

SECTION 8. INNOVATIVE ECONOMY

DOI: 10.46299/ISG.2025.MONO.ECON.1.8.1

8.1 Legal implications of big data and artificial intelligence in customs supervision

Artificial intelligence and big data are key technologies of digital transformation that are now actively being implemented in all spheres of human life. Artificial intelligence is defined as the ability of computer systems to imitate human intelligence by analyzing information and making decisions based on machine learning and algorithmic models [208]. At the same time, big data refers to a set of information flows of enormous volume that require complex analytical methods for processing and interpretation [209].

The integration of big data and artificial intelligence (AI) into customs supervision has the potential to revolutionize global trade by enhancing efficiency, accuracy, and transparency. With the exponential growth of international trade and digital transactions, customs authorities are increasingly relying on these technologies to streamline procedures, detect fraudulent activities, and improve risk management. However, as these technologies evolve, they also introduce significant legal challenges, particularly regarding data privacy, security, and accountability. The legal implications of using AI and big data in customs supervision are critical, as they raise questions about compliance with international regulations, the protection of personal data, and the responsibilities of automated decision-making systems. Addressing these issues is crucial for ensuring that the adoption of advanced technologies aligns with legal and ethical standards, safeguarding both commercial interests and individuals' rights.

Applying AI and big data analytics in customs is an essential step towards enhancing the efficiency and transparency of customs control. The interaction of these technologies creates new opportunities for customs control, enabling the automation of cargo inspection processes, risk prediction, and the detection of violations in international trade. The digitalization of customs procedures significantly reduces the processing time of customs declarations and improves the accuracy of inspections

[210]. Additionally, it helps decrease the level of smuggling and customs offenses through automated monitoring of cargo movement [211]. Moreover, optical character recognition (OCR) technologies in international transportation allow for the rapid processing of customs documents and minimize the risk of human errors [212]. All these innovations increase the efficiency of customs procedures and reduce corruption risks [213].

However, implementing AI and big data in customs control raises serious discussions. Privacy and personal data protection issues arise in accordance with international standards such as GDPR and CCPA, as automated systems can process large volumes of sensitive information, requiring reliable security mechanisms and transparent regulation. Furthermore, the issue of accountability for algorithm decisions emerges: who will be responsible in case of an erroneous customs decision – the AI developer, government authorities, or cargo owners? [214]. There are also risks of algorithmic discrimination and data distortion, which may affect the fairness of customs supervision [215].

The Use of AI-Based Analytics for Detecting Violations in Trade

Technological innovations are evolving faster than ever, creating both opportunities and challenges. In today's world, the volume of international trade is increasing, making it more difficult to detect violations and fraudulent schemes. Traditional data analysis methods no longer provide sufficient speed and accuracy in identifying risks. Artificial intelligence can play a key role in customs control by enabling the efficient analysis of large volumes of data to detect potential violations. The implementation of analytical algorithms allows customs authorities to analyze customs declarations, transactions, and historical data to identify patterns that may indicate possible offenses [216].

In East Africa, the Regional Electronic Cargo Tracking System reduces smuggling levels by allowing customs authorities to track cargo movements in real-time and identify potential risks [211]. In China, due to the specific characteristics of the system, cross-border cargo clearance requires multiple documents, so AI-based automated systems analyze customs declarations and documents to detect suspicious

transactions, increasing the accuracy and efficiency of the process [217]. These systems apply machine learning methods and algorithmic analysis to identify fraudulent schemes rapidly. In Hungary, implementing AI has improved the efficiency of official inspections conducted by the customs administration [210].

Brazil is addressing the challenges of rapid e-commerce growth within the customs framework by focusing on efficiency and trade flow control. The country uses artificial intelligence and the Authorized Economic Operator (AEO) program. This scheme provides reliable traders with advantages in customs procedures. AI-driven automated risk analysis also transforms and facilitates customs processes [218]. Using blockchain technology in combination with AI contributes to greater transparency in customs control and supply chains overall [219].

Colombia's experience provides valuable lessons for other countries on integrating AI into customs operations. Optimization of violation detection has enhanced the security of customs processes, but a system failure highlighted the importance of strengthening protection against malicious actors and ensuring effective communication. Investments in system upgrades and artificial intelligence are crucial for maintaining inspection accuracy [220].

Table 1 presents a comparison of traditional and AI-based automated customs control.

Table 1

Comparison of Traditional and AI-Based Automated Customs Control

Criterion	Traditional Control	AI-Based Automated Control
Processing Speed	Slow due to manual verification	High due to automation
Accuracy of Violation Detection	Limited by human factor	High due to algorithmic analysis
Corruption Risks	High due to human influence	Low due to objective analysis
Costs	High due to inspector wages	Optimized through automation

Author's Contribution

Table 1 shows that traditional customs control has a slow processing speed due to manual verification, limited accuracy in detecting violations due to human factors, and high corruption risks. The costs of traditional control are also higher due to the wages of inspectors. In contrast, AI-based automated control ensures high processing speed,

high accuracy through algorithmic analysis, low corruption risks, and optimized costs due to automation.

Thus, the use of AI in customs control has the potential to enhance inspection efficiency and reduce costs significantly. However, it is crucial to maintain a balance between technological capabilities and legal regulations governing data processing in customs operations.

GDPR, CCPA, and Other Privacy Concerns in Customs Data Processing

Privacy and personal data protection issues are becoming increasingly important in today's globalized world, especially in customs data processing. The growing volume of international trade and digital technologies necessitates strict compliance with privacy standards to protect the rights of individuals and legal entities. The use of big data and artificial intelligence in customs processes significantly improves control efficiency, but at the same time, it raises concerns about personal data privacy.

Legislative initiatives such as the General Data Protection Regulation (GDPR) in the European Union and the California Consumer Privacy Act (CCPA) in the United States establish strict requirements for processing and storing personal information. Both laws share a common goal – ensuring control over personal data – yet differ in scope and specific requirements.

Table 2

Comparison of GDPR and CCPA

Characteristic	GDPR	CCPA
Territorial Scope	All companies processing EU citizens' data	Businesses working with California residents
Type of Protected Data	Any personal data	Only consumers' personal
Data Subject Rights	Access, rectification, erasure, processing restriction, data portability	Access, deletion, opt-out of data sale
Reporting Obligations	High	Moderate
User Control Over Data	Full	Limited
Penalties for Violations	Up to 4% of annual turnover or €20 million	Up to \$7,500 per intentional violation

Source [221, 222]

Customs authorities process large volumes of personal data, including information about cargo senders and recipients, customs clearance details and transaction history, financial data, and payments. Therefore, it is crucial to consider privacy requirements. For example, in the EU, customs services are required to ensure the anonymization or pseudonymization of personal data by Articles 25 and 32 of the GDPR [221]. Similarly, the CCPA mandates that companies disclose to consumers how their data is used and allow them to opt out of its sale [222].

Customs authorities and companies involved in international transportation face several challenges in personal data protection, including the rise in cyberattacks on customs databases, unauthorized use of personal data by third parties, and difficulties in cross-border data transfers [223]. However, modern technologies help ensure data security in customs processes. Table 3 presents technologies and their advantages for data security.

Table 3

Comparison of GDPR and CCPA

Technology	Advantages for Customs Data
Artificial Intelligence	Automation of analysis, detection of suspicious transactions
Blockchain	Data immutability, protection against unauthorized modifications
OCR Technologies	Fast reading of customs documents
Data Encryption	Protection against unauthorized access
Multi-Factor Authentication	Enhanced security for accessing customs systems

Джерело [223,224]

Managing the privacy of customs data is a critically important task for businesses and government agencies. Compliance with GDPR, CCPA, and other international standards is necessary to ensure personal and commercial information security. Implementing advanced technologies, such as blockchain and artificial intelligence, can significantly enhance the protection of customs data and improve the efficiency of processes in international trade.

Ethical and Legal Risks of Automated Customs Control

Automating customs control based on artificial intelligence (AI) and big data has significant potential to increase the efficiency of customs procedures, reduce

processing time for goods, and enhance process transparency. However, new ethical and legal risks require detailed analysis along with these positive changes. The key challenges include data privacy protection, liability for decisions made by automated systems, and the possibility of discrimination or bias in algorithms [224]. Table 4 presents a comparative analysis of the challenges and risks of computerized customs control.

Table 4

Comparative Analysis of Risks in Automated Customs Control

Risk Category	Potential Impact	Example Mitigation Measures
Ethical Challenges		
Transparency	Unpredictable decisions	Implement AI explanation mechanisms
Algorithmic Bias	Discrimination against goods/countries	Regular algorithm audits
Data Privacy Protection	Information leaks	Strengthen cybersecurity measures
Legal Risks		
Liability	Lack of clear norms	Development of international standards
Regulatory Barriers	Incompatibility of legislation	Global harmonization of rules

Авторська розробка

Automated customs systems make decisions based on algorithms that are not always transparent to users. This can create risks of unjustified blocking of goods or delays, affecting business and international trade [225]. AI systems may reproduce or even amplify existing biases, leading to unequal treatment of certain countries, companies, or goods. Automated systems process large amounts of data that include personal information. Inadequate protection levels can lead to data breaches or unauthorized use of information [220].

The question arises: who is responsible for AI's erroneous decisions – the technology provider, the customs authority, or the state? The lack of clear accountability can complicate legal disputes. Unifying customs procedures within international trade requires aligning regulatory approaches across countries.

Differences in the legal regulation of automated control may lead to conflicts between states.

Automating customs control holds significant potential, but its implementation has several ethical and legal challenges. To reduce risks, transparent decision-making mechanisms must be developed, compliance with international standards must be ensured, and data privacy protection must be strengthened. These aspects will help avoid potential threats and make customs procedures more effective and secure.

Artificial intelligence (AI) and big data are key in transforming customs monitoring, contributing to increased control efficiency, reduced violations, and optimized customs declaration processing procedures. One of the main advantages of implementing AI in customs is the ability to analyze large data sets in real-time, which helps effectively detect suspicious transactions and fraudulent schemes. Studies show that systems built on machine learning algorithms significantly reduce customs document processing times and improve decision-making accuracy. The experience of China, Africa, Colombia, and the European Union demonstrates the effectiveness of automated risk analysis mechanisms based on historical customs data and behavioral models of importers and exporters.

However, the automation of customs control brings several new challenges related to data confidentiality, personal information protection, and ensuring the transparency of algorithmic decisions. Regulations such as GDPR in the European Union and CCPA in the United States impose strict data processing limitations, requiring customs authorities to develop mechanisms to protect information and individuals' rights to control their personal data. This challenges cross-border information exchange as different jurisdictions apply distinct approaches to regulating digital privacy. Another critical issue is responsibility for errors made by automated systems. This aspect remains contentious and requires international legal regulation. Particular attention must be paid to algorithmic discrimination, as certain automated decisions may disproportionately affect specific groups in global trade activities.

Considering all these aspects, the future of implementing AI and big data analytics in customs monitoring depends on aligning technological development with legal and

ethical standards. In the future, more attention should be given to developing transparent algorithms, control mechanisms, and accountability for automated systems. Additionally, it would be beneficial to establish international standards for using AI in the customs sector, ensuring unified approaches to control and processing customs information.

Given current trends, it can be concluded that the efficiency and security of customs procedures will significantly improve with the implementation of AI. However, this process must be accompanied by careful legal regulation. Further research and the development of international standards will contribute to harmonizing technological innovations with legislative requirements, allowing for a balance between government agencies' needs and international trade participants' interests.