УДК 658:005.94:338.24:502.131.1

T. Kulinich,
PhD in Economics, Associate Professor, Associate Professor
of the Department of Management of Organizations,
Lviv Polytechnic National University
ORCID ID: https://orcid.org/0000-0003-0110-7080
V. Nahornyi,
PhD in Economic Sciences, Associate Professor, Associate Professor of the Department of
Economics, National University of Life and Environmental Sciences of Ukraine
ORCID ID: https://orcid.org/0000-0001-5551-4779
M. Sydorov,
PhD student, National University of Life and Environmental Sciences of Ukraine
ORCID ID: https://orcid.org/0009-0004-0855-7644

DOI: 10.32702/2306-6814.2025.22.261

INFORMATIONAL, ANALYTICAL AND MANAGERIAL SUPPORT FOR THE ECONOMIC SECURITY AND SUSTAINABLE DEVELOPMENT OF ENTREPRENEURIAL STRUCTURES

Т. В. Кулініч,
к. е. н., доцент кафедри менеджменту організацій,
Національний університет "Львівська політехніка"
В. В. Нагорний,
к. е. н., доцент, доцент кафедри економіки,
Національний університет біоресурсів і природокористування України
М. С. Сидоров,
здобувач вищої освіти третього (освітньо-наукового) рівня,
Національний університет біоресурсів і природокористування України

ІНФОРМАЦІЙНА, АНАЛІТИЧНА ТА УПРАВЛІНСЬКА ПІДТРИМКА ЕКОНОМІЧНОЇ БЕЗПЕКИ ТА СТІЙКОГО РОЗВИТКУ ПІДПРИЄМНИЦЬКИХ СТРУКТУР

The purpose of this article is to substantiate the theoretical foundations and practical solutions for providing informational, analytical, and managerial support to the economic security of business structures, with an emphasis on the implementation of remote monitoring with artificial intelligence functions. As a result of the conducted research, it has been confirmed that ensuring the economic security and sustainable development of all organizationally established business entities (regardless of their form of ownership, industry affiliation, size, or type of activity) under conditions of digital transformation requires a transition to new, intellectually oriented management models based on the integration of data, analytics, and management processes. It is substantiated that the effectiveness of informational, analytical, and managerial support is determined not only by the conceptual principles of its construction but, above all, by the use of service algorithms that operate

on the principle of cyclic integration — "data →analytics →decision →implementation →new data" — ensuring integrity, adaptability, and a proactive nature of management. It has been proven that the informational efficiency of the system is ensured by the continuous updating of the data array (Dt), which reflects the dynamics of the internal and external environment of business structures; analytical efficiency is achieved through the use of artificial intelligence algorithms for forecasting, classification, and anomaly detection; managerial efficiency is attained through the automated generation, adoption, and implementation of management decisions aimed at stabilization and development; and intellectual adaptability is formed through the operation of a self-learning module that ensures the adaptation and correction of management models in response to environmental changes. Taken together, this forms a comprehensive decision support system capable of self-renewal, adaptation, and proactive response, ensuring the resilience and economic security of business structures under modern conditions of digital transformation. The prospects for further research lie in the development of intelligent digital monitoring models capable of automatic learning, forecasting, and correction of management scenarios for the development of business structures within the context of digital transformation.

Метою статті є обгрунтування теоретичних засад і розроблення практичних рішень щодо формування інформаційної, аналітичної та управлінської підтримки економічної безпеки підприємницьких структур, з акцентом на впровадження систем віддаленого моніторингу з функціями штучного інтелекту. У результаті проведеного дослідження підтверджено, що забезпечення економічної безпеки та стійкого розвитку всіх організаційно оформлених суб'єктів підприємницької діяльності (незалежно від форми власності, галузевої належності, розміру чи виду господарювання) в умовах цифрової трансформації потребує переходу до нових, інтелектуально орієнтованих моделей управління, заснованих на інтеграції даних, аналітики та управлінських процесів. Обгрунтовано, що ефективність інформаційної, аналітичної та управлінської підтримки визначається не лише концептуальними принципами її побудови, а й, насамперед, застосуванням сервісних алгоритмів, які функціонують за принципом циклічної інтеграції: "дані →аналітика →рішення →реалізація →нові дані". Такий підхід забезпечує цілісність, адаптивність і випереджувальний характер управління. Доведено, що інформаційна ефективність системи забезпечується безперервним оновленням масиву даних (Dt), який відбиває динаміку внутрішнього та зовнішнього середовища підприємницьких структур; аналітична ефективність реалізується через використання алгоритмів штучного інтелекту для прогнозування, класифікації та виявлення аномалій; управлінська ефективність досягається шляхом автоматизованого формування, ухвалення та реалізації управлінських рішень, спрямованих на стабілізацію діяльності та забезпечення розвитку; інтелектуальна адаптивність формується завдяки функціонуванню модуля самонавчання, який забезпечує адаптацію та корекцію моделей управління відповідно до змін зовнішнього та внутрішнього середовища. У сукупності це формує комплексну систему підтримки управлінських рішень, здатну до самооновлення, адаптації та випереджувального реагування, що забезпечує стійкість функціонування та економічну безпеку підприємницьких структур у сучасних умовах цифрової трансформації. Перспективи подальших досліджень полягають у розробленні інтелектуально-цифрових моделей моніторингу, здатних до автоматичного навчання, прогнозування та корекції управлінських сценаріїв розвитку підприємницьких структур із урахуванням динаміки цифрового середовища.

Key words: artificial intelligence; business structures; sustainable development; economic security; risk analysis; environmental, social, and economic indicators.

Ключові слова: штучний інтелект; підприємницькі структури; стійкий розвиток; економічна безпека; аналіз ризиків; екологічні, соціальні та економічні індикатори.

PROBLEM STATEMENT

Modern business structures' functioning is characterized by a high level of uncertainty, dynamic changes in the external environment, and an increasing number of risks affecting economic security and sustainable development. At the same time, not only the outlined processes but also the digital transformation of business, the rise of cyber threats, and the volatility of market relations necessitate the transition to new management models based on data, analytics, and intelligent technologies. In this context, informational, analytical, and managerial support becomes a strategic tool for ensuring operational stability (through

enhancing adaptability to external challenges) and competitiveness of all organizationally established business entities, regardless of their form of ownership, industry affiliation, size, or type of economic activity.

One of the key directions of such support is the development of a remote monitoring system that enables real-time tracking of financial and economic indicators, resource efficiency levels, security risks, and potential threats to sustainable development. The implementation of artificial intelligence (AI) technologies in these systems creates new opportunities for forecasting, automated decision-making, anomaly detection in data, and the generation of management recommendations based on deep analysis of information flows.

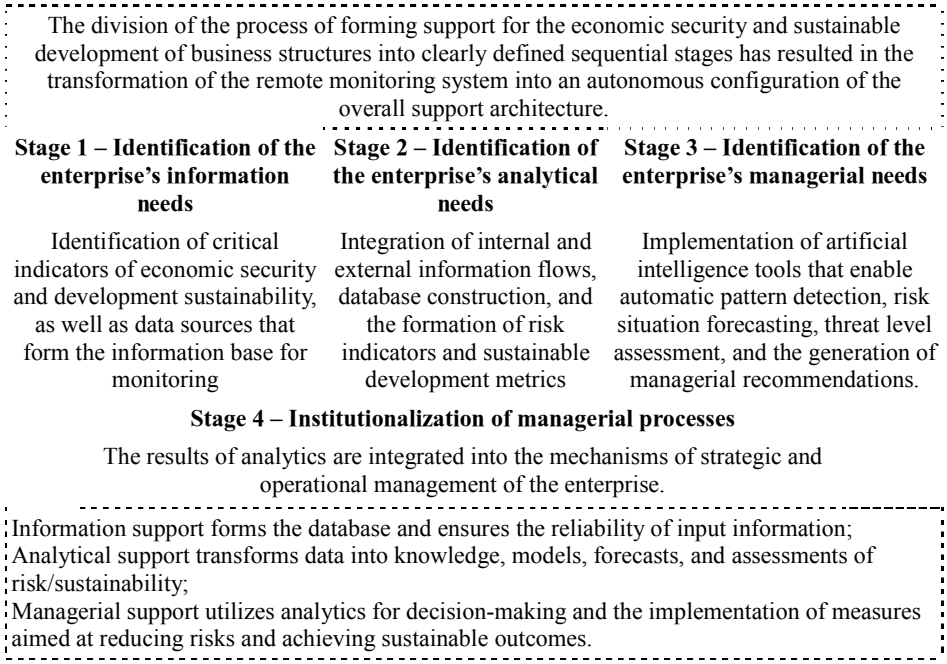

Figure 1. The logic of structuring the stages involved in developing informational, analytical, and managerial support for ensuring the economic security and sustainability of business structures

Source: created by the authors based on [1; 3; 5—6].

The intelligent analytical tools enable a transition from reactive to proactive management of economic security and sustainable development, providing early warning of crises and enhancing the effectiveness of corporate control systems. As a result, enterprises gain the ability not only to reduce losses from risks but also to build strategic advantages through increased digital maturity, integration of management processes, and the development of sustainable business models.

ANALYSIS OF RESEARCH AND PUBLICATIONS

Despite the considerable attention paid to the issues of information support for management and the implementation of artificial intelligence (AI) in business processes-which have been actively studied by H. Pysarevska [6], N.I. Melnyk, O.V. Kravchenko, V.S. Stolia-renko [4], Yu.Yu. Smoliak, and A.V. Kholodnytska [7] — the issue of a comprehensive integration of informational, analytical, and managerial support in the context of economic security and sustainable development remains insufficiently explored.

In particular, the approaches to constructing integrated models of remote monitoring, defining their structure, functional capabilities, and methods for assessing the effectiveness of such systems within entrepreneurial structures of various types and scales, require further clarification.

Thus, the relevance of the study is determined by the need to develop scientifically grounded approaches to the creation of intelligent analytical systems for supporting economic security and ensuring the sustainable development of business entities, based on the principles of digitalization, remote management, and the use of artificial intelligence.

FORMULATION OF THE ARTICLE'S OBJECTIVES

The purpose of this article is to substantiate the theoretical foundations and practical solutions for forming informational, analytical, and managerial support for the economic security of business structures, with an emphasis on the implementation of remote monitoring with artificial intelligence functions.

THE PAPER MAIN BODY

Within the framework of the study, it is emphasized that the formation of informational, analytical, and managerial support for various management decisions of business structures (including those related to economic security and development sustainability) requires the implementation of remote monitoring with artificial intelligence functions. Given its complex nature, it is recommended to consider this formation as an isolated process, as this allows for a clear definition of its goals, objectives, stages, and outcomes, as well as minimizing the influence of external factors that may distort information flows or disrupt the logic of management system development within business structures.

An isolated consideration of the process ensures the methodological integrity of the study and facilitates the structuring of its stages, specifically through the definition of a conceptual framework that contributes to the coherence and delineation of interconnections between the informational, analytical, and managerial components of decision-making support (see Fig. 1).

Therefore, we agree with the opinion of Pysarevska H. [6] and Kovtunenko Yu.V. [3] that such isolation allows for the division of the process of forming managerial decision support related to the economic security and

Table 1. Algorithms and directions for the institutionalization of managerial processes

Direction	Directions for the institutionalization of managerial processes	Commands or instructions through which information and analytical results are integrated into the mechanisms of strategic and operational management of the enterprise
Economic Security	Risk response procedures. Management dashboards for different. organizational levels Information flows and data integration.	Automated collection and classification of risk data from internal and external sources (finance, market, cybersecurity). Risk analysis using AI algorithms: anomaly detection, forecasting of critical scenarios. Implementation of integrated dashboards visualizing risks and security indicators. Transmission of analytical conclusions into strategic and operational management processes. Automatic updating of procedures and recommendations based on the analysis of new data and forecasting models
Sustainable Development	Procedures for responding to changes in key environmental, social, and economic indicators. Dashboards for strategic planning. Data integration for managerial decision-making.	Identification and collection of data on key sustainable development indicators from various sources in real time. Scenario modeling using AI and assessment of their impact on business processes. Integration of data into dashboards for managerial analysis and strategic planning. Forecasting long-term consequences of decisions based on machine learning models. Regular review of procedures and automatic adjustment of recommendations in response to changes in the external environment.

Source: created by the authors based on [1—3; 7].

sustainable development of business structures into clearly defined sequential stages. It is important that, as a result of this structural organization, the remote monitoring system transforms into an autonomous configuration of the overall support architecture (informational, analytical, and managerial), which remains effective regardless of the enterprise's form of ownership, industry affiliation, size, or type of economic activity. That is, such a system [3; 5—6]:

— can automatically adjust monitoring parameters to the specific characteristics of a given enterprise;

— does not require a complete restart when operating conditions change;

— functions as a management support service that provides up-to-date information, analytics, and recommendations in real time.

At the first stage, the identification of the enterprise's information needs is carried out, along with the determination of critical indicators of economic security and development sustainability, as well as the identification of data sources that form the monitoring information base (financial, production, personnel, logistics, environmental, etc.) [5].

The second stage involves the identification of the enterprise's analytical needs, within which internal and external information flows are integrated, databases are constructed, and risk indicators and sustainability metrics are developed. At this level, it is essential to ensure data compatibility and reliability, which creates the prerequisites for the proper functioning of artificial intelligence algorithms [6].

The third stage involves the identification of the enterprise's managerial needs, within which artificial intelligence tools are implemented to enable automatic pattern detection, risk situation forecasting, threat level assessment, and the generation of managerial recommendations. Within the remote monitoring system, AI functions not only allow the identification of deviations from normative parameters but also explain their causes and propose optimal response scenarios.

At the fourth stage, the institutionalization of managerial processes takes place — that is, sequences of clear commands or instructions are initiated, through which information and analytical results are integrated into the mechanisms of strategic and operational management of the enterprise (see Table 1).

It should be noted that proper structuring of work stages serves only as a conceptual framework for forming a clear and organized informational, analytical, and managerial support system for the management of business structures, but it does not guarantee its effectiveness in the practical implementation of various managerial tasks. Work structuring implies that the defined process is divided into logical stages (data collection, analysis, planning, implementation, etc.); however, it does not ensure efficiency if [4; 6—7]:

1. Data quality or reliability is lacking — even a perfect model will not function properly with "garbage" input data.

2. The algorithm is not adaptive — static models are unable to respond to crisis or non-standard situations.

3. Feedback mechanisms are not integrated — if results are not adjusted according to changes in the external environment, the system loses relevance.

4. There is a gap between analytics, accumulated information, and managerial decisions — when analytical results are not applied in management practice.

A telling example is the case of the private enterprise "EcoFood," whose management in 2023 implemented an informational, analytical, and managerial support system for production safety (as a component of overall economic security [3]), with clearly structured stages: collection of financial, production, and marketing data; processing in the analytical module; preparation of recommendations for management; and decision-making regarding production expansion. However, in 2024, it became apparent that the system did not account for external risks — specifically, fluctuations in energy prices and changes in regulatory requirements for "green" products. The decision to invest in a new production line proved economically unjustified because the analytics were based on outdated data and did not allow for adaptation. As a result, in 2024, the enterprise suffered losses of UAH 2.2 million, even though all stages of the process had been formally executed correctly.

In fact, structuring is a necessary but not sufficient condition for the effectiveness of managerial support. Real efficiency is achieved through the use of a service algorithm that operates on the principle of cyclical integration of data and analytics generated by the

content of managerial tasks (see Table 2), adjusted according to the objectives related to the economic security and sustainable development of business structures.

A single service algorithm forms a closed loop of informational, analytical, and managerial support, within which data collection, processing, interpretation, scenario modeling, and implementation of managerial actions take place, followed by their evaluation and adjustment. This means that [1; 4—5]:

1. Information support creates the basis for decision-making, forming an integrated information space that ensures continuous collection, storage, and transmission of relevant data;

2. Analytical support transforms data arrays into knowledge, models risks and development scenarios, and ensures the justification of managerial actions;

3. Managerial support implements analytical conclusions in practice — through mechanisms for response, stabilization, and monitoring the effectiveness of decisions.

Table 2. Delegation of tasks for supporting the economic security and sustainable development of business structures

Support direction	Tasks for ensuring economic security	Tasks for ensuring sustainable development
Informational	Formation of a unified database of internal and external risk indicators. Ensuring continuous data collection through remote monitoring systems. Informational integration of financial, production, and market indicators to identify potential threats.	Formation of a system of environmental, social, and economic sustainability indicators Collection and storage of data on resource intensity, emissions, energy efficiency, and social standards Ensuring access to data for assessing progress on ESG indicators
Analytical	Identification and forecasting of risks (financial, market, technological). Modeling of crisis development scenarios. Assessment of business process vulnerabilities using artificial intelligence algorithms.	Assessment of sustainability dynamics across three dimensions (economic, social, environmental). Forecasting the effects of managerial decisions on long-term development. Formation of an integrated sustainable development index.
Managerial	Development of procedures for responding to risks and crisis signals. Automated generation of decisions to stabilize financial, informational, and operational security. Creation of dashboards for management at various organizational levels	Definition of strategic priorities for sustainable development. Development and implementation of digitization, energy efficiency, and "green" technology programs. Real-time monitoring of the effectiveness of managerial decisions

Source: created by the authors based on [1; 4—5].

Specifically, regarding the economic security of business structures (Dt1), such an algorithm in formal (algorithmic-formula) form is expressed as [8]:

$$Dt1=FS(Dt,At,Rt,Mt,Pt,FAI) \quad (1);$$

where:

— Dt — input data array (internal Dint and external Dext);

— At=f1(Dt,FAI) — result of data analytical processing using artificial intelligence algorithms (classification, forecasting, anomaly detection);

— Rt=f2(At) — assessment of risk levels and vulnerabilities;

— Mt=f3(Rt,At) — managerial decisions (strategic, tactical, operational);

— Pt=f4(Mt) — implementation of stabilizing and preventive measures;

— FAI — functional artificial intelligence module that provides self-learning, adaptation, and predictive correction.

Regarding the sustainable development of business structures, such an algorithm in formal (algorithmic-formula) form is expressed as [8]:

$$Dt2=FSSR(Dt,At,St,Mt,Pt,FAI) \quad (2),$$

where:

— Dt — data array across the three components of sustainability (economic, social, environmental);

— At=f1(Dt,FAI) — result of data analytical processing using artificial intelligence functions (multidimensional analysis, trend forecasting, detection of inefficient or critical deviations);

— St=f2(At) — calculation of the integrated sustainable development index based on normalized and weighted indicators;

— Mt=f3(St,At) — managerial decisions aimed at achieving an optimal balance between economic efficiency and social-environmental responsibility;

— Pt=f4(Mt) — implementation of sustainable development programs and projects (digitization, production modernization, "green" transformation, ESG initiatives);

— FAI — functional artificial intelligence module that ensures continuous monitoring, self-renewal of forecasting models, and adaptation of managerial scenarios to changes in the external environment and internal factors.

Regarding the functionality of the outlined algorithms, it is determined by:

— Actions in the At=f1(Dt,FAI) module, which allow not only diagnosing the current state but also forecasting possible development scenarios;

— Actions in the Rt, Mt, and Pt modules, which generate substantiated decisions adapted to real conditions, enhancing the flexibility and effectiveness of management;

— Actions in the FAI module, which ensure system self-learning, automatic updating of forecasting models, and adaptation of managerial scenarios to dynamic changes in the economic, social, and environmental environment.

The cyclic nature of algorithms (1) and (2) lies in the fact that the output results of each calculation stage become input data for the next cycle, creating a closed loop for managing the economic security of business structures.

Thus, service algorithms-both in the context of ensuring the economic security of business structures and in the area of their sustainable development-enable the continuous reception and updating of the data array Dt, which encompasses internal and external parameters of business structures' operations. This allows the system to remain relevant and responsive to changes in the environment.

CONCLUSIONS

The results of the conducted research confirm that ensuring the economic security and sustainable development of business structures under conditions of digital transformation requires a transition to new, intelligently oriented management models based on the integration of data, analytics, and managerial processes. It is substantiated that the effectiveness of informational, analytical, and managerial support is determined not only by the conceptual principles of its construction but, above all, by the application of service algorithms operating on the principle of cyclical integration — "data → analytics → decision → implementation → new data" — ensuring integrity, adaptability, and proactive management.

It has been proven that informational efficiency of the system is ensured by continuous updating of the data array (Dt), which reflects the dynamics of the internal and external environment of business structures; analytical efficiency is realized through the use of artificial intelligence algorithms for forecasting, classification, and anomaly detection; managerial efficiency is achieved through automated generation, adoption, and implementation of managerial decisions (Rt,Mt,Pt) aimed at stabilization and development; and intellectual adaptability is formed through the operation of the self-learning module (FAI), which ensures the adaptation and correction of management models according to environmental changes.

Taken together, this forms a comprehensive decision support system capable of self-renewal, adaptation, and proactive response, ensuring the resilience and economic security of business structures in the modern context of digital transformation.

Prospects for further research lie in the development of intelligent-digital monitoring models capable of automatic learning, forecasting, and adjustment of managerial scenarios for the development of business structures under conditions of digital transformation.

Література:

1. Гнилянська О.В., Карий О.І. Ефективне використання інтернету речей (iot) в адміністративному менеджменті: завдання та можливості для організацій у сучасному бізнес-середовищі. Підприємництво і торгівля. 2023. № 39. С. 58—66.

2. Діденко М.В. Інформаційне забезпечення управління зовнішньоекономічною діяльністю на основі інноваційних технологій. Економічний вісник університету. 2021. № 37. С. 128—132.

3. Ковтуненко Ю.В. Застосування штучного інтелекту у системі управління підприємством: проблеми та переваги. Оглядова стаття. Economic journal Odessa polytechnic university. 2019. № 2 (8). С. 93—99.

4. Мельник Н.І., Кравченко О.В., Столяренко В.С. Використання ІТ-технологій у зовнішньоекономічній діяльності суб'єктів господарювання в умовах глобалізації економіки. Технологічні та дизайнерські аспекти сучасного розвитку виробництва. 2020. № 2 (32). С. 116—123.

5. Новаківський І.І., Рачинська Г.В. Застосування штучного інтелекту для управління інноваційними процесами у ланцюгах вартості. Вісник НУ "Львівська політехніка". 2011. № 720. С. 303—309.

6. Писаревська Г. Інформаційне забезпечення управління зовнішньоекономічною діяльністю підприємства. Економіка та суспільство, 2023. № 51. https://doi.org/10.32782/2524-0072/2023-51-31

7. Смоляк, Ю. Ю., Холодницька, А. В. (2024). Штучний інтелект в управлінні підприємством: трансформація ролі менеджера в індустрії 4.0. Проблеми сучасних трансформацій. Серія: економіка та управління. 2024. № 11. https://doi.org/10.54929/2786-5738-2024-11-04-12

8. Linton O. Mathematical Functions. Wooden Books. 2023. 526 p.

References:

1. Hnylyanska, O.V. and Kary, O.I. (2023). "Effective use of the Internet of Things (IoT) in administrative management: tasks and opportunities for organizations in the modern business environment", Pidpryyemnytstvo i torhivlya, vol. 39, pp. 58—66.

2. Didenko, M.V. (2021), "Information support for the management of foreign economic activities based on innovative technologies", Ekonomichnyy visnyk universytetu, vol. 37, pp. 128—132

3. Kovtunenko, Y.V. (2019), "Application of artificial intelligence in the enterprise management system: problems and advantages", Review article. Economic journal Odessa polytechnic university, vol. 2 (8), pp. 93—99.

4. Melnyk, N.I., Kravchenko, O.V. and Stolyarenko, V.S. (2020), "The use of IT technologies in foreign economic activities of business entities in the context of economic globalization", Tekhnolohichni ta dyzayners'ki aspekty suchasnoho rozvytku vyrobnytstva, vol. 2 (32), pp. 116—123.

5. Novakivskyi, I.I. and Rachynska, G.V. (2011), "Application of artificial intelligence to manage innovation processes in value chains", Visnyk NU "L'vivs'ka politekhnika", vol. 720, pp. 303—309.

6. Pisarevska, G. (2023), "Information support for the management of foreign economic activities of an enterprise", Ekonomika ta suspil'stvo, vol. 51. https://doi.org/10.32782/2524-0072/2023-51-31

7. Smolyak, Yu. Yu., and Kholodnytska, A. V. (2024), "Artificial Intelligence in Enterprise Management: Transformation of the Manager's Role in Industry 4.0", Problemy suchasnykh transformatsiy. Seriya: ekonomika ta upravlinnya, vol. 11. https://doi.org/10.54929/2786-5738-2024-11-04-12

8. Linton, O. (2023), Mathematical Functions, Wooden Books, Bury St Edmunds, UK.

Стаття надійшла до редакції 09.11.2025 р.