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Editorial Address: 78, Dunav Blvd., Plovdiv 4003, Bulgaria

tel. +359 882009578; +359 32960360

science@uard.bg

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ECONOMIC NEGOTIATIONS IN THE DIGITAL ERA: DEVELOPING AN INTEGRATED DIGITAL ECONOMIC NEGOTIATION FRAMEWORK BASED ON EIGHT GOVERNING PRINCIPLES

Svetlana Rusu

*National Institute for Economic Research (NIER)
Academy of Economic Studies of Moldova (AESM)
Chişinău, Republic of Moldova*

Abstract: Digital transformation is reshaping economic negotiations by changing how information is generated, processed, and used in strategic decision-making. Traditional negotiation theories, focused mainly on bargaining power, information asymmetry, and interpersonal interaction, do not fully capture the complexity of technology-mediated economic exchanges. This paper develops the Integrated Digital Economic Negotiation Framework (IDENF), a conceptual model explaining how digital capabilities influence negotiation effectiveness in the global economy. Based on the literature on negotiation theory, digital transformation, artificial intelligence, and information economics, the study proposes eight principles of economic negotiations in a digitalized world: data intelligence, AI-augmented decision-making, digital trust, technological adaptability, digital transparency, ethical digital governance, networked collaboration, and continuous digital learning. The framework contributes to the literature by reconceptualizing economic negotiations as hybrid socio-technological processes where human expertise and digital infrastructures jointly shape negotiation outcomes.

Note: The article was elaborated within the framework of Subprogram 030101 „Strengthening the resilience, competitiveness, and sustainability of the economy of the Republic of Moldova in the context of the accession process to the European Union”, institutional funding.

Keywords: economic negotiations; digital transformation; artificial intelligence; big data analytics; digital trust; negotiation strategy; information asymmetry; technological adaptability; digital governance.

INTRODUCTION

The rapid advancement of digital technologies has fundamentally transformed the global economic landscape, reshaping the ways governments, multinational corporations, international organizations, and private enterprises interact and negotiate. Digitalization has become one of the most influential drivers of economic development, affecting international trade, foreign direct investment, financial markets, global value chains, and cross-border commercial relations. Technologies such as artificial intelligence (AI), big data analytics, blockchain, cloud computing, the Internet of Things (IoT), and digital communication platforms have not only accelerated economic globalization but have also altered the mechanisms through which economic negotiations are conducted. Consequently, negotiation processes are becoming increasingly technology-driven, data-intensive, and geographically independent.

Digital transformation has generated entirely new areas of economic negotiations that scarcely existed two decades ago. Governments now negotiate international rules concerning digital trade, cross-border data flows, digital taxation, cybersecurity, electronic commerce, artificial intelligence governance, intellectual property protection, digital financial services, and platform regulation. At the same time, private companies negotiate issues related to data ownership, cloud infrastructure, algorithm licensing, technology transfer, digital partnerships, and cybersecurity standards. These developments have significantly expanded both the complexity and multidimensionality of economic negotiations.

LITERATURE REVIEW

Economic negotiation has been extensively studied within economics, management, and international business literature. Early theories conceptualized negotiation primarily as a process of conflict resolution and resource allocation between actors with different preferences. One of the foundational contributions was provided by Herbert A. Simon, who demonstrated that decision-making processes are constrained by limited information, cognitive limitations, and uncertainty. This perspective became highly relevant for understanding negotiation behavior, where actors rarely possess complete knowledge about alternatives and future outcomes.

The role of power and dependence in negotiations was further developed by Richard Emerson, who emphasized that bargaining outcomes depend on resource control and asymmetric dependencies between actors. Similarly, Thomas Schelling highlighted the importance of strategic interaction, commitment, and credible threats in negotiation processes.

A major shift in negotiation theory occurred with the development of the distinction between distributive and integrative negotiation. Roger Fisher, William Ury, and Bruce Patton proposed that effective negotiations should move beyond positional bargaining toward interest-based approaches focused on cooperation and mutual value creation.

METHODOLOGY

The study is based on a qualitative literature synthesis approach, integrating contributions from several research fields, including negotiation theory, information economics, digital transformation, artificial intelligence, strategic management, and organizational capabilities. The analysis focuses on identifying how digital technologies influence key elements of economic negotiations, including information management, decision-making processes, trust formation, transparency, adaptability, and cooperation mechanisms.

The development of the IDENF framework followed three analytical stages. First, a review of classical and contemporary negotiation theories was conducted to identify the fundamental mechanisms shaping negotiation outcomes, including bargaining power, information asymmetry, strategic interaction, cooperation, and value creation. Second, the study examined the impact of digital transformation on negotiation processes by analyzing the role of artificial intelligence, big data analytics, digital platforms, cybersecurity, and digital governance. Third, the identified theoretical dimensions were integrated into a unified framework and translated into eight principles of economic negotiations in a digitalized world.

NEW AREAS OF ECONOMIC NEGOTIATIONS IN THE DIGITAL ECONOMY

One of the most significant consequences of digital transformation has been the emergence of entirely new subjects of economic negotiations. Among these, digital trade has become one of the fastest-growing components of international commerce. Governments negotiate rules governing cross-border electronic commerce, consumer protection, electronic signatures, customs procedures for digital goods, and the free movement of digital services. International agreements increasingly include dedicated chapters addressing digital commerce, reflecting its growing importance for global economic integration.

Similarly, negotiations concerning cross-border data governance have become central to international economic relations. Data have evolved into a strategic economic asset comparable to capital, labor, and technology. Consequently, countries negotiate rules concerning data localization, privacy protection, digital sovereignty, and international data transfers. Different regulatory models, including the European Union's emphasis on personal data protection, the United States' market-oriented approach, and China's state-centered governance model, illustrate how digitalization has introduced new dimensions of economic negotiation.

Artificial intelligence represents another rapidly expanding field of economic negotiations. Businesses increasingly negotiate AI licensing agreements, access to proprietary algorithms, ownership of AI-generated intellectual property, ethical standards for automated decision-making, and liability for algorithmic outcomes. Governments and international organizations are likewise developing frameworks to regulate AI applications in finance, international trade, healthcare, and public administration. As AI becomes integrated into commercial decision-making, negotiations increasingly address questions of transparency, accountability, explainability, and algorithmic fairness.

The rapid expansion of digital platforms has also generated new negotiation agendas. Global companies such as Amazon, Alibaba, Microsoft, Google, Apple, and Meta influence international trade patterns through platform-based business models. Governments negotiate issues concerning competition policy, digital taxation, market access, platform accountability, consumer rights, and the responsibilities of dominant digital intermediaries. Consequently, economic negotiations increasingly extend beyond traditional trade policy into the broader governance of digital markets.

Blockchain technology and digital financial innovations further contribute to the evolution of negotiation topics. Smart contracts, decentralized finance (DeFi), digital currencies, and tokenized assets require negotiators to address questions related to legal recognition, transaction security, regulatory compliance, and financial stability. The emergence of central bank digital currencies (CBDCs) has additionally stimulated international negotiations concerning payment interoperability, monetary sovereignty, and cross-border financial transactions.

TRANSFORMATION OF NEGOTIATION FORMATS

Digitalization has not only altered the content of economic negotiations but has fundamentally transformed their organizational formats. Virtual negotiation environments have become an integral component of international business, particularly following the COVID-19 pandemic. Video conferencing platforms, collaborative cloud-based workspaces, digital document management systems, and secure communication technologies enable negotiators to conduct complex discussions without geographical constraints.

Online negotiations provide substantial economic advantages. Organizations significantly reduce travel costs, shorten negotiation cycles, improve access to international partners, and facilitate continuous communication throughout the negotiation process. Real-time collaboration tools allow multiple experts, including economists, lawyers, financial analysts, engineers, and cybersecurity specialists, to participate simultaneously regardless of location. Such interdisciplinary participation enhances the analytical quality of negotiation outcomes.

Nevertheless, virtual negotiations also introduce new limitations. Building interpersonal trust, interpreting non-verbal communication, managing informal interactions, and resolving conflicts often prove more challenging in digital environments. Technical disruptions, cybersecurity vulnerabilities, differences in digital infrastructure, and varying levels of technological competence may influence negotiation effectiveness. Consequently, many organizations increasingly adopt hybrid negotiation models that combine face-to-face strategic meetings with virtual operational sessions, thereby maximizing both efficiency and relationship building.

THE CHANGING PRINCIPLES OF ECONOMIC NEGOTIATIONS

While the fundamental objective of economic negotiations, achieving mutually beneficial agreements, remains unchanged, digital transformation has significantly modified the principles that determine negotiation success. Transparency has become increasingly dependent upon secure information sharing and digital traceability. Trust extends beyond interpersonal relationships to include confidence in technological systems, cybersecurity protocols, digital identities, and platform reliability. Information management has evolved from collecting data to generating actionable insights through artificial intelligence and advanced analytics.

Moreover, successful negotiators must now integrate technological competence into their traditional negotiation skills. Understanding cybersecurity risks, evaluating AI-generated recommendations, interpreting predictive analytics, and managing digital communication channels have become essential professional competencies. Ethical considerations have also acquired greater importance as negotiators increasingly rely on automated decision-support systems capable of influencing bargaining strategies and commercial outcomes.

The transformation of negotiation principles reflects a broader transition from an industrial economy, where competitive advantage largely depended upon physical resources, toward a knowledge-based digital economy in which information, technology, and innovation constitute the primary sources of value creation. Therefore, effective economic negotiations increasingly require a balanced integration of economic reasoning, technological expertise, strategic communication, and ethical governance.

PRINCIPLES OF ECONOMIC NEGOTIATIONS IN A DIGITALIZED WORLD: A NORMATIVE EXTENSION OF THE INTEGRATED DIGITAL ECONOMIC NEGOTIATION FRAMEWORK (IDENF)

The transformation of the global economic environment under the influence of digital technologies requires a reconsideration of traditional approaches to economic negotiations. Classical negotiation theories have primarily emphasized information exchange, bargaining power, institutional factors, interpersonal communication, and strategic behavior as the main determinants of negotiation outcomes. However, the increasing integration of artificial intelligence, big data analytics, digital platforms, and cybersecurity mechanisms has fundamentally changed the nature of economic interactions. Negotiations are no longer conducted exclusively through direct human communication but increasingly occur within complex digital ecosystems characterized by data-driven decision-making, algorithmic support, technological uncertainty, and interconnected networks of economic actors.

In response to these transformations, this study proposes the **Integrated Digital Economic Negotiation Framework (IDENF)**, which conceptualizes economic negotiations in the digital era as a multidimensional process influenced by technological capabilities, information management, institutional trust, and adaptive competencies. Unlike traditional models that consider negotiation primarily as a process of strategic interaction between parties, IDENF emphasizes that successful negotiations in the digital economy depend on the ability of actors to integrate technological resources with human expertise.

To operationalize this framework, the study formulates eight fundamental principles of economic negotiations in a digitalized world. These principles represent normative guidelines that explain how organizations, governments, and economic actors can enhance negotiation effectiveness under conditions of digital transformation.

1. The Principle of Data Intelligence: Transforming Information into Strategic Knowledge

In traditional negotiation theory, information represents one of the most important sources of bargaining power. The ability to access, control, and strategically use information determines the negotiation position of economic actors. However, digital transformation has significantly expanded the volume, speed, and complexity of available information. Consequently, competitive advantage increasingly depends not merely on information availability but on the capacity to transform large-scale digital data into meaningful strategic knowledge.

The principle of data intelligence suggests that effective economic negotiations require the systematic collection, processing, and interpretation of digital information related to markets, competitors, consumers, supply chains, and institutional environments. Big data analytics enables negotiators to identify patterns, anticipate market developments, evaluate risks, and develop evidence-based negotiation strategies.

Within the IDENF framework, data intelligence represents the initial mechanism through which digital transformation influences negotiation processes. The transition from information availability to analytical capability reduces uncertainty and improves strategic decision-making.

Accordingly, the first proposition is formulated:

Proposition 1 (Data Intelligence Principle): *The ability of economic actors to transform digital information into strategic intelligence positively influences negotiation effectiveness by reducing uncertainty and improving decision quality.*

2. The Principle of Artificial Intelligence-Augmented Decision-Making: Developing Hybrid Negotiation Intelligence

The increasing adoption of artificial intelligence introduces a new dimension into economic negotiations. While traditional approaches emphasize human experience, intuition, and communication skills, digital environments create opportunities for combining human judgment with algorithmic analytical capabilities.

The principle of artificial intelligence-augmented decision-making argues that future negotiation competence will depend on the ability to establish effective cooperation between human expertise and technological systems. Artificial intelligence can support negotiators through predictive analysis, scenario modelling, automated information processing, and evaluation of potential negotiation outcomes.

However, AI should not be perceived as a substitute for human negotiation capabilities. Instead, it functions as an augmentation mechanism that enhances analytical capacity while maintaining the importance of creativity, emotional intelligence, cultural awareness, and ethical judgment.

Within IDENF, artificial intelligence represents a transformation mechanism that converts available digital information into actionable negotiation strategies.

Therefore:

Proposition 2 (AI-Augmented Decision-Making Principle): *The integration of artificial intelligence into negotiation processes enhances strategic capabilities by improving forecasting, scenario evaluation, and decision accuracy.*

3. The Principle of Digital Trust: Establishing Confidence in Technology-Mediated Interactions

Trust has historically represented a fundamental component of successful economic negotiations. Nevertheless, digitalization modifies the nature of trust by introducing new forms of technological dependence. In digital environments, economic actors must trust not only negotiation partners but also technological infrastructures, platforms, data management systems, and cybersecurity mechanisms.

The principle of digital trust emphasizes that secure and transparent technological environments constitute a prerequisite for effective digital negotiations. Concerns related to cybersecurity breaches, unauthorized data access, algorithmic manipulation, and technological failures may negatively affect willingness to cooperate and limit the development of long-term economic relationships.

Consequently, digital trust becomes a strategic asset that supports cooperation, reduces transaction costs, and increases confidence among negotiating parties.

Within the IDENF framework, digital trust functions as a mediating mechanism connecting technological capabilities with sustainable negotiation outcomes. Thus:

Proposition 3 (Digital Trust Principle): *The level of trust in digital infrastructures and technological systems positively affects the stability and sustainability of economic negotiations.*

4. The Principle of Technological Adaptability: Building Dynamic Negotiation Capabilities

The rapid evolution of digital technologies creates continuous changes in economic environments. Organizations and institutions that rely exclusively on traditional negotiation approaches may experience difficulties adapting to new forms of interaction, digital platforms, and emerging business models.

The principle of technological adaptability considers the ability to learn, adjust, and integrate new technologies as a critical negotiation capability. Digital transformation requires

economic actors to continuously develop technological literacy, organizational flexibility, and strategic responsiveness.

From the perspective of IDENF, adaptability represents a dynamic capability that allows negotiators to respond effectively to technological disruptions and changing market conditions.

Therefore:

Proposition 4 (Technological Adaptability Principle): *Higher levels of technological adaptability strengthen the ability of economic actors to respond effectively to changing negotiation environments.*

5. The Principle of Digital Transparency and Information Symmetry: Reducing Uncertainty in Economic Interactions

Information asymmetry has traditionally influenced negotiation outcomes by creating unequal bargaining positions between parties. Digital technologies have the potential to reduce such asymmetries through improved access to information, digital platforms, and transparent transaction mechanisms.

The principle of digital transparency suggests that greater accessibility and reliability of information contribute to more balanced and efficient negotiations. Digital platforms, data-sharing mechanisms, and advanced monitoring technologies can increase visibility regarding market conditions, contractual obligations, and performance indicators. However, transparency must be balanced with strategic confidentiality, as excessive openness may reduce competitive advantages. Within IDENF, digital transparency contributes to improving negotiation efficiency by creating a more predictable and reliable interaction environment. Accordingly:

Proposition 5 (Digital Transparency Principle): *Increased digital transparency contributes to more efficient negotiations by reducing information asymmetry and uncertainty among economic actors.*

6. The Principle of Ethical and Responsible Digital Governance: Ensuring Sustainable Negotiation Practices

Digital transformation generates not only opportunities but also ethical challenges. The use of artificial intelligence and advanced analytics raises questions related to algorithmic bias, privacy protection, unequal technological access, and responsible data management.

The principle of ethical digital governance emphasizes that technological efficiency cannot be separated from social responsibility. Sustainable economic negotiations require mechanisms that ensure fairness, accountability, transparency, and responsible use of digital technologies.

Within IDENF, ethical governance represents a balancing mechanism between technological innovation and responsible economic interaction. Therefore:

Proposition 6 (Ethical Governance Principle): *Responsible governance of digital technologies enhances legitimacy, fairness, and sustainability in economic negotiations.*

7. The Principle of Networked Collaboration: Moving from Bilateral Bargaining toward Digital Ecosystems

Digitalization has transformed economic relationships from isolated bilateral interactions into complex networks involving multiple stakeholders, including companies, governments, consumers, technological platforms, and international organizations.

The principle of networked collaboration argues that modern negotiations increasingly focus not only on value distribution but also on value creation. Digital ecosystems facilitate cooperation, knowledge exchange, innovation partnerships, and long-term strategic relationships.

Within IDENF, network collaboration explains how digital connectivity changes the structure of negotiation processes. Thus:

Proposition 7 (Networked Collaboration Principle): *Digital connectivity promotes collaborative negotiation models based on shared value creation and ecosystem-based cooperation.*

8. The Principle of Continuous Digital Learning: Developing Long-Term Negotiation Competence

The final principle recognizes that digital negotiation capabilities cannot be achieved through one-time technological adoption. Continuous learning and competence development are necessary for maintaining competitiveness in rapidly changing environments.

Economic actors must continuously improve their understanding of digital technologies, analytical methods, cybersecurity practices, and intercultural communication in digital contexts.

Within IDENF, continuous learning represents the mechanism ensuring long-term adaptation and evolution of negotiation capabilities. Therefore:

Proposition 8 (Continuous Digital Learning Principle): *Continuous development of digital competencies strengthens long-term negotiation performance and resilience.*

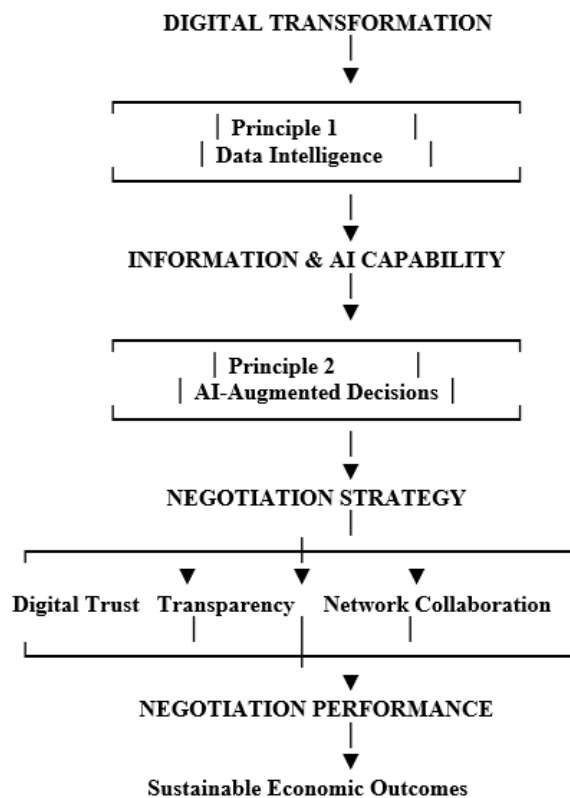


Figure 1: Integrated Digital Economic Negotiation Framework (IDENF)

*Source: elaborated by the author based on the literature review;
visual design assisted by artificial intelligence tools*

CONCLUSION

Digital transformation is changing the way economic negotiations are conducted. Traditional negotiation approaches focused mainly on information, bargaining power, and communication between actors. However, the development of artificial intelligence, big data

analytics, digital platforms, and cybersecurity has created a new environment where technological capabilities become an important factor influencing negotiation outcomes.

This paper proposes the Integrated Digital Economic Negotiation Framework (IDENF) to explain how digital transformation affects economic negotiations. The framework is based on eight principles: data intelligence, AI-supported decision-making, digital trust, technological adaptability, digital transparency, ethical digital governance, networked collaboration, and continuous digital learning.

The main contribution of this study is the integration of technological, organizational, and relational dimensions into a single framework. It shows that successful negotiations in the digital era depend not only on the ability to exchange information and manage relationships but also on the capacity to use digital tools, build trust in technological environments, and adapt to continuous changes.

The proposed framework has practical implications for businesses, policymakers, and international organizations by highlighting the importance of digital skills, responsible technology use, and cooperation in improving negotiation performance.

Future research should empirically test the IDENF framework in different economic sectors and countries to evaluate the influence of digital capabilities on negotiation outcomes.

Overall, this study demonstrates that digital transformation is not only a technological change but also a transformation of the principles, strategies, and capabilities required for effective economic negotiations.

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DATA GOVERNANCE IN THE ERA OF ARTIFICIAL INTELLIGENCE: SECURITY CHALLENGES IN THE BANKING SECTOR OF THE REPUBLIC OF MOLDOVA. THE DAMA-DMBOK MODEL AND IMPLEMENTATION PERSPECTIVES

Aurelia Turcan, Lucia Gujuman

Academy of Economic Studies of Moldova, Republic of Moldova

Abstract: Banking institutions in the Republic of Moldova manage significant volumes of sensitive information daily, and the quality of data management directly affects operational security, regulatory compliance, and public trust. In the context of the accelerated adoption of artificial intelligence in the financial sector, data security becomes a major challenge, and data governance a strategic necessity. Particularly under the conditions of the digitalization of the **Information System of the National Bank of Moldova**, where periodic reports are entirely transmitted electronically and validated through hundreds of rules, the need for a coherent governance framework becomes imperative. This paper proposes a strategic data governance framework adapted to the specifics of the domestic banking sector, based on the international DAMA-DMBOK model, with an emphasis on the security and data quality components essential for implementing artificial intelligence solutions. The research analyzes the current challenges faced by commercial banks in Moldova, including mixed technological infrastructures, legacy systems, and the increasing pressure of reporting requirements to the National Bank of Moldova.

Keywords: data governance, DAMA-DMBOK, artificial intelligence, digital security, banking sector, Republic of Moldova.

INTRODUCTION

In the era of accelerated digitalization and widespread adoption of artificial intelligence (AI), data has become one of the most valuable assets of organizations. The banking sector, by its very nature, manages impressive volumes of sensitive information, and the quality of this management directly affects operational security, regulatory compliance, and public trust [12]. In this context, artificial intelligence promises to revolutionize financial services through process automation, offer personalization, real-time fraud detection, and improved risk management. However, this promise comes with major security challenges: AI models are only as good as the data they consume. Poor quality, incomplete, or unreliable data generates erroneous decisions, while poorly secured data becomes vulnerable to cyberattacks and information leaks.

The financial dimension of this problem is significant. According to data provided by Gartner, poor data quality costs companies an average of \$12.9 million annually. These losses are not just abstract figures but translate into lost profits, ineffective marketing campaigns, wrong strategic decisions, and ultimately, loss of market competitiveness [14]. Faced with these challenges, many organizations try to find exclusively technological solutions: they implement new tools, build voluminous Data Lakes, and hire Data Scientists with substantial remuneration. Paradoxically, however, this approach often aggravates informational chaos, transforming "data lakes" into veritable "data swamps," where valuable information is irretrievably lost [14].

The real cause of these dysfunctions, however, does not lie in the technology used, but in the absence of a coherent data management system. It was precisely to create such a system that DAMA-DMBOK (Data Management Body of Knowledge) was developed — a compendium of world best practices in data management, elaborated by the DAMA International Association [5]. Far from being a simple bureaucratic standard or a theoretical document, DAMA-DMBOK represents a rigorous engineering approach that allows organizations to transform informational chaos into a well-structured, highly efficient system capable of supporting the strategic objectives of the business [14].

The Republic of Moldova is in an accelerated process of digital transformation, and the banking sector is no exception to this trend. The National Bank of Moldova (NBM) has implemented the SIRBNM information system, a modern platform that has enabled the complete digitalization of periodic reporting by licensed banks [8]. Moreover, starting from 2024, national legislation has been harmonized to impose strict requirements on financial institutions regarding the management of risks associated with information and communication technologies (ICT), information security, and business continuity. These technological and regulatory advancements create the necessary, but not sufficient, premises for a safe and efficient adoption of artificial intelligence in the domestic banking sector.

In this context, *data governance is no longer just an option or a compliance requirement, but becomes an essential condition for the security and modernization of commercial banks in the era of artificial intelligence.* This article, the first in a series dedicated to this theme, aims to analyze the DAMA-DMBOK conceptual framework and highlight its relevance for data security in the banking sector of the Republic of Moldova, in the context of the increasingly accelerated adoption of technologies based on artificial intelligence.

THE SIRBNM SYSTEM AND THE CHALLENGES OF BANKING DATA SECURITY IN THE REPUBLIC OF MOLDOVA

The National Bank of Moldova (NBM) has implemented the *Information System of the National Bank of Moldova (SIRBNM system)*, a modern digital IT platform that has enabled *100% of periodic reports* from licensed banks to be transmitted electronically [8].

To better understand the context of banking reporting digitalization in the Republic of Moldova, Table 1 presents the main characteristics of the SIRBNM system implemented by the National Bank and its implications for data security and governance.

Table 1. The SIRBNM information system and its implications for data governance in the banking sector

Characteristic	Description	Implications for security
System Type	Modern information system for electronic reporting	Requires quality data from banks
Implemented by	National Bank of Moldova (NBM)	High compliance standards
Main Purpose	Collection, validation, and management of reports	Automation and error reduction
Users	Licensed banks and financial entities	Large volume of sensitive data
Validation	Hundreds of automated rules*	Demonstrates complexity of banking data

* The system applies hundreds of validation rules to ensure data accuracy:

- The "Monetary Statistics" report (1,356 rows) is validated through **327 rules**.
- The "Interest Rates on Loans and Deposits" report is verified by approximately **1,000 validation rules**.

Furthermore, starting from 2024, national legislation has been harmonized to impose strict requirements on banks regarding the management of risks associated with information and communication technologies (ICT), information security, and business continuity.

The adoption of artificial intelligence in the banking sector raises three major categories of security challenges, also relevant for the domestic context. Table 2 synthesizes these challenges and their specific impact on banks in the Republic of Moldova.

Table 2. Security challenges in adopting artificial intelligence in the banking sector and the impact on Moldovan banks

Challenge Category	Description	Impact on Moldovan Banks
Data Quality	AI models require complete, correct, and up-to-date data. Bad data generates "garbage in, garbage out."	Risk of erroneous reporting to NBM, wrong lending decisions, financial losses
Data Confidentiality and Protection	Banks manage personal, financial data, transactions. Their use in AI models raises compliance issues (GDPR).	Risk of sanctions, loss of customer trust, litigation
Cybersecurity	AI models can be attacked through data poisoning, inference attacks. The data infrastructure becomes a privileged target.	Risk of fraud, information leaks, financial instability

The NBM has shown constant openness to adopting international best practices. A recent example is the implementation, with the support of the USAID project "Financial Sector Transparency in Moldova," of a state-of-the-art IT solution for preventing money laundering risks, based on artificial intelligence and machine learning algorithms [4].

In this context, data governance is no longer just an option or a compliance requirement, but becomes an essential condition for the modernization and digitalization of commercial

banks [12]. Without a solid governance framework, the security risks associated with AI can outweigh the potential benefits.

The SIRBNM system represents a concrete example of advanced digital infrastructure in the financial sector of the Republic of Moldova. Its implementation has brought significant benefits for data security:

1. Complete digitalization: All reports are transmitted electronically, eliminating risks associated with paper and manual processes.
2. Automated validation: Hundreds of validation rules ensure data accuracy before acceptance, preventing errors.
3. Enhanced security: Reports are transmitted with a secure electronic signature, access being granted only to persons authorized by the reporting entities.
4. Audit and traceability: The system allows tracking all operations, essential for security and compliance.

The success of SIRBNM demonstrates:

- The clear direction towards digitalization of the National Bank and the entire financial sector.
- The necessity of quality data – the large number of validation rules (hundreds to a thousand) shows how important data accuracy is.
- The dependence on data security – without correct and secure data, reports cannot be successfully transmitted, and banks become vulnerable to sanctions and operational risks.

Thus, SIRBNM creates the technical premises for which a data governance framework becomes essential. Banks must manage their data internally as rigorously as the NBM system validates them externally.

What is a Data Governance Framework?

A data governance framework provides a comprehensive structure for managing data within an organization. It establishes policies, standards, and procedures designed to ensure data accuracy, security, and compliance with regulations in force. When correctly implemented, such a framework minimizes risks, optimizes business operations, and enables informed decision-making [1]. In other words, the data governance framework is the means to implement data governance in organizations.

There are several recognized examples of data governance frameworks, widely tested and used, such as [1]:

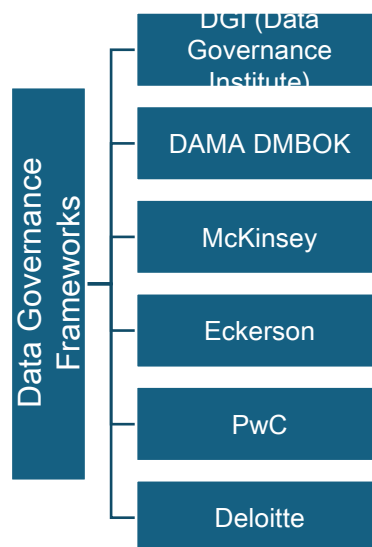


Figure 1. Data Governance Frameworks

Source: Elaborated based on [1]

These frameworks offer internationally recognized models and methodologies for implementing data governance in organizations, each with its own principles, structures, and best practices adapted to business needs and regulatory requirements.

To better understand the motivation behind implementing a data governance framework in the context of AI adoption, Gartner conducted an analysis of the main reasons why organizations update their data management framework, illustrated in Figure 2.

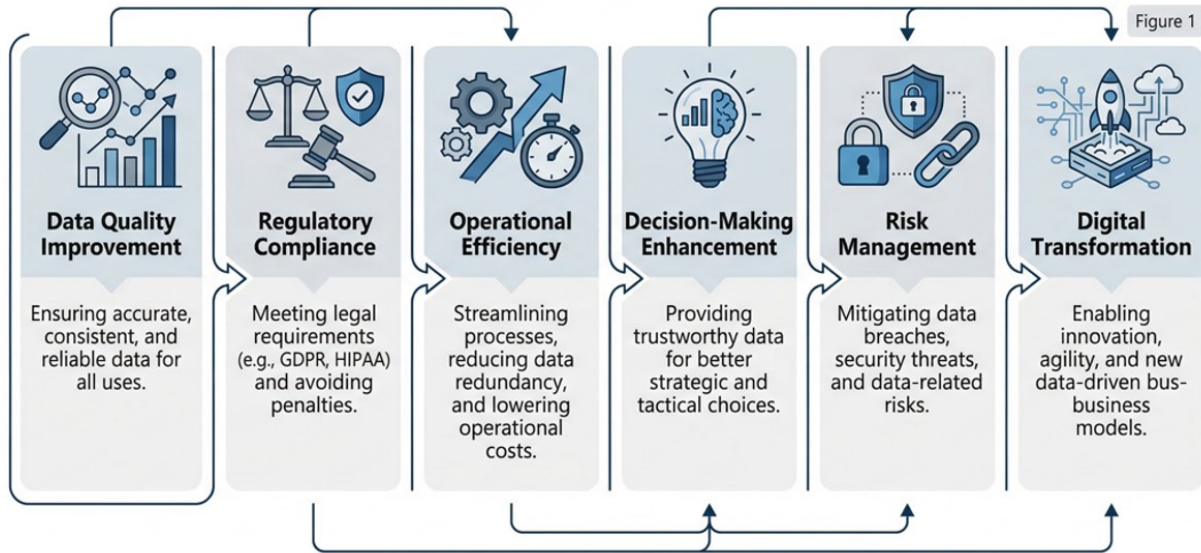


Figure 2. Reasons for organizing and updating the data management framework in organizations

Source: Adapted from Gartner, retrieved from Intellias (2025) [7]

The information presented highlights the main reasons:

- *Compliance with new regulations (approximately 35%) – including the 2024 ICT security requirements.*
- *Improving decision quality (approximately 25%) – essential for AI models.*
- *Reducing operational costs (approximately 20%).*
- *Increasing operational efficiency (approximately 15%).*
- *Other reasons (approximately 5%) [7].*

These data confirm that for banks in the Republic of Moldova, adopting a data governance framework responds both to external pressures (regulations) and internal needs for process optimization and security in the context of AI adoption.

THE DAMA-DMBOK MODEL: CONCEPTUAL FRAMEWORK FOR DATA SECURITY IN THE AI ERA

The DAMA (Data Management Association) International has developed the DAMA-DMBOK (Data Management Body of Knowledge) guide, internationally recognized as the main reference in the field of data management [5]. The choice of this model for designing the strategic framework intended for Moldovan banks is motivated by:

1. Comprehensive coverage of data management and alignment with financial regulations.
2. Clear organizational structure it describes.
3. Promotion of data quality and security as central elements.
4. Capacity to consider the banking specifics, including the use of dispersed systems.

5. Relevance for AI adoption – the model provides the necessary foundation to ensure that data used in AI models is trustworthy and secure.

The DAMA-DMBOK model conceptualizes data governance as a central hub coordinating 10 interconnected knowledge areas, represented graphically in Figure 3. In the context of security for AI, certain areas gain increased importance.



Figure 3. Hub Model for Data Governance Framework [13]

At the center of these 10 areas lies Data Governance, which acts as a coordination and control function, establishing the decision-making framework, defining responsibilities, and overseeing the application of standards across all other functions. The 10 knowledge areas, with an emphasis on their relevance for security in the AI era, are:

Table 3. DAMA-DMBOK knowledge areas and their relevance for data security in the AI era

Domain/Area	Description	Relevance for AI Security
1. Data Architecture	Aligning data assets with company strategy, defining global requirements and designing solutions to meet them.	Defines standards and secure integration zones between applications.
2. Data Modeling and Design	The process of discovering, analyzing, and representing data requirements in a precise form, called a data model.	Ensures coherent data structures, essential for training AI models.
3. Data Storage and Operations	Designing, implementing, and managing storage structures, backup, and data archiving.	Data protection at the storage level, backup, and recovery in case of attack.
4. Data Security	Defining and implementing policies to ensure authentication, authorization, and audit of access to data.	CRITICAL - Preventing unauthorized access to data used by AI.
5. Data Integration and	Processes related to transferring and consolidating data between data	Ensures secure data flows between systems, preventing

Domain/Area	Description	Relevance for AI Security
Interoperability	stores, applications, and organizations.	data contamination.
6. Document and Content Management	Planning and controlling processes concerning data and information, regardless of format (structured or unstructured).	Access control to documents and unstructured content.
7. Reference and Master Data	Managing shared data to ensure a "single source of truth" and reduce redundancies.	Ensures a unique and secure source of truth for master data used in AI.
8. Data Warehousing & Business Intelligence	Planning and controlling data production processes for decision support and reporting.	Data protection in analysis and reporting processes.
9. Metadata	Planning, implementing, and controlling processes related to metadata (data about data).	CRITICAL - Enables understanding of data provenance, essential for detecting "data poisoning" attacks.
10. Data Quality	Planning and controlling processes to ensure data aligns with user needs.	CRITICAL - Ensures accuracy, completeness, and consistency of data for AI models.

Source: Elaborated based on DAMA International, 2017 [5]

At the center of these 10 areas lies data governance, which acts as a coordination and control function, establishing the decision-making framework, defining responsibilities, and overseeing the application of standards across all other functions.

Particularities of Implementation in the Republic of Moldova

For banks in the Republic of Moldova, implementing the DAMA-DMBOK model must consider particularities such as:

- Mixed technological infrastructure, with legacy systems and insufficient documentation – a major security vulnerability.
- Specific organizational culture, which requires a shift from a siloed approach to an integrated one.
- Regulatory pressure exerted by the NBM and complex reporting requirements.
- Limited resources for investment in new security technologies.

International experiences demonstrate that adapting the model to the local context is essential for success.

RESULTS OF IMPLEMENTING THE MODEL FOR DATA SECURITY IN THE AI ERA

Implementing a data governance framework based on DAMA-DMBOK, with an emphasis on security, generates a series of concrete benefits, demonstrated in international practice. The experience in this field of various countries and financial institutions demonstrates that adopting a structured data governance framework brings significant improvements both operationally and in terms of information security.

The DAMA-DMBOK model structures data management into 10 interconnected areas, coordinated by the central governance function. Table 4 details each domain and highlights its specific contribution to data security in the context of artificial intelligence adoption.

Table 4. Operational benefits and impact on security following DAMA-DMBOK implementation (Czech Republic example)

Benefit	Impact on Security
<i>Unified Dictionary</i>	Enables rapid identification of sensitive data and application of uniform controls
<i>Impact Analysis</i>	Rapid assessment of consequences of a potential security breach
<i>Reduced Integration Costs</i>	Integrated systems are easier to secure than dispersed ones
<i>Improved Testing Quality</i>	More rigorous security testing before production deployment
<i>Precise Definition of Competences</i>	Clear responsibilities for data security (Data Owners, Data Stewards)

Source: Elaborated based on [2]

These results, documented in the case of a bank in the Czech Republic that implemented a similar data governance program [2], demonstrate that investment in structured frameworks like DAMA-DMBOK brings measurable benefits for information security.

Another eloquent example is a mutual bank in Australia, which implemented the DAMA-DMBOK framework in just six weeks, successfully addressing critical compliance deficits with APRA regulations (CPS 234, CPS 230), NIST Cybersecurity standards, and Australian privacy principles [3]. Following implementation, the bank now operates with:

- Stricter controls on financial data confidentiality;
- Reduced regulatory risks due to alignment with legislative requirements;
- Better traceability of data-driven decisions;
- Increased preparedness for AI, by consolidating data security, access controls, and governance structures.

In the context of the Republic of Moldova, where the National Bank of Moldova has already implemented the SIRBNM system and is preparing the ground for advanced solutions based on artificial intelligence [4], a similar governance framework would allow banks to respond promptly and correctly to reporting requirements, avoiding penalties and consolidating public trust in the financial-banking system.

A remarkable success story comes from **Banco de Crédito del Perú**, which implemented an automated data quality assessment system based on DAMA-DMBOK. The results obtained are impressive [9]:

- 100% of the data sources used in commercial credit auditing were successfully analyzed;
- Processing time for each data source was reduced by 10 times;
- The system evaluated six dimensions of data quality according to the DAMA model: completeness, plausibility, accuracy, uniqueness, validity, and consistency.

These international examples confirm that implementing a solid data governance framework, based on the DAMA-DMBOK model, generates quantifiable benefits both operationally and in terms of information security, preparing financial institutions for the safe adoption of advanced technologies such as artificial intelligence.

PREMISES FOR THE SAFE ADOPTION OF AI IN THE MOLDOVAN BANKING SECTOR

A solid data governance framework creates the premises for adopting advanced technologies, such as artificial intelligence, in a safe and controlled manner. For banks in the Republic of Moldova, this means:

- **AI models trained on quality data** – correct and predictable decisions.
- **Protection of sensitive data** – compliance with GDPR and NBM requirements.
- **Early detection of attacks** – through traceability and continuous monitoring.
- **Customer trust** – essential in the banking sector.
- **Competitiveness** – the ability to innovate safely.

The NBM has already announced the implementation of a state-of-the-art IT solution for preventing money laundering, based on artificial intelligence and machine learning algorithms [4]. This solution will enable the supervision of all banking operations and will function as a single point of access and visualization of information from numerous databases. For such solutions to function optimally, banks must have solid data governance internally.

Perhaps the most important result of implementing a data governance framework is the transformation of data management from a compliance obligation into a real instrument of institutional performance and modernization [12].

A Czech bank confirmed that *"the project's initial ideas regarding the contributions of data governance implementation and the implementation of support tools, such as models, dictionaries, record assignment, governance, etc., were correct, and this area brings significant benefits to the company's life to this day"* [2].

For banks in the Republic of Moldova, this means the ability to use data not only for reporting but also for:

- Identifying market trends and adapting products under secure conditions.
- Personalizing offers for clients without compromising confidentiality.
- Optimizing internal processes and reducing costs.
- Developing new products and services based on data analysis, safely.

CONCLUSIONS AND RECOMMENDATIONS

Following the analysis of the national and international context, the following main conclusions were highlighted:

1. The stringent need for implementation of a data governance framework is supported both by local regulatory requirements (including the new 2024 requirements on ICT security) and by the security challenges generated by AI adoption in the financial sector.
2. Technological advancements, such as the NBM's SIRBNM system which has fully digitized the periodic reporting of banks [8], demonstrate the clear direction towards digitalization and automation, making robust data management essential for security.
3. The DAMA-DMBOK model offers a solid conceptual framework, internationally tested, which can be successfully adapted to the specifics of Moldovan banks, as demonstrated by similar experiences in Australia, the Czech Republic, or Peru, focusing on data security and quality components.
4. The benefits of implementation are multiple and quantifiable, as demonstrated by international case studies: reduction of data processing time by up to 10 times [9], improved regulatory compliance, increased preparedness for AI, and transformation of data security into a competitive advantage.

Recommendations for Banks in the Republic of Moldova

Based on the analysis conducted, we formulate the following recommendations for implementing a data governance framework that addresses security challenges in the AI era:

1. Adopt a phased approach with a focus on security, starting with an assessment of current maturity in critical areas (data security, data quality, metadata management) and continuing with prioritizing the areas with the highest impact on security.
2. Create clear roles and responsibilities for data security, including the appointment of Data Owners and Data Stewards with explicit responsibilities regarding the protection of sensitive data.
3. Invest in modern metadata and data quality management platforms, to automate collection, monitoring, and reporting processes, including for early threat detection.
4. Develop an organizational culture oriented towards data security, through training and awareness programs at all hierarchical levels, focusing on the risks associated with AI.
5. Collaborate with the NBM and other financial institutions for the exchange of best practices and harmonization of security standards at the sector level.
6. Prepare for the adoption of advanced technologies, by ensuring a solid data governance foundation that will subsequently allow the safe implementation of artificial intelligence and machine learning solutions.

Finally, we emphasize that the integration of data governance in the banking sector is no longer just a compliance requirement, but becomes an essential condition for the security and modernization of commercial banks in the era of artificial intelligence. Implementing a solid data governance framework offers banks the opportunity to consolidate their strategic position in the market, facilitating the transition to an advanced, secure, and competitive digital environment. Such an approach not only ensures alignment with current regulations but also creates the premises for responsible innovation, operational efficiency, and increased customer trust in digital banking services.

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MOLDOVAN IT SECTOR: CHALLENGES AND PERSPECTIVES

Vlada Colesnicova, Anastasia Ichizli

Academy of Economic Studies of Moldova, Republic of Moldova

Abstract: According to data from Moldovan National Bureau of Statistics, the World Bank, and ATIC, Moldovan IT sector is one of the fastest-growing segments of the national economy, employing more than 25000 specialists and generating more than 500 million US dollars in annual service exports. However, its development is constrained by an acute shortage of skilled personnel (4000 to 6000 specialists per year), high emigration of IT specialists, underdeveloped infrastructure outside Chisinau, a complex regulatory framework, and geopolitical risks. Future measures to stimulate growth include reforming IT education, creating regional hubs, transitioning from outsourcing to product-based companies, expanding the IT park regime, and promoting Moldova as the most convenient outsourcing destination for the EU and the US. Due to the national strategy, Moldova could increase its IT services exports from 1.5 to 2 billion US dollars by 2030 and enter the top 30 global outsourcing destinations.

Note: The article was elaborated within the framework of Subprogram 030101 „Strengthening the resilience, competitiveness, and sustainability of the economy of the Republic of Moldova in the context of the accession process to the European Union”, institutional funding.

Keywords: Digital Economy, Moldovan IT Sector, Moldova IT Park (MITP), IT Services Export, Data Processing, Web Page Administration, Strategic Growth 2030.

INTRODUCTION

In the context of global digitalization and rapid technological advancement, information technology (IT) is becoming one of the key drivers of economic growth and national competitiveness. In many countries around the world, the IT sector plays a vital role in fostering an innovation-driven economy, stimulating entrepreneurship, creating high-paying jobs, and

developing international trade in services. For small countries with limited natural resources, such as the Republic of Moldova, the development of the IT industry is of particular strategic value, as it enables accelerated economic modernization and integration into the global digital space.

In recent years, Moldova's IT sector has shown steady positive growth. Due to government support, the growing number of technology companies, and expanding export opportunities, this industry is gradually becoming one of the most important sectors of the national economy. According to data from the National Bureau of Statistics of the Republic of Moldova, the World Bank, and the Association of Information and Communication Technology Companies, more than 35000 professionals work in the country's information technology sector, and annual exports of IT services exceed 600 million [1]. Thus, in the period from January to September 2025, the IT sector accounted for more than a quarter of the Republic of Moldova's total service exports, which exceeded \$600 million [2]. This growth demonstrates the high effectiveness of the chosen model for the sector's development and confirms the IT sector's growing role in the country's economy.

The government initiative to establish the Moldova Innovation Technology Park - the country's first virtual IT park - provided a significant boost to the industry's development. These government support measures for businesses include a simplified tax regime and a favorable regulatory environment, and they encourage the attraction of foreign investment. As a result, the number of IT companies in the country has increased significantly, and their operations have become more focused on international markets.

One of the industry's most significant achievements was that, in 2025, the revenue of companies based at Moldova IT Park exceeded 1 billion dollars US for the first time reflecting the sector's strong growth and its growing role in the country's economy.

The IT industry also features high salaries and is one of the most attractive employment sectors for young professionals.

However, despite these positive trends, the development of the IT sector is accompanied by a number of structural challenges. Among the most significant are a severe shortage of qualified professionals - with an annual deficit estimated at 4000 to 6000 people - high emigration of IT personnel, and uneven infrastructure development between the capital and the regions.

THE MAIN GOAL AND METHODOLOGY

The main goal of this work is to analyze the current situation and development trends of the IT sector in the Republic of Moldova, as well as to identify the main challenges and perspectives for this industry's further growth in the context of the country's integration into the global digital economy and the European Economic Area.

The following researches methods were used in the presented work: analysis, synthesis, logical method, monographic method, comparative analysis, etc. The analysis in this research is based on data from national reports, as: Report MITP on the Activities of Moldovan Innovation Technology Park Residents in 2025 and examination the opinions of experts from the IT industry of the country.

ANALYSIS OF MOLDOVAN IT SECTOR

The modern IT sector in the Republic of Moldova is characterized by a high level of specialization and a focus on international markets. Most companies operate in the fields of software development, data processing, IT consulting, as well as the provision of technical support and digital platform management services. A significant share of enterprises operates within the Moldova Innovation Technology Park [3], which forms the institutional framework for the sector's development.

The functional structure of the IT sector is also characterized by a predominance of export-oriented services. The most significant areas of activity include software development, data processing and web administration, IT consulting, and customer service centers. These areas form the basis of companies' revenues and define the specialization of Moldovan IT companies in the international market.

Moreover, the sector's structure demonstrates a combination of companies with both local and foreign capital, which contributes to the formation of a sustainable technology ecosystem. The presence of international investors facilitates technology transfer, expands sales markets, and enhances the competitiveness of Moldovan IT companies.

Thus, the structure of Moldova's IT sector is characterized by a high concentration on specialized technology services, a significant export orientation, and the active participation of companies with diverse capital structures. These factors form the basis for the sector's further development and its integration into the global digital economy.

The Moldovan Innovation Technology Park (MITP) plays a key role in the formation and development of the Republic of Moldova's IT ecosystem. The park was established to stimulate the growth of technology companies, attract foreign investment, and enhance the country's competitiveness in the international digital services market. A distinctive feature of this structure is its online format, which allows companies to operate without the need for a physical presence in a single location, thereby significantly simplifying business operations. Established in 2018, the Moldova Innovation Technology Park is the first e-Park in Europe to offer a flat tax rate of 7% and a stable environment guaranteed by the government through 2035, with an operational term extending through 2037 [4].

The activities of the IT Park are regulated by a special legal framework established by the Moldovan Law No. 77/2016 [4], which provides for a simplified system of taxation and administrative procedures for residents. In particular, resident companies pay a flat tax of 7% of turnover, which significantly reduces the tax burden and creates favorable conditions for the development of technology-based entrepreneurship. However, Moldovan authorities are considering phasing out tax incentives for the IT sector in order to bring tax legislation into line with EU standards [1].

According to MITP Report 2025 [3], during the period 2018–2025, the Moldova Innovation Technology Park experienced rapid and steady growth in the number of residents: from 338 in 2018 to 2725 in 2025, representing an increase of more than 8 times over the analyzed period, confirming its role as the main catalyst for the development of the IT sector and related industries in the Republic of Moldova [3]. The presence of companies with diverse capital structures fosters international cooperation, technology exchange, and the expansion of sales markets for Moldovan IT companies.

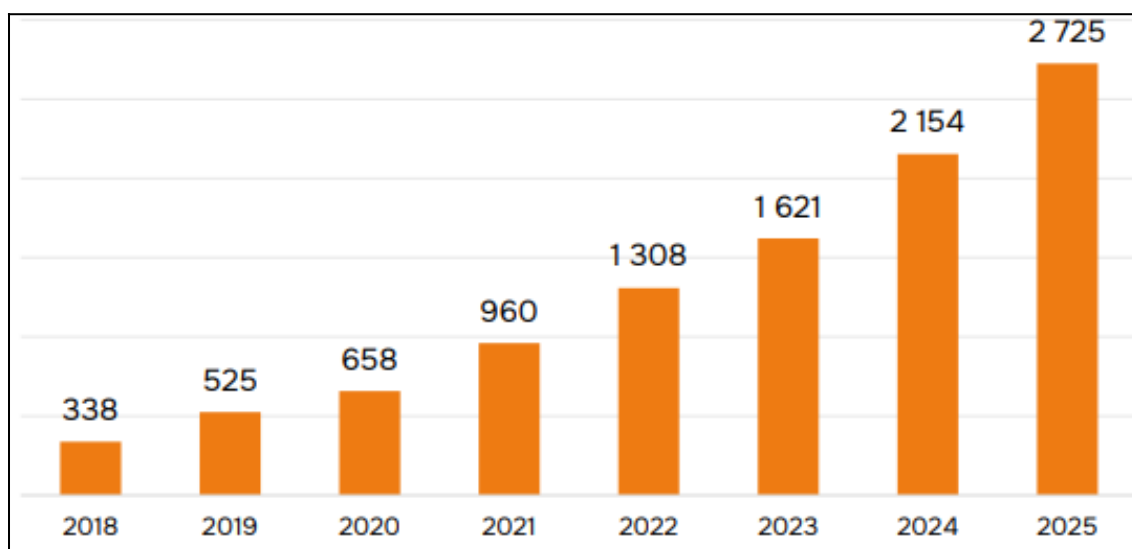


Figure 1. Trends in the number of residents in the MITP, 2018–2025

Source: [3]

In 2025, the trend of expanding the geography of the countries of origin of MITP resident companies continued. The number of countries from which resident companies originate reached 46 in 2025, compared to 41 in 2024 and 38 in 2023.

In 2025, the total turnover of Moldova IT Park residents reached 18.86 billion MDL, marking the highest level recorded since the Park's launch. Compared to 2024, when the turnover was 15.17 billion MDL, the annual growth was 24.3%, or 3.69 billion MDL [3].

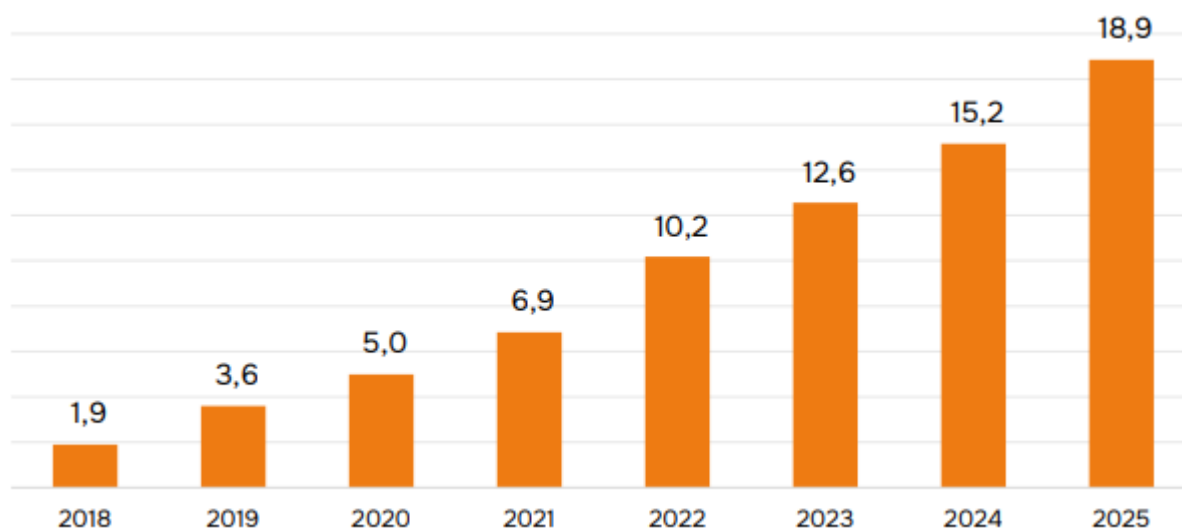


Figure 2. Evolution of turnover in the MITP, 2018–2025, billion MDL

Source: [3]

An analysis of the financial indicators of the park's residents indicates a high degree of specialization among companies in their core business activities. In 2025, eligible sales revenue from residents of the Moldova Innovation Technology Park reached 18.50 billion MDL, representing the dominant component of the Park's total turnover. The share of eligible sales in total turnover remains very high, at approximately 98%, confirming that the economic performance of the MITP is generated almost entirely by activities falling under the eligible

regime. Compared to 2024, when revenue from eligible sales was 14.78 billion MDL, 2025 saw an annual increase of about 25%, a rate higher than in previous years. [3]. This revenue structure has persisted for several years and indicates that most companies focus specifically on the technology services provided under the IT Park regime.

Therefore, the Moldova Innovation Technology Park is a central element of the national IT infrastructure, providing favorable conditions for the development of technology companies, the growth of digital service exports, and the formation of a modern innovation-driven economy in the Republic of Moldova.

Exports remain the dominant area of activity for companies based at the Moldova Innovation Technology Park. Most of the technology services and products created by Moldovan IT companies are geared toward international markets, primarily the European Union and the United States. In 2025, there was a significant increase in export sales. Compared to the previous year, exports increased [3]. This demonstrates the high competitiveness of Moldovan IT companies in the international market.

Another factor driving growth is the capital structure of companies. Approximately 60% of export revenues are generated by companies with local capital, while 40% come from companies with foreign investment. This indicates the active involvement of both domestic businesses and international investors in the development of the country's IT ecosystem.

Custom Software accounts for the largest share of export revenue—62.01 million lei, with a 49% contribution—which significantly exceeds the figures for other types of activities. This confirms the high level of specialization of Moldovan companies in the development of software products and customized solutions for international clients. Data Processing and Web Page Administration rank second. This segment includes services for managing digital platforms, data processing, and supporting online services. The third most significant sector is IT Consulting. This segment includes consulting services in the areas of digital transformation, software implementation, and optimization of companies' IT infrastructure. Call center services also account for a significant share. This segment is actively developing thanks to the high level of foreign language proficiency among Moldovan specialists and the relatively low cost of labor. Editing of other software products accounts for the smallest share among the top 5, but this segment also plays an important role in the software development chain.

Thus, the structure of Moldova's IT services exports shows a strong focus on software development, data processing, and IT consulting, which is in line with global trends in the technology industry.

Despite the dominant role of exports, the domestic IT services market in the Republic of Moldova will undergo a qualitative transformation by 2025. It will transform from a supporting segment into a strategic platform for innovation, driven by both government procurement and the growing automation needs of local businesses.

According to the 2025 Activity Report of Moldova IT Park (MITP) residents, revenue from services sold on the domestic market totaled 184.8 million lei. Although the domestic market accounts for only about 2% of MITP's total revenue (with exports accounting for 98%), its importance for the country's digital resilience is growing. In leu terms, domestic sales showed a 13% increase compared to the previous year (2025), confirming the overall trend toward the digitalization of the national economy [3]. Large-scale national programs serve as the key driver of the domestic market. An example of the deep integration of IT solutions into public administration is the "Program for the Digitalization of the Internal Affairs System for 2022–2025" [7]. This initiative provides for:

- The creation and modernization of state information resources (Criminal Information Registry, Automated Information System for Offense Records, etc.).
- The deployment of mobile and portable terminals for police officers (coverage in district centers has reached 99.85%).

➤ The development of the “MConnect” government platform to ensure data interoperability.

According to statistical data, the main drivers of demand in the domestic market are:

➤ The financial sector and Fintech: the implementation of online banking and data protection systems.

➤ Retail and e-commerce: the transition of local retail chains to omnichannel sales models.

➤ Cybersecurity: growing demand for critical infrastructure protection services, as highlighted in the IT Investment Guide for Moldova [3]

According to data from Ookla [8], a global leader in network analytics, Republic of Moldova ranked 70th in mobile Internet with a speed of 61.71 Mbps, dropping three spots compared to the previous year, and 50th in fixed broadband Internet with a speed of 152.49 Mbps in the global mobile internet speed ranking as of 2025. In total, mobile internet was tested in 104 countries worldwide, and fixed broadband internet in 152 countries worldwide.

Among our neighbors, Romania also dropped four spots and ranks 56 (82.72 Mbps) for mobile internet access speed and 16th (with a speed of 273.44 Mbps) for fixed broadband internet. Ukraine ranks 86 and 77, respectively. In terms of fixed internet speed, our country demonstrates higher performance indicators compared to the United Kingdom, Austria, Cyprus, Latvia, Germany, Italy, Estonia, Russia and Bulgaria. In 2025, Singapore ranks first globally for fixed internet connectivity, with an average speed of 420.92 Mbps. The top ten also included the United Arab Emirates, Hong Kong, several European countries, and the United States, which ranked 8th with a speed of 308.11 Mbps. Russia ranks 79th in this segment with a speed of 91.30 Mbps. The lowest fixed internet speeds were recorded in countries such as Ethiopia, Cameroon, Afghanistan, Turkmenistan, Syria, and Cuba, where speeds do not exceed 3–4 Mbps. In the mobile internet speed, the United Arab Emirates and other wealthy Arab monarchies lead the way. Bulgaria, Brazil, Georgia, and South Korea also rank highly. Among Western European countries, only Denmark made it into the top ten. Ukraine ranks 86th in this segment with a speed of 44.98 Mbps.

Table 1. The Speedtest Global Index 2025

Mobile Internet			Fixed Broadband Internet		
	Country	Mbps		Country	Mbps
1	United Arab Emirates	681.18	1	Singapore	420.92
2	Qatar	583.12	2	United Arab Emirates	398.42
7	Bulgaria	250.80	71	Bulgaria	93.97
56	Romania	82.72	16	Romania	273.44
70	Rep.Moldova	61.71	50	Rep.Moldova	152.49
86	Ukraine	44.98	77	Ukraine	91.82

Source: elaborated by the authors using [8]

Human capital is the foundation of Moldova’s IT industry, and labor market trends in 2025 reflect both the sector’s rapid success and growing structural challenges. As of 2025, 25,803 specialists are officially employed by companies based at the Moldova Innovation Technology Park [3]. The total number of people employed in the country’s IT sector, including freelancers and employees of companies outside the park, exceeds 35,000. There has been steady growth in staffing: in the first half of 2025 alone, the number of jobs at MITP increased by more than 1,000.

The IT sector continues to lead the national economy in terms of salary levels. According to data from the National Bureau of Statistics (BNS RM) [5], the average nominal gross salary in the information and communications sector in 2024–2025 is the highest in the country, significantly exceeding the averages for other industries. Thus, the average salary at MITP resident companies reached approximately 45,000–49,000 lei, making the sector the most attractive for young professionals and contributing to the return of qualified personnel from abroad. According to the MITP report, the average salary in the MITP sector was 49,850 lei in 2025.

The industry is becoming younger and more inclusive. Women constitute about 35% of MITP employees, one of the highest rates in the region. The average age of workers in the sector is 25–35, underscoring the role of IT as a key driver in retaining young people in the country.

CHALLENGES OF THE MOLDOVAN IT SECTOR

Despite its growth through the Moldova IT Park, Moldova's IT sector faces challenges: a shortage of skilled workers due to emigration, a decline in mobile internet speeds (ranking 66th in 2025), and the need to adapt to regional economic instability. Key issues include the “brain drain,” the gap between education and market needs, and the need to digitize traditional industries.

Despite its export orientation, the domestic IT services market in the Republic of Moldova will undergo a qualitative transformation by 2025. It is evolving from a supporting segment into a strategic platform for innovation, driven by both government procurement and the growing automation needs of local businesses. According to the 2025 financial reports of Moldova Innovation Technology Park (MITP) residents, domestic market sales maintain stable growth. Revenue from domestic services amounted to 18.9 billion lei. Although the domestic market accounts for only 2% of MITP's total revenue (with exports accounting for 98%), its importance for the country's digital sustainability is growing.

The main consumers of IT solutions within the country are:

- The public sector: Large-scale investments under the 2023–2030 Digital Transformation Strategy are aimed at modernizing public services and ensuring their cross-border compatibility with the EU [3, 6].

- Financial sector and retail: Local companies are actively investing in e-commerce, fintech solutions, and customer experience management systems.

Despite high incomes, the labor market faces serious challenges:

- Skills shortage: The market's annual demand is estimated at 4,000–6,000 new professionals, while the education system produces half as many. An acute shortage of personnel is felt even in government agencies, where a lack of ICT specialists is hindering the implementation of digital solutions [3].

- Competition for talent: Moldovan companies are forced to compete for specialists with global giants amid high demand for service exports, which already account for more than 25% of the country's total service exports [4].

- Skills gap: There is a mismatch between the skills of university graduates and the requirements of businesses focused on complex international projects in the fields of AI, cloud technologies, and cybersecurity [6].

National digitalization programs have become a key driver of growth in the domestic market. An example of the integration of IT solutions into public administration is the program for the digitalization of the internal affairs system (2022–2025) [7]. Projects to create unified digital platforms for law enforcement agencies enable the automation of processes, increasing transparency and the speed of interagency coordination.

CONCLUSIONS

The analysis of the IT sector in the Republic of Moldova shows that it is a leading industry in the national economy. The achievement of a turnover of USD 1 billion by Moldovan IT Park residents is a historic achievement abroad, confirming the effectiveness of public-private partnerships and a unique tax regime.

However, to maintain future growth rates, it is necessary to shift the focus from simply increasing the number of companies to qualitatively developing human resources and supporting innovative product startups. Successful integration into the European economic space will require Moldova not only to provide high-quality code but also to create a fully-fledged digital ecosystem capable of retaining talent and generating its own intellectual products. Provided a stable regulatory environment is maintained, the IT industry has the potential to double its contribution to the country's GDP in the next five years, becoming the foundation for the complete digital transformation of Moldovan society.

Also, the Digital Transformation Strategy of the Republic of Moldova for 2023-2030 [9] stipulates that by 2030, 100% of public services will be available in electronic format. The key objectives of the Strategy are focused on the sustainable development of the country, such as:

- Development of a digital society, where electronic services are accessible to all citizens.
- Strengthening the ICT sector through investment in research and development (R&D). Increasing the competitiveness of the Republic of Moldova on the global market by creating an innovative and resilient economy.
- Enhancing the efficiency of public institutions through the widespread use of technology. The government must be transparent, and administrative work - paperless.
- Ensuring a secure and inclusive digital environment, where personal data is protected and cybersecurity is robust.
- Building a digital nation brand by promoting achievements in this field. Highlighting our potential in the technology sector and creating a positive image of the country at the international level.

Due to the national strategy, Moldova could increase its IT services exports from 1.5 to 2 billion US dollars by 2030 and enter the top 30 global outsourcing destinations. Also, future measures to stimulate the growth of the national IT sector include reforming IT education, creating regional hubs, transitioning from outsourcing to product-based companies, expanding the IT park regime, and promoting Moldova as the most convenient outsourcing destination for the EU and the US.

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COMPARATIVE ANALYSIS OF THE COUNTRIES BASED ON FM GLOBAL RESILIENCE INDEX: SPECIAL VIEW ON THE REPUBLIC OF MOLDOVA

Vlada Colesnicova

Academy of Economic Studies of Moldova, Republic of Moldova

Abstract: This paper analyzes global structural resilience by synthesizing findings from the FM Global Resilience Index, identifying Denmark, Luxembourg, Singapore, Norway, and Switzerland as leaders in business stability, risk management, and digitalization. It evaluates key dimensions of risk, finding that while top nations excel in climate adaptation, energy security, and logistics, global vulnerabilities persist regarding climate exposure, single-source manufacturing, and social inequality. A special focus of this study is dedicated to the vulnerability analysis of the Republic of Moldova. The article is based on a combined qualitative and quantitative secondary data analysis using a comparative approach that utilizes metrics from the FM Global Resilience Index, the World Bank Logistics Performance Index, and the Legatum Prosperity Index. The methodology includes assessing national structural resilience through the analysis of macroeconomics, climate adaptation, energy infrastructure, logistics, and social cohesion.

Note: The article was elaborated within the Subprogram 030101 „Strengthening the resilience, competitiveness, and sustainability of the economy of the Republic of Moldova in the context of the accession process to the European Union”, institutional funding.

Keywords: FM Global Resilience Index, business environment stability, climate change adaptation, energy security, supply chain resilience, social resilience, comparative country analysis, risk management.

INTRODUCTION

This time, characterized by escalating geopolitical tensions, climate change, and economic instability, has made structural resilience one of the key factors determining national competitiveness, long-term stability, and security. This study analyzes the main factors determining global resilience through the lens of adaptation to physical climate change, energy security, supply chain reliability, and social cohesion, using data from leading rankings such as the FM Global Sustainability Index.

THE MAIN GOAL, METHODOLOGY AND DATA USES

The main objective of this study is to identify systemic factors of resilience alongside structural vulnerabilities, thereby offering practical recommendations for enhancing the adaptability of economic systems in conditions of high uncertainty. Also, this study evaluates global structural resilience by analyzing factors driving macroeconomic stability, climate change adaptation, and risk management across leading nations. A special focus of this study is dedicated to the vulnerability analysis of the Republic of Moldova.

The methodology employs a mixed-methods approach, combining secondary data analysis of global benchmarks (e.g., FM Global Resilience Index) with comparative country analysis and multi-criteria risk evaluation of systemic vulnerabilities.

To comprehensively assessment structural resilience, the study uses secondary data from three international sources: the FM Resilience Index (macroeconomic stability), the World Bank Logistics Performance Index (logistics), and the Legatum Prosperity Index (social dimension). The analysis covers current macro trends through 2026, reflecting the impact of geopolitical shifts, the energy transition, and the restructuring of logistics chains.

RESULTS

According to the FM Global Resilience Index, the countries that offer the most stable business environments and economies are [1, 2]:

1. Denmark: A global leader thanks to its high productivity, educated workforce, and advanced cybersecurity.
2. Luxembourg: It has an extremely stable economy and solid physical infrastructure.
3. Singapore: The only Asian country in the global top rankings, recognized for its risk management and digitalization.
4. Norway
5. Switzerland

Therefore, according to the FM Global Resilience Index, Denmark (100.0), Luxembourg (98.4), and Singapore (97.5) top the rankings, demonstrating strong performance in cybersecurity, climate risk management, and economic stability. Denmark, Luxembourg, and Singapore top the FM Resilience Index ranking for structural resilience, due to their high productivity, financial stability, and high-quality logistics infrastructure. Close the top five are Norway (97.3) and Switzerland (97.2), although the analysis shows that even leading economies are vulnerable in the face of new digital and environmental threats. This analysis revealed that, with European models dominating, the main risk for the leading countries remains their external dependence on imported resources or technologies.

1) According to the FM Global Resilience Index, countries' resilience to natural disasters and climate change is as follows:

1. Countries least exposed/with a very high capacity for adaptation: Monaco, Iceland, Ireland.

2. Most vulnerable areas: countries such as the Philippines or India face massive exposure to extreme weather events and have fewer resources to manage the immediate consequences.

Monaco, Iceland, and Ireland have the highest climate security sub-indices, due to their geographic location and preventive investments. At the same time, the Philippines (48.92 points) and India are characterized by high vulnerability to natural disasters and low adaptive capacity, which is hindering their economic recovery.

2) Energy security - measures a country's ability to ensure affordable, stable, and sustainable energy without critical geopolitical dependencies. Key indicators: diversification of energy sources, share of renewable energy, independence from imports, and efficiency of electrical grids. Top-performing countries: Sweden, Denmark, and Finland lead the rankings thanks to their rapid transition to green energy and advanced storage technologies. Vulnerabilities: countries that rely exclusively on a single supplier of gas or oil (as was the case for many European nations before 2022).

According to data from the FM Resilience Index, Eurostat, and the World Energy Council, Sweden, Denmark, and Finland lead in energy security due to their extensive diversification and high share of renewable energy. The main vulnerabilities stem from high dependence on fossil fuel imports in countries such as Cyprus and Malta, as well as the risks associated with the intermittency of renewable energy sources in the absence of adequate storage systems.

3) Supply chain resilience — measures an economy's ability to maintain the flow of goods, raw materials, and components even during crises (pandemics, wars, maritime blockades). Key indicators: quality of logistics infrastructure (ports, railways), customs transparency, supplier diversification, and domestic production capacity. Top-performing countries: Singapore, Germany, and the United States (according to the World Bank Logistics Performance Index). These countries have highly technologically advanced logistics hubs and fast alternative routes. Vulnerabilities: massive global dependence on semiconductors from Taiwan or on industrial production concentrated solely in China.

According to the World Bank's official portal, the World Bank Logistics Performance Index (LPI), which provides comprehensive country rankings based on the quality of ports, railways, customs clearance, and the speed of alternative routes, as well as the World Bank's Logistics Performance Index, Singapore (4.3 points), Germany (4.1 points), and the United States (3.8 points) are the leaders in supply chain resilience, providing high-speed and high-quality infrastructure. Critical vulnerabilities in the global economy include the concentration of semiconductor production in Taiwan (more than 50% of the market) and dependence on industrial production in China (up to 70% in certain sectors).

Romania, Republic of Bulgaria, and Republic of Moldova represent three different levels of resilience, illustrating a spectrum within the European region ranging from developed, integrated systems to developing ones that are vulnerable to external shocks. According to the latest data from the FM Resilience Index and the World Bank Logistics Performance Index (LPI), the rankings and key indicators for these countries are as follows:

Table 1. Comparative country profile

No	Country	FM Resilience Index Position	World Bank LPI Score	Core Strengths	Key Vulnerabilities
1	Romania	Top 50	3.2	Diversified energy sector, EU financial stability.	Customs bureaucracy, river flooding risks, severe inter-regional infrastructure gaps;

No	Country	FM Resilience Index Position	World Bank LPI Score	Core Strengths	Key Vulnerabilities
					prolonged bureaucratic customs clearance processes.
2	Bulgaria	60 - 65	3.2	Developed port infrastructure, integration into the EU logistics network.	Political volatility, extremely high industrial energy intensity, historical dependency on monolithic hydrocarbon pathways.
3	Moldova	88 (51.2 points)	2.5	Rapid energy sector reforms, strong financial backing from the EU.	High import dependency, shortage of logistics capacity, severe exposure to regional military conflicts, low private capital inflow.

Source: elaborated by the author used summary data from FM Resilience Index, World Bank Logistics Performance Index (LPI)

Romania represents the regional stabilizer. By Business Environment and Macroeconomics indicators - the country ranks among the world's 50 most resilient economies, according to FM Global. This is driven by high levels of foreign direct investment and its status as a full member of the EU [4]. By the indicators of Supply Chains and Logistics, the scores 3.2 points on the LPI index, thanks to the strategic importance of the Port of Constanța on the Black Sea. The main vulnerability is the relatively slow (by EU standards) customs clearance process and the infrastructure gap between regions. By the indicators of Energy and Climate, according the OECD data, Romania enjoys a high degree of energy independence thanks to its own resources (natural gas, hydropower, and nuclear power), but the National Adaptation Strategy identifies risks of droughts and river flooding in the eastern regions [5].



Figure 1. Romania ranks 41th in the FM Resilience Index with an overall score of 74.1

Source: [https://www.fm.com/resources/resilience-index/explore-the-data/?&cr=ROU&sn=ex\[1\]](https://www.fm.com/resources/resilience-index/explore-the-data/?&cr=ROU&sn=ex[1])

Republic of Bulgaria represents the industrial and logistics Hub. By the indicators Business Environment and Macroeconomics: ranks in the second tier of the FM Global Index. Demonstrates financial stability, underpinned by a hard peg of the national currency (the lev) to the euro. By the indicators Supply Chains and Logistics: shares a score of 3.2 points on the LPI with Romania. The ports of Varna and Burgas, as well as trans-European transport corridors, ensure a steady flow of goods [6]. By the indicators Energy and Climate: Bulgaria is actively reducing its dependence on a single hydrocarbon supplier by accelerating the construction of interconnectors with Greece, but its industry's energy intensity remains among the highest in the EU.



Figure 2. Bulgaria ranks 47th in the FM Resilience Index with an overall score of 69.2

Source: [https://www.fm.com/resources/resilience-index/explore-the-data/?&cr=ROU&sn=ex\[1\]](https://www.fm.com/resources/resilience-index/explore-the-data/?&cr=ROU&sn=ex[1])

Republic of Moldova represents overcoming structural crises. By the indicators Business Environment and Macroeconomics: Moldova ranks 88th in the FM Resilience Index with an overall score of 51.2.

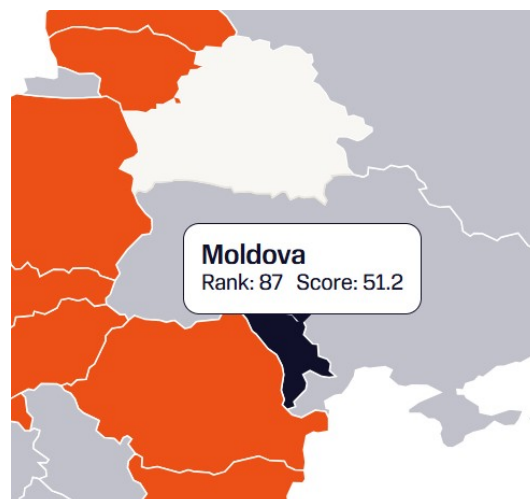


Figure 3. Moldova ranks 88th in the FM Resilience Index with an overall score of 51.2

Source: [https://www.fm.com/resources/resilience-index/explore-the-data/?&cr=MDA&sn=ex\[1\]](https://www.fm.com/resources/resilience-index/explore-the-data/?&cr=MDA&sn=ex[1])

The country has been hit by a cascade of external shocks (rising energy prices, proximity to military conflict), which limits the inflow of private capital [7]. By the indicators Supply Chains and Logistics: The LPI score is 2.5 points. The economy suffers from a lack of high-tech logistics hubs, but its status as an EU candidate country serves as an “anchor” for reforms to transportation infrastructure. By the indicators Energy Security: A critical area that is currently being actively strengthened. Moldova has made a breakthrough by synchronizing its power grids with the European ENTSO-E system and building new interconnections with Romania, thereby reducing its vulnerability to geopolitical blackmail.

The Southeastern European corridor presents a fragmented resilience landscape, where EU integration acts as the primary differentiator between the stable models of Romania and Bulgaria and the transitional, high-vulnerability economy of Moldova. While Romania and Bulgaria leverage structural stability, Moldova is pivoting toward risk mitigation through strategic energy and infrastructure synchronization with the EU, indicating that institutional alignment is critical for regional economic security.

4) Social Resilience - measures a community's ability to remain united, prevent conflicts, and protect vulnerable citizens during crises. Key indicators: level of trust in the government, equal access to healthcare, literacy rate, and social safety nets (welfare, pensions). Top-performing countries: Norway, Finland, and New Zealand (according to the Legatum Prosperity Index). These societies have high social cohesion and widespread trust in state institutions. Vulnerabilities: extreme economic inequality and misinformation, which lead to polarization and social fragmentation.

According to data from the Legatum Prosperity Index, which assesses the Social Capital subindex and related components of social stability, the exact indicators and metrics for each country are distributed as follows:

Detailed data on the leading countries  Norway consistently ranks 3rd in the world in terms of overall social capital. The level of trust in institutions exceeds 75%, and in terms of personal freedoms and inclusivity, the country holds the undisputed top spot globally. Finland ranks among the top 5 in the world in terms of trust in government institutions and the legal system. Coverage of the population by basic social protection measures (social benefits and pensions) stands at 100%. Over the past decade, New Zealand has consistently been recognized as one of the world's leaders in the effectiveness of local communities. The level of civic engagement and trust among citizens (interpersonal capital) keeps the country in the top ten global economies in terms of social cohesion.

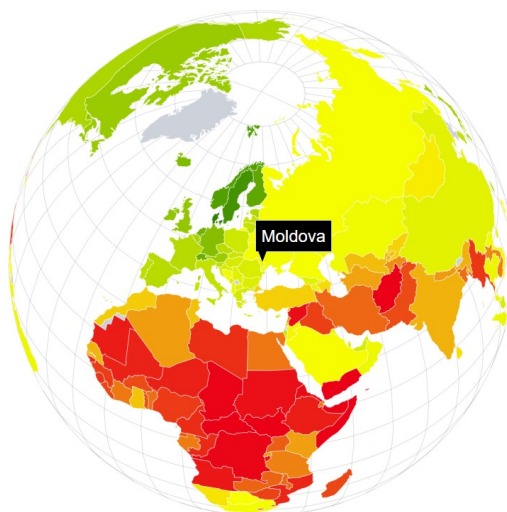


Figure 4. Legatum Prosperity Index for Moldova

Source: [https://index.prosperity.com/globe\[9\]](https://index.prosperity.com/globe[9])

Moldova is 70th in the overall Prosperity Index rankings. Since 2011, Moldova has moved up the rankings table by 23 places. Moldova performs most strongly in Education and Living Conditions but is weakest in Natural Environment. The biggest improvement compared to a decade ago came in Living Conditions.

Analytical reports from the Legatum Institute and the World Bank highlight systemic risks to social stability:

➤ A crisis of trust: According to research, the average global level of trust in communities and trust in neighbors has declined by an average of 6 percentage points in recent years (in developing countries, the decline reached up to 17 percentage points).

➤ Access to Healthcare: In countries with high levels of social inequality (as measured by the Gini coefficient), the difference in life expectancy between high- and low-income groups ranges from 7 to 10 years.

➤ Social protection gap: Globally, despite progress (for the first time, more than 52.4% of the population is covered by at least one type of social benefit), 3.8 billion people remain completely unprotected in the face of crises.

CONCLUSIONS

This study confirms that structural resilience, driven by cybersecurity, energy diversification, and logistics, is key to national stability, with Denmark, Luxembourg, and Singapore leading global rankings. However, reliance on external resources and concentrated supply chains creates significant vulnerabilities, necessitating a transition toward localized, diversified economic systems and stronger infrastructure, particularly within the varied stability models of Romania, Bulgaria, and Moldova.

Within the European region, the *Republic of Moldova* (ranked 88th in the FM Resilience Index with an overall score of 51.2) represents a clear example of a small, open economy undergoing deep systemic crises while transforming its structural vulnerabilities into strategic opportunities. Due to its exposure to a cascade of severe external shocks - including geopolitical instability from its proximity to a military conflict and high energy price volatility—the country has historically been one of the most sensitive to regional disruptions.

Moldova's current structural resilience across key sectors is defined by the following dimensions:

- *Energy Security (The Main Breakthrough)*: Despite a historical dependence on a single supplier and a lack of domestic fossil resources, the country has achieved a critically important step toward autonomy. The synchronization of its power grids with the European ENTSO-E system and the diversification of supply channels have successfully mitigated the risks of energy blackmail, shifting Moldova from a vulnerable node into an active participant in regional integration.

- *Supply Chains and Logistics (The Critical Vulnerability)*: A low score on the World Bank's Logistics Performance Index (LPI of 2.5 points) underscores a severe shortage of high-tech logistics hubs, deteriorated transport infrastructure, and persistent customs barriers that hinder fluid trade.

- *Macroeconomics and Business Environment*: Proximity to an active conflict zone naturally limits the influx of private foreign direct investment (FDI). However, its status as an EU candidate country serves as a vital institutional "anchor" that stabilizes the macroeconomic framework, guarantees financial support from international partners, and drives targeted structural reforms.

Moldova's position demonstrates that under conditions of extreme uncertainty, severe crises can act as catalysts for rapid modernization. To enhance its national competitiveness, the country's primary task is to convert European integration funding into the physical

modernization of its transport networks, the deployment of energy storage systems, and the long-term stabilization of its domestic economy.

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WOMEN IN STEM: ANALYSIS AND PERSPECTIVES

Svetlana Rusu, Tatiana Colesnicova

Academy of Economic Studies of Moldova, Republic of Moldova

Abstract: The underrepresentation of women in science, technology, engineering, and mathematics (STEM) remains one of the most persistent challenges facing knowledge-based economies. Despite substantial progress in female educational attainment and labour market participation, gender disparities continue to characterize STEM education, employment, research productivity, and leadership positions. This paper analyses global trends in women's participation in STEM, identifies the structural and socio-cultural determinants of gender inequality, and examines the implications of gender gaps for economic development and innovation performance. Using data from UNESCO, OECD, the World Economic Forum, and national statistical agencies, the study demonstrates that while women represent approximately one-third of researchers worldwide, their participation varies considerably across regions and disciplines. The findings reveal that the principal challenge is no longer access to education but rather retention and career advancement, commonly referred to as the "leaky pipeline." The article argues that increasing women's participation in STEM is both a social justice imperative and an economic necessity, as gender diversity contributes positively to innovation capacity, productivity growth, and sustainable development.

Keywords: women in STEM, gender equality, innovation, labour market, scientific research, leaky pipeline, human capital

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INTRODUCTION

The Fourth Industrial Revolution has fundamentally transformed labour markets and the global economy by increasing the importance of scientific knowledge, technological innovation, and digital competencies. In this context, science, technology, engineering, and mathematics (STEM) have become strategic sectors that determine national competitiveness, productivity growth, and long-term economic development. The increasing digitalisation of economies, the transition toward green technologies, and the rapid development of artificial intelligence have significantly increased the demand for highly qualified STEM professionals.

However, despite these transformations, women remain significantly underrepresented in many STEM fields. The persistence of gender disparities in scientific and technological professions constitutes both a social and an economic challenge. From the perspective of human capital theory, the underutilisation of women's talents represents a substantial loss of productive potential. From the perspective of innovation economics, limited gender diversity reduces the range of perspectives necessary for scientific creativity and technological advancement.

The issue of women's participation in STEM has attracted increasing attention among policymakers, international organisations, and researchers. The United Nations Sustainable Development Goals, particularly Goal 5 on gender equality and Goal 9 on innovation and infrastructure, recognise the importance of increasing female participation in scientific and technological sectors. Similarly, the European Union, UNESCO, and the OECD have adopted numerous initiatives aimed at reducing gender disparities in education and employment. Despite these efforts, progress has been uneven and relatively slow. Global statistics indicate that women represent approximately one-third of all researchers and less than one-third of the STEM workforce. Furthermore, female representation decreases substantially at successive career stages, especially in engineering, information technology, and senior academic positions.

LITERATURE REVIEW

The academic literature on women in STEM has evolved considerably during the past three decades. Earlier studies focused primarily on gender differences in cognitive abilities and educational preferences. Contemporary research, however, increasingly recognises that gender disparities are predominantly the result of social, institutional, and cultural factors.

Human Capital Theory suggests that educational and occupational choices are influenced by investments in skills and expected economic returns. According to this perspective, individuals choose educational pathways that maximise their future income and employment opportunities. However, the human capital approach alone cannot explain persistent gender disparities in STEM. Women today attain higher education at rates equal to or greater than men in many countries, yet significant occupational segregation remains.

Gender Role Theory argues that social norms and stereotypes influence individual aspirations and career choices. Girls are often socialised to perceive mathematics, engineering, and technology as masculine domains, resulting in lower self-confidence and reduced participation in these disciplines.

The concept of the "leaky pipeline" remains one of the most influential frameworks for understanding women's underrepresentation in STEM. The theory suggests that female participation declines progressively at each educational and professional stage, resulting in significantly lower representation among senior researchers and leaders.

Recent studies also highlight the importance of intersectionality, demonstrating that gender inequalities are compounded by factors such as ethnicity, socioeconomic background, and geographical location.

METHODOLOGY

This study employs a descriptive and comparative analytical approach based on secondary data obtained from international organisations, including UNESCO, OECD, Eurostat, and national statistical agencies. The analysis focuses on four dimensions: STEM education, STEM employment, career advancement and leadership, economic implications of gender disparities. Comparative statistical analysis is used to identify regional trends and policy implications.

GLOBAL TRENDS IN WOMEN'S PARTICIPATION IN STEM

Understanding global patterns of women's participation in STEM is essential for assessing progress toward gender equality and identifying the structural barriers that continue to limit female representation in scientific and technological professions. Table 1 demonstrates that significant gender disparities persist throughout the entire STEM ecosystem despite substantial progress in women's educational attainment. The smallest gender gap is observed in overall STEM employment (20%), suggesting that women increasingly participate in scientific and technical professions. However, the relatively higher proportion of women in the STEM labour force is largely driven by their concentration in life sciences, healthcare, and education-related scientific occupations rather than in high-technology and engineering sectors.

Table 1. Global Indicators of Gender Representation in STEM, 2025

Indicator	Women (%)	Men (%)	Gender Gap (percentage points)
Researchers worldwide	33	67	34
STEM graduates worldwide	35	65	30
Employment in STEM occupations (global average)	40	60	20
Employment in engineering occupations	18	82	64
Employment in computer science and ICT	20	80	60
Senior STEM leadership positions	10	90	80

Source: Compiled by the author based on UNESCO Institute for Statistics (2025), OECD (2025), and the World Economic Forum (2025).

The data reveal a pronounced vertical and horizontal segregation within STEM professions. Horizontal segregation is reflected in the substantial underrepresentation of women in engineering and information and communication technologies, where the gender gaps reach 64% and 60%, respectively. These fields remain among the most male-dominated professional domains globally and are often associated with higher salaries, greater innovation potential, and stronger career advancement opportunities.

An even more concerning finding is the severe underrepresentation of women in senior STEM leadership positions, where women occupy only approximately 10% of decision-making roles. The 80%-point gap between men and women in leadership indicates that barriers to advancement remain deeply embedded in scientific institutions and technological industries. This pattern supports the "leaky pipeline" hypothesis, according to which female participation decreases progressively at successive career stages.

The comparison between educational attainment and employment outcomes is equally revealing. Although women account for approximately 35% of STEM graduates globally, their representation among researchers and senior professionals remains significantly lower. This discrepancy suggests that increasing access to education alone is insufficient to achieve gender equality in STEM. Structural factors, including occupational stereotypes, unequal caregiving responsibilities, implicit bias in promotion and recruitment, and limited access to professional networks, continue to constrain women's career progression.

From an economic perspective, these disparities represent a substantial underutilisation of human capital. Given the growing global demand for highly qualified STEM professionals, the persistent exclusion of women from high-value technological occupations may contribute to labour shortages, reduce innovation capacity, and limit long-term economic growth. Consequently, policies aimed at improving female retention and advancement in STEM should be considered not only instruments of social justice but also strategic investments in economic competitiveness and sustainable development.

REGIONAL ANALYSIS

The figure illustrates substantial cross-country differences in the representation of women in STEM occupations. Although the global average indicates that women constitute approximately 40% of the STEM workforce, the data reveal considerable heterogeneity, with female participation ranging from 42% to 57% among the countries presented. Such variation suggests that women's representation in STEM is determined not solely by the level of economic development but rather by a complex interaction of institutional, historical, educational, and socio-cultural factors.

The most notable finding is the leading position of Mongolia, where women account for 57% of all STEM employment. This result challenges the traditional assumption that highly industrialised economies necessarily provide the most favourable conditions for women's participation in science and technology. The Mongolian case demonstrates that high female representation can be achieved when educational opportunities are relatively equitable and women have broad access to professional occupations. Similarly, Belarus, Lesotho, and several Eastern European countries maintain relatively high female participation rates, partly reflecting historical educational traditions that encouraged women's engagement in mathematics, engineering, and scientific professions.

Another important observation is the presence of considerable regional diversity. Several Latin American countries, including Barbados, Uruguay, Brazil, and Argentina, demonstrate female participation rates significantly above the global average. This pattern may be explained by comparatively high female enrolment in higher education and public policies promoting gender equality in professional occupations. Nevertheless, previous research indicates that these relatively favourable participation rates often coexist with significant inequalities in career advancement and leadership representation. The results also suggest that aggregate participation rates may conceal important forms of occupational segregation. In many countries, women are disproportionately concentrated in life sciences, healthcare, environmental sciences, and educational research, whereas engineering, information technology, and advanced manufacturing remain predominantly male-dominated sectors. Consequently, a high overall proportion of women employed in STEM does not necessarily imply the achievement of genuine gender equality across all scientific and technological disciplines. The figure further highlights the importance of institutional and cultural determinants of gender equality in STEM. The coexistence of both developed economies, such as the United States and Switzerland, and middle-income countries, such as Mongolia and Kyrgyzstan, among the leaders in female STEM participation indicates that gross domestic product per capita is not the principal determinant of gender outcomes. Instead, educational

policies, labour market structures, family support systems, and cultural attitudes toward women's employment appear to play a more decisive role.

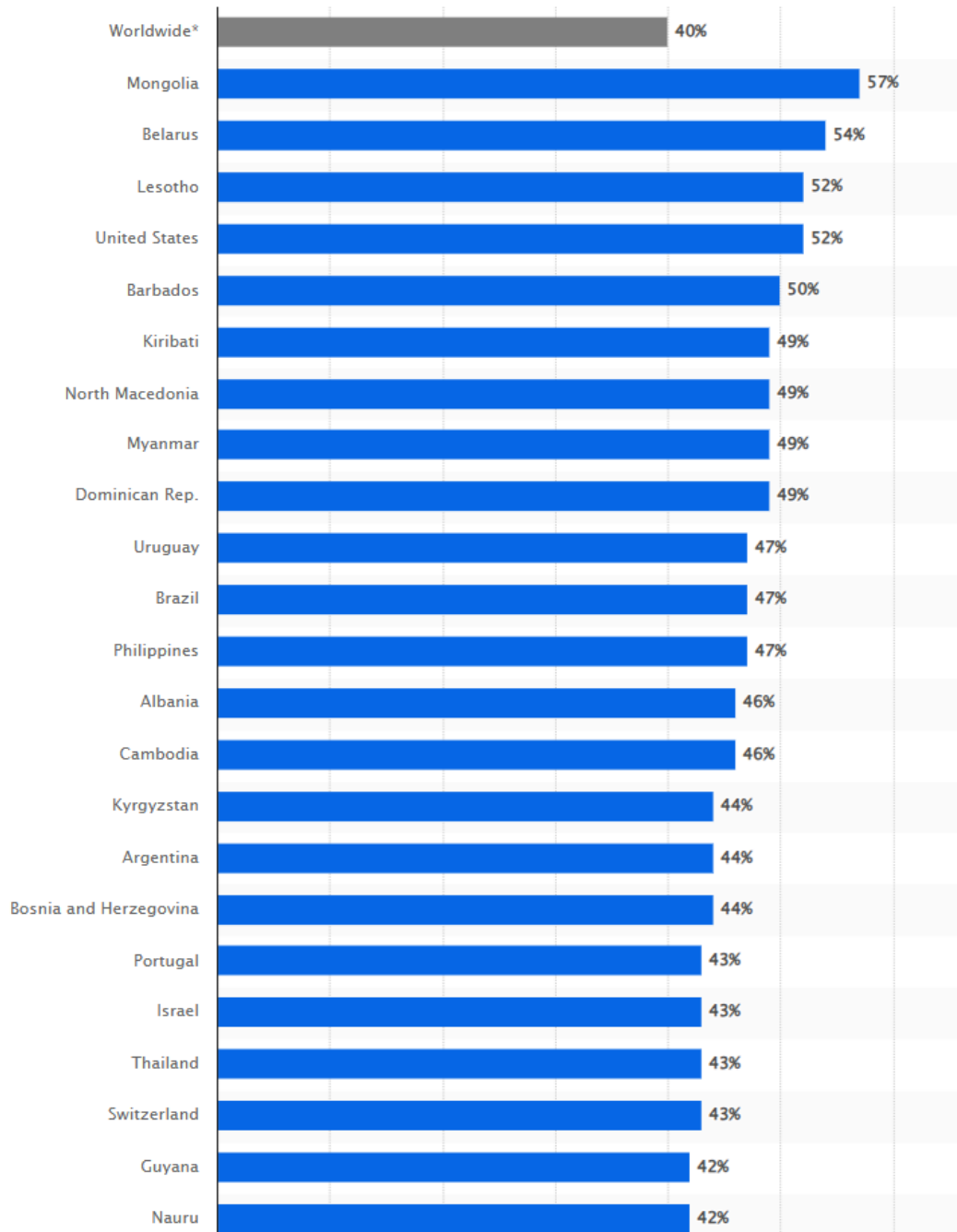


Figure 1. Share of Women Employed in STEM Occupations by Country, 2023

Source: Author's elaboration based on data from the International Labour Organization (ILO), as reproduced in Statista (2024), Share of women employed in STEM fields worldwide and in selected countries in 2023.

From a theoretical perspective, the findings support both Human Capital Theory and the Leaky Pipeline Theory. While educational opportunities for women have expanded considerably, significant disparities remain in terms of occupational specialisation, career progression, and leadership representation. The persistence of these inequalities indicates that increasing women's access to STEM education alone is insufficient to achieve gender parity. Structural barriers, including gender stereotypes, unequal distribution of caregiving

responsibilities, limited access to professional networks, and implicit bias in recruitment and promotion, continue to constrain women's career trajectories.

From an economic perspective, the underrepresentation of women in certain STEM fields represents an inefficient allocation of human capital. As the global demand for highly qualified STEM professionals continues to increase, economies that fail to fully utilise female talent risk exacerbating labour shortages, reducing innovation capacity, and limiting long-term productivity growth. Therefore, policies aimed at increasing women's participation in STEM should focus not only on expanding access to education but also on improving retention, career advancement, and leadership opportunities.

Overall, the findings demonstrate that meaningful progress toward gender equality in STEM requires comprehensive and multidimensional policy interventions. Countries with relatively high female participation provide evidence that institutional support, inclusive educational systems, and gender-sensitive labour market policies can substantially reduce disparities and contribute to a more diverse and innovative scientific workforce.

STRUCTURAL DETERMINANTS OF GENDER INEQUALITY IN STEM

Despite significant progress in female educational attainment and labour force participation, gender inequalities remain deeply embedded in STEM professions. The persistence of these disparities cannot be attributed to a single factor but rather to the interaction of socio-cultural, institutional, and economic determinants that influence women's educational and professional trajectories.

Gender stereotypes continue to shape educational aspirations and career choices from an early age. Scientific and technological professions have traditionally been perceived as masculine domains requiring analytical and technical skills that are often culturally associated with men. Consequently, girls frequently receive less encouragement to pursue mathematics, engineering, and computer science, despite demonstrating academic performances comparable to or even exceeding those of boys.

Research based on the expectancy-value theory suggests that career choices are significantly influenced by self-perceptions and social expectations. Women often underestimate their abilities in mathematics and technology-related subjects, reducing their likelihood of selecting STEM educational pathways. Such stereotypes contribute to horizontal segregation, whereby women are concentrated in biological sciences and healthcare while remaining underrepresented in engineering and information technology.

Occupational segregation remains one of the most visible manifestations of gender inequality in STEM. According to OECD statistics, women account for approximately 50% of professionals in life sciences but only 18% in engineering and 20% in computer science. This imbalance reflects not only differences in educational preferences but also structural barriers within labour markets. Women often encounter difficulties in accessing high-paying technological occupations and are less likely to occupy decision-making and leadership positions. This phenomenon is commonly described as the "glass ceiling", referring to invisible institutional barriers that prevent women from advancing to senior positions despite equivalent qualifications and performance.

The underrepresentation of women in leadership positions has significant implications for organisational diversity and innovation. Female leaders often play an important role in mentoring younger generations of scientists and contributing to more inclusive institutional cultures. Therefore, increasing women's representation in leadership positions is essential for achieving sustainable progress toward gender equality.

The unequal distribution of unpaid care work represents another major obstacle to women's advancement in STEM careers. Despite increasing female labour market participation, women continue to assume a disproportionate share of household and caregiving

responsibilities. Scientific careers often require long working hours, geographical mobility, and continuous productivity, conditions that may conflict with family responsibilities. Consequently, many women reduce their professional activities or leave STEM occupations entirely during childbearing and caregiving periods.

The COVID-19 pandemic further exposed these inequalities. Female researchers experienced greater reductions in scientific productivity than their male counterparts due to increased domestic responsibilities and limited access to research facilities. The long-term consequences of these disruptions continue to affect women's publication records and career progression. Although explicit discrimination has declined considerably, implicit bias remains an important factor influencing recruitment, promotion, and access to research funding. Numerous studies indicate that identical scientific applications are frequently evaluated differently depending on the applicant's gender.

Women are also less likely to receive prestigious research grants and are underrepresented in scientific advisory bodies and editorial boards. Such institutional biases contribute to lower visibility and reduced opportunities for professional advancement. Consequently, gender inequalities in STEM should be understood as systemic phenomena requiring comprehensive policy interventions rather than individual adaptation strategies. One of the most influential frameworks for understanding women's underrepresentation in STEM is the concept of the "leaky pipeline." This theory describes the progressive decline in female representation at successive educational and professional stages. Although women have achieved near parity in undergraduate education in many countries, their representation decreases significantly during postgraduate studies, doctoral programmes, postdoctoral research, and senior academic positions.

Several factors contribute to this process: insufficient mentoring opportunities, limited professional networks, work-life balance challenges, implicit bias in promotion procedures, organisational cultures that remain predominantly male-dominated.

The transition from doctoral education to permanent research positions represents one of the most critical stages in the pipeline. Empirical studies indicate that women are more likely than men to leave academic careers during this period due to career uncertainty and family responsibilities.

The consequences of the leaky pipeline extend beyond individual careers. The departure of highly qualified women from STEM professions represents a substantial loss of human capital and reduces the diversity necessary for scientific innovation. Furthermore, the limited presence of women in senior positions reduces the availability of female role models and mentors for younger generations. Addressing the leaky pipeline therefore requires interventions throughout the entire educational and professional lifecycle rather than focusing exclusively on increasing female enrolment in STEM programmes.

ECONOMIC AND SOCIAL IMPLICATIONS OF GENDER GAPS IN STEM

The underrepresentation of women in STEM has significant economic and social consequences that extend far beyond issues of equality and social justice. From the perspective of human capital theory, gender disparities in STEM represent an inefficient utilisation of productive resources. Governments invest substantial resources in female education, yet labour market barriers prevent many women from fully contributing to scientific and technological development. The loss of female talent contributes to labour shortages in high-technology sectors and reduces the availability of highly qualified professionals capable of responding to emerging global challenges. A growing body of evidence suggests that diversity contributes positively to innovation outcomes. Diverse research teams are more likely to generate creative solutions, challenge established assumptions, and produce higher-quality scientific outputs. Increasing women's participation in STEM therefore contributes directly to innovation capacity

and economic competitiveness. Countries that successfully integrate women into scientific and technological professions may benefit from greater productivity, enhanced research performance, and more dynamic labour markets. Gender equality in STEM also has broader societal implications. Female scientists frequently contribute to research areas that directly affect social welfare, including healthcare, education, environmental sustainability, and social innovation. Moreover, the visibility of women in scientific professions challenges traditional gender stereotypes and encourages future generations of girls to pursue careers in science and technology. Consequently, increasing women's participation in STEM contributes not only to economic development but also to social transformation and inclusive growth.

FUTURE PERSPECTIVES AND POLICY RECOMMENDATIONS

Despite persistent challenges, recent developments provide reasons for optimism. Increasing public awareness of gender inequalities and the growing demand for STEM professionals have encouraged governments and international organisations to implement policies aimed at improving female participation and retention. Future progress will depend on the adoption of comprehensive and multidimensional strategies. First, educational interventions should begin early. Schools must actively encourage girls to develop interests in mathematics, science, and technology through inclusive teaching methods and exposure to female role models. Second, mentorship and networking opportunities should be strengthened. Professional networks and mentoring programmes facilitate career advancement, increase visibility, and provide essential support during critical career transitions. Third, labour market institutions should promote greater flexibility. Family-friendly policies, parental leave, and affordable childcare services are essential for reducing career interruptions and improving retention. Fourth, organisations should implement transparent recruitment and promotion procedures. Regular monitoring of gender disparities in salaries, promotions, and leadership representation can help identify and eliminate institutional biases. Finally, increasing female representation in leadership positions should become a strategic priority. Women leaders contribute to more inclusive organisational cultures and play a critical role in supporting future generations of female scientists.

The evidence presented throughout this study suggests that achieving gender equality in STEM requires systemic and long-term commitment. Policies that focus exclusively on increasing female enrolment in educational programmes are insufficient. Sustainable progress depends on creating institutional environments that support women's participation, retention, and advancement throughout their professional careers. Ultimately, increasing women's participation in STEM is not merely a matter of social justice; it is an economic imperative and a prerequisite for building innovative, resilient, and sustainable societies capable of addressing the complex challenges of the twenty-first century.

CONCLUSION

The analysis demonstrates that, despite considerable progress in women's educational attainment and labour market participation, significant gender disparities persist in STEM fields. Women remain underrepresented in engineering, information technology, and leadership positions, highlighting the continued existence of structural and institutional barriers. The findings confirm that the main challenge is not access to STEM education but rather the retention and advancement of women throughout their professional careers. Factors such as gender stereotypes, occupational segregation, work-life balance challenges, and implicit bias continue to contribute to the "leaky pipeline" phenomenon. From an economic perspective, the underrepresentation of women in STEM represents an inefficient use of human capital and limits innovation capacity and economic competitiveness. Therefore, promoting gender equality in STEM should be considered both a social imperative and a strategic investment in

sustainable development. Future efforts should focus on comprehensive policies that support women's participation, retention, and leadership in STEM, including mentorship programmes, equal opportunities in recruitment and promotion, and family-friendly workplace practices. Creating more inclusive scientific and technological environments is essential for fully utilising the potential of both women and men and for addressing the complex challenges of the twenty-first century.

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ECONOMIC MODERNIZATION OF THE APPLE SECTOR IN MOLDOVA: PLANTING MATERIAL AND INTENSIFICATION OF ORCHARDS

Viorel Turetski

*Academy of Economic Studies of Moldova, Republic of Moldova
National Institute for Economic Research (NIER)*

Abstract: The article analyzes the structural transformation of the fruit-growing sector in the Republic of Moldova within the context of agricultural development and the reorientation of exports. It highlights the strategic role of agriculture in the national economy, as well as the significance of horticultural products in foreign trade. Apples hold a dominant position within agricultural exports, underscoring their importance for sectoral performance and the trade balance.

Current conditions are driving a shift in export flows toward markets with high standards for quality, food safety, and traceability, necessitating the adaptation of production technologies and varietal structures to meet consumer demands. The study highlights the transition from extensive systems to intensive and super-intensive orchards, which are characterized by higher productivity and economic efficiency. Emphasis is placed on the importance of high-quality planting material, modern rootstocks, and effective certification systems as key factors in enhancing the competitiveness and sustainability of the fruit-growing sector.

Keywords: fruit growing, apple, export, planting material, super-intensive system, competitiveness.

ИКОНОМИЧЕСКА МОДЕРНИЗАЦИЯ НА СЕКТОРА НА ЯБЪЛКИТЕ В МОЛДОВА: ПОСАДЪЧЕН МАТЕРИАЛ И ИНТЕНЗИФИКАЦИЯ НА ОВОЩНИТЕ НАСАЖДЕНИЯ

Виорел Турецки

*Академия за икономически изследвания на Молдова
Национален институт за икономически изследвания*

Резюме: Статията анализира структурната трансформация на овощарския сектор на Република Молдова в контекста на аграрното развитие и преориентацията на износа. Подчертава се стратегическата роля на селското стопанство в националната икономика, както и значимостта на градинарските продукти във външната търговия. В рамките на аграрния износ ябълките заемат доминираща позиция, което потвърждава тяхното значение за секторните резултати и за търговския баланс.

При настоящите условия износните потоци се преориентират към пазари с високи стандарти за качество, безопасност на храните и проследимост, което налага адаптиране на производствените технологии и сортовата структура към изискванията на потребителите. Изследването откроява прехода от екстензивни системи към интензивни и суперинтензивни насаждения, характеризиращи се с по-висока производителност и икономическа ефективност. Акцентът е поставен върху значението на висококачествения посадъчен материал, модерните подложки и ефективните системи за сертификация като ключови фактори за повишаване на конкурентоспособността и устойчивостта на овощарския сектор.

Ключови думи: овощарство, ябълка, износ, посадъчен материал, суперинтензивна система, конкурентоспособност.

ВЪВЕДЕНИЕ

Аграрният сектор на Република Молдова допринася съществено за формирането на брутния вътрешен продукт, със среден дял от приблизително 7–11% през последните години в зависимост от климатичните условия и икономическите тенденции. Значението му е още по-изразено във външната търговия, където агрохранителните продукти представляват около 40–45% от общия износ, което подчертава структурната специализация на националната икономика [3].

Структурата на аграрния износ отразява относителен баланс между зърнените и градинарските култури, което свидетелства за двойна ориентация на сектора. В този контекст ябълките заемат приблизително 26,7–27% от аграрния износ, потвърждавайки стратегическата им роля в динамиката на външната търговия и укрепването на приходите в овощарството [4].

В актуалния геополитически контекст износът на ябълки се преориентира към пазарите на Европейския съюз, както и към страни като Египет и Индия, за сметка на традиционните пазари в постсъветското пространство. Този преход наложи привеждане в съответствие с по-строги стандарти за качество, безопасност на храните, проследимост и технологично съответствие, както и адаптиране на производството към специфичните предпочитания на отделните пазари.

Потребителските предпочитания варират значително по региони: в Южна и Централна Европа и в САЩ се ценят сладко-кисели, ароматни и сочни ябълки; в Централна и Северна Европа преобладава търсенето на плодове с твърда и хрупкава месеста част; на азиатските пазари се предпочитат предимно сладки ябълки с ниска

киселинност. Тези особености налагат адаптиране на сортовата структура и производствените технологии към изискванията на всеки целеви пазар [2].

Следователно модернизацията на насажденията чрез преход от екстензивни към суперинтензивни системи с висока продуктивност се превръща в стратегическа посока, обусловена преди всичко от осигуряването на качествен посадъчен материал. Развитието на модерни разсадници и изграждането на ефективна система за мониторинг са основни предпоставки за повишаване на конкурентоспособността на сектора на външните пазари.

Приносът на настоящото изследване се състои в интегрирането на икономическия анализ на овощарския сектор с оценка на процеса на технологична модернизация и ролята на сертифицирания посадъчен материал като определящ фактор за конкурентоспособността на външните пазари. Статията предлага синтетична перспектива върху връзката между реструктурирането на насажденията, адаптацията към международните търговски изисквания и укрепването на износа на ябълки, формулирайки релевантни изводи за устойчивото развитие на сектора.

МЕТОДОЛОГИЯ НА ИЗСЛЕДВАНЕТО

Проучването се основава на описателно-аналитичен подход, базиран на анализ на вторични статистически данни от официални национални и международни източници. Използван е документален анализ за изследване на концептуалната рамка и секторните тенденции, както и сравнителен метод за оценка на структурната динамика на производството и износа. Интерпретацията на резултатите е извършена чрез икономически синтез с цел идентифициране на основните тенденции и тяхното въздействие върху конкурентоспособността на овощарския сектор.

Статията е разработена в рамките на подпрограма 030101 „Укрепване на устойчивостта, конкурентоспособността и устойчивото развитие на икономиката на Република Молдова в контекста на процеса на присъединяване към Европейския съюз“, институционално финансиране.

РЕЗУЛТАТИ И ДИСКУСИИ

Овощарският сектор на Република Молдова представлява един от най-важните отрасли на националното селско стопанство както чрез своя принос към износа, така и чрез стратегическата си роля за развитието на селските райони и оползотворяването на почвено-климатичните предимства на страната. Многовековната традиция в отглеждането на овощни дървета, генетичното разнообразие на сортовете и отличителното органолептично качество на молдовските плодове затвърдиха позицията на този сектор на външните пазари. В рамките на овощарската структура културата на ябълката заема централно място, осигурявайки преобладаващия дял от производството и износа на плодове.

На световно равнище ябълката (*Malus domestica*), вид от семейство Rosaceae, е една от най-разпространените овощни култури в умерения пояс. Разнообразието от сортове, получени чрез селекция и хибридизация, позволи разширяване на ареала на отглеждане в Европа, Азия и Северна Америка. През последните десетилетия глобалното производство на ябълки нараства постоянно, като понастоящем надхвърля 95 милиона тона годишно, отглеждани върху приблизително 4,6–4,7 милиона хектара. Азия категорично доминира световния пазар, като Китай осигурява повече от половината от глобалното производство с годишни обеми над 45 милиона тона. Съединените американски щати, Турция, Полша и Индия допълват групата на основните производители, всеки с продукция от порядъка на 3–5 милиона тона годишно [5]. В Европейския съюз общото производство надхвърля 10 милиона тона, като Полша е регионален лидер, следвана от Италия и Франция.

Това глобално разпределение отразява не само природните предимства, но и високото равнище на технологизация. Страните с висока производителност са внедрили в широк мащаб интензивни и суперинтензивни системи на отглеждане, базирани на висока гъстота на засаждане и използване на слабо растящи подложки. Ако в традиционните екстензивни системи гъстотата не надвишаваше 300 дървета/ха при средни добиви от 12–15 т/ха, то в интензивните системи се достига 1 000 – 1 500 дървета/ха и продукция от 40–50 т/ха, а в суперинтензивните гъстотата може да надхвърли 4 000–6 000 дървета/ха с добиви от 60–70 т/ха или дори повече при оптимални условия. Тази технологична еволюция радикално промени икономиката на отглеждането на ябълката, повишавайки ефективността на използването на земята и рентабилността на инвестициите.

Овощарският сектор на Република Молдова следва съвременните направления на модернизация и технологична интензификация. Последните данни показват, че през последните години площта на ябълковите насаждения бележи постоянно намаление – от приблизително 56,6 хил. ха през 2020 г. до около 44,2 хил. ха, оценени за 2025 г., докато средното годишно производство е вариало значително: през 2020 г. са произведени около 480 хил. тона, през 2021 г. – 648 хил. тона, през 2022 г. – 446 хил. тона, през 2023 г. – 518 хил. тона, а за 2024 г. е оценено производство от 404 хил. тона [6]. В същото време, според специализираните отчети за реколтната кампания 2024, Република Молдова е изнесла между приблизително 105 000 и 110 000 тона ябълки от реколта 2024 в рамките на период, обхващащ съответния маркетингов интервал (юли 2024 – юни 2025), доставени в над 30 държави, включително в Европейския съюз, което свидетелства за диверсификация на пазарите на реализация. Това реструктуриране бе обусловено от преориентацията на износа към пазари със строги изисквания относно калибрирането, еднородността и качеството на плодовете, особено Европейския съюз, Близкия изток и Азия [7].

Прилагането на суперинтензивната технология предполага използването на слабо растящи подложки, по-специално от групата М9, присадени със съвременни търговски сортове. Подложката М9 се превърна в глобален стандарт за модерните насаждения поради способността си да намалява растежната сила на дървото, да ускорява встъпването в плододаване и да позволява висока гъстота на засаждане. Въпреки това, при климатичните условия на Република Молдова тази подложка проявява чувствителност към засушаване, към кръвната въшка и към бактериалния рак, което ограничава икономическата продължителност на насажденията.

В международен контекст селекцията и подобряването на подложките се превърнаха в стратегическо направление на овощарските изследвания. В Европейския съюз бяха разработени подобрени клонове на М9 (като Т337, Ражам 1, Ражам 2, Нис 29), а в Съединените щати бе създадена серията Geneva (G11, G41 и др.), призната с повишената си устойчивост на болести, почвена адаптивност и ефективност при усвояването на хранителни вещества [8]. В множество европейски държави над 90% от новите насаждения се създават със сертифициран посадъчен материал, произхождащ от специализирани разсадници, интегрирани с изследователски центрове.

Глобалната индустрия за производство на посадъчен материал от ябълка се разви пропорционално с разширяването на интензивните системи. Италия, Нидерландия, Полша и Франция са сред основните европейски износители на подложки и сертифицирани присадени дръвчета, доставяйки ежегодно милиони бройки към пазарите на Източна Европа, Северна Африка и Централна Азия. В САЩ производството на подложки от серията Geneva доведе до реструктуриране на разсадниковия сектор, а щати като Вашингтон и Ню Йорк се превърнаха в основни центрове за размножаване и износ. На регионално равнище Полша се утвърди не само като голям производител на

ябълки, но и като важен доставчик на посадъчен материал за Централна и Източна Европа.

В Република Молдова производството на посадъчен материал има солидна традиция, но настоящият капацитет не покрива изцяло търсенето, породено от разширяването на суперинтензивните насаждения. През 80-те години годишното производство надхвърляше 10 милиона присадени дръвчета, ниво, достигнато на фона на ясно изразена възходяща динамика още от втората половина на 70-те години, когато обемът нарасна от 6,9 милиона до над 10,3 милиона броя в рамките на четири години [9]. Тази експанзия отразяваше структурното укрепване на овощарския сектор в рамките на планираната аграрна икономика, осигурявайки материалната база за разширяване на търговските насаждения, увеличаване на дела на овощарството в структурата на селскостопанската продукция и интегриране на републиката в междурепубликанската система за снабдяване с плодове и суровини за преработка. Икономическият преход обаче доведе до рязко намаляване на производствения обем до приблизително 300 хил. броя през 2003 г. Впоследствие секторът бе ревитализиран, достигайки над 7 милиона броя през 2016 г., но ориентацията към съвременни подложки и високоефективни клонове остава недостатъчно развита, което ограничава пълната адаптация към изискванията на съвременните овощарски технологии.

Понастоящем значителна част от посадъчния материал, използван за създаване на модерни насаждения, е вносен, но неговото качествено равнище не винаги отговаря на техническите изисквания на високоефективните търговски плантации. В специализираните европейски разсадници висококачественият посадъчен материал – а именно сертифицирани, добре развити присадени дръвчета, подготвени за засаждане в интензивни или суперинтензивни системи – може да достигне стойности между 30 € и над 60 € за брой, в зависимост от възрастта, калибъра, типа подложка и приложимите стандарти за сертификация. За разлика от това, на пазара на Република Молдова често се срещат търговски оферти за стандартни овощни дръвчета на значително по-ниски цени – приблизително 1,5–3,3 € за брой. Тези екземпляри обаче обикновено са с по-малки размери, с недостатъчно развита вегетативна структура и без необходимите технически спецификации за създаване на високоплътни търговски насаждения [10].

Тази несъответствие между технологичните изисквания на суперинтензивните системи и качеството на наличния на пазара посадъчен материал представлява съществено препятствие в процеса на структурна модернизация на сектора, ограничавайки потенциала за производителност, однородност и конкурентоспособност на новите насаждения.

Съществен проблем е свързан със сертификацията и контрола на качеството. В модерните системи официалната сертификация гарантира сортовата автентичност, генетичната чистота и фитосанитарния статус на посадъчния материал. Липсата на стабилна система за мониторинг може да доведе до сортови смесвания или до въвеждане на инфектиран материал с отрицателно въздействие върху устойчивостта на насажденията [1]. В развитите държави интеграцията на научните изследвания с производството на посадъчен материал чрез научно-производствени асоциации позволи поддържането на високи стандарти и бързата адаптация към новите пазарни изисквания.

В условията на диверсификация на пазарите и засилване на международната конкуренция Република Молдова следва да ускори модернизацията на разсадниковия сектор. Инвестициите в инфраструктура, внедряването на подобрени подложки, адаптирани към абиотичен и биотичен стрес, както и укрепването на системата за сертификация представляват съществени условия за повишаване на конкурентоспособността. Развитието на ефективна национална индустрия за

производство на посадъчен материал не само ще намали зависимостта от внос, но и ще създаде предпоставки за износ на присадени дръвчета в региона.

Като цяло развитието на молдовския овощарски сектор потвърждава дълбока структурна трансформация: намаляване на екстензивните площи, повишаване на производителността, ориентация към суперинтензивни технологии и интеграция в съвременни стойностни вериги. Бъдещата конкурентоспособност обаче зависи от укрепването на генетичната и технологичната база на посадъчния материал – фундаментален елемент на новата парадигма на развитие. Само чрез конвергенция между научни изследвания, инвестиции и последователни публични политики секторът на производството на ябълки в Република Молдова ще може напълно да реализира своя икономически и експортен потенциал

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A MODEL FOR QUANTITATIVE RISK ASSESSMENT IN A BULGARIAN MULTIPROFILE HOSPITAL FOR ACTIVE TREATMENT

Stoycho Stoev

University of agribusiness and rural development, Plovdiv, Bulgaria

Abstract: The aim of the article is to present in detail the practical aspects of risk management in healthcare organizations. The quantitative risk assessment model was created using a probability-impact matrix (PIM) with probabilistic modeling of risk factors. Real data from the risk registers of an anonymous multi-profile hospital for active treatment, located in a large Bulgarian regional city in Bulgaria, were used.

Keywords: healthcare, quantitative risk assessment matrix, probabilistic modeling, Pareto analysis.

МОДЕЛ ЗА КОЛИЧЕСТВЕНА ОЦЕНКА НА РИСКА В БЪЛГАРСКА МНОГОПРОФИЛНА БОЛНИЦА ЗА АКТИВНО ЛЕЧЕНИЕ

Стойчо Стоев

Висше училище по агробизнес и развитие на регионите - Пловдив

Резюме: Целта на статията е да представи в детайли практическите аспекти на риск мениджмънта в здравните организации. Моделът за количествена оценка на риска е създаден посредством матрица вероятност – въздействие (PIM) с вероятностно моделиране на рисковите фактори. Използвани са реални данни от риск регистрите на анонимна многопрофилна болница за активно лечение, намираща се в голям български областен град в България.

Ключови думи: здравеопазване, матрица за количествена оценка на риска, вероятностно моделиране, анализ на Парето.

Основната цел при управлението на риска в здравеопазването е да се създаде такава система, която да е в състояние да защити здравната организация от финансови и нематериални загуби, а така също и от такива събития, които биха попречили за постигане стратегически цели на болничното заведение. Правилното управление на риска помага да се осигури възможност за непрекъснатост на болничната дейност. Управлението на непрекъсваемостта на бизнеса е пряко свързано с качеството на риск мениджмънта.

Към края на 2024 г. анонимна многопрофилна болница за активно лечение, намираща се в голям български областен град разполага с над 150 легла за активно лечение и 243 души медицински персонал, от които 72 лекаря и 171 специалисти по здравни грижи. Бюджетът на болницата за 2024 година е определен на приблизително 13, 25 млн. лв.

Таблица 1 представя първата част от риск регистъра на анонимната болница. Както се вижда риск регистъра на болницата съдържа 7 колони.

Таблица 1. Риск регистър на превантивни рискове
Период 01.01-31.12.2024 г.

Risk Id	Рисково събитие	Дата на инцидент	Честота бр./год	Пряка щета, лв.	Косвена щета, лв.	Мерки
P1	Падане на пациент с фрактура	12.02.2024, 15.05.2024, 08.11.2024	3	12 500 (лечение, изследвания)	28 200 (загуба на доверие, съдебни разходи)	осигуряване придържащи средства
P2	Медикаментозна грешка (неправилна доза антибиотик)	22.03.2024, 30.08.2024	2	33 800 (коригиране на лечение, доп. престой)	15 000 (потенциална съдебна отговорност, репутационни загуби)	увеличаване на персонала, маркировка на лекарства
P3	Интраоперативна инфекция при ендопротезиране на тазобедрена става	14.6.2024	1	282 000 (повторна операция, антибиотици)	17 000 (продължителен престой, рехабилитация)	актуализация антисептични протоколи, вентилация в ОП

Risk Id	Рисково събитие	Дата на инцидент	Честота бр./год	Пряка щета, лв.	Косвена щета, лв.	Мерки
P4	Венозна тромбоза след операция	10.04.2024, 05.10.2024	2	19 700 (лечение, доп. престой)	126 500 (увеличаване на инвалидност, съдебен риск)	актуализация стандартизирани протоколи за профилактика
P5	Декубитални язви при неподвижни пациенти	хроничен проблем	4	18 000 (лечение, специални превръзки)	27 000 (продължителна хоспитализация)	Увеличаване брой сестри, антидекубитални матраци
P6	Грешка в идентификация на пациент преди операция	17.9.2024	1	42 000 отмяна на операция, повторно планиране	125 000 репутационна вреда, потенциално наказание от РЗИ	въвеждане на двойна проверка

Първата показва идентификатора на конкретния вид риск, втората съдържа кратко описание на рисковото събитие, третата датата на регистрираното рисково събитие или периода на извадката с исторически данни, четвъртата колона показва честотата на рисковото събитие на годишна база или друг период от време, петата показва количествената оценка на пряката щета в лева (въздействието) върху фирмата, шестата е сумата на косвените щети и последната седма колона описва планираните мерки за ограничаване или избягване на риска.

В таблица 1 са представени основните количествени параметри на превантивните рискове, регистрирани в болницата за периода 01.01-31.12.2024 г. Не са включени превантивни рискове, които според ръководството оказват пренебрежимо малко въздействие върху болницата или не са актуални в бъдеще.

**Таблица 2. Риск регистър на външни рискове
(Различен период на регистрация)**

Risk Id	Рисково събитие	Дата на инцидент	Честота (бр./год)	Пряка щета, лв.	Косвена щета, лв.	Мерки
Ex1	Прекъсване на доставка за медицински консумативи	10-12.07.2024	1	15 000 (експедитивни доставки на висока цена)	122 000 (отлагане на планови операции, риск за пациенти)	диверсифицирани доставки, поддържане на запаси
Ex2	Кибератаки с криптиране на данни за пациенти	период 4 години	0,25	8 000 (възстановяване на системи, техническа поддръжка)	45 000 (спрян електронен регистър, ръчно водене, загуба на данни, санкции от КЗЛД)	допълнителна софтуерна защита, обучение за киберсигурност
Ex3	Продължително прекъсване на захранването с електроенергия	24-25.01.2024 (36 часа)	1	52 000 (работа на аварийни агрегати, повреда на оборудване)	110 000 (прехвърляне на критични пациенти, отменени процедури, риск за живота)	надежден аварийен генератор, поддръжка на UPS системи
Ex4	Грип с повишена заболяемост сред персонала	дек.23	1	18 500 (заместване на персонал, извънредни)	140 000 (намален капацитет, отложени)	ваксинация на персонала, резервен персонален план

= 58 =

Академично издателство „Талант“

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Risk Id	Рисково събитие	Дата на инцидент	Честота (бр./год)	Пряка щета, лв.	Косвена щета, лв.	Мерки
				заплати)	планови грижи, риск от вътрешболнични инфекции)	

В таблицата 2 са представени количествените параметри на основните външните рискове, регистрирани в болницата на годишна база, но за различни периоди т.е. за някои рискове болницата събира исторически данни от 4 години (кибератаки с криптиране на данни - Ex2), а останалите три за един период (01.01-31.12.2024 г.).

Не са включени външни рискове, които според ръководството оказват пренебрежимо малко въздействие върху болницата или не са актуални в бъдеще.

**Таблица 3. Регистър на стратегически рискове
(Различен период на регистрация)**

№	Рисково събитие	Дата/период на инцидент	Честота (бр./год)	Пряка щета, лв.	Косвена щета, лв.	Мерки
S1	напускане на квалифициран медицински персонал	2021/24 г.	76	25 000 (разходи за набиране и обучение на нов персонал)	50 000+ (загуба на експертиза, намалено качество)	повишаване на заплати, подобряване условия на труд
S2	намаление на клинични пътеки, поради демографски спад	статистически тенденции за последните 5 години	2/5 = 0,4	135 290 лв. (прогнозна загуба за 2025 г.)	неизчислима (невъзможност за иновации, влошаване на инфраструктура)	рекламни кампании, разкриване на дистанционни центрове
S3	остаряло критично медицинско оборудване	Исторически данни 2020-2024	3/5=0,6	85 936 лв. (ср. стойност за ремонт)	30 000 (скъпа поддръжка, неточна диагностика)	дългосрочен бюджет за капиталови разходи, проектно финансиране
S4	отлив на пациенти към конкуренти	Исторически данни 2019-2024	2/6=0,333	722 796 лв. (намаляване на приходи от здравни каса и частни пациенти)	неизчислима (загуба на пазарен дял, затруднена акредитация)	подобряване на обслужването, позитивна реклама,
S5	несъответствие с нови европейски и национални регулаторни изисквания	Одит от РЗИ на 22.11.2024	83%	75 000 (непосредствени глоби/санкции)	200 000 (задължителни корективни действия, спиране на финансиране)	отдел за качество и риск мениджмънт

Таблица 3 показва последната трета част от риск регистъра на анонимната болница. Тук са представени количествените параметри на **стратегическите рискове**, регистрирани в болницата на годишна база, но отново извадките с исторически данните в риск регистрите болницата са с различен период т.е. за някои рискове се ползват външни данни за

последните пет години (демографския спад в областта), текучество на кадри от 3 години и др. , но това е често срещано в практиката.

Първият стратегически рисков фактор „напускане на квалифициран медицински персонал (brain drain)“ S1 е с период на регистрацията от 3 години (2021/24 г.). За този три годишен период са напуснали общо 76 медици.

Вторият стратегически риск е „намалени приходи, поради редукция клинични пътеки, причинено от демографски спад“ S2. Тук болницата разполага с исторически данни за изпълнението на планираните спрямо реализираните клинични пътеки за последните пет години.

Третият стратегически риск е „остаряло критично медицинско оборудване“ S3. Тук разполагаме с данни от предходни години и честота на това събитие е 4 за период от 5 години.

Четвъртият рисков фактор от регистъра на стратегическите рискове е „намаляване на доверието в болницата и отливане на пациенти към частни клиники (S4). Тук разполагаме с данни от предходни години и честота на това събитие е 2 за период от 6 години.

Петият рисков фактор от регистъра на стратегическите рискове е несъответствие с нови европейски и национални регулаторни изисквания (GDPR, клинични стандарти) (S5) и са важни резултатите от последния одит на болницата от РЗИ на 22.11.2024. Тук по аналогия с другите групи рискове не са включени стратегически събития, които според ръководството оказват пренебрежимо малко въздействие върху болницата или не са актуални в бъдеще.

Важно е да бъде отбелязано, че част от финансовите данни са модифицирани по определен математически алгоритъм от съображения за конфиденциалност.

Построяването на матрицата вероятност- въздействие (PIM) изисква въз основа на данните от риск регистрите да бъдат изчислени вероятности за настъпване на всяко рисково събитие. При тяхното изчисляване са възможни да се използват различни бази като среден престой на пациент в дни, максимален престой на пациенти в дни, среден брой операции и др. Изчислените вероятности за конкретните рискове ще бъдат представени по групи.

Групата на превантивните рискове включва шест основни рискови събития: падане на пациент с фрактура P1, Медикаментозни грешки P2 , интраоперативни инфекции P3, венозни тромбози след операция P4, декубитални язви P5 и грешки в идентификация на пациент P6.

Първият риск от групата превантивни рискове е „падане на пациент“ с идентификатор P1. Данни: 3 регистрирани случая през 2024 г. при среден брой на леглодни 36,5 дни.

$$P = \frac{\text{бр честоти за година}}{\text{общ бр събития}} = \frac{3}{36,5} = 0,082 \text{ или } 8,2\%$$

Показва вероятността произволен пациент да падне по време на средния си престой в болницата.

Вторият рисков фактор от регистъра на превантивните рискове (таблица 1) са медикаментозните грешки P2. Честота на това събитие е 2 през 2024 година. Вероятността се изчислява по аналогичен начин:

$$P = \frac{2}{36,5} * 100 = 5,48 \%$$

Третият рисков фактор от регистъра на превантивните рискове са интраоперативни инфекции. Тук базата е средния брой проведени операции за година (28,40 бр.). Вероятността да се случи интраоперативна инфекция през следващата година е:

$$P = \frac{1}{28,40} * 100 = 4,47 \%$$

Четвъртият рисков фактор от регистъра на превантивните рискове е случаи на венозен тромбоза. Тук базата е средния брой проведени операции за година (28,40 бр). Вероятността да се случи венозен тромбоза през следващата година е:

$$P = \frac{2}{28,40} * 100 = 7,04 \%$$

Петият рисков фактор от регистъра на превантивните рискове е случаи на декубитални язви. Тук базата е средния брой отново среден брой на леглодни. Вероятността да се случи венозен тромбоза през следващата година е:

$$P = \frac{4}{36,5} * 100 = 11 \%$$

Шестият рисков фактор от регистъра на превантивните рискове е грешки в идентификацията на пациенти. Тук базата може да бъде средния брой леглодни или среден брой пациенти. Вероятността да се случи грешки в идентификацията на пациенти през следващата година е:

$$P = \frac{1}{36,5} * 100 = 2,7 \%$$

Групата на **външните рискове** включва четири основни рискови събития: прекъсване на доставки за медицински консумативи (Ex1), кибератаки с криптиране на данни за пациенти (Ex2), продължително прекъсване на захранването с електроенергия (Ex3) и грип с повишена заболяемост сред персонала (Ex4).

Първият риск от групата външните рискове е „прекъсване на доставки за медицински консумативи“ с идентификатор Ex1. Данни: 1 регистриран случай с продължителност 3 дни през 2024 г. при среден брой на леглодни 36,5 дни.

$$P = \frac{3}{365} * 100 = 0,82 \% \text{ за ден}$$

$$\text{Годишна вероятност} = 1 - (1 - \text{Месечна вероятност})^{365}$$

$$P = 1 - (1 - 0,82\%)^{365} = 95,05\%$$

Това не означава 95% всеки ден, а че през годината има 95,05% шанс да се случи поне веднъж.

Вторият рисков фактор от регистъра на външните рискове (таблица 3.2) са кибератаки Ex2. Тук разполагаме с данни от предходни години и честота на това събитие е 1 за период от 4 години. За прогнозиране вероятността на такива редки събития обикновено се използва Поасоново разпределение. Както бе обяснено в глава втора, за може да изчислим вероятност при Поасоново разпределение е необходим само един параметър и това е средният брой събития. Конкретно за кибератаките средния брой е $1/4 = 0,25$ средно за година. От тук като използваме формулата за кумулативната функция на Поасоновото разпределение изчисляваме вероятността да се случат 0 кибератаки през следващата година:

$$CDF(X < 0) = \sum_{k=0}^x \lambda^k \frac{e^{(-\lambda)}}{k!} = \sum_{k=0}^0 0,25^0 \frac{2,71828^{-0,25}}{0!} = 0,7788$$

т.е. вероятността да нямаме кибератаки през следващата година е 77,88%, а вероятността да се случат една или повече е $1 - 77,88\% = 22,12\%$

Третият рисков фактор от регистъра на външните рискове са прекъсване на електричество. През 2024 г. се е случил един инцидент с продължителност 36 часа. Вероятността да се случи прекъсване на електричество през следващия час е:

$$P = \frac{36}{8760} * 100 = 0,41 \%$$

$$P = 1 - (1 - 0,41\%)^{8760} = 100\%$$

Това че през годината 100% ще се случи поне веднъж прекъсване на електричество.

Четвъртият рисков фактор от регистъра на външните рискове е грипна епидемия (E4). Честота на това събитие 1 събитие през 2024 година. Това означава, че 1 грипна вълна се е случила през 2024 с 100% вероятност, ако не разполагаме с данни от предходни години, то логично може да очакваме същата вероятност и през следващата година.

Групата на **стратегическите рискове** включва пет основни рискови събития: напускане на квалифициран персонал (S1), по-ниско ниво на клинични пътеки в резултат от демографски спад (S2), остаряло критично медицинско оборудване (S3), Намаляване на доверието в болницата и отлив на пациенти (S4) и несъответствие с нови европейски и национални регулаторни изисквания (GDPR, клинични стандарти) (S5).

Първият риск от групата стратегически рискове е „напускане на квалифициран персонал“ с идентификатор S1. Данни: от среден брой на медицинския персонал е изчислен на 239,3 за последните три години като са напуснали общо 76 лекари и медицински специалисти. Общият брой човеко-дни за 3 години ще бъде $239,3 \cdot 3 = 717,9$. Годишната вероятност за напускане ще бъде изчислена като:

$$P = \frac{76}{717,9} \cdot 100 = 10,59 \%$$

Вероятността поне един квалифициран специалист да напусне ще бъде изчислена по познатата формула:

$$P(x > 1) = 1 - (1 - 0,1059)^{239,3} = 100\%$$

Вторият риск от групата стратегически рискове е „намаление на клинични пътеки“ с идентификатор S2. Поради демографски спад и конкуренция от частни болници, болницата не достига планирания обем клинични пътеки. Финансиране на клинични пътеки по НАЗОК за 2024 8,3 млн. лв. Очакваният демографски спад за 2026 г. се очаква да бъде 1,63%. От тук очакваното въздействие на този вид риск за следващата година е изчислено като планираното финансиране по НАЗОК за 2025 г. от 8,3 млн. лв. се умножи с 1,63% т.е. $8,3 \text{ млн. лв.} \cdot 1,63\% = 135\,290 \text{ лв.}$

Вероятността да се случи намаление в изпълнението на клиничните пътеки се изчислява въз основа на историческите данните на болницата от таблица 4.

Таблица 4. Изпълнение на клинични пътеки за периода 2020 -2024

Година	Планирани	Реализирани	% изпълнение	Недостиг
2020	6 100	6 218	101,9%	не
2021	6 200	6 034	97,3%	Да
2022	6 000	6 051	100,9%	Не
2023	5 300	5 311	100,21%	Не
2024	5 230	5 099	97,50%	Да

От таблицата виждаме, че за последните 5 години при 2 от тях регистрираме не изпълнение на планираните клинични пътеки и съответно вероятността да се реализира неизпълнение на клинични пътеки е изчислена като:

$$P = \frac{\text{брой периоди с недостиг КП}}{\text{общ бр. наблюдавани периоди}} \cdot 100 = \frac{2}{5} = 40 \%$$

Третият риск от групата стратегически рискове е „остаряло критично медицинско оборудване“ с идентификатор S3. Тук разполагаме с данни от предходни години и честота на това събитие е 4 за период от 5 години. За прогнозиране вероятността се използва Поасоново разпределение. Както бе обяснено в глава втора, за може да изчислим вероятност при Поасоново разпределение е необходим само един параметър и това е средният брой събития. Конкретно за аварийите средния брой е $4/5 = 0,8$ средно за година. От тук като използваме формулата за кумулативната функция на Поасоновото разпределение изчисляваме вероятността да се случат 0 аварии на през следващата година:

$$= 62 =$$

$$CDF(X < 0) = \sum_{k=0}^x \lambda^k \frac{e^{-\lambda}}{k!} = \sum_{k=0}^0 0,8^k \frac{2,71828^{-0,8}}{k!} = 0,4493$$

т.е. вероятността да нямаме аварии на критично медицинско оборудване през следващата година е 44,93%, а вероятността да се случат една или повече е 1-44,93% = 55,07%.

Четвъртият рисков фактор от регистъра на стратегическите рискове е „намаляване на доверието в болницата и отливане на пациенти към частни клиники (S4). Вероятността да се случи намаление в изпълнението на клиничните пътеки се изчислява въз основа на историческите данни на болницата от таблица 5.

Таблица 5. Годишно изменение в броя на пациентите за периода 2020 -2024

Година	бр. пациенти	Годишна промяна	Отлив $\geq 10\%$
2019	18 200	+8,19%	не
2020	16 800	-7,69%	не
2021	14 900	-11,31%	да
2022	14 122	-5,22%	не
2023	14 655	+3,77%	не
2024	13 029	-11,10%	да

От таблицата виждаме, че за последните 6 години при 2 от тях регистрираме не изпълнение на планираните клинични пътеки и съответно вероятността да се реализира неизпълнение на клинични пътеки е изчислена като:

$$P = \frac{\text{брой периоди с отлив} > 10\%}{\text{общ бр. наблюдавани периоди}} * 100 = \frac{2}{6} = 33,33\%$$

Петият рисков фактор от регистъра на стратегическите рискове е несъответствие с нови европейски и национални регулаторни изисквания (GDPR, клинични стандарти) (S5). основа на оценка на възможностите и ресурсите на болницата вероятността за бъдещи санкции е определена на 83%.

Таблица 6. Изчисляване скоринг оценки на рисковите фактори

Risk Id	Рисково събитие	Вероятност	Пряка щета, лв.	Косвени щети, лв.	Обща щета	Скоринг оценка
P1	Падане на пациент с фрактура	8,20%	12500	28200	40700	3 337 лв.
P2	Медикаментозна грешка (неправилна доза антибиотик)	5,48%	33800	15000	48800	2 674 лв.
P3	Интраоперативна инфекция при ендопротезиране на тазобедрена става	4,47%	282000	17000	299000	13 365 лв.
P4	Венозна тромбоза след операция	7,04%	19700	126500	146200	10 292 лв.
P5	Декубитални язви при неподвижни пациенти	11%	18000	27 000	45000	4 950 лв.
P6	Грешка в идентификация на пациент преди операция	2,70%	42000	125000	167000	4 509 лв.
Ex1	Прекъсване на доставка за медицински консумативи	95,05%	15000	122000	137000	130 219 лв.
Ex2	Кибератака с криптиране на данни за пациентни	22,12%	8000	45000	53000	11 724 лв.

= 63 =

Risk Id	Рисково събитие	Вероятност	Пряка щета, лв.	Косвени щети, лв.	Обща щета	Скоринг оценка
Ex3	Продължително прекъсване на захранването с електроенергия	100%	52000	110000	162000	162 000 лв.
Ex4	Грип с повишена заболяемост сред персонала	100%	18500	140000	158500	158 500 лв.
S1	напускане на квалифициран медицински персонал (brain drain)	100%	25000	50000	75000	75 000 лв.
S2	намаление на клинични пътеки, поради демографски спад	40%	135290	0	135290	54 116 лв.
S3	остаряло критично медицинско оборудване	55,07%	85936	30000	115936	63 846 лв.
S4	отлив на пациенти към конкуренти	33,33%	722796	0	722796	240 908 лв.
S5	несъответствие с нови европейски и национални регулаторни изисквания (GDPR, клинични стандарти)	83%	75000	200000	275000	228 250 лв.

Бюджет 1163690 лв.

Таблица 6 показва изчислените общи щети, скоринг оценките на отделните рискове и необходимия бюджет на болницата за покриване на риска в нейната дейност за следващата година.

Тук загубите за болницата са под формата на глоби и санкции. Вероятността да се наложат бъдещи санкции се определя въз основа на регистрираните отклонения в прилагането на регулаторните стандарти и възможностите определена част да могат да бъдат отстранени.

Таблица 7. Приоритизиране на рисковете

Ранг	Risk Id	Рисково събитие	Скоринг оценка
1	S4	отлив на пациенти към конкуренти	240 908 лв.
2	S5	несъответствие с нови европейски и национални регулаторни изисквания	228 250 лв.
3	Ex3	продължително прекъсване на захранването с електроенергия	162 000 лв.
4	Ex4	грип с повишена заболяемост сред персонала	158 500 лв.
5	Ex1	прекъсване на доставка за медицински консумативи	130 219 лв.
6	S1	напускане на квалифициран медицински персонал (brain drain)	75 000 лв.
7	S3	остаряло критично медицинско оборудване	63 846 лв.
8	S2	намаление на клинични пътеки, поради демографски спад	54 116 лв.
9	P3	интраоперативна инфекция при ендопротезиране на тазобедрена става	13 365 лв.
10	Ex2	кибератака с криптиране на данни за пациентни	11 724 лв.
11	P4	венозна тромбоза след операция	10 292 лв.
12	P5	декубитални язви при неподвижни пациенти	4 950 лв.
13	P6	грешка в идентификация на пациент преди операция	4 509 лв.

Ранг	Risk Id	Рисково събитие	Скоринг оценка
14	P1	падане на пациент с фрактура	3 337 лв.
15	P2	медикаментозна грешка	2 674 лв.

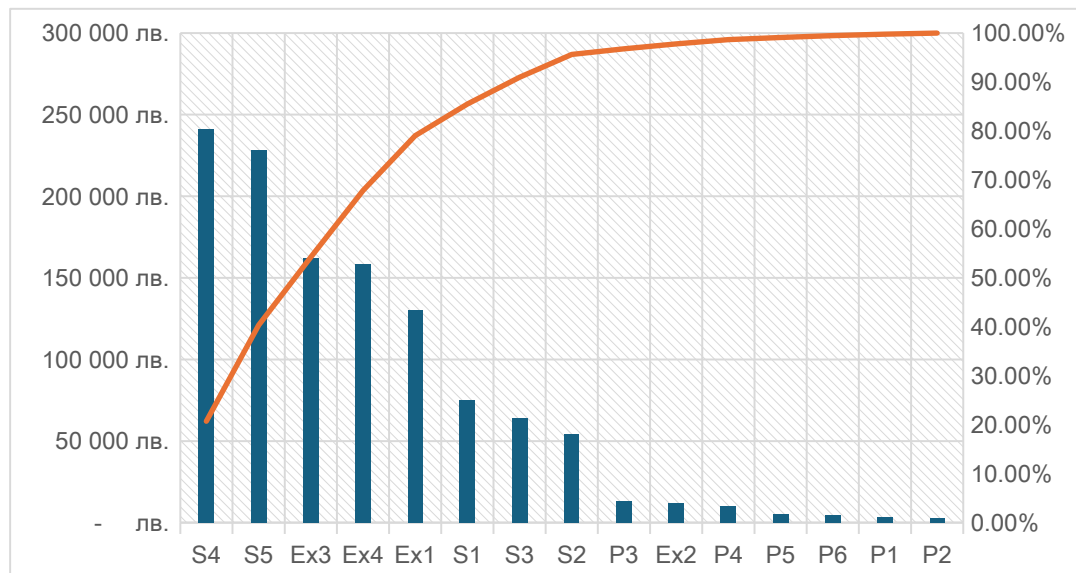
Чрез изчислените в таблица 6 скоринг оценки отделните рискове стават съизмерими и сравними. Приоритизирането на регистрираните рискове означава да бъдат подредени според тяхната опасност за болничното заведение.

Таблица 8. Анализ на Парето

Risk Id	Рисково събитие	Скоринг оценка	% от бюджета	кумулятивен %
S4	отлив на пациенти към конкуренти	240 908 лв.	20,70%	20,70%
S5	несъответствие с нови европейски и национални регулаторни изисквания (GDPR, клинични стандарти)	228 250 лв.	19,61%	40,32%
Ex3	Продължително прекъсване на захранването с електроенергия	162 000 лв.	13,92%	54,24%
Ex4	Грип с повишена заболяемост сред персонала	158 500 лв.	13,62%	67,86%
Ex1	Прекъсване на доставка за медицински консумативи	130 219 лв.	11,19%	79,05%
S1	напускане на квалифициран медицински персонал (brain drain)	75 000 лв.	6,45%	85,49%
S3	остаряло критично медицинско оборудване	63 846 лв.	5,49%	90,98%
S2	намаление на клинични пътеки, поради демографски спад	54 116 лв.	4,65%	95,63%
P3	Интраоперативна инфекция при ендопротезиране на тазобедрена става	13 365 лв.	1,15%	96,78%
Ex2	Кибератака с криптиране на данни за пациентни	11 724 лв.	1,01%	97,79%
P4	Венозна тромбоза след операция	10 292 лв.	0,88%	98,67%
P5	Декубитални язви при неподвижни пациенти	4 950 лв.	0,43%	99,10%
P6	Грешка в идентификация на пациент преди операция	4 509 лв.	0,39%	99,48%
P1	Падане на пациент с фрактура	3 337 лв.	0,29%	99,77%
P2	Медикаментозна грешка (неправилна доза антибиотик)	2 674 лв.	0,23%	100,00%

От таблица 7 се вижда, че най-голяма опасност за болницата се явяват двата стратегически риска: отлив на пациенти към конкуренти (S4) и несъответствие с нови европейски и национални регулаторни изисквания (S5), следвани от три външни риска.

Изследването на рисковете в болницата се допълва от направеният анализ на Парето в показан в таблица 3.8 и визуализиран на графика 3.1. Анализът показва, че 6 от общо 15 наблюдавани риска генерират 85,49% от общата загуба на болницата. Управлението на първите три риска дава на-голяма възвръщаемост и е задължително условие за ефективен риск мениджмънт.



Графика 1. Диаграма на Парето

Основни изводи: Необходимият бюджет за покриване на рисковете в болничната дейност през следващата година възлиза на 1 163 690 лв., което представлява приблизително 8,78% от целия бюджет на здравното заведение. Болницата е изправена пред критично предизвикателство със стратегическите рискове, които застрашават нейната дългосрочна устойчивост. Вътрешните (предотвратими) рискове са в голяма степен контрол, но изискват постоянен мониторинг. Ключът към успеха е балансиран подход между незабавна реакция на критичните стратегически рискове, стартиране на стратегическо планиране за финансово и репутационно възстановяване и непрекъснато подобряване в качеството на медицинските услуги.

Следващ етап в управлението на рисковете изисква разработване на детайлен план за действие с конкретни отговорници, срокове и бюджет за всяка препоръка.

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STRUCTURE AND DYNAMICS OF NATIONAL RISK PERCEPTIONS IN BULGARIA AND CENTRAL AND EASTERN EUROPE (2023-2026): IMPLICATIONS FOR THE AGRI-FOOD SECTOR

Vesela Angelova

University of agribusiness and rural development, Plovdiv, Bulgaria

Abstract. Risk perception is a subject of economic analysis in its own right, insofar as it influences the allocation of attention and resources regardless of the actual degree of risk exposure. The aim of the study is to identify the structure and dynamics of national risk perceptions in Bulgaria and seven countries in Central and Eastern Europe, and to relate them to the climate exposure of the agri-food sector. The tasks include tracking global trends by semantic groups, extracting and systematising national data, identifying the distinctive features of the Bulgarian structure, and correlating it with available assessments of the economic burden and climate exposure of agriculture. The applied methodology uses two sources from four consecutive editions of the World Economic Forum's Global Risks Report for the period 2023–2026: the Global Risks Perception Survey for the global picture and the Executive Opinion Survey for the national level. The data were extracted from the text versions of the reports and cross-checked line by line against the original appendices. To ensure comparability given the varying number of risks, an average normalised ranking by group was used. The results reveal two consistent trends for Bulgaria: economic risk ranks first in all four editions, whilst climate risk is absent from the top five throughout the entire period. The only environmental concern is pollution, which ranks fifth in 2025. A comparison with climate exposure estimates reveals a discrepancy: agriculture accounts for 1.8% of gross domestic product, whilst drought causes over half of the losses suffered by the European agricultural sector, with insurance cover extending to 20% of the country's land area.

Keywords: risk perception, global risks, agri-food sector, climate exposure, Central and Eastern Europe.

INTRODUCTION

The perception of risk is a subject in its own right within economic analysis. It does not necessarily correspond to objective exposure, but it influences the allocation of attention and resource - both in public policy and in corporate decisions regarding investment and insurance. The distinction between expert risk assessment and the perception of non-specialists was first established in the seminal work of Slovic (1987), who demonstrated that lay perception is shaped by the qualitative characteristics of a threat, rather than solely by its probability and scale. This is precisely the stated aim of the World Economic Forum's (WEF) Global Risks Report: to provide decision-makers with an understanding of the risk environment.

This study examines the structure of national risk perceptions in Bulgaria and neighbouring countries in Central and Eastern Europe during the period 2023-2026. The choice of subject stems from the following observation: the agri-food sector in Bulgaria makes a limited contribution to gross domestic product, but has a documented high level of climate exposure. If risk perception shapes the environment for sectoral decision-making, the structure of that perception is of economic significance.

The object of this study is national risk perceptions in Bulgaria, Greece, Croatia, the Czech Republic, Poland, Romania, Hungary and Slovenia, as reflected in the editions of the Global Risks Report for the period 2023-2026. *The subject* of the study is on the structure and dynamics of these perceptions across thematic risk groups, examined in comparison with the global picture and in relation to the climate exposure of the agri-food sector.

The study is based on the assumption that the structure of national risk perception in Bulgaria is characterised by sustained economic dominance and, at the same time, by a persistent absence of climate risk, despite the documented high exposure of the agri-food sector. This discrepancy, if confirmed for the entire period under review, represents a structural feature of perception rather than a fluctuation between individual surveys.

The objectives of the study are as follows:

- to trace the dynamics of global risk perceptions by thematic groups using an indicator that is comparable across varying numbers of risks;
- to extract and systematise the national data for the eight countries under comparison from the appendices of the four editions;
- to determine whether the structure of Bulgarian risk perception differs from the regional one and, if so, in what respects;
- to relate the identified structure to existing assessments of the economic burden and climate exposure of the agri-food sector;
- to draw conclusions regarding the significance of the identified discrepancy for sectoral decisions and agricultural policy.

The study has five limitations:

1. The focus of the analysis is on perception, not risk: the reports reflect the views of the managers surveyed, rather than measured exposure;
2. The lower limit of the period is 2023, with the 2020-2022 editions excluded for methodological reasons set out in the methodology section;
3. The study does not measure sector-specific risks or assess the adaptive capacity of Bulgarian agriculture, and the link to the agri-food sector is interpretative and relies on external sources for the exposure;
4. The composition of the national sample varies from one edition to the next, which limits the comprehensiveness of the dynamic analysis for individual countries;
5. The size of the national samples is not published by the WEF, and it is therefore not possible to assess the statistical significance of the differences between neighbouring countries.

LITERATURE REVIEW

The literature on which this study is based falls into three main areas: the discrepancy between the perception of risk and objective exposure to risk in agriculture; criticism of the WEF reports as a source; and assessments of the agri-food sector's exposure to climate change.

Research into adaptive behaviour in agriculture has identified what is known as the 'risk-action gap'. The perception of climate risk often acts as a necessary but insufficient condition for adaptation, as the relationship between perception and the measures taken is not straightforward (van Valkengoed & Steg, 2019). Some studies find a significant positive effect (Abid et al., 2015), whilst others report a weak or absent relationship, citing financial constraints and practical considerations as stronger motivators than risk perception itself (Huang et al., 2024). A meta-analysis of 106 studies across 23 countries found that climate experience and knowledge, often regarded as key drivers of adaptation, are in fact weakly associated with it, unlike self-efficacy and social norms (van Valkengoed & Steg, 2019).

A separate line of research compares farmers' perceptions with meteorological data and identifies systematic discrepancies, including differences in the understanding of what constitutes 'normal conditions' and drought.

This study follows in this tradition, but at a different level of analysis: it examines business leaders' perceptions of the country as a whole, rather than individual farmers' perceptions of their own farms. This represents a gap in the literature, as the national level of risk perception is rarely correlated with sectoral exposure.

The WEF reports are a widely used source, but they are also subject to criticism. Aven (2025) reviews the risk-science methodology of the reports, focusing on the 2024 edition, and concludes that there are several problematic aspects leading to an inaccurate characterisation of the risks. To this should be added a fact stated in the reports themselves: the reports are produced in partnership with Marsh McLennan and Zurich Insurance Group - an insurance broker and an insurer, respectively. This is not interpreted here as grounds for dismissing the source, but rather as a methodological clarification: the entities co-funding the study operate in a market that may be affected by its findings.

The specialist literature on Bulgaria identifies agriculture as the sector of the national economy most vulnerable to climate change. Georgieva et al. (2022) document the effects on yields in years of drought based on an analysis of agrometeorological conditions for the period 1986-2015 and find that vulnerability varies by region, with the areas of most intensive agriculture being the hardest hit- the North-East and North-Central regions.

Motta et al. (2025) assess the economic consequences of drought for 1,366 administrative units in Europe and identify significant regional disparities: losses are increasing in the southern, south-eastern and western regions and decreasing in the northern regions. According to the study, some regions may face expected annual losses of between 1 and 2 per cent of regional gross domestic product, whilst in certain regions agriculture could lose between 10 and 15 per cent of its economic output. An earlier assessment by Cammalleri et al. (2020) as part of the PESETA IV project ranks Romania and Bulgaria among the most affected economies in the EU relative to the size of their economies, with losses reaching nearly 0.5 per cent of gross domestic product in Romania, Bulgaria and Greece in the event of a 3°C rise in temperature. This assessment refers to the 1981-2010 baseline period and is structural in nature.

The economic weight of the sector in the countries under review is set out in Table 1.

Table 1. Share of agriculture in gross domestic product, 2024

Country	Share of GDP
Greece	3,2%
Romania	2,5%
Bulgaria	1,8%
Croatia	1,8%
the Czech Republic, Poland, Slovenia, Hungary	below 1,8%
EU-27 (average)	1,2%

Source: Eurostat (2025). Key figures on the European food chain - 2025 edition.

The indicator is presented for 2024, rather than as an average for the period 2023-2026, for three reasons. Eurostat publishes country-specific shares for 2024; for 2023, only changes relative to 2009 are available; for 2025, no shares have been published; and 2026 has not yet ended. Alternative databases provide annual time series using a different methodology, which includes forestry and fisheries, and therefore give a figure of 2.07 per cent for Bulgaria compared with 1.8 per cent according to Eurostat; combining the two sources would yield a value that does not correspond to either methodology. The share is a structural indicator with slow-moving trends - for Bulgaria, it decreased by 1.4 percentage points over the period 2009-2024 - which is why 2024, the mid-point of the observed period, is representative.

The breakdown of drought-related losses by sector is set out in Table 2.

Table 2. Breakdown of drought-related losses by economic sector

Sector	EU, 2025 estimate	EU, 2020 estimate
Agriculture	around 55%	53%
Power Engineering	20%	23%
Water supply	15%	14%
Buildings and infrastructure	8%	8%
Transport	2%	2%

Source: Motta et al. (2025), base period 1991-2020; Cammalleri et al. (2020), PESETA IV, Task 7, base period 1981-2010

No breakdown for Central and Eastern Europe is published in any of the sources; the available regional unit is the 'Continental' sub-region according to the IPCC classification, to which Bulgaria and Romania belong and for which the share of agriculture is estimated at 50 per cent. Both estimates relate to modelled current conditions, rather than to specific years within the observation period.

A comparison of the two assessments is revealing in two respects:

1. The distribution is consistent: two independent studies with different base periods - one ending in 2010, the other in 2020 - yield virtually identical shares. The differences do not exceed three percentage points in any sector, and for buildings and transport the figures are identical. This means that this is a structural feature of the European economy, rather than a snapshot dependent on specific events.

2. Agriculture is the sector most affected in both assessments, accounting for more than half of the total losses. The ratio relative to the sector's economic weight is disproportionate: agriculture accounts for 1.2 per cent of the Union's gross domestic product, but bears over 53 per cent of the economic losses caused by drought. For Bulgaria, this discrepancy is even more

pronounced, as the sector's share of the national economy is half a percentage point above the EU average, whilst the country ranks among those most affected in terms of relative losses.

The research logic of the article follows from the three strands outlined in this review. The agri-food sector makes a small contribution to gross domestic product but is highly exposed to climate risks. If risk perception influences the prioritisation of resources, the systematic absence of climate risk from the national perception, despite documented high exposure of the most vulnerable sector, represents a discrepancy of economic significance. The study does not claim that the risk perception of the surveyed managers directly determines farmers' adaptation behaviour; rather, it argues that it shapes the environment in which decisions on investment, insurance and public support are made. The economic models for managing this risk - optimisation, insurance and stochastic models - have been systematised for the Bulgarian context by Dzhandarmov (2024), who identifies agriculture as one of the highest-risk sectors of the economy.

RESEARCH METHODOLOGY

The analysis covers four editions of the Global Risks Report - 2023, 2024, 2025 and 2026. Two types of data from each edition have been used. The Global Risks Perception Survey (GRPS) provides the global picture: respondents assess the severity of each risk over one-, two- and ten-year horizons; for the purposes of this study, the short-term two-year ranking has been used. The Executive Opinion Survey (EOS) provides the national perspective: business leaders identify the five risks they believe pose the greatest threat to their own country over the next two years.

National data are published in the annexes: 2026 edition - Annex C; 2025 - Annex C, Table C.2; 2024 - Annex C, Table C.2; 2023 - Annex B, Table B.2. The data has been extracted from the text versions of the files and cross-checked line by line against the original annexes. The classification into groups follows the World Economic Forum's own categorisation into five groups - economic, environmental, geopolitical, social and technological. The advantage of this approach is that it avoids the need to introduce a custom taxonomy.

An average normalised position by group has been used to provide an overall picture. This indicator addresses the issue of varying numbers of risks across individual issues. Each position is converted using the formula $(n - \text{rank}) / (n - 1)$, where n is the number of risks in the relevant issue, after which the values are averaged across the group. A value of 1.000 corresponds to the highest weighting, and 0.000 to the lowest.

The comparability of the publications in terms of key methodological parameters is set out in Table 3.

Table 3. Comparability of the editions according to methodological parameters

Publication	Number of risks	GRPS respondents	EOS respondents	Measured quantity
2023	32	1 249	≈12 000 / 121	Probability and impact
2024	34	1 490	≈11 000 / 113	Weight
2025	33	over 900	over 11 000 / 116	Weight
2026	33	over 1 300	over 11 000 / 116	Weight

Source: World Economic Forum (2023, 2024, 2025, 2026), 'Overview of methodology' sections of the respective editions. The number of respondents in the EOS is given alongside the number of economies covered.

The 2020, 2021 and 2022 editions have been excluded from the comparative framework for four separate reasons, each of which is sufficient in its own right:

1. Change in the measured variable: up to and including the 2022 edition, the GRPS assesses risks by probability and impact, whilst from the 2023 edition onwards, the assessment is based on severity - a single indicator defined as the impact on the population, the economy or natural resources on a global scale. This is not a change in scale, but a change in the measured variable; consequently, the average values from the two periods are not comparable.

2. A change in time horizons: earlier editions used two-year and ten-year horizons, depending on the nature of the issue under consideration, whilst the 2023 edition introduces three time frames - current crises, two years and ten years.

3. Break in the list of risks: in 2023, the list was revised with the addition of two new risks and the splitting of 'failure of climate action' into two separate risks; the report itself notes that the names and definitions of the remaining risks have been revised, consolidated or expanded.

4. Pandemic distortion: the 2020- 2022 editions were compiled under circumstances in which health and social risks carried exceptional weight, incomparable to that of the rest of the period.

The possible alternative- a five-year or longer period - would add one or more data points at the cost of a sample that is incomparable in design. The four-year timeframe is consistent: all four editions use the same metrics, the same timeframes and a similar list of risks.

The methodological limitations are:

1 The composition of the national sample varies: Croatia is missing in 2023, and Slovakia is missing in 2024 and 2026, making a dynamic analysis for these two countries impossible.

2. The names of the risks vary from edition to edition, as does their number (35 in the 2023 EOS, 36 in the 2024 edition, and 33 in later editions); therefore, the comparison is based on meaning rather than literal correspondence; For example, "Labor shortage" from 2024 and "Labor and/or talent shortage" from 2025 are treated as a single risk.

3. The survey sample size varies- from over 1,400 respondents in the GRPS in 2024 to about 900 in 2025 - and the SIF does not publish data that would allow one to assess whether the decline affects individual occupational and regional groups equally.

4. In Appendix B of the 2023 edition, Hungary appears twice with different data; the duplicate entry has been checked and the second entry has been used where referenced.

Key findings. The trends in global risk perceptions, broken down by thematic groups, are presented in Table 4.

Table 4. Average normalised position by risk category

Risk categories	2023	2024	2025	2026	Δ
Икономически	0,536	0,439	0,406	0,500	-0,036
Eco-friendly	0,785	0,581	0,547	0,448	-0,337
Geopolitical	0,452	0,386	0,531	0,427	-0,025
Public	0,435	0,572	0,580	0,569	+0,134
Technological	0,280	0,500	0,458	0,484	+0,205

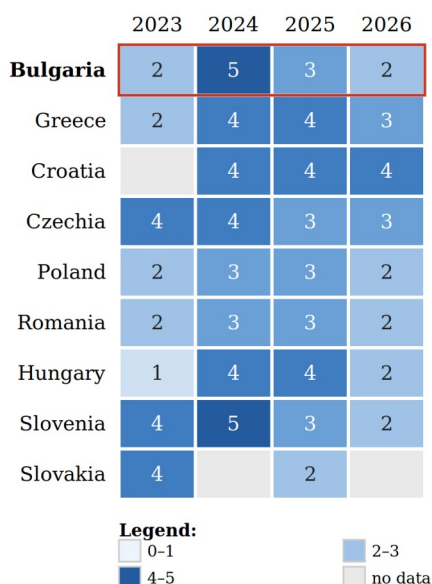
Source: World Economic Forum (2023, 2024, 2025, 2026), Global Risks

Perception Survey, short-term biennial ranking; author's calculations. The environmental group lost 0.337- an entire order of magnitude more than any other group - and did so steadily, without a single upward trend over four years. The number of environmental risks in the top ten positions falls from five to two as early as 2024 and does not recover thereafter. The 2026 edition notes that all environmental risks are declining in terms of absolute severity, not just in rank. The economic group follows a V-shaped trajectory: from 0.536 in 2023, it falls to 0.406 in 2025 and returns to 0.500 in 2026. Social risks are the only group to show sustained growth,

which then stabilises - from 0.435 to around 0.570. It is these risks that displace environmental risks from the top of the ranking, rather than economic risks.

The structure of risk perceptions in Bulgaria and the eight countries included in the comparison over the entire period is summarised in Figure 1. The left-hand map shows the number of economic risks in the top five for each country, by publication, whilst the right-hand map shows the presence and type of environmental risk.

Map 1. Economic risks (count, 0-5)



Map 2. Ecological risk

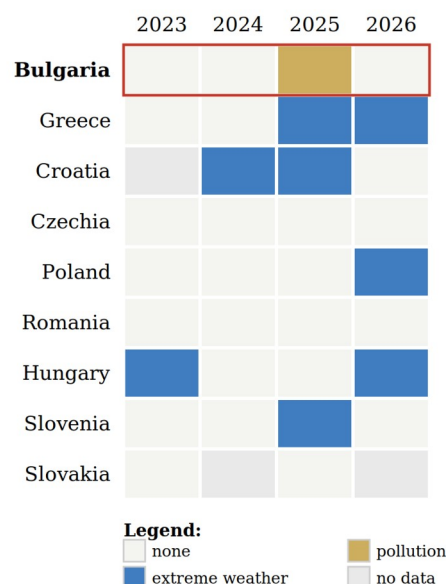


Figure 1. Breakdown of risk perceptions in Bulgaria and Central and Eastern Europe by publication: economic risks (number) and environmental risk

Source: World Economic Forum (2023, 2024, 2025, 2026), Executive Opinion Survey; risks grouped according to the SIF classification and the author's calculations. The classification corresponds to Table 1. Grey cells indicate that the country was not included in the sample for the relevant edition.

A summary of the Bulgarian data for the entire period is presented in Table 5.

Table 5. Structure of risk perception in Bulgaria, 2023-2026

Publication	Economic risks	Environmental risk	Key risk
2023	2 от 5	none	Inflation
2024	5 от 5	none	Economic downturn
2025	3 от 5	Pollution (5th place)	Inflation
2026	2 от 5	none	Economic downturn

Source: World Economic Forum (2023, 2024, 2025, 2026), Executive Opinion Survey; compiled by the author.

The research hypothesis is confirmed for the entire period. Bulgaria did not list any extreme weather events among its top five in any of the four editions. The only environmental issue mentioned is pollution, which ranked fifth in 2025. The absence of climate risk is a consistent feature of national perception, rather than a fluctuation between individual editions.

However, economic concentration does not follow a linear trend. The sequence 2- 5- 3- 2 represents a peak in 2024, rather than a sustained rise or fall. The 2024 edition reflects the EOS from 2023 - a period of peak inflation expectations in the region. This is a reaction to a specific macroeconomic moment, rather than a structural development. For this reason, phrasing that describes ‘increasing’ or ‘declining’ economic dominance would be inaccurate.

Two observations remain consistent throughout the entire period:

1. Economic risk ranks first in all four editions- inflation in 2023 and 2025, and an economic downturn in 2024 and 2026;

2. Climate risk has not featured in the top five in any of the four years.

It is precisely the combination of these two constants, rather than the dynamics between them, that constitutes the key finding of the study.

A methodological clarification is required regarding environmental risks. Pollution and extreme weather events are different risks, although they are grouped together in the WEF classification. When broken down by group, the conclusion for 2025 is correct and specifically tailored to climate, and the 2025 edition does not differ from the other three.

In the other countries, a shift in the nature of the leading risks can be observed. In 2023, geopolitical risks feature in the top five for all eight countries included, whilst in 2026 such risks remain only in Poland and, to some extent, in Greece and Slovenia. Conversely, social risks are increasing significantly, which is consistent with the global trend shown in Table 4. The composition of countries with environmental sensitivity varies between editions: in 2024, only Croatia faces environmental risk; in 2025, Greece, Croatia and Slovenia; and in 2026, Greece, Poland and Hungary.

DISCUSSION AND CONCLUSIONS

The study identifies two consistent constants in the structure of Bulgarian national risk perception during the period 2023-2026. Economic risk ranks first in all four surveys, whilst climate risk is absent from the top five throughout the entire period. It is the combination of these two constants, rather than the dynamics between them, that constitutes the main finding.

A comparison with the agri-food sector’s exposure to climate change reveals a discrepancy. The sector accounts for 1.8% of the country’s gross domestic product, yet drought causes over half of the economic losses in European agriculture, and specialist literature identifies the sector as the most vulnerable in the national economy to climate change. Public perception does not reflect this exposure.

The discrepancy identified is not unusual at a regional level, but is more pronounced in Bulgaria than in neighbouring countries. Greece, Poland and Hungary report environmental risk in the 2026 edition; Bulgaria does not report any such risk in any of the four editions. At the same time, the composition of countries classified as environmentally sensitive varies between editions, suggesting that environmental perception in the region is unstable and likely event-driven.

Several recommendations could be drawn from these findings:

1. When developing sectoral adaptation policies, national risk perception should not be relied upon as an indicator of priority, as the data show a systematic discrepancy between exposure and perception.

2. Information and advisory activities in the agricultural sector should take into account that climate risk is not part of the prevailing perception of risk within the business environment, which has implications for the way in which adaptation measures and insurance products are formulated. The available set of economic models for risk management in agriculture (Dzhandarmov, 2024) suggests that their application depends on the prior recognition of risk as a priority - a condition that the absence of climate risk in perceptions, as established here, does not ensure.

3. Prioritizing public support for adaptation should be based on measured risk exposure rather than expressed concern, insofar as the two do not coincide.

Future research could compare national perceptions of risk with those of farmers themselves. The present study examines business leaders' perceptions of the country as a whole, and a comparison with the farm level would make it possible to assess whether the discrepancy is also evident there.

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