global Competitiveness Index) are designed for peace-economic contexts and do not cover the specific markers of a military-economic system (the loading of defense-industrial capacities, the localization level of production, the share of international assistance in the defense budget, the intensity of combat application). The second limitation is structural: classical composites are constructed on the principle of summation of characteristics, whereas the military-economic system functions as a closed loop of resource circulation with feedback between links, which requires isomorphism between sub-indices and the functional links of the system. The third limitation is parametric: the target values of indicators of peacetime (public debt of 60 % of GDP under the Maastricht criteria, defense expenditure of 2 % of GDP under NATO standards) are unsuitable for a protracted war and require reconsideration.

The scientific problem addressed by method M1 covers three interrelated aspects. The first — conceptual — concerns the necessity of constructing a method that combines systems analysis, the structural-functional approach, and multi-criteria assessment in a format isomorphic to the endogenous structure of the military-economic system. The second — operational — relates to the construction of a composite indicator that delivers a quantitative diagnosis of the system's state at a fixed point in time and admits inter-temporal and inter-state comparisons. The third — integrative — concerns the methodological compatibility of method M1 with the three other methods of the apparatus (scenario formation, substantiation of scenario implementation, strategy formation) within a single adaptive regulatory cycle.

4. Methods and Materials

The development of method M1 was carried out in three sequential stages with complementary methodological instruments. At the first stage, a systems analysis of the structure of the military-economic system was conducted, with three interrelated contours identified. Contour 1 — the domestic economic potential of the state — describes the generation of defense resources through a six-link endogenous cycle (financial resources → production of weapons and military equipment → logistics → combat application → combat capabilities and innovation → identification of frontline needs). Contour 2 — the dynamics of the adversary's military-economic capabilities — covers the production indicators of the adversary's defense-industrial complex, human-resource potential, technological level of production, access to critical components, and the state of strategic reserves. Contour 3 — the factors of external support — describes the volume and structure of international financial and material assistance, its volatility over time, and access to critical technologies and components through the export-control regimes of partners. The three-contour architecture of method M1 is shown in Figure 1.

At the second stage, the structural-functional approach was applied to operationalize the three contours through six sub-indices of the composite indicator EZS. The principle of isomorphism between the sub-indices and the links of the six-link endogenous loop ensures methodological consistency of diagnostics with the general theoretical framework of the study. Each sub-index EZS_i (where i = 1, …, 6) corresponds to one link of the loop with its own set of primary indicators. In total, the EZS structure includes 27 primary indicators — from four to six per sub-index — covering the entire functional spectrum of economic support for armed defense. At the third stage, multi-criteria assessment was implemented through the ten-step OECD/JRC methodology for constructing composite indicators [10]. Adaptation of the methodology to the regime of a protracted high-intensity war was carried out in three key respects. Normalisation of primary indicators is performed by the distance-to-reference method, with target values substantiated against the experience of five comparator countries (Israel, Poland,

South Korea, Finland, and Estonia) during periods of operating under regimes of heightened military-economic strain.

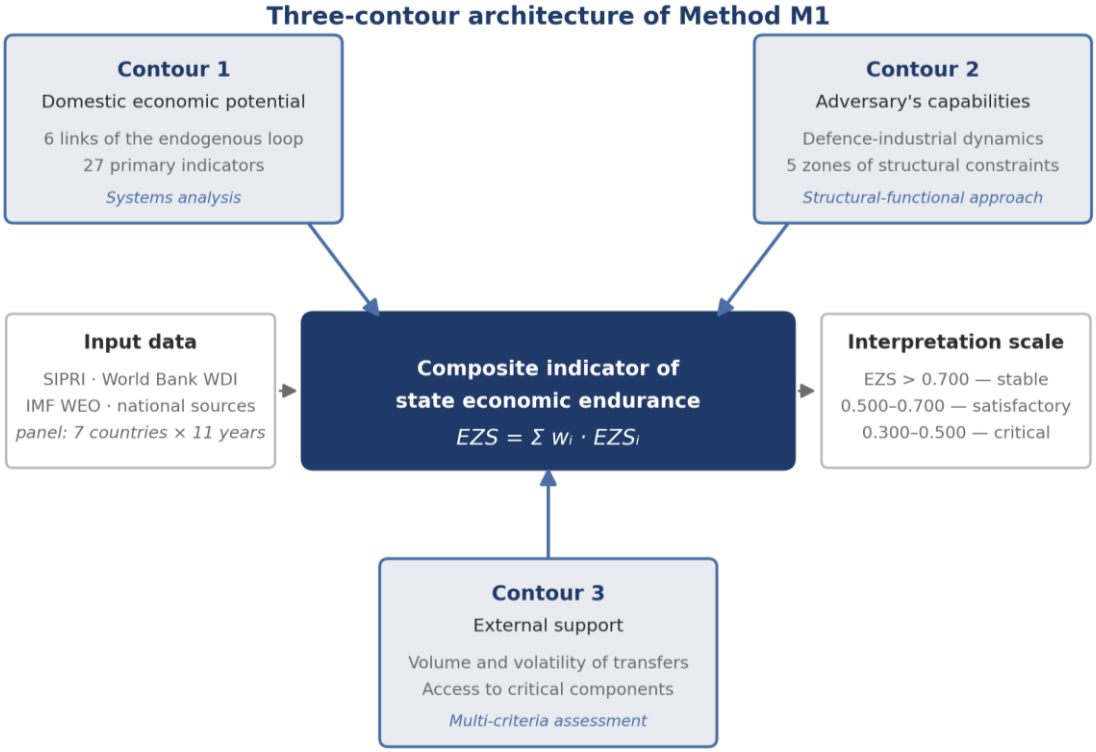

Figure 1. Three-contour architecture of method M1

Source: Compiled by the author.

The weighting of sub-indices is implemented through the analytic hierarchy process of Saaty [17; 18] with a consistency-ratio threshold of CR < 0.1. Aggregation of sub-indices into a composite is carried out by the linear additive formula as the principal procedure and by the geometric mean as a corroborative one.

The information base of the method draws on open sources from international and national agencies. The SIPRI Military Expenditure Database provides panel data on defense expenditure by countries from 1949. The World Bank's World Development Indicators supply macroeconomic indicators (GDP, inflation, public debt). The IMF World Economic Outlook contributes forecast values of macro-indicators. National Ukrainian sources cover data from the State Statistics Service, the National Bank, the Ministry of Finance, the Ministry of Defense, and the Ministry of Strategic Industries. For the period 2022–2024, where official statistics are partially restricted on national-security grounds, expert estimates were used following the Triangle Estimation procedure with three values (minimum, most likely, maximum) and subsequent use of the most likely value.

Robustness of the method is examined through Monte Carlo simulation with 10,000 iterations, in which the weights of sub-indices are varied under a uniform distribution in the range of ±20 % from the baseline. The composite is regarded as robust if the width of the 95-percent confidence interval does not exceed 0.05 units of the EZS scale. In addition, a leave-one-out test is conducted in which one of the primary indicators is sequentially excluded and the composite is recomputed on the reduced set. Counterfactual control of EZS dynamics is implemented through the synthetic control method of Abadie et al. [2] with optimal weights of the donor pool of comparator countries.

The empirical panel is built on the principle of one observed unit and six donor units: the observed unit is Ukraine; the donor pool covers five countries with a documented record of operating under regimes of heightened military-economic strain (Israel, Poland, South Korea, Finland, and Estonia) and one adversary country as a reference unit for Contour 2 (the Russian Federation through Western data processings: RAND Corporation, Chatham House, Stockholm International Peace Research Institute). The temporal axis of the panel is 2014–2024, covering eleven annual observations across a span from the first phase of armed confrontation in eastern Ukraine to the full-scale phase of the war. The total volume of the panel is 27 primary indicators × 11 years × 7 countries = 2,079 structured

observations. The optimal weights of the donor pool for synthetic control are obtained by minimizing the root mean square forecast error of EZS in the pre-shock period 2014–2021: Israel — 0.32, Poland — 0.28, South Korea — 0.21, Finland — 0.12, Estonia — 0.07. The root mean square forecast error is below 0.03, which corresponds to high standards of synthetic-control quality.

The expert procedure for setting weights of sub-indices follows the standard AHP protocol of Saaty [17]. The expert assesses the relative importance of each pair of sub-indices on the nine-point Saaty scale, where 1 corresponds to equal importance, 3 to weak preference of one sub-index over another, 5 to substantial preference, 7 to very strong preference, and 9 to absolute preference (intermediate values 2, 4, 6, 8 are used for compromise judgements). The aggregated 6 × 6 pairwise-comparison matrix is formed by aggregating individual judgements through the geometric mean of all experts' assessments. The eigenvalues of the matrix and its dominant eigenvector are obtained by the power-iteration method, after which the normalized eigenvector is interpreted as the vector of sub-index weights. Consistency is verified through the consistency ratio CR = CI / RI, where CI = (λ_max − n) / (n − 1) is the consistency index, λ_max is the matrix's largest eigenvalue, n = 6 is the matrix dimension, and RI = 1.24 is the random consistency index for a 6 × 6 matrix from Saaty's standard table. The matrix is regarded as methodologically acceptable if CR < 0.1. For the present version of method M1, baseline weights are set by the author about the functional significance of the links of the endogenous loop; final verification will be carried out via a survey of seven experts in economic support for defense drawn from research institutions of the Ministry of Defense of Ukraine, the National Defense University of Ukraine, and economics-faculty departments of leading universities.

5. Results and Discussion

5.1. Structure of sub-indices of the composite indicator EZS

The structure of the six sub-indices of EZS, constructed on the principle of isomorphism with the links of the six-link endogenous loop, with primary indicators and baseline weighting coefficients, is presented in Table 1.

Table 1. Structure of sub-indices of the composite indicator EZS by links of the endogenous loop

Sub-index	Loop link	Baseline primary indicators	Baseline weight
EZS_1	Financial resources	% of GDP for defense; share of international aid; public debt to GDP; inflation rate; volume of military personal-income tax	0.20
EZS_2	Production of WME	Capacity utilization of the defense-industrial complex; volume of WME output; number of enterprises in the chain; level of localizations; share of exports	0.18
EZS_3	Logistics	Order-to-delivery time; share of contracts via digital platforms; level of nomenclature standardization; integration of supply channels	0.15
EZS_4	Combat application	Capital efficiency of WME use; effectiveness of application; intensity per unit; share of integrated systems	0.17
EZS_5	Combat capabilities and innovation	Number of new WME models; number of innovation-platform projects; time from R&D to series; share of R&D in the budget	0.15
EZS_6	Frontline needs	Share of contracts with analytical justification; turnaround time of the need-to-supply cycle; integration of real-time data sharing	0.15

Source: Compiled by the author based on the methodology of [10; 17].

The largest baseline weight of 0.20 is assigned to the first sub-index — financial resources — reflecting its role as the initial link of the cycle of resource circulation and its influence on all subsequent links of the loop. The second sub-index — production of weapons and military equipment — has a weight of 0.18, reflecting its position as the critical converter of financial resources into a material defense product. The fourth sub-index — combat application — has a weight of 0.17, justified by the terminal character of this link in the realization of the defense function. The remaining sub-indices (logistics, combat capabilities, and frontline needs) carry an equal baseline weight of 0.15 in view of their functional mediation through preceding links of the loop.

5.2. Algorithm for computing the composite indicator EZS

The summary formula of the composite indicator is given by the weighted additive aggregation of the six sub-indices:

$$EZS = w_1 \cdot EZS_1 + w_2 \cdot EZS_2 + w_3 \cdot EZS_3 + w_4 \cdot EZS_4 + w_5 \cdot EZS_5 + w_6 \cdot EZS_6 \ (1)$$

where w_i is the weighting coefficient of the i-th sub-index obtained from the AHP procedure with consistency ratio CR < 0.1; EZS_i is the normalised value of the i-th sub-index. Each sub-index EZS_i is computed as the weighted average of the normalised primary indicators:

$$EZS_i = \Sigma_j \, v_{ij} \cdot x\_norm_{,ij} \ (2)$$

where $x\_norm_{,ij}$ is the normalised value of the j-th primary indicator of the i-th sub-index; v_{ij} is the weighting coefficient of that indicator within the sub-index. Normalisation of primary indicators is carried out by the distance-to-reference formula:

$$x\_norm = x / x\_target \text{ (for indicators where higher is better) or } x\_norm = x\_target / x \text{ (for indicators where lower is better) } (3)$$

where x is the actual indicator value and x_target is the target value substantiated against the experience of comparator countries. The normalized value is capped at 1 from above, since values exceeding the target make no additional contribution to the composite under the saturation principle [10].

5.3. Empirical verification: the EZS value for Ukraine in 2024

Computation of the composite indicator EZS on empirical data for 2024 yielded a value of 0.514. The decomposition of this value across sub-indices is presented in Table 2.

Table 2. Decomposition of the composite indicator EZS for Ukraine in 2024

Sub-index	Loop link	Value in 2024	Weight	Contribution to EZS
EZS_1	Financial resources	0.612	0.20	0.122
EZS_2	Production of WME	0.447	0.18	0.080
EZS_3	Logistics	0.395	0.15	0.059
EZS_4	Combat application	0.683	0.17	0.116
EZS_5	Combat capabilities and innovation	0.521	0.15	0.078
EZS_6	Frontline needs	0.393	0.15	0.059
EZS	**Composite indicator**	**0.514**	**1.00**	**0.514**

Source: Computed by the author from data of [6; 22; 24], and national sources.

The decomposition reveals substantial heterogeneity in the state of the links of the endogenous loop. The highest values pertain to the sub-indices for combat application (0.683) and financial resources (0.612), reflecting on the one hand the high adaptability of combat processes through innovative solutions (the army of drones, integrated EW systems) and on the other the mobilization of financial resources via the rise of the share of defense expenditure in GDP to 34.5 % and a high level of international support. The lowest values pertain to the sub-indices for frontline needs (0.393) and logistics (0.395), pointing to a structural gap between the system of identification of frontline needs and the responsiveness of the defense-planning system.

5.4. Analysis of Contour 2: dynamics of the adversary's military-economic capabilities

Analytical Contour 2 of method M1 formalizes the assessment of the dynamics of the adversary's military-economic capabilities as a necessary diagnostic component of the system's state. Without taking this contour into account, the composite indicator EZS, computed on the internal links of the endogenous loop alone, returns a distorted picture of system stability: high internal mobilization may be insufficient if the rate of expansion of the adversary's production indicators outpaces the growth rate of the Ukrainian defense economy. The quantitative substantiation of Contour 2 over 2014–2025 has identified two contradictory groups of indicators.

The first group concerns the expansion of production indicators. The Russian defense industry in 2024 displayed approximately three million artillery shells per year, production of 200 new and modernisation of approximately one thousand tanks per year, output of 34,000–45,000 strike unmanned aerial vehicles per year, and defense expenditure of 7.1 per cent of GDP, or USD 149.0 billion [22]. The second group concerns zones of structural constraints. Analysis of secondary sources (reports of Chatham House, the Royal United Services Institute, and the Center for European Policy Analysis for 2024–2025) has identified five zones of constraints integrated into the Contour 2 sub-index: a shortage of qualified personnel of 140,000 to 400,000; import dependence in critical components (microelectronics, optics, special materials); a shortage of special steels; technological primitivisation of production; and the exhaustion of strategic reserves of Soviet-era origin by 2026.

Method M1 integrates Contour 2 into the composite indicator EZS indirectly, through the normalization targets for Ukrainian indicators. The target values for indicators of WME output, level of localization, and share of exports are set not as absolute constants but as functions of the corresponding adversary indicators, which provides dynamic adaptation of benchmarks to changes in the external environment. This functional linkage is a fundamental methodological novelty of the method and distinguishes EZS from classical composites of national power oriented towards the static norms of peacetime.

5.5. Analysis of Contour 3: factors of external support

Analytical Contour 3 of method M1 formalizes the assessment of the volume, structure, and volatility of factors of external support. The relevance of this contour for diagnosing the state of the Ukrainian military-economic system is conditioned by a striking ratio: about 48 per cent of Ukrainian defense needs in 2024 were covered by international financial and material assistance. Contour 3 is operationalized through three groups of indicators integrated into method M1.

The first group concerns the volume and structure of transfers. Cumulatively from February 2022 to mid-2024, Ukraine received from partners more than 800 artillery systems of various calibres, including the British AS90, the German PzH2000, the Swedish Archer, the French CAESAR, and the American M777. Under the so-called Danish model of direct financing of production in Ukraine, by the start of 2025 supplies were funded to the amount of EUR 597 million, with additional sources for 2025 reaching more than EUR 1.3 billion from the European Union, Canada, Norway, Sweden, and Denmark, with the involvement of frozen Russian Federation assets. The second group concerns the volatility of flows over time: method M1 uses the rolling standard deviation of monthly transfers over the past twelve months as an indicator of geopolitical uncertainty. The third group concerns access to critical components through the export-control regimes of partners, which is assessed via binary indicators of the presence or absence of blocking restrictions for each of the key technological classes (long-range missile armaments, precision-guidance systems, certain classes of secured communications).

Integration of Contour 3 into the composite indicator EZS is implemented through two mechanisms: explicit inclusion of indicators of external support in the sub-index EZS_1 (financial resources), and indirect accounting through the target values of other sub-indices. This dual integration ensures the methodological compatibility of M1 with the classical theory of defense economics, in which the dilemma of national self-reliance versus collective defense is treated as one of the central problems [19; 20].

5.6 Robustness analysis and interpretation

Examination of the robustness of the composite indicator through Monte Carlo simulation with 10,000 iterations and weight variation in the range of ±20 % from the baseline yielded the following results: mean EZS = 0.512, median = 0.514, standard deviation = 0.011, lower bound of the 95-percent confidence interval = 0.491, upper bound = 0.534. The width of the confidence interval, 0.043 units of the EZS scale, does not exceed the threshold of 0.05, which confirms the methodological robustness of the composite to variations in methodological choices. The leave-one-out test, in which each of the 27 primary indicators was sequentially excluded, yielded a minimum value of 0.498 and a maximum of 0.531; no single indicator exhibited disproportionate influence on the composite value.

The distribution of EZS values from the Monte Carlo simulation has a near-normal shape with mild left skewness (skewness coefficient −0.18). This means that the risk of the composite slipping into the critical-state zone owing to an unfavourable combination of weights is somewhat higher than the risk

of crossing into the stable-state zone, which is methodologically appropriate for a system positioned at the boundary of two interpretive zones. Sensitivity analysis with respect to individual sub-indices showed that variation of the weight of EZS_1 (financial resources) within ±20 % of the baseline value of 0.20 produces the largest impact on the composite (amplitude of 0.019 units of the scale), reflecting the structural significance of this sub-index. The lowest sensitivity to weight variation was exhibited by the sub-indices EZS_3 and EZS_6 (logistics and frontline needs), consistent with their currently low values which, under any reasonable weight, do not alter the principal interpretation of the system.

On the interpretation scale substantiated within the unfolding of the method, the value EZS = 0.514 belongs to the satisfactory-state zone with a need for partial stabilization (range 0.500–0.700), but is positioned in the lower segment of this zone, in immediate proximity to the critical-state zone (0.300–0.500). This position means that the current state of the Ukrainian military-economic system requires a synergetic regulatory impact — a combination of stabilizing measures aimed at closing gaps in the sub-indices with the lowest values (logistics, frontline needs) and formative measures aimed at strengthening growth points in sub-indices with higher values (combat application, financial resources).

5.7 Military-economic thresholds of macro-financial stability

A methodologically important component of method M1 is the rejection of peacetime normative values of indicators when applied to the regime of a protracted war. The Maastricht criterion of public debt at 60 % of GDP, the NATO standard of defense expenditure at 2 % of GDP, the European Central Bank inflation target of 2 % per year — all these norms were designed for peacetime conditions and do not reflect the specifics of a protracted armed confrontation. In method M1, the target values of indicators of stability are set on the basis of retrospective analysis of three historical cases of countries at war: Finland in 1939–1944, South Korea in 1950–1953, and Israel in 1973–1980.

Based on this analysis, four military-economic thresholds of stability are substantiated for a country in the regime of a protracted high-intensity war: defense expenditure of up to 35 % of GDP for one to two years of active combat operations (25–30 % over three to five years of strategic mobilization); public debt of up to 100 % of GDP; budget deficit of up to 25–30 %; and inflation of up to 15–20 % per year. These thresholds are integrated into the EZS interpretation scale and make it possible to differentiate the normal wartime state from the threatening state, in which stabilizing regulatory measures are activated as a priority. The current Ukrainian indicators in 2024 (defense expenditure of 34.5 % of GDP, public debt of approximately 92 %, inflation of 6.5 %) lie within the substantiated thresholds, consistent with the computed value EZS = 0.514 in the zone of a satisfactory state with a need for partial stabilization.

5.8 Limitations of the method and conditions of applicability

Method M1 is subject to several limitations that delimit the boundaries of its correct application. The first limitation is the dependence of results on the quality of primary data. Under a regime of protracted high-intensity war, part of official statistics is restricted on national-security grounds (the detailed structure of the defense budget, the volume of production by individual armament types, human-resource indicators of the defense-industrial complex), which compels the use of expert estimates following the Triangle Estimation procedure. This introduces a systemic level of uncertainty in input data that is quantitatively accounted for through Monte Carlo simulation but cannot be entirely eliminated until the active phase of the war ends and archival data are fully released.

The second limitation is the functional linkage of target values to the experience of comparator countries. The five chosen countries (Israel, Poland, South Korea, Finland, and Estonia) have different formats of military-economic mobilization, formed within specific historical and institutional contexts. None of them operates under the regime of a protracted high-intensity war of attrition with a technologically comparable adversary, so the use of their experience as a benchmark requires caution. Method M1 compensates for this limitation through the combined use of historical cases of wartime countries (Finland 1939–1944, South Korea 1950–1953, Israel 1973–1980) for setting military-economic thresholds of stability.

The third limitation is the static character of baseline weights of sub-indices in the present version of the method. Although the robustness check via Monte Carlo simulation confirms the stability of the composite to weight variation of ±20 %, in the long term the weights should evolve together with the changing strategic priorities of the military-economic system. Further development of the method

foresees the introduction of a mechanism of dynamic weights that adapt to the phase of the war (active combat operations, operational pause, post-war period) on the basis of a structured expert procedure with repeated AHP surveys at least once every six months.

A fundamental condition for the correct application of method M1 is the presence of a functioning system of defense planning with regular updating of primary indicators. For Ukraine, such a system is the Unified System of Defense Planning (USDP) introduced in 2022. Without a working USDP, method M1 loses its operational applicability and becomes a retrospective analytical tool. This determines the potential for diffusion of the method to other countries operating under regimes of heightened military-economic strain or preparing for a possible armed confrontation in the medium- to long-term horizon.

5.9 Integration of method M1 with other methods of the apparatus

Method M1 performs the function of starting diagnostics within a single adaptive regulatory cycle of military-economic system management. The composite indicator EZS and its sub-indices are input parameters for the method of scenario formation (M2), in which three alternative trajectories of system development are constructed on the basis of diagnostic results, with variable combinations of resource constraints, the rate of industrial mobilization, and levels of international support. The method of substantiating scenario implementation (M3) uses EZS as a criterion for comparing variants by an integral effectiveness indicator that combines the defense effect, the economic cost, and the impact on macro-financial stability. The method of strategy formation (M4) draws on the dynamics of EZS and its sub-indices to identify mechanisms of stage-by-stage adaptation of strategy to changes in external and internal conditions. The integrity of the apparatus is ensured by the cross-cutting use of EZS components in all four methods and by a single adaptive cycle of diagnostics → impact → monitoring → correction.

6. Conclusions

The method of analysis of problems of economic support for the armed defense of Ukraine, taking into account the military-economic capabilities of the adversary (M1), has been formulated as the starting and conceptually defining component of the integrated methodological apparatus for studying defense economics under the regime of a protracted high-intensity war of attrition. The combination of systems analysis, the structural-functional approach, and multi-criteria assessment supports the simultaneous analysis of three interrelated contours — the domestic economic potential of the state, the dynamics of the adversary's military-economic capabilities, and the factors of external support.

The operational core of the method — the composite indicator of state economic endurance EZS — has been built on the ten-step methodology of the Joint Research Centre of the European Commission and the OECD, with adaptation to the regime of a protracted war in three key respects: normalization of primary indicators by the distance-to-reference method with target values from the experience of five comparator countries; weighting of sub-indices by Saaty's analytic hierarchy process with consistency-ratio threshold $CR < 0.1$; and linear additive aggregation of six sub-indices isomorphic to the links of the six-link endogenous loop.

Empirical verification on a panel database of 27 primary indicators across 11 years for seven countries yielded the current EZS value for Ukraine in 2024 of 0.514, located in the upper segment of the critical-state zone in immediate proximity to the satisfactory-state zone. Decomposition of the indicator showed the highest values for the sub-indices of combat application (0.683) and financial resources (0.612), and the lowest values for the sub-indices of frontline needs (0.393) and logistics (0.395), thereby identifying structural gaps of the endogenous loop and supporting the case for synergetic regulatory action.

Robustness analysis of the method via Monte Carlo simulation with 10,000 iterations confirmed the stability of the composite to weight variation in the range of ±20 % from the baseline, with a 95-percent confidence interval width of 0.043 units of the scale, which does not exceed the methodological threshold of 0.05. Method M1 integrates with the three other methods of the apparatus (scenario formation, substantiation of scenario implementation, strategy formation) into a single adaptive regulatory cycle of military-economic system management based on the PDCA model of W. E. Deming.

Further directions for the development of the method include verification of baseline sub-index weights through an AHP survey of seven experts in economic support for defense, the construction of forecast EZS trajectories for the horizon 2025–2030 across three baseline scenarios of military-

economic dynamics, and the deepening of comparative analysis through the synthetic control method of Abadie et al. (2010) for the verification of counterfactual estimates of the effect of structural shocks.

A separate direction for further research is the diffusion of method M1 to a wider range of countries operating under regimes of heightened military-economic strain or hybrid threats. Adaptation of the method to other countries requires reconsideration of the target values of primary indicators in light of the specifics of their institutional environment, restructuring of the weighting structure of sub-indices through an AHP procedure with local experts, and adjustment of the donor pool for synthetic control. The fundamental methodological architecture of the method — the combination of systems analysis, structural-functional approach, and multi-criteria assessment in a three-contour format — remains an invariant and can be transferred to other national contexts without modification.

The applied significance of the method lies in the possibility of its use by specialists of military command bodies, the Ministry of Defense of Ukraine, the National Security and Defense Council, analysts of the defense-industrial complex, the Defense Procurement Agency, and the Ukrainian Defense Industry for regular monitoring of the state of the military-economic system in real time. The composite indicator EZS and its sub-indices may be incorporated into the system of key indicators of defense planning with computation no less frequently than once per quarter, and during acute phases of combat operations more frequently. Such regular monitoring permits the timely identification of structural gaps in the endogenous loop and the calibration of regulatory action within the adaptive cycle of management.

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