UDC: 658.7:004.8
JEL Classification: D81 + L81 + C55

Sergiienko T. I.

INTEGRATION OF BIG DATA TECHNOLOGIES INTO THE SYSTEM OF QUANTITATIVE ASSESSMENT OF ECONOMIC RISKS FOR E-COMMERCE AND E-TRADE ENTERPRISES UNDER DIGITAL TRANSFORMATION

National University "Zaporizhzhia Polytechnic", Zaporizhzhia, Ukraine

The article examines theoretical, methodological, and applied aspects of integrating Big Data technologies into the system of quantitative assessment of economic risks for e-commerce and e-trade enterprises within the context of digital transformation of the global business environment. It is substantiated that the rapid growth of data volumes, transactional intensity, multichannel digital communication with consumers, and the expansion of online platforms are shaping a fundamentally new architecture of economic risks for both types of enterprises – e-commerce and e-trade. This architecture is characterized by high dynamism, nonlinearity, and forecasting complexity, which necessitates the use of Big Data analytics, machine learning algorithms, artificial intelligence tools, and predictive modeling for timely identification and mitigation of risk events. Particular attention is paid to the transformation of risk management approaches in e-commerce and e-trade enterprises, where traditional expert-based assessment methods are increasingly replaced by automated systems analyzing large volumes of structured and unstructured data. It is demonstrated that the use of Big Data enhances the accuracy of assessing financial, operational, behavioral, and reputational risks and enables the transition from a reactive to a proactive risk management model for both categories of enterprises. The purpose of the article is to develop a conceptual model for integrating Big Data technologies into the quantitative risk assessment system of e-commerce and e-trade enterprises, taking into account the specifics of the digital environment, high demand volatility, networked interactions, and the need for prompt managerial decision-making. The methodological foundation of the study includes systemic and process-oriented approaches, economic-mathematical modeling, big data analysis methods, regression analysis, clustering, correlation modeling, neural network algorithms, as well as elements of scenario and simulation forecasting. The use of an integrated approach allowed the formation of a multi-level risk assessment model combining analytical, predictive, and managerial components. The scientific novelty lies in the creation of an integrated risk analytics model that synchronizes internal operational and financial enterprise data, external market signals, macroeconomic indicators, and customer behavioral analytics into a single digital decision-support system for e-commerce and e-trade enterprises. The proposed approach allows the calculation of an enterprise's integral digital risk index and enhances its resilience under conditions of economic digital transformation.

Keywords: Big Data, e-commerce, e-trade, economic risks, digital transformation, predictive analytics, machine learning, risk management.

DOI: 10.32434/2415-3974-2026-23-1-188-198

Introduction and problem statement

The current stage of global economic development is characterized by a new technological breakthrough associated with the rapid, exponential growth of information volumes. According to analysts from international IT companies, the global data pool has increased manifold in recent years, with the primary growth coming from unstructured or partially structured data. These include user information markers, text messages, multimedia content, transaction logs, sensor data, log files, and other sources that cannot be processed using traditional relational database tools. The expansion of information flows necessitates the use of specialized hardware and software, distributed computing systems, and advanced data analysis algorithms [9, p. 31]. Classical statistical methods and standard data processing algorithms prove insufficient for handling large volumes of heterogeneous information, which is characterized by high update rates and complex structures.

In response to these challenges, leading global IT companies such as IBM, Google, and Microsoft have initiated the development of fundamentally new approaches to data storage, processing, and analytics. As a result, a set of tools and methods for analyzing large and weakly structured information resources has emerged, collectively known as Big Data. This concept combines distributed computing, cloud technologies, machine learning, and predictive analytics to transform raw data into actionable managerial knowledge.

At the same time, the digital transformation of business drives radical changes in the functioning of e-commerce and e-trade enterprises [2]. The operations of e-trade platforms, marketplaces, and digital services are accompanied by high levels of economic uncertainty, linked to demand volatility, cyberattacks, fraudulent activities, logistical disruptions, changes in consumer behavior, and regulatory transformations. Under these conditions, risks are dynamic, multidimensional, and often latent.

Unlike traditional business models, e-commerce and e-trade enterprises operate in an environment of continuous data generation. The number of online transactions, user information markers, behavioral metrics, reviews, ratings, and social signals is growing exponentially. These data form the analytical foundation for the quantitative assessment of financial, operational, behavioral, and reputational risks.

The relevance of the topic lies in the fact that contemporary global challenges, the growth of digital data volumes, and increasing competition create a demand for effective methods of quantitative assessment of economic risks for e-commerce and e-trade enterprises. The integration of Big Data technologies enables real-time monitoring of risk factors, the development of predictive models of event progression, and the enhancement of business resilience under conditions of digital transformation.

The scientific problem consists in developing an integrated risk analytics model that synchronizes internal operational and financial enterprise data, external market signals, macroeconomic indicators, and customer behavioral analytics into a unified digital decision-support system. The proposed approach allows for the calculation of an integral digital risk index for e-commerce and e-trade enterprises and increases their resilience in the context of economic digital transformation.

The theoretical significance of the study is determined by the need to advance modern methods of economic risk management under digital transformation. Research on the integration of Big Data technologies into the quantitative risk assessment system of e-commerce and e-trade enterprises has important theoretical value, as it contributes to a deeper understanding of the relationship between business process digitalization and risk management.

The integration of Big Data technologies becomes a key factor in modernizing risk management processes, as it enables the processing of large data volumes, enhances transparency in assessments, and facilitates the development of predictive models for strategic decision-making. The combination of a risk-oriented approach and Big Data analytics allows e-commerce and e-trade enterprises to respond more flexibly to market instability, improve competitiveness, and lay the foundation for sustainable development in the digital economy.

Analysis and research of publications

The issues of digital economic transformation, the development of e-commerce, and the implementation of Big Data technologies are actively investigated in contemporary scientific studies. The theoretical foundations of Big Data economy formation and its impact on digital economy development are outlined in the work of S. Bilohur [1], where conceptual approaches to the transformation of economic systems under the influence of large data sets are substantiated and strategic directions for their development are identified. The emergence of the Big Data market in Ukraine and its role in post-war economic recovery are examined by N. Vakshynska and O. Shandrivska [2], who emphasize the institutional and infrastructural prerequisites for the effective use of big data in the business environment.

Transformational processes in e-trade under the influence of digital technologies are analyzed in the work of V. Zhukovska and V. Klymansky [3], which

highlights the features of business process changes and enterprise adaptation to new digital operating models. Conceptual differences between e-business, e-commerce, and e-trade are systematized in the study by Y. Shkrygun [11], which is important for a precise definition of the research object. The essence of Big Data technology and its business applications are presented in the work of I. Shkyrta and V. Lazar [10], which identifies key characteristics of big data and their impact on management processes. Practical aspects of implementing business analytics information systems using Big Data are studied by O. Stets and I. Lazarenko [7], who highlight the importance of analytical platforms for supporting managerial decision-making.

The impact of analytical data on enterprise performance is considered in the work of O. Stetsenko and Y. Bobrov [6], demonstrating the relationship between the use of digital analytics and improved business outcomes. The use of data analytics in financial management is examined by S. Suprunenko, A. Chornovol, and V. Havryliuk [8], who emphasize the role of digital tools in enhancing financial process transparency. Issues of risk management in the digital environment are highlighted in the works of S Loban [5], which analyze mechanisms for minimizing enterprise risks in digital space and their effect on competitiveness. Additional aspects of digital transformation of management systems are discussed in the collective monograph edited by V. Voronkova and N. Metelenko [4], which defines innovative vectors of management development under digitalization. Specific aspects of information technology applications in business analytics under crisis conditions are investigated by N. Yurik, T. Kuzhda, and N. Shveda [12], emphasizing the importance of analytical tools for ensuring organizational resilience. The advantages and risks of e-business under digital transformation are discussed in the study by V. Tkachuk, T. Melnyk, and Y. Bohoyavlenska [9], highlighting the need for a systematic approach to risk management.

Despite the substantial number of scientific studies in the fields of digital economy, e-commerce, Big Data, and risk management, the integration of Big Data technologies specifically into the quantitative assessment system of economic risks for e-commerce and e-trade enterprises remains insufficiently developed. Most studies address individual aspects of digitalization or data analytics but do not propose a comprehensive model of an integrated digital risk index that synchronizes financial, operational, behavioral, and macroeconomic indicators into a unified decision-support system. Therefore, further scientific research is needed to develop a comprehensive approach to integrating Big Data technologies into the quantitative risk assessment system of e-commerce and e-trade enterprises under digital transformation, which determines the relevance and scientific novelty of this study.

Purpose of the article

The aim of the article is to develop a conceptual model for integrating Big Data technologies into the quantitative risk assessment system of e-commerce and e-trade enterprises, taking into account the specifics of the digital environment, high demand volatility, networked interactions, and the need for prompt managerial decision-making.

Presentation of the main material

The large volumes of data generated daily provide businesses with new opportunities for in-depth analysis, evidence-based decision-making, and forecasting future trends. In the context of increasing market complexity, high demand dynamics, and rapid changes, the implementation of Big Data technologies becomes a key factor for the successful strategic development of e-commerce and e-trade enterprises.

In information technologies, Big Data represents a set of methods and tools for processing large volumes of structured and unstructured dynamic data of various types, with the aim of analysis, supporting managerial decision-making, and enhancing risk management efficiency in e-commerce and e-trade enterprises [10, p. 52]. These data can be structured (e.g., databases), unstructured (e.g., texts, images), or semi-structured (e.g., log files, system monitoring files) [5, p. 144].

The use of Big Data technologies allows for the simultaneous processing of different types of data, improves the accuracy of economic risk forecasts, and enables more informed strategic managerial decisions. This is especially important for e-commerce and e-trade enterprises operating in a highly dynamic digital environment. A conceptual representation of Big Data is presented in Fig.

Thus, Fig. presents the conceptual characteristics of Big Data, highlighting five key features of the technology and their significance for the assessment of economic risks in e-commerce and e-trade enterprises:

a) volume – the amount of data accumulated, which requires specialized storage and processing methods;

b) velocity – the speed at which data is generated and the need for high-speed processing for timely decision-making;

c) variety – the ability to process different types of data simultaneously, including structured, semi-structured, and unstructured data;

d) veracity – the economic impact and benefits derived from the application of Big Data technologies;

e) value – the quality of data, which determines the accuracy of analyses and forecasts [7, p. 130].

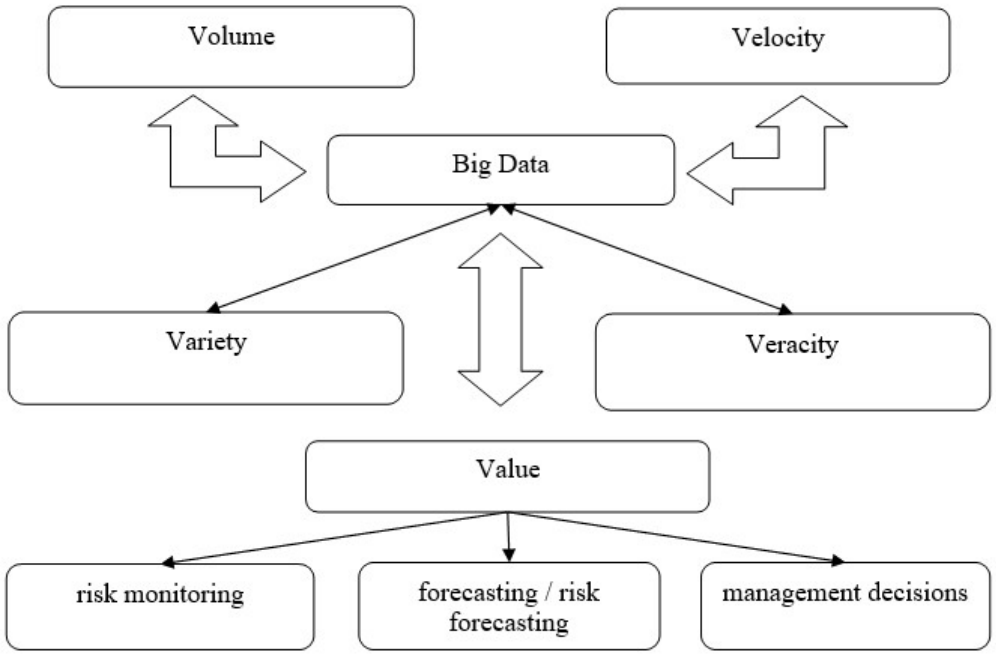

Fig. Conceptual characteristics of big data for economic risk assessment

Source: compiled by the author

Effective use of Big Data requires a comprehensive approach to monitoring, structuring, filtering, and identifying hierarchical relationships among data. In the context of economic risk assessment for e-commerce and e-trade enterprises, Big Data technologies enable the simultaneous analysis of numerous variables, the detection of global trends, and the generation of forecasts for strategic planning and risk management.

The table below summarizes the key characteristics of Big Data and their significance for managing economic risks in e-commerce and e-trade enterprises (Table 1).

Table 1

Key characteristics of big data and their significance for economic risk assessment in e-commerce and e-trade enterprises

Characteristic	Significance	Application for Risk Assessment
Volume	Large volumes of data from various sources, continuously accumulating	Enables analysis of large-scale transaction flows, customer behavior, and business processes to identify systemic risks and anomalies
Velocity	Rapid data generation and real-time processing	Ensures timely detection of risk situations, quick response to market changes, and loss minimization
Variety	Different types of data (text, graphics, transactions, log files)	Allows comprehensive analysis of various risk factors and integration of information from multiple sources for more accurate forecasting
Veracity	Economic impact from data use, reliability of sources	Supports effective investment and managerial decision-making, assessment of benefits from implementing analytical systems
Value	Data quality and accuracy, determining the reliability of conclusions	Increases the accuracy of economic risk forecasts and ensures the reliability of strategic planning and managerial decisions

Source: compiled by the author

The analysis of the key characteristics of Big Data demonstrates that the application of big data technologies in the economic risk assessment system of e-commerce and e-trade enterprises improves the accuracy of forecasts, the timeliness of responses to risk situations, and the validity of managerial decisions. Integrating these characteristics provides a comprehensive approach to risk monitoring, forecasting potential threats, and developing effective management strategies in a dynamic digital economy [5, p. 139].

In the digital economy, particularly in e-commerce and e-trade, Big Data technologies are especially relevant in areas such as credit scoring, customer segmentation, economic risk management, and the operation of Anti-Fraud Systems (AFS) [12, p. 98]. E-trade is a component of e-commerce, which in turn is a key element of the digital economy, contributing to accelerated global economic development, the creation of new markets, and ensuring inclusive and sustainable innovative growth. E-commerce encompasses all types of business operations and customer interactions through digital platforms, whereas e-trade specifically covers the online sale of goods and services [11, p. 318]. The growth in internet users, active use of social networks, and the spread of IoT technologies have led to a rapid increase in data volumes, stimulating the development and implementation of Big Data tools. Active application of these technologies enhances service quality for both B2B and B2C consumers in traditional and digital economies, supporting more effective risk management and strategic planning [2, p. 248].

At the same time, effective use of Big Data technologies requires a comprehensive approach to data processing and analysis. It is crucial not only to accumulate large volumes of heterogeneous information but also to ensure its systematization, reliability, protection, and compliance with legal and ethical standards. Equally important are technological and personnel aspects: the operation of analytical systems requires the involvement of highly qualified specialists and the use of modern hardware and software solutions that enable effective risk monitoring and predictive modeling. In the absence of adequate organizational, technological, and legal support, the implementation of Big Data may not only fail to provide the expected competitive advantages but may also generate additional economic and reputational risks for e-commerce and e-trade enterprises (Table 2).

Table 2

Main problems and challenges of big data implementation in e-commerce and e-trade

Problem Area	Problem Description	Potential Impact on Business	Possible Solutions
Data Quality	Incomplete, inaccurate, or outdated data	Low accuracy of forecasts, incorrect managerial decisions	Implementation of data validation and cleansing procedures
Security and Privacy	Processing of personal and corporate data	Risk of information leaks, legal and reputational consequences	Encryption, access control, compliance with GDPR and local laws
Data Processing Complexity	Heterogeneity, velocity, and volume of data	Complicates analytics and increases IT costs	Use of modern cloud platforms and analytical tools
Human Resources	Need for highly skilled data analysts and engineers	Inefficient use of Big Data systems	Staff training and development, involvement of external experts
Ethical and Legal Aspects	Processing and use of personal data	Ethical violations, legal sanctions	Implementation of ethical data use policies, compliance with legislation

Source: compiled by the author

The analysis of the main problems and challenges in implementing Big Data indicates that the effective use of big data in e-commerce and e-trade enterprises requires a comprehensive approach. Such an approach involves ensuring the quality and reliability of information resources, their proper protection, compliance with ethical and legal standards, as well as the availability of qualified personnel and modern technological infrastructure. Failure to meet these conditions can reduce forecasting accuracy, increase operational costs, and raise financial and reputational risks for the enterprise [1, p. 238].

Thus, despite technical, organizational, and ethical challenges, the integration of Big Data

technologies into the quantitative economic risk assessment system enables e-commerce and e-trade enterprises to improve the validity of managerial decisions, respond promptly to potential threats, and ensure sustainable development in a digital environment.

The main challenges include managing large volumes of heterogeneous information, ensuring data reliability and cybersecurity, structuring data for analytics and forecasting, and the need for highly qualified personnel and modern technological infrastructure, which entails additional costs for implementing analytical systems. Special attention should be paid to the ethical aspects of information use, as Big Data systems process personal data and must comply with legal requirements for data protection.

At the same time, the development and implementation of Big Data-based business analytics systems is strategically important for modern organizations. These systems contribute to improved operational efficiency, adaptability to market changes, enhanced forecasting, automation of business processes, and the creation of innovative products. Therefore, Big Data serves not only as a tool for improving risk management but also as a factor for the long-term competitive development of enterprises in the digital economy.

To systematize the results, it is advisable to present Table 3, which reflects the key areas of Big Data application in e-commerce and e-trade enterprises and their impact on economic risk assessment.

Table 3

Areas of big data application in e-commerce and e-trade enterprises and their impact on risk assessment

Application Area	Data Types	Use for Economic Risk Assessment	Benefits
Customer Scoring	Transactions, behavioral data	Enables assessment of financial reliability and credit risk of individual customers and customer groups	Reduces financial losses, improves accuracy of credit evaluations, and allows fast decision-making regarding credit issuance or service provision
Segmentation	Demographic, behavioral, social	Identifies high-risk customer groups and analyzes their behavior	Optimizes marketing strategies, forecasts demand, adapts offers, and reduces risk of losses due to mispositioned products
Risk Management	Financial, operational, market data	Monitors potential threats, detects anomalies and risk events	Improves managerial decision-making, enables timely response to threats, reduces losses, and enhances business process resilience
Anti-Fraud Systems (AFS)	Transactions, log files, behavioral patterns	Detects suspicious operations and transactions that may threaten financial stability	Reduces financial and reputational risks, prevents fraud schemes, and increases customer trust
Sales Forecasting	Historical data, behavioral patterns	Analyzes trends, seasonality, and demand for goods and services	Improves planning, increases business process flexibility, enables timely response to market changes, and enhances competitiveness

Source: compiled by the author

The analysis of Big Data application areas in e-commerce and e-trade enterprises demonstrates that the integration of big data technologies significantly improves the effectiveness of economic risk assessment. The use of data for customer scoring, segmentation, forecasting, and anti-fraud activities enables timely identification of potential threats, informed managerial decision-making, and optimization of business processes [8]. Thus, the implementation of Big Data contributes to improved forecast accuracy, reduced financial and operational risks, and overall strengthening of enterprise competitiveness in the context of digital economic transformation.

The implementation of the proposed Big Data application areas in risk assessment systems requires the use of specific machine learning algorithms, the choice of which depends on the nature of the data and the type of risk. In particular:

– for customer scoring and credit risk assessment, classification algorithms such as Gradient Boosting Machines (XGBoost, LightGBM) or Random Forest

are most effective, as they allow processing a large number of nonlinear features;

– in Anti-Fraud Systems (AFS), unsupervised learning methods such as Isolation Forest or Local Outlier Factor (LOF) are appropriate, as they specialize in detecting anomalies in transaction logs;

– for forecasting behavioral risks and temporal demand volatility, recurrent neural networks (RNNs) with LSTM (Long Short-Term Memory) architecture are suitable, as they can account for long-term dependencies and seasonal fluctuations in consumer digital footprints;

– risk group segmentation is based on clustering algorithms (K-means, DBSCAN), which allow identifying latent patterns in customer behavior that may indicate potential churn or reduced loyalty.

The use of this toolkit ensures a transition from descriptive analytics to predictive analytics, enabling the modeling of the integral risk index R_{BD} considering the dynamics of input parameters in real time [6, p. 25].

To quantitatively formalize the results of Big Data analytics, an integral digital risk index for e-commerce and e-trade enterprises is proposed, which aggregates multidimensional risk parameters into a single summary indicator.

The integral risk index R_{BD} is defined as the weighted sum of partial sub-indices:

$$RBD = \sum_{i=1}^{n} w_i \times R_i \quad , \tag{1}$$

where R_i— normalized sub-index of the i-th type of economic risk;
w_i — weight coefficient reflecting the significance of the corresponding risk;
n — the number of risk types considered in the model.

Within the structure of the integral index, it is advisable to distinguish the following key sub-indices:

$$RBD = w_1 R_f + w_2 R_0 + w_3 R_b + w_4 R_r + w_5 R_c \quad , \tag{2}$$

where R_f— financial risk (credit losses, liquidity issues, transaction disruptions);
R_o — operational risk (logistics delays, technical failures, cyber threats);
R_b — behavioral risk (demand fluctuations, customer churn, anomalous activity);
R_r — reputational risk (negative reviews, information attacks);
R_c — regulatory and compliance risk.

Normalization of the indicators is carried out using the following formula:

$$R_i = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}} \quad , \tag{3}$$

where X_i — the actual value of the risk parameter;
X_{min} — minimum value of the indicator;
X_{max} — maximum value of the indicator.

Weight coefficients w_i can be determined by expert assessment methods, principal component analysis, machine learning algorithms, historical data on actual losses.

At the same time, the following condition for normalization of the weight coefficients is applied:

$$\sum_{i=1}^{n} w_i = 1, \tag{4}$$

which ensures the balance of the model and the correctness of aggregating the partial sub-indices into a single integral indicator.

The resulting integral risk index allows: monitoring the enterprise's risk profile in real time, creating a business risk map, forecasting extreme scenarios, making strategic management decisions.

For practical interpretation of the integral indicator, the following risk level gradation is recommended:

0–0,25 – low risk level;
0,26–0,50 – moderate risk level;
0,51–0,75 – elevated risk level;
0,76–1,00 – critical risk level.

Within the framework of digital analytics, the integral indicator can be represented as a dynamic function $RBD_{(t)}$, which reflects the change in the risk level over time and allows the identification of periods of increasing instability or accumulation of risk potential.

At the same time, the practical implementation of the integral risk index model in a digital environment requires consideration of international institutional frameworks for data governance, which regulate the procedures for data collection, storage, processing, and cross-border exchange, as well as ensure compliance with ethical and legal standards at the global level.

Adherence to such frameworks enables e-commerce and e-trade enterprises to use Big Data technologies transparently and responsibly, minimize the risks of non-compliance with personal data protection requirements, and maintain a balance between economic efficiency and information security.

Conclusions

The article substantiates that the digital transformation of e-commerce and e-trade enterprises drives the formation of a new architecture of economic risks, characterized by dynamism, nonlinearity, high propagation speed of risk events, and interdependence of influencing factors. Under such conditions, traditional risk assessment methods gradually lose their predictive effectiveness, highlighting the need to integrate Big Data technologies into the system of quantitative evaluation of economic risks. It has been demonstrated that the application of Big Data analytics ensures a shift from a reactive risk management model to a proactive one based on forecasting, scenario analysis, and early anomaly detection. The integration of internal financial and operational indicators with behavioral, transactional, and macroeconomic data forms a multi-level digital risk analytics system, enhancing the accuracy of quantitative assessments.

A conceptual approach is proposed for forming an integral digital risk index for e-commerce and e-trade enterprises, which synthesizes the results of clustering, regression modeling, neural network processing, and predictive analytics into a unified decision support system. This approach enables comprehensive quantitative assessment of financial, operational, behavioral, and reputational risks, increasing the adaptability of business models under digital transformation. It is substantiated that the effectiveness of Big Data integration depends not only on the level of technological infrastructure but also on the institutional frameworks for data governance, adherence to ethical standards of data use, and the digital competencies of personnel. Compliance with international personal data protection standards and transparency of algorithmic solutions contribute to minimizing regulatory and reputational risks.

The practical significance of the results lies in the possibility of implementing the developed approach for quantitative assessment of economic risks into corporate risk management systems of e-commerce and e-trade enterprises, ensuring enhanced justification of strategic decisions and business resilience in the digital economy.

Prospects for further research include the development of quantitative risk assessment models considering the specifics of different sectors of e-commerce and trade and the scale of enterprises, as well as the implementation of machine learning analytics algorithms for real-time Big Data processing. An important direction is the study of optimal institutional and legal mechanisms for global data governance, which will allow balancing economic efficiency and user data protection. Additionally, it is promising to investigate the impact of Big Data integration on sustainable business development, improving competitiveness and adaptability under digital transformation.

REFERENCES

1. Bilohur, S. (2025). Kontseptsiia ekonomiky velykykh danykh i tsyfrovoyi ekonomiky: vyklyky ta napriamy rozvytku [The concept of Big Data economy and digital economy: challenges and directions of development]. *Humanities Studies, 22*(99), 236–247. DOI: https://doi.org/10.32782/hst-2025-22-99-26 [in Ukrainian].

2. Vakshynska, N. Yu., & Shandrivska, O. Ye. (2023). Spetsyfika rozvytku rynku Big Data dlia potreb vidnovlennia ekonomiky Ukrainy v postvoiennyi period [Specifics of Big Data market development for post-war economic recovery in Ukraine]. *Menedzhment ta pidpryiemnytstvo v Ukraini: etapy stanovlennia i problemy rozvytku – Management and Entrepreneurship in Ukraine: the stages of formation and problems of development, 2*(9), 244–256. DOI: https://doi.org/10.23939/smeu2023.02.244 [in Ukrainian].

3. Zhukovska, V., & Klymanskyi, V. (2024). Transformatsiia biznes-protsesiv na pidpryiemstvi elektronnoi torhivli: vpliv tsyfrovykh tekhnolohii [Transformation of business processes in e-commerce enterprises: impact of digital technologies]. *Ekonomika ta suspilstvo – Economy and Society, 66*. DOI: https://doi.org/10.32782/2524-0072/2024-66-69 [in Ukrainian].

4. Sergiienko, T. I., Krainik, O. M., & Kuris, Yu. V. (2025). Innovatsiini vektory tsyfrovoyi transformatsii ekolohichnoho menedzhmentu v konteksti zelenoi ekonomiky [Innovative vectors of digital transformation of ecological management in the context of the green economy]. In V. H. Voronkova & N. H. Metelenko (Eds.), *Ekologichnyi menedzhment u systemi tsyfrovykh innovatsii staloho rozvytku: stratehii dlia zelenoi ekonomiky, metalurhii ta biznesu [Ecological management in the system of digital innovations for sustainable development: strategies for green economy, metallurgy, and business]* (pp. 142–190). Lviv-Torun: Liha-Pres. DOI: https://doi.org/10.36059/978-966-397-542-9 [in Ukrainian].

5. Sergiienko, T. I., & Loban, S. I. (2024). Mekhanizmy minimalizatsii ryzykiv promyslovoho pidpryiemstva u tsyfrovomu prostori ta yikh vpliv na konkurentospromozhnist [Mechanisms of industrial enterprise risk minimization in digital space and their impact on competitiveness]. In V. H. Voronkova (Ed.), *Formuvannia kontseptsii tsyfrovoyi transformatsii osvity ta sotsialno-vidpovidalnoho tsyfrovoho hromadianyna u konteksti yevropeiskoho dosvidu [Formation of the concept of digital transformation of education and socially responsible digital citizen in the context of European experience]* (pp. 136–179). Lviv-Torun: Liha-Pres. DOI: https://doi.org/10.36059/978-966-397-447-7 [in Ukrainian].

6. Stetsenko, O., & Bobrov, Ye. (2024). Vplyv analitychnykh danykh na efektyvnist pidpryiemstva [Impact of

analytical data on enterprise efficiency]. *Vcheni zapysky Universytetu "KROK" – Scientific Notes of the University "KROK", 4*(76), 22–29. DOI: https://doi.org/10.31732/2663-2209-2024-76-22-29 [in Ukrainian].

7. Stets, O., & Lazarenko, I. (2024). Informatsiyni systemy biznes-analityky z vykorystanniam Big Data tekhnolohii [Business analytics information systems using Big Data technologies]. *Modeling the Development of the Economic Systems, 3,* 129–136. DOI: https://doi.org/10.31891/mdes/2024-13-25 [in Ukrainian].

8. Suprunenko, S., Chornovol, A., & Havryliuk, V. (2024). Vykorystannia analityky danykh dlia upravlinnia finansovymy protsesamy v tsyfrovomu seredovyshchi Ukrainy [Use of data analytics for financial process management in Ukraine's digital environment]. *Ekonomika ta suspilstvo – Economy and Society, 62.* DOI: https://doi.org/10.32782/2524-0072/2024-62-51 [in Ukrainian].

9. Tkachuk, V. O., Melnyk, T. Yu., & Bohoiavlenska, Yu. V. (2021). Elektronnyi biznes: perevahy ta ryzyky v period tsyfrovoyi transformatsii [E-business: advantages and risks during digital transformation]. *Ekonomika, upravlinnia ta administruvannia – Economics, Management and Administration, 4*(98), 28–36. DOI: https://doi.org/10.26642/ema-2021-4(98)-28-36 [in Ukrainian].

10. Shkyrta, I. M., & Lazar, V. F. (2019). Tekhnolohiia Big Data: sutnist, mozhlyvosti dlia biznesu [Big Data technology: essence and opportunities for business]. *Naukovyi visnyk Mukachivskoho derzhavnoho universytetu. Seriia Ekonomika – Scientific Bulletin of Mukachevo State University. Series "Economics", 2*(12), 51–56. DOI: https://doi.org/10.31339/2313-8114-2019-2(12)-51-56 [in Ukrainian].

11. Shkryhun, Yu. O. (2020). "Elektronnyi biznes", "elektronna komertsiia" ta "elektronna torhivlia": vidminnosti i osoblyvosti ["E-business", "e-commerce", and "electronic trade": differences and features]. *Upravlinnia ekonomikoiu: teoriia ta praktyka – Management of Economy: Theory and Practice,* 312–325. DOI: https://doi.org/10.37405/2221-1187.2020.312-325 [in Ukrainian].

12. Yuryk, N. Ye., Kuzhda, T. I., & Shveda, N. M. (2023). Zastosuvannia informatsiinykh tekhnolohii pry biznes-analyzi diialnosti orhanizatsii v kryzovykh umovakh [Application of information technologies in business analysis of organizations in crisis conditions]. *Halytskyi ekonomichnyi visnyk – Galician economic journal, 81*(2), 96–105. DOI: https://doi.org/10.33108/galicianvisnyk_tntu2023.02.096 [in Ukrainian].

Received 03.03.2026.
Revised 01.04.2026.
Accepted 10.05.2026.
Published 30.05.2026.

ІНТЕГРАЦІЯ ТЕХНОЛОГІЙ BIG DATA В СИСТЕМУ КІЛЬКІСНОГО ОЦІНЮВАННЯ ЕКОНОМІЧНИХ РИЗИКІВ ПІДПРИЄМСТВ ЕЛЕКТРОННОЇ КОМЕРЦІЇ ТА ТОРГІВЛІ В УМОВАХ ЦИФРОВОЇ ТРАНСФОРМАЦІЇ

Сергієнко Т. І.

У статті досліджено теоретико-методологічні та прикладні аспекти інтеграції технологій Big Data у систему кількісного оцінювання економічних ризиків підприємств електронної комерції та електронної торгівлі в умовах цифрової трансформації глобального бізнес-середовища. Обґрунтовано, що стрімке зростання обсягів даних, інтенсивності транзакційної активності, багатоканальної цифрової комунікації зі споживачами та розширення онлайн-платформ формує принципово нову архітектуру економічних ризиків для обох типів підприємств – e-commerce і e-trade. Така архітектура характеризується високою динамічністю, нелінійністю та складністю прогнозування, що зумовлює необхідність застосування аналітики великих даних, алгоритмів машинного навчання, інструментів штучного інтелекту та предиктивного моделювання для своєчасної ідентифікації та мінімізації ризикових подій. Особливу увагу приділено трансформації підходів до ризик-менеджменту підприємств електронної комерції та електронної торгівлі, де традиційні методи експертного оцінювання поступаються місцем автоматизованим системам аналізу великих масивів структурованої та неструктурованої інформації. Доведено, що використання Big Data дозволяє підвищити точність оцінювання фінансових, операційних, поведінкових та репутаційних ризиків, а також забезпечити перехід від реактивної до проактивної моделі управління ризиками для підприємств обох категорій – електронної комерції і торгівлі. Метою статті є розроблення концептуальної моделі інтеграції технологій Big Data у систему кількісного оцінювання економічних ризиків підприємств електронної комерції та електронної торгівлі з урахуванням специфіки цифрового середовища, високої волатильності попиту, мережевого характеру взаємодії та необхідності оперативного прийняття управлінських рішень. Методологічну основу дослідження становлять системний і процесний підходи, економіко-математичне моделювання, методи аналізу великих масивів даних, інструменти регресійного аналізу, кластеризації, кореляційного моделювання, нейромережеві алгоритми, а також елементи сценарного та імітаційного прогнозування. Використання комплексного підходу дозволило сформувати багаторівневу модель оцінювання ризиків, що поєднує аналітичний, прогностичний та управлінський компоненти. Наукова новизна полягає у формуванні інтегрованої моделі ризик-аналітики, яка синхронізує внутрішні операційні та фінансові дані підприємства, зовнішні ринкові сигнали, макроекономічні індикатори та поведінкову аналітику клієнтів у єдину цифрову систему підтримки управлінських рішень для підприємств електронної комерції та електронної торгівлі. Запропонований підхід дозволяє розраховувати інтегральний цифровий ризик-індекс підприємства та підвищувати його стійкість в умовах цифрової трансформації економіки.

Ключові слова: Big Data, електронна комерція, електронна торгівля, економічні ризики, цифрова трансформація, предиктивна аналітика, машинне навчання, ризик-менеджмент.

INTEGRATION OF BIG DATA TECHNOLOGIES INTO THE SYSTEM OF QUANTITATIVE ASSESSMENT OF ECONOMIC RISKS FOR E-COMMERCE AND E-TRADE ENTERPRISES UNDER DIGITAL TRANSFORMATION

Sergiienko T. I.*

National University “Zaporizhzhia Polytechnic”, Zaporizhzhia, Ukraine

***e-mail: sergienko7921@gmail.com**

Sergiienko T. I. ORCID: **https://orcid.org/0000-0002-4654-9248**

The article examines theoretical, methodological, and applied aspects of integrating Big Data technologies into the system of quantitative assessment of economic risks for e-commerce and e-trade enterprises within the context of digital transformation of the global business environment. It is substantiated that the rapid growth of data volumes, transactional intensity, multichannel digital communication with consumers, and the expansion of online platforms are shaping a fundamentally new architecture of economic risks for both types of enterprises – e-commerce and e-trade. This architecture is characterized by high dynamism, nonlinearity, and forecasting complexity, which necessitates the use of Big Data analytics, machine learning algorithms, artificial intelligence tools, and predictive modeling for timely identification and mitigation of risk events. Particular attention is paid to the transformation of risk management approaches in e-commerce and e-trade enterprises, where traditional expert-based assessment methods are increasingly replaced by automated systems analyzing large volumes of structured and unstructured data. It is demonstrated that the use of Big Data enhances the accuracy of assessing financial, operational, behavioral, and reputational risks and enables the transition from a reactive to a proactive risk management model for both categories of enterprises. The purpose of the article is to develop a conceptual model for integrating Big Data technologies into the quantitative risk assessment system of e-commerce and e-trade enterprises, taking into account the specifics of the digital environment, high demand volatility, networked interactions, and the need for prompt managerial decision-making. The methodological foundation of the study includes systemic and process-oriented approaches, economic-mathematical modeling, big data analysis methods, regression analysis, clustering, correlation modeling, neural network algorithms, as well as elements of scenario and simulation forecasting. The use of an integrated approach allowed the formation of a multi-level risk assessment model combining analytical, predictive, and managerial components. The scientific novelty lies in the creation of an integrated risk analytics model that synchronizes internal operational and financial enterprise data, external market signals, macroeconomic indicators, and customer behavioral analytics into a single digital decision-support system for e-commerce and e-trade enterprises. The proposed approach allows the calculation of an enterprise’s integral digital risk index and enhances its resilience under conditions of economic digital transformation.

Keywords: Big Data, e-commerce, e-trade, economic risks, digital transformation, predictive analytics, machine learning, risk management.

REFERENCES

1. Bilohur, S. (2025). Kontseptsiia ekonomiky velykykh danykh i tsyfrovoyi ekonomiky: vyklyky ta napriamy rozvytku [The concept of Big Data economy and digital economy: challenges and directions of development]. *Humanities Studies, 22*(99), 236–247. DOI: https://doi.org/10.32782/hst-2025-22-99-26 [in Ukrainian].

2. Vakshynska, N. Yu., & Shandrivska, O. Ye. (2023). Spetsyfika rozvytku rynku Big Data dlia potreb vidnovlennia ekonomiky Ukrainy v postvoiennyi period [Specifics of Big Data market development for post-war economic recovery in Ukraine]. *Menedzhment ta pidpryiemnytstvo v Ukraini: etapy stanovlennia i problemy rozvytku – Management and Entrepreneurship in Ukraine: the stages of formation and problems of development, 2*(9), 244–256. DOI: https://doi.org/10.23939/smeu2023.02.244 [in Ukrainian].

3. Zhukovska, V., & Klymanskyi, V. (2024). Transformatsiia biznes-protsesiv na pidpryiemstvi elektronnoi torhivli: vpliv tsyfrovykh tekhnolohii [Transformation of business processes in e-commerce enterprises: impact of digital technologies]. *Ekonomika ta suspilstvo – Economy and Society, 66.* DOI: https://doi.org/10.32782/2524-0072/2024-66-69 [in Ukrainian].

4. Sergiienko, T. I., Krainik, O. M., & Kuris, Yu. V. (2025). Innovatsiini vektory tsyfrovoyi transformatsii ekolohichnoho menedzhmentu v konteksti zelenoi ekonomiky [Innovative vectors of digital transformation of ecological management in the context of the green economy]. In V. H. Voronkova & N. H. Metelenko (Eds.), *Ekologichnyi menedzhment u systemi tsyfrovykh innovatsii staloho rozvytku: stratehii dlia zelenoi ekonomiky, metalurhii ta biznesu [Ecological management in the system of digital innovations for sustainable development: strategies for green economy, metallurgy, and business]* (pp. 142–190). Lviv-Torun: Liha-Pres. DOI: https://doi.org/10.36059/978-966-397-542-9 [in Ukrainian].

5. Sergiienko, T. I., & Loban, S. I. (2024). Mekhanizmy minimalizatsii ryzykiv promyslovoho pidpryiemstva u tsyfrovomu prostori ta yikh vpliv na konkurentospromozhnist [Mechanisms of industrial enterprise risk minimization in digital space and their impact on competitiveness]. In V. H. Voronkova (Ed.), *Formuvannia kontseptsii tsyfrovoyi transformatsii osvity ta sotsialno-vidpovidalnoho tsyfrovoho hromadianyna u konteksti yevropeiskoho dosvidu [Formation of the concept of digital transformation of education and socially responsible digital citizen in the context of European experience]* (pp. 136–179). Lviv-Torun: Liha-Pres. DOI: https://doi.org/10.36059/978-966-397-447-7 [in Ukrainian].

6. Stetsenko, O., & Bobrov, Ye. (2024). Vplyv analitychnykh danykh na efektyvnist pidpryiemstva [Impact of analytical data on enterprise efficiency]. *Vcheni zapysky Universytetu “KROK” – Scientific Notes of the University “KROK”, 4*(76), 22–29. DOI: https://doi.org/10.31732/2663-2209-2024-76-22-29 [in Ukrainian].

7. Stets, O., & Lazarenko, I. (2024). Informatsiyni systemy biznes-analityky z vykorystanniam Big Data tekhnolohii [Business analytics information systems using Big Data technologies]. *Modeling the Development of the Economic Systems, 3,* 129–136. DOI: https://doi.org/10.31891/mdes/2024-13-25 [in Ukrainian].

8. Suprunenko, S., Chornovol, A., & Havryliuk, V. (2024). Vykorystannia analityky danykh dlia upravlinnia finansovymy protsesamy v tsyfrovomu seredovyshchi Ukrainy [Use of data analytics for financial process management in Ukraine's digital environment]. *Ekonomika ta suspilstvo — Economy and Society, 62*. DOI: https://doi.org/10.32782/2524-0072/2024-62-51 [in Ukrainian].

9. Tkachuk, V. O., Melnyk, T. Yu., & Bohoiavlenska, Yu. V. (2021). Elektronnyi biznes: perevahy ta ryzyky v period tsyfrovoyi transformatsii [E-business: advantages and risks during digital transformation]. *Ekonomika, upravlinnia ta administruvannia — Economics, Management and Administration, 4*(98), 28–36. DOI: https://doi.org/10.26642/ema-2021-4(98)-28-36 [in Ukrainian].

10. Shkyrta, I. M., & Lazar, V. F. (2019). Tekhnolohiia Big Data: sutnist, mozhlyvosti dlia biznesu [Big Data technology: essence and opportunities for business]. *Naukovyi visnyk Mukachivskoho derzhavnoho universytetu. Seriia Ekonomika — Scientific Bulletin of Mukachevo State University. Series "Economics", 2*(12), 51–56. DOI: https://doi.org/10.31339/2313-8114-2019-2(12)-51-56 [in Ukrainian].

11. Shkryhun, Yu. O. (2020). "Elektronnyi biznes", "elektronna komertsiia" ta "elektronna torhivlia": vidminnosti i osoblyvosti ["E-business", "e-commerce", and "electronic trade": differences and features]. *Upravlinnia ekonomikoiu: teoriia ta praktyka — Management of Economy: Theory and Practice,* 312–325. DOI: https://doi.org/10.37405/2221-1187.2020.312-325 [in Ukrainian].

12. Yuryk, N. Ye., Kuzhda, T. I., & Shveda, N. M. (2023). Zastosuvannia informatsiinykh tekhnolohii pry biznes-analyzi diialnosti orhanizatsii v kryzovykh umovakh [Application of information technologies in business analysis of organizations in crisis conditions]. *Halytskyi ekonomichnyi visnyk — Galician economic journal, 81*(2), 96–105. DOI: https://doi.org/10.33108/galicianvisnyk_tntu2023.02.096 [in Ukrainian].