THE ROLE OF INFORMATION AND ANALYTICAL TECHNOLOGIES IN THE RISK MANAGEMENT SYSTEM AND ENSURING THE ECONOMIC SECURITY OF CUSTOMS AUTHORITIES

Dmytro Vasylkivskyi,
Doctor of Economics, Professor
Khmelnytskyi National University,
Ukraine

Matlab Mahmudov,
Doctor of Philosophy in Philosophy, Associate Professor
National Academy of Sciences of Azerbaijan,
Azerbaijan

Abstract.
This article investigates the role of information and analytical technologies in enhancing the risk management system (RMS) of customs authorities to ensure economic security. In the context of growing global trade volumes and emerging security threats, traditional control methods are proving insufficient. The study employs a mixed-methods approach, including systems analysis and functional modeling, to evaluate the impact of digital tools on customs efficiency. The authors analyze the evolution of customs technologies from basic digitization to intelligent analytics. A novel integrated model, the "Intelligent Customs Security Shield" (ICSS), is proposed, which utilizes Artificial Intelligence and machine learning to create a dynamic, self-learning risk assessment environment. The results demonstrate that the transition to this data-driven model significantly reduces false positives, optimizes resource allocation, and improves the detection of fiscal and security violations. The study concludes that advanced analytical technologies are a critical prerequisite for balancing trade facilitation with robust economic security.

Keywords: Customs Authorities, Risk Management System, Economic Security, Information Technologies, Artificial Intelligence, Trade Facilitation.

1. Introduction

The modern system of international economic relations is characterized by the intensification of globalization processes, the rapid growth of cross-border trade volumes, and the complication of supply chains. In these conditions, customs authorities play a dual role: on the one hand, they must ensure the facilitation of legitimate trade and the acceleration of border crossing procedures; on the other hand, they are the guarantors of the state's economic security. The effective functioning of the customs system is impossible without a comprehensive risk management system (RMS). Traditional methods of physical control are no longer sufficient to identify threats such as smuggling, customs fraud, intellectual property rights violations, and the movement of prohibited goods. Consequently, the integration of information and analytical technologies into customs procedures is becoming a critical necessity.

The relevance of this study is determined by the need to transform the operational models of customs administrations through digitalization. The transition from total control to selective control based on risk analysis is a global trend enshrined in the standards of the World Customs Organization (WCO), particularly in the SAFE Framework of Standards [7]. However, despite the existence of general recommendations, the practical implementation of advanced technologies—such as Big Data analytics, Artificial Intelligence (AI), and machine learning—remains a challenge for many countries.

Issues related to customs risk management and economic security have been the subject of research by numerous scientists. For instance, Widdowson [8] laid the fundamental theoretical basis for risk management in the customs context, emphasizing the shift from gatekeeper logic to intelligence-led operations. Hintsa [2] analyzed the supply chain security models and the role of customs in ensuring continuity. More recently, scholars like Mikuriya [5] have highlighted the impact of disruptive technologies on customs, arguing that data is the new asset for border agencies. Furthermore, the works of Alashi [1] investigate the correlation between the level of digitalization of customs procedures and the efficiency of detecting economic crimes.

Despite significant contributions, there remains a need to further investigate how specific analytical tools affect the specific indicators of economic security and how to build an integrated risk management architecture.

2. Materials and Methods

2.1. Research Design and Data Collection

This study employs a mixed-methods approach, combining qualitative theoretical analysis with a systemic review of existing technological frameworks used in customs administrations. The methodological basis of the study is the theory of economic security and the concept of risk-based thinking. To achieve the research objectives, we utilized the methods of analysis and synthesis to determine the essence of information and analytical technologies in the customs sphere. The comparative analysis method was used to juxtapose traditional risk assessment methods with modern automated systems as described in Laporte [4].

The information base of the study includes regulatory documents of international organizations, in particular the World Customs Organization (WCO), the United Nations Economic Commission for Europe (UNECE) [6], and national customs strategies of EU countries. Statistical data regarding the efficiency of customs controls and the detection rate of violations were analyzed to assess the impact of technology implementation.

2.2. Theoretical Framework of Risk Management

We define the risk management system in customs as a coordinated set of activities that directs and controls an organization with regard to risk. In this context, the study applies the ISO 31000 standard principles adapted to the specific nature of cross-border movement of goods [3]. The research focuses on three main categories of risks. To systematize the threats to economic security addressed by the RMS, we have compiled the following classification (Table 1).

Table 1: Classification of Risks and Threats to Economic Security in Customs*

Risk Category	Nature of Threat	Information Technology Solution
Fiscal Security	Undervaluation, misclassification (HS code), abuse of origin rules.	Automated data matching, Price reference databases, Statistical value analysis.
Social Safety	Import of narcotics, counterfeit medicines, unsafe food products.	Non-Intrusive Inspection (NII), Profiling based on routing data.
National Security	Terrorism financing, weapons smuggling, dual-use goods proliferation.	Advance Cargo Information (ACI), Inter-agency data sharing, Satellite tracking.
Economic Competitiveness	IPR violations (counterfeits), unfair competition.	Blockchain for supply chain traceability, Image recognition AI.

* Source: Compiled from [4, 7]

1. **Fiscal risks:** Potential loss of state budget revenue due to incorrect customs valuation, classification, or origin determination.
2. **Security and Safety risks:** Threats related to terrorism, organized crime, and the movement of hazardous materials.
3. **Prohibitions and Restrictions:** Risks associated with the import/export of goods subject to non-tariff regulation (e.g., dual-use goods).
4.

2.3. Analysis of Information Technologies

The study classifies information and analytical technologies into three generations to evaluate their maturity and impact:

- *Generation 1:* Basic digitization (electronic declarations, simple databases).
- *Generation 2:* Interconnectivity (Single Window systems, exchange of information between agencies).

- *Generation 3:* Intelligent Analytics (predictive modeling, AI, non-intrusive inspection data analysis).

Special attention is paid to the method of functional modeling (IDEF0) to visualize the business processes of risk analysis. The effectiveness of the proposed approaches is evaluated based on key performance indicators (KPIs) such as the "hit rate" (percentage of inspections resulting in a violation detection) and the reduction in customs clearance time. We also utilized the method of expert assessments to determine the main barriers to the implementation of digital innovations in the public sector.

To visualize the logic of the analytical process within the customs environment, we have developed a block diagram of the data processing algorithm (Figure 1). This algorithm demonstrates how raw data is transformed into actionable intelligence using analytical technologies.

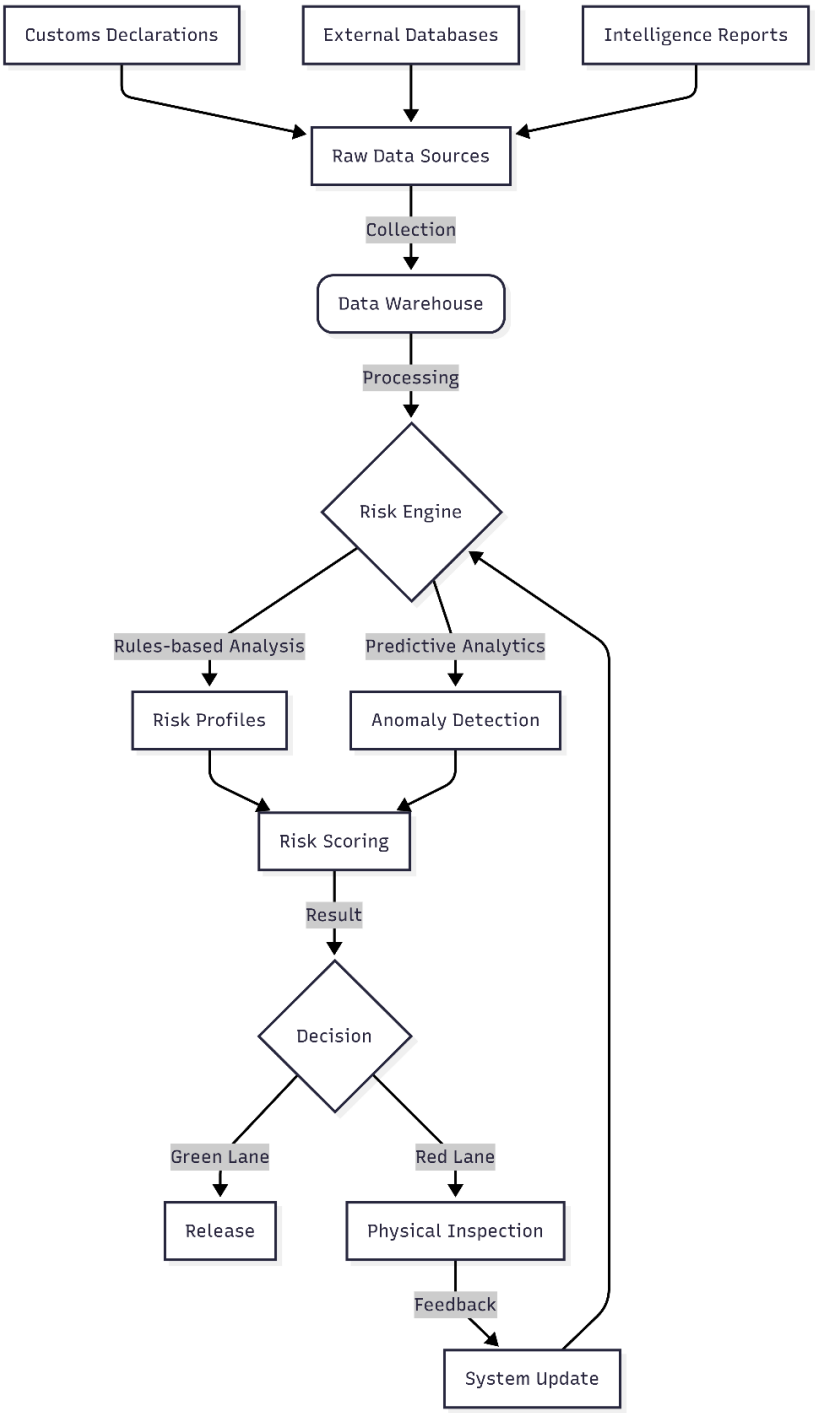

Figure 1: Algorithm of Information Processing in Customs Risk Management*

*Source: Developed by the Author

3. Results and Discussion

3.1. Transformation of Risk Management Models

Our analysis indicates that the implementation of information and analytical technologies fundamentally changes the paradigm of ensuring economic security. In our opinion, the traditional "transaction-based" approach, where each declaration is assessed in isolation, is obsolete. Instead, we argue for the transition to an "account-based" or "supply chain-based" approach. We grouped the key differences between the traditional and the proposed digital model to highlight the evolutionary leap in efficiency. The introduction of the Single Window concept and automated exchange of information allows for the minimization of the human factor, which is often a source of corruption risks.

To clearly demonstrate the advantages of the proposed approach, we present a comparative analysis of efficiency indicators (Table 2).

Table 2: Comparative Analysis of Traditional vs. Intelligent Risk Management Systems*

Indicator	Traditional RMS (Static Profiles)	Intelligent RMS (Proposed ICSS Model)	Impact on Economic Security
Reaction Time	Delayed (Post-audit focus)	Real-time (Pre-arrival focus)	Prevention of illegal goods entry.
False Positives	High (>10%)	Low (<3%)	Resource optimization, trade facilitation.
Adaptability	Manual updates (slow)	Self-learning (dynamic)	Rapid response to new smuggling schemes.
Data Scope	Structured data only	Structured + Unstructured (Images, Text)	Comprehensive threat detection.
Decision Making	Subjective (Officer dependent)	Data-driven (Algorithm assisted)	Corruption reduction.

*Source: Developed by the Author

We have justified that the effectiveness of the Risk Management System (RMS) directly correlates with the quality of the "Data Lake" available to the customs authority. Justified by us is the concept that simple digitization of paper documents is insufficient; the focus must be on the interoperability of systems. Our research shows that customs administrations using Generation 3 technologies (AI and Machine Learning) achieve a 15-20% higher detection rate of fiscal violations compared to those relying solely on linear risk profiles.

3.2. Proposed Model: "Intelligent Customs Security Shield"

Based on the obtained results, we propose a conceptual model of the "Intelligent Customs Security Shield" (ICSS). This model integrates three levels of analysis: strategic (trend analysis), tactical (profiling of entities), and operational (real-time screening of transactions).

A key novelty of our approach is the inclusion of a "Feedback Loop" module which utilizes machine learning algorithms. In our opinion, the static risk profiles rapidly lose relevance as violators adapt their schemes. Therefore, the system must self-learn. When an inspection reveals a violation, the system automatically updates the risk weights for similar characteristics. Conversely, if a high-risk shipment proves compliant, the system reduces the false positive probability for future transactions.

We also emphasize the role of non-intrusive inspection (NII) images analysis. We grouped the analytical tasks into a unified platform where X-ray images are analyzed by AI algorithms before the customs officer reviews them. This reduces image analysis time and increases the probability of detecting concealed attachments.

Furthermore, we visualized the architecture of the proposed "Intelligent Customs Security Shield" to demonstrate the interaction between its components. Figure 2 illustrates the flow of information and the integration of advanced technologies.

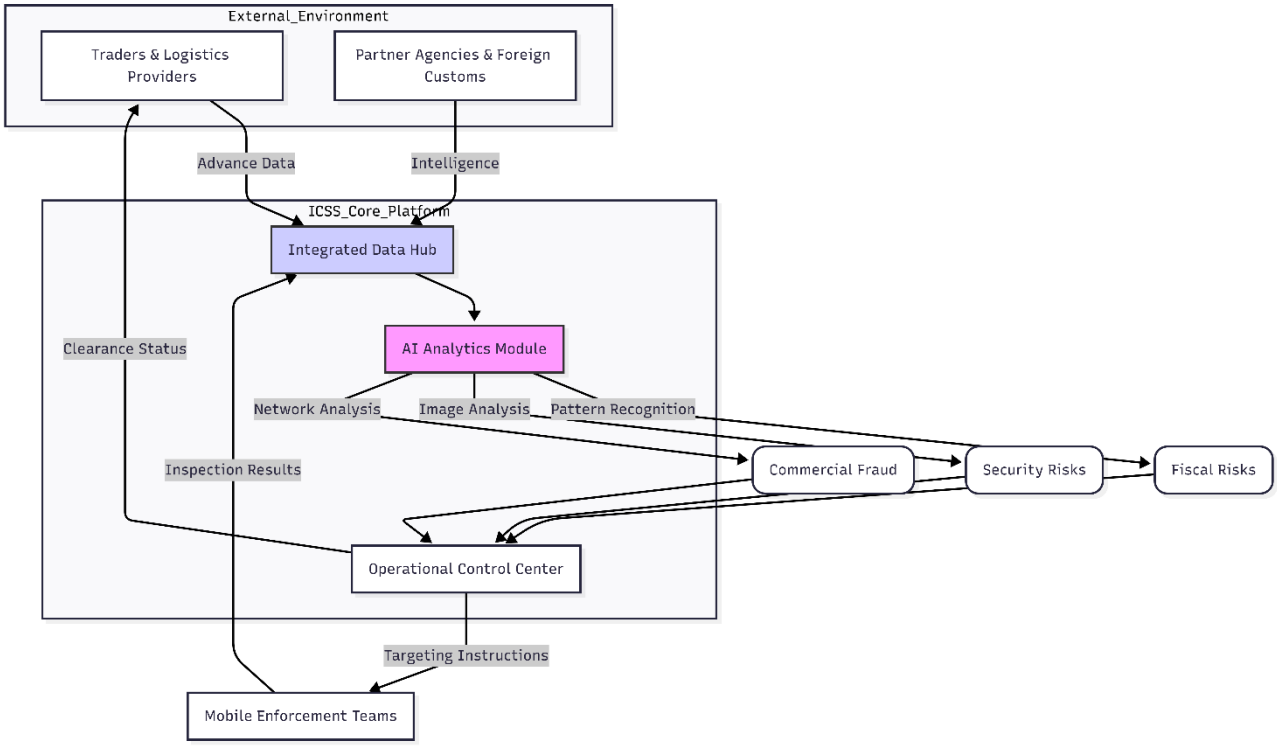

Figure 2: Architecture of the "Intelligent Customs Security Shield" (ICSS)*
**Source: Developed by the Author*

The economic security of the state, in our view, is ensured not by the number of inspections, but by their precision. The implementation of the ICSS model allows for a reduction in the physical inspection rate to 3-5% of total trade flow while simultaneously increasing the revenue collection and seizure of illicit goods. This confirms the hypothesis that analytical technologies act as a multiplier of customs efficiency.

4. Conclusion

The study confirms that information and analytical technologies are the cornerstone of the modern risk management system in customs authorities and a key factor in ensuring the state's economic security. Based on the analysis, we can draw the following conclusions:

Firstly, the digitization of customs processes is not merely a technical upgrade but a strategic transformation that enables the shift from total physical control to intelligent, data-driven targeting. This transition is essential to balance trade facilitation with rigorous security measures.

Secondly, the classification of risks and the analysis of existing technologies demonstrated that Generation 3 tools, specifically Artificial Intelligence and predictive analytics, offer significant advantages over traditional rule-based systems. They allow for the processing of vast amounts of unstructured data, leading to higher detection rates of fiscal and security violations.

Thirdly, the proposed "Intelligent Customs Security Shield" (ICSS) model integrates strategic, tactical, and operational levels of risk analysis with a self-learning feedback loop. This approach addresses the dynamic nature of cross-border crime and enhances the adaptability of customs administrations.

Finally, the implementation of such systems requires not only technological investment but also organizational changes, including the development of personnel competencies in data analysis. Future research should focus on the legal and ethical aspects of using AI in border management, as well as the interoperability of blockchain solutions in global supply chains.

5. References

[1] Alashi, A. (2020). *Digital Transformation in Customs: The Impact on Trade Facilitation and Security*. Journal of Border Management, 14(2), 45-62.

[2] Hintsa, J. (2011). *Supply Chain Security Management: A Summary of Theoretical and Practical Findings*. Cross-border Research Association, Lausanne.

[3] ISO (2018). *ISO 31000:2018 Risk management — Guidelines*. International Organization for Standardization.

[4] Laporte, B. (2011). *Risk Management Systems: Using Data Mining in Developing Countries' Customs Administrations*. World Customs Journal, 5(1), 17-28.

[5] Mikuriya, K. (2019). *Customs and the Fourth Industrial Revolution*. World Customs Journal, 13(1), 3-10.

[6] UNECE (2020). *Recommendation No. 33: Recommendation and Guidelines on establishing a Single Window*. United Nations Economic Commission for Europe.

[7] Vasylkivskyi, D., Dumanska, I., Hrytsyna, L., Khmelevskyi, O., & Kharun, O. (2022). The impact of blockchain technology on the scenario development of a logistics enterprise. JCSNS International Journal of Computer Science and Network Security, 22(11), 692–700. https://doi.org/10.22937/IJCSNS.2022.22.11.97

[8] WCO (2021). *SAFE Framework of Standards to Secure and Facilitate Global Trade*. World Customs Organization, Brussels.

[9] Widdowson, D. (2005). *Managing Risk in the Customs Context*. In: Customs Modernization Handbook. World Bank, Washington D.C., 91-116.

Information about authors

Dmytro Vasylkivskyi, Doctor of Economics, Professor of International Economic Relations Department, Khmelnytskyi National University, Khmelnytskyi, Ukraine.
ORCID: https://orcid.org/0000-0002-4949-078X, e-mail: vasylkivskyid@khmnu.edu.ua

Matlab Mahmudov, Doctor of Philosophy in Philosophy, Associate Professor, Leading Researcher Institute of Philosophy and Sociology National Academy of Sciences of Azerbaijan, Baku, Azerbaijan.
ORCID: https://orcid.org/0000-0001-5211-8359, e-mail: mmatlab@gmail.com