UDC 338.1:330.341.1
JEL C63, C53, D81, G32, L26
DOI: https://doi.org/10.32782/bsnau.D2026.2.14

ADAPTATION OF MODERN ANALYTICAL TOOLS FOR ASSESSING THE RISKS OF MILITARY STARTUPS

Stanislav Horbachenko
Doctor of Economic Sciences, Professor,
Head of the Department of Artificial Intelligence and Mathematical Modeling,
National University «Odesa Law Academy»
ORCID ID: 0000-0001-8442-9581
stasgorbachenko@onua.edu.ua

Olena Chepurna
Candidate of Physical and Mathematical Sciences, Associate Professor,
Associate Professor of the Department of Artificial Intelligence and Mathematical Modeling,
National University «Odesa Law Academy»
ORCID ID: 0000-0002-1432-0799
chepurna@onua.edu.ua

Tetiana Kuklinova
Candidate of Economic Sciences, Associate Professor,
Associate Professor of the Department of Artificial Intelligence and Mathematical Modeling,
National University «Odesa Law Academy»
ORCID ID: 0000-0002-1370-2883
tetiana.kuklinova@onua.edu.ua

This study examines the structural characteristics and risk formation mechanisms of military-tech startup ecosystems in Central and Eastern Europe based on quantitative data describing funding volumes and startup activity. The purpose of the research is to adapt modern analytical tools for assessing ecosystem risk under conditions of structural heterogeneity and non-linear development. The methodological approach combines normalization techniques, index-based modelling, and structural analysis. Two key dimensions of ecosystem development are considered: investment capacity and entrepreneurial intensity. On this basis, an integral development index and a structural imbalance indicator are constructed, allowing for a multidimensional assessment of ecosystem configurations rather than a single aggregated evaluation.The results demonstrate that similar levels of ecosystem development may correspond to fundamentally different internal structures. In particular, high levels of entrepreneurial activity are not always supported by proportional investment capacity, while substantial financial resources may be concentrated within a limited number of projects. This divergence indicates that risk emerges not only from insufficient resources but also from the misalignment between financial and innovation components. The analysis further reveals diminishing returns to funding, suggesting that increases in investment lead to less than proportional growth in the number of startups. The study contributes to the existing literature by introducing structural imbalance as a key analytical dimension and by integrating multiple analytical tools into a unified framework for ecosystem assessment. The proposed approach provides a more comprehensive understanding of military-tech startup ecosystems and offers a methodological basis for evaluating their efficiency, scalability, and resilience under conditions of uncertainty and rapid technological change.

Keywords: *efficiency analysis, military-tech startups, project management, mathematical modeling, risk assessment, business analytics, digitalization, digital product development, product management, investments.*

Formulation of the problem in general terms. The transformation of defence and dual-use innovation systems in the context of ongoing geopolitical instability has significantly reshaped the structural dynamics of military-tech startup ecosystems. Unlike conventional sectors, where development trajectories can be approximated through relatively stable relationships between investment and output, defence-tech environments evolve under conditions of technological acceleration, operational urgency, and institutional constraints. These factors generate heterogeneous configurations in which financial resources, entrepreneurial activity, and innovation capacity interact in a non-linear manner, limiting the explanatory power of traditional aggregated indicators.

Analysis of recent research and publications. The theoretical conceptualization of innovation ecosystems as structured collectives of heterogeneous actors is developed by E. Autio and L. D. W. Thomas [1], who identify participant

heterogeneity, interdependence, and system-level outcomes as the defining characteristics that distinguish ecosystems from other organizational collectives such as supply chains or industry clusters. The relationship between geopolitical risk and investment behavior in the defense industry is examined by C. Gheorghe and O. Panazan [2]. In addition, J. Beckley demonstrates that contemporary risk assessment approaches are enhanced through the integration of data-driven analytics and expert judgment, enabling more effective decision-making under conditions of uncertainty [3].

Therefore, E. Wassenius and B. I. Crona argue that traditional risk assessment frameworks must be adapted to account for increasing system complexity, emphasizing the need for flexible, forward-looking, and interdisciplinary approaches to effectively address future uncertainties [4]. Also O. M. Zhurba substantiates that state support for startups and the development of venture capital are key instruments for enhancing the competitiveness of the IT sector and fostering innovation-driven economic growth [5]. Moreover, R. Loik examines the stimulation of Ukraine's startup ecosystem, highlighting key funding sources and investment mechanisms in the context of digitalization as critical drivers of innovation and entrepreneurial growth [6]. Furthermore, A. Krasnoshapka analyzes the development and management of defense tech startups in Ukraine, emphasizing how contemporary geopolitical challenges shape their strategic, analytical, and innovation-driven growth trajectories within the national economy. These findings underscore the limitations of one-dimensional evaluation models and indicate the need for analytical frameworks capable of capturing internal structural imbalances and non-linear development trajectories.

Despite the richness of existing contributions, the reviewed literature lacks integrated frameworks that simultaneously quantify investment capacity, entrepreneurial intensity, and structural imbalance as endogenous risk factors within a single analytical model. This gap motivates the methodological approach developed in the present study.

Formation of the objectives of the article. The objective of this article is to develop a multidimensional analytical framework for the identification and assessment of structural risks in military-tech startup ecosystems across Central and Eastern Europe, through the integration of index-based modelling, normalization, and regression analysis, with the aim of revealing structural imbalances between investment capacity and entrepreneurial intensity as key determinants of systemic vulnerability.

Methods of research. The methodological approach is based on the transformation and analysis of empirical data on defense-tech ecosystems. To ensure comparability across countries, the initial indicators are normalized using the min–max method. On this basis, an integral development index is constructed, combining investment capacity and entrepreneurial activity.

To account for possible inconsistencies between these components, a structural imbalance indicator is introduced. In addition, a logarithmic regression model is applied to capture the non-linear relationship between funding and the number of startups. The empirical basis consists of quantitative data on funding volumes and startup counts across Central and Eastern European countries.

Results of the study. Institutional and policy-oriented studies further emphasize that defence innovation ecosystems are shaped by the interaction of technological capabilities, regulatory frameworks, and strategic priorities [9, 10, 11]. This perspective reinforces the necessity of moving beyond static and aggregated indicators toward multidimensional approaches that account for the internal coherence of ecosystem components and their dynamic interactions.

The analytical component of this study is grounded in quantitative indicators describing the development of defence-tech and dual-use startup ecosystems in Central and Eastern Europe, obtained from publicly available datasets [8]. These data include information on funding volumes and the number of startups across countries and are used exclusively as an empirical basis for independent modelling.

At the descriptive level, the dataset reveals a pronounced asymmetry between financial and entrepreneurial components. Countries differ not only in the scale of investment but also in the density of startup activity, which indicates that ecosystem development is structurally heterogeneous rather than proportionally distributed This observation is consistent with the broader transformation of military-tech sectors under conditions of technological acceleration and operational demand, where rapid innovation cycles coexist with constraints in scaling and financing mechanisms [12].

Additionally, to formalize these observations, two primary variables are considered: the total funding volume allocated to defence-tech startups and the number of startups operating within each national ecosystem. These variables represent two distinct but interrelated dimensions of development: investment capacity and entrepreneurial intensity. Their joint consideration enables moving beyond descriptive comparison toward structural analysis.

Therefore, the initial inspection of the dataset suggests that the relationship between these variables is non-linear. In several cases, relatively high levels of funding are associated with a limited number of startups, while in others a dense startup environment emerges under comparatively constrained financial conditions. Such configurations indicate that ecosystem performance cannot be adequately evaluated using a single aggregated indicator, as different structural profiles may correspond to similar absolute values.

For clarity of interpretation, the empirical data are summarized in Table 1.

The data presented in Table 1 illustrate that countries with comparable levels of funding may exhibit significantly different levels of entrepreneurial activity. For example, Slovakia demonstrates the highest funding volume but a relatively small number of startups, whereas Ukraine shows the opposite configuration, combining moderate funding with a high density of entrepreneurial initiatives. This divergence indicates that risk within defence-tech ecosystems is not solely determined by resource availability but is also shaped by the internal structure of resource allocation and utilization. Thus, the analytical problem is reformulated

Table 1

Key indicators of defence-tech ecosystem development in selected CEE countries

Country	Funding (million €)	Number of startups
Ukraine	36.55	60+
Poland	82.78	~10
Estonia	37.70	~8
Slovakia	157.84	~5
Bulgaria	113.61	~4–5
Czechia	25.30	~4–5
Latvia	26.26	~2
Lithuania	22.56	~3–4
Croatia	13.22	~3

Source: compiled by the authors based on [8]

from measuring absolute performance to identifying structural relationships between investment and entrepreneurial dynamics. This provides the basis for constructing a formal model that captures both the level of development and the degree of internal imbalance.

To ensure comparability across countries, the variables presented in Table 1 are transformed into a dimensionless form using min–max normalization. This procedure eliminates scale effects and allows the analysis to focus on relative positions within the sample rather than absolute magnitudes. Formally, each indicator is normalized as follows:

$$\tilde{X}_i = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}}, \quad (1)$$

where X_i denotes the observed value of a variable for country i, and $X_{\min}$, $X_{\max}$ represent the minimum and maximum values across the dataset (The Recursive, 2025) [9].

Based on the normalized indicators, an integral index of ecosystem development is constructed. This index combines investment capacity and entrepreneurial intensity into a single analytical measure:

$$M_i^* = 0.45\tilde{F}_i + 0.55\tilde{S}_i, \quad (2)$$

where $\tilde{F}_i$ is the normalized funding volume and $\tilde{S}_i$ is the normalized number of startups. The weighting scheme reflects the assumption that entrepreneurial density captures not only current activity but also the potential for ecosystem expansion. However, the integral index alone does not capture the internal structure of the system. Two countries with similar values of M_i^* may differ significantly in the way financial and entrepreneurial components are distributed. For this reason, a second indicator is introduced to measure structural imbalance:

$$D_i^* = \left| \tilde{F}_i - \tilde{S}_i \right|. \quad (3)$$

This indicator reflects the degree of synchronization between investment and startup activity. Low values indicate structural alignment, while high values signal asymmetry between resource availability and innovation output. The calculated results are summarized in Table 2.

The results indicate that high levels of development are not necessarily associated with structural balance. In particular, countries with the highest values of the integral index also exhibit significant imbalance, suggesting that one component dominates the other. This finding supports the interpretation that ecosystem risk emerges from internal misalignment rather than from insufficient resource availability alone.

To enhance analytical clarity, the results are visualized in a two-dimensional space defined by the integral index and the imbalance indicator.

The graphical representation reveals distinct structural configurations. Countries located in the upper-right quadrant combine relatively high levels of development with pronounced imbalance, indicating rapid but uneven growth. In contrast, countries positioned in the lower-left quadrant

Table 2

Integral development index and structural imbalance of defence-tech

Country	Integral development index M_i^*	Structural imbalance D_i^*
Ukraine	0.62	0.84
Poland	0.29	0.34
Estonia	0.13	0.07
Slovakia	0.48	0.95
Bulgaria	0.33	0.64
Czechia	0.08	0.00
Latvia	0.05	0.07
Lithuania	0.06	0.00
Croatia	0.02	0.04

Source: author's calculations based on [8]

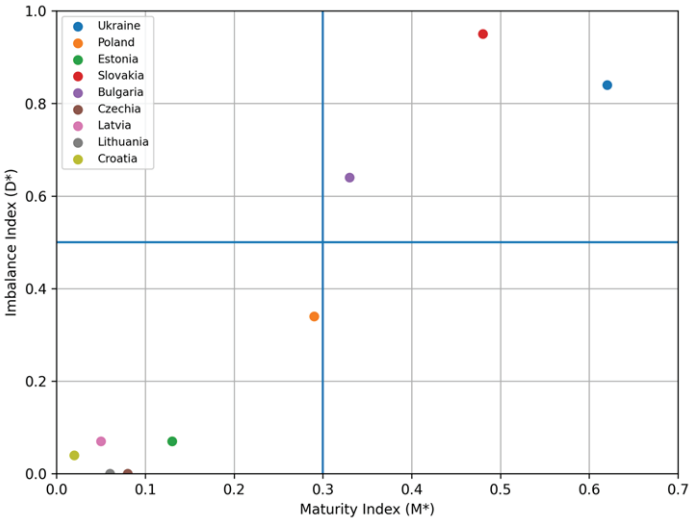

Fig. 1. Distribution of countries in the "development–imbalance" space of defence-tech ecosystems

Source: author's elaboration

exhibit both low development and structural consistency, reflecting stable but limited ecosystems.

Thus, intermediate positions correspond to transitional configurations in which one component gradually adjusts to the other. This visualization demonstrates that ecosystem development follows multiple structural trajectories rather than a single linear path. Such differentiation is particularly important for risk assessment, as it highlights that vulnerability is linked not only to scale but also to the internal coherence of the system. The introduction of the two-dimensional representation $\left(M_i^*, D_i^*\right)$ thus provides a more nuanced analytical perspective. It allows identifying structural types of ecosystems and forms the basis for further analysis of efficiency and dynamic interactions between investment and entrepreneurial activity.

To further examine the relationship between investment capacity and entrepreneurial activity, the analysis is extended using a logarithmic regression model. This specification allows capturing non-linear interactions between variables and interpreting the relationship in terms of elasticity, which is particularly relevant in the context of heterogeneous ecosystems [8].

The model is defined as:

$$\ln S_i = \alpha + \beta \ln F_i + \varepsilon_i, \quad (4)$$

where S_idenotes the number of defence-tech startups, F_irepresents the funding volume, and βmeasures the elasticity of entrepreneurial activity with respect to investment.

The use of logarithmic transformation is methodologically justified, as it reduces the impact of extreme values and enables comparison across countries with significantly different scales of development. At the same time, this approach reflects the economic interpretation of diminishing marginal effects, which are typical for innovation-driven sectors characterized by resource concentration and scaling processes [13].

Also the estimated relationship indicates that the coefficient βis positive but significantly less than one. This result implies that increases in funding lead to less than proportional increases in the number of startups. In other words, the marginal contribution of additional financial resources to the creation of new entrepreneurial entities decreases as funding grows. This pattern reflects a transition from extensive growth, driven by the emergence of new startups, to intensive growth, characterized by the scaling and consolidation of existing projects [14].

Thus the results of the analysis demonstrate that the development of military-tech startup ecosystems in Central and Eastern Europe cannot be adequately interpreted through traditional linear relationships between funding and innovation activity. Empirical evidence indicates that ecosystems evolve under conditions of structural heterogeneity, where the interaction between investment capacity and entrepreneurial intensity produces multiple development trajectories [8].

A key finding is that similar levels of overall development may correspond to fundamentally different internal configurations. In particular, ecosystems characterized by high entrepreneurial density but limited funding exhibit strong adaptive capacity but face constraints in scaling and long-term sustainability. Conversely, ecosystems with substantial financial resources but a limited number of startups demonstrate a concentration of capital that does not fully translate into broad-based innovation activity. These structural asymmetries confirm that risk is not solely determined by the availability of resources, but rather by the degree of alignment between key components of the ecosystem.

Also the introduction of the structural imbalance indicator provides an additional analytical layer that allows identifying hidden sources of systemic vulnerability. High imbalance values reflect a mismatch between investment flows and innovation output, which may lead to inefficiencies in resource allocation and reduced ecosystem resilience. This interpretation is consistent with observations regarding the challenges of scaling military-tech innovations, where access to funding, regulatory constraints, and production

capabilities play a critical role in determining the trajectory of development [14].

Furthermore, the regression analysis highlights the presence of diminishing returns to funding, indicating that increases in financial resources lead to less than proportional growth in startup activity. This suggests that beyond a certain threshold, additional investment is primarily directed toward scaling existing projects rather than generating new entrepreneurial initiatives. Such dynamics are typical for innovation ecosystems operating under conditions of technological complexity and institutional constraints, where growth shifts from expansion to consolidation.

A group of scholars emphasize the necessity of stimulating the development of startups [15-18]. Thus, these findings suggest that risk in military-tech startup ecosystems should be interpreted as an endogenous structural phenomenon. It emerges from the interaction between uneven resource distribution, non-linear development patterns, and declining marginal efficiency of investment. This perspective allows moving beyond static risk assessment toward a dynamic understanding of ecosystem evolution.

Conclusions. This study proposes an analytical framework for assessing military-tech startup ecosystems based on the integration of investment and entrepreneurial dimensions. By combining normalization techniques, index-based modelling, and structural analysis, the research provides a multidimensional representation of ecosystem development that captures both scale and internal configuration. The findings indicate that ecosystem performance is determined not only by the volume of available resources but also by the degree of structural alignment between financial and innovation components. The introduction of the structural imbalance indicator enables identifying configurations associated with increased systemic risk, while the regression-based analysis reveals diminishing returns to investment as a key mechanism shaping ecosystem dynamics.

The proposed model contributes to the methodological development of analytical tools for studying high-risk innovation systems operating under conditions of uncertainty and rapid technological change. It offers a framework for evaluating not only the level of development but also the efficiency and sustainability of resource transformation processes within military-tech ecosystems.

From a practical perspective, the results highlight the importance of coordinated development policies that ensure alignment between funding mechanisms and entrepreneurial activity. Future research may extend the proposed framework by incorporating additional variables, such as institutional capacity, regulatory environment, and technological specialization, in order to further refine the assessment of ecosystem resilience and long-term growth potential.

References:

1. Autio E., Thomas L. D. W. (2022). Researching ecosystems in innovation contexts. *Innovation & Management Review*, vol. 19, no. 1, pp. 12–25. DOI: https://doi.org/10.1108/INMR-08-2021-0151
2. Gheorghe C., Panazan O. (2024). Investigating the effect of geopolitical risk on defense companies' stock returns. *Heliyon,* vol. 10, no. 24, e40974. DOI: https://doi.org/10.1016/j.heliyon.2024.e40974
3. Beckley J. (2025). Advanced risk assessment techniques: merging data-driven analytics with expert insights to navigate uncertain decision-making processes. *International Journal of Research Publication and Reviews*, vol. 6(3), pp. 1454–1471.
4. Wassenius E., Crona B. I. (2022) Adapting risk assessments for a complex future. *One Earth*, vol. 5(1), pp. 35–43.
5. Zhurba O. M. (2025). Derzhavna pidtrymka startapiv i venchurnykh investytsii yak element konkurentnoi polityky u sferi informatsiinykh tekhnolohii [State support of startups and venture investments as an element of competition policy in the field of information technologies]. Akademichni vizii – Academic Visions, no. 48. DOI: https://doi.org/10.5281/zenodo.17715611 (in Ukrainian)
6. Loik R. (2025). Stymuliuvannia rozvytku startap-ekosystemy v Ukraini: dzherela finansuvannia ta investytsii v umovakh tsyfrovizatsii [Stimulating the development of the startup ecosystem in Ukraine: sources of financing and investments in the conditions of digitalization]. *Investytsii – Investments*, pp. 229–234. (in Ukrainian)
7. Krasnoshapka A. (2026). Analitychnyi vymir rozvytku ta upravlinnia defense tech startapamy v Ukraini za umov suchasnykh heopolitychnykh vyklykiv [Analytical dimension of development and management of defense tech startups in Ukraine under modern geopolitical challenges]. *Ekonomika ta suspilstvo – Economy and Society*, no. 83. DOI: https://doi.org/10.32782/2524-0072/2026-83-11 (in Ukrainian)
8. The Recursive (2025). *Defence tech in Central and Eastern Europe.* Available at: https://thedefender.media/uk/insights/cee-defence-tech-report/
9. EU defence innovation scheme: overview. (2023). *European Commission*. Available at: https://defence-industry-space.ec.europa.eu
10. RAND Corporation (2023). Defense innovation and emerging technologies. Available at: https://www.rand.org
11. Defence data and innovation landscape. (2023). *European Defence Agency.* Available at: https://eda.europa.eu
12. The state of the military-tech direction in Ukraine: challenges and prospects. (2024). *Kyivstar Business Hub* Available at: https://hub.kyivstar.ua/articles/stan-napryamku-military-tech-v-ukrayini-vikliki-ta-perspektivi. (in Ukrainian)
13. Investments in defence tech and miltech: Investor interests and scaling challenges. (2024). *Blue-Bird.* Available at: https://www.blue-bird.tech/news/investicziyi-u-defense-tech-ta-miltech-shho-czikavit-investoriv-ta-vikliki-masshtabuvannya
14. Kapstein E., Ospital J., Wolff G. B. (2026). Reforming European defence procurement to boost military innovation and startups. *Bruegel.* Available at: http://www.jstor.org/stable/resrep78615
15. Lehkobyt I., Kotsan I., Pavlov K., Pavlova O. (2025). Military-tech startups: navigating innovation and resilience in extreme conditions. European Journal of Economics and Management. No. 11(3). pp. 5–15. DOI: https://doi.org/10.46340/eujem.2025.11.3.1

16. Stoliarchuk Ya., Solodkovskyi Yu. (2026). Kompanii-startapy u suchasnii instytutsiinii strukturi innovatsiinoi diialnosti malykh i serednikh pidpryiemstv [Startup companies in the modern institutional structure of innovation activity of small and medium enterprises]. *Herald of Khmelnytskyi National University. Economic Sciences,* no. 350(1), pp. 539–548. DOI: https://doi.org/10.31891/2307-5740-2026-350-74 (in Ukrainian)
17. Lytvyn I. V., Danyliuk Yu. V. (2023) Startap-industriia Ukrainy v umovakh hlobalizatsiinykh vyklykiv [Startup industry of Ukraine in the conditions of globalization challenges]. *Menedzhment ta pidpryiemnytstvo v Ukraini: etapy stanovlennia ta problemy rozvytku – Management and Entrepreneurship in Ukraine: Stages of Formation and Problems of Development*, no. 1 (9), pp.189–202. (in Ukrainian)

Список використаної літератури:

1. Autio E., Thomas L. D. W. Researching ecosystems in innovation contexts. *Innovation & Management Review.* 2022. vol. 19, no. 1, pp. 12–25. DOI: https://doi.org/10.1108/INMR-08-2021-0151
2. Gheorghe C., Panazan O. Investigating the effect of geopolitical risk on defense companies' stock returns. 2024. *Heliyon*, vol. 10, no. 24, e40974. DOI: https://doi.org/10.1016/j.heliyon.2024.e40974
3. Beckley J. Advanced risk assessment techniques: merging data-driven analytics with expert insights to navigate uncertain decision-making processes. *International Journal of Research Publication and Reviews.* 2025. No. 6(3). P. 1454–1471.
4. Wassenius E., Crona B. I. Adapting risk assessments for a complex future. *One Earth.* 2022. No. 5(1). P. 35–43.
5. Лоік Р. Стимулювання розвитку стартап-екосистеми в Україні: джерела фінансування та інвестиції в умовах цифровізації. *Інвестиції.* 2025. С. 229–234.
6. Красношапка А. Аналітичний вимір розвитку та управління defense tech стартапами в Україні за умов сучасних геополітичних викликів. *Економіка та суспільство*. 2026. 83. URL:https://doi.org/10.32782/2524-0072/2026-83-11
7. Журба О. М. Державна підтримка стартапів і венчурних інвестицій як елемент конкурентної політики у сфері інформаційних технологій. Академічні візії. 2025. № 48. DOI: https://doi.org/10.5281/zenodo.17715611
8. The Recursive. *Defence tech in Central and Eastern Europe.* URL: https://thedefender.media/uk/insights/cee-defence-tech-report/ (дата звернення: 31.03.2026).
9. European Commission. *EU defence innovation scheme: Overview*. https://defence-industry-space.ec.europa.eu (дата звернення: 31.03.2026).
10. RAND Corporation. *Defense innovation and emerging technologies*.2023. URL: https://www.rand.org (дата звернення: 31.03.2026).
11. European Defence Agency. *Defence data and innovation landscape.* URL: https://eda.europa.eu (дата звернення: 31.03.2026).
12. The state of the military-tech direction in Ukraine: challenges and prospects. *Kyivstar Business Hub.* URL: https://hub.kyivstar.ua/articles/stan-napryamku-military-tech-v-ukrayini-vikliki-ta-perspektivi (дата звернення: 31.03.2026).
13. Інвестиції у defense tech та miltech: що цікавить інвесторів та виклики масштабування. *Blue-Bird.* URL: https://www.blue-bird.tech/news/investicziyi-u-defense-tech-ta-miltech-shho-czikavit-investoriv-ta-vikliki-masshtabuvannya/ (дата звернення: 31.03.2026).
14. Kapstein E., Ospital J., Wolff G. B. Reforming European defence procurement to boost military innovation and start-ups. *Bruegel,* 2026. URL: http://www.jstor.org/stable/resrep78615 (дата звернення: 31.03.2026).
15. Lehkobyt I., Kotsan I., Pavlov K., Pavlova O. Military-tech startups: navigating innovation and resilience in extreme conditions. *European Journal of Economics and Management.* 2025. № 11(3). pp. 5–15. DOI: https://doi.org/10.46340/eujem.2025.11.3.1
16. Столярчук Я., Солодковський Ю. Компанії-стартапи у сучасній інституційній структурі інноваційної діяльності малих і середніх підприємств. *Herald of Khmelnytskyi National University. Economic Sciences*. 2026. № 350(1). С. 539–548. DOI: https://doi.org/10.31891/2307-5740-2026-350-74
17. Литвин І.В., Данилюк Ю.В. Стартап-індустрія України в умовах глобалізаційних викликів. *Менеджмент та підприємництво в Україні: етапи становлення та проблеми розвитку*. 2023. № 1 (9) С. 189-202

***Горбаченко Станіслав Анатолійович**, доктор економічних наук, професор, завідувач кафедри штучного інтелекту та математичного моделювання, Національний університет "Одеська юридична академія". **Чепурна Олена Євгенівна,** кандидат фізико-математичних наук , доцент, доцент кафедри штучного інтелекту та математичного моделювання, Національний університет «Одеська юридична академія». **Куклінова Тетяна Вікторівна,** кандидат економічних наук, доцент, доцент кафедри штучного інтелекту та математичного моделювання, Національний університет "Одеська юридична академія".*

АДАПТАЦІЯ СУЧАСНИХ АНАЛІТИЧНИХ ІНСТРУМЕНТІВ ДЛЯ ОЦІНКИ РИЗИКІВ ВІЙСЬКОВИХ СТАРТАПІВ

У цьому дослідженні розглядаються структурні характеристики та механізми формування ризиків екосистем військово-технологічних стартапів у Центральній та Східній Європі на основі кількісних даних, що описують обсяги фінансування та активність стартапів. Метою дослідження є адаптація сучасних аналітичних інструментів для оцінки ризику екосистеми в умовах структурної гетерогенності та нелінійного розвитку. Методологічний підхід поєднує методи нормалізації, моделювання на основі індексів та структурний аналіз. Розглядаються два ключові виміри розвитку екосистеми: інвестиційна спроможність та інтенсивність підприємництва. На цій основі побудовано інтегральний індекс розвитку та показник структурного дисбалансу, що дозволяє проводити багатовимірну оцінку конфігурацій екосистеми, а не єдину агреговану оцінку. Результати

демонструють, що подібні рівні розвитку екосистеми можуть відповідати принципово різним внутрішнім структурам. Зокрема, високий рівень підприємницької активності не завжди підтримується пропорційною інвестиційною спроможністю, тоді як значні фінансові ресурси можуть бути зосереджені в межах обмеженої кількості проектів. Ця розбіжність свідчить про те, що ризик виникає не лише через недостатність ресурсів, але й через невідповідність між фінансовою та інноваційною складовими. Аналіз також виявляє зменшення віддачі від фінансування, що свідчить про те, що збільшення інвестицій призводить до менш пропорційного зростання кількості стартапів. Дослідження доповнює існуючу літературу, вводячи структурний дисбаланс як ключовий аналітичний вимір та інтегруючи численні аналітичні інструменти в єдину структуру для оцінки екосистеми. Запропонований підхід забезпечує більш повне розуміння екосистем військово-технологічних стартапів та пропонує методологічну основу для оцінки їхньої ефективності, масштабованості та стійкості в умовах невизначеності та швидких технологічних змін.

Ключові слова: *аналіз ефективності, управління проєктами, математичне моделювання, оцінка ризиків, бізнес-аналітика, дігіталізація, створення IT-продукту, продакт менеджмент, інвестиції, військово-технологічні стартапи.*

Дата надходження статті: 03.04.2026
Дата прийняття статті: 24.04.2026
Дата публікації статті: 29.05.2026