

Artificial intelligence in Customs

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Abstract

Artificial intelligence (AI) is getting to be an inevitable part of processes and activities in various fields. Customs control is becoming more extensive as a result of globalizing international trade. The new reality defines the implementation of AI as a priority factor for effectiveness in control activities, including customs. In this regard, how AI is applied in customs determines the relevance and interest of the study. The aim of this research is to present the role, application and challenges of AI in the activities of customs. In the study have been used the descriptive - analytical approach, the methods of comparison, analysis and synthesis

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Introduction

Digital transformation is rapidly changing the working environment and poses challenges for timely handling of new requirements and proper handling of ever-changing techniques and approaches. The digitisation of customs is now a rapidly evolving activity, encompassing the processes of introducing digital technologies into customs procedures and operations in order to increase the efficiency of customs controls, reduce costs and improve service to operators. Artificial Intelligence (AI) is an essential tool, technology and feature of digitizing processes in every field and activity, and new realities make its implementation in customs as a determining factor for control.

The modernisation of customs is a continuous process determined by the adequate use of available technologies, while paying attention to global trends and changes in legislation related to the subject and objectives of customs control and surveillance. *Decision 70/2008/EC on a paperless environment for customs and trade*, also referred to as the e-Customs Decision, is the key legislation related to the e-Customs initiative, promoting a shift to a coherent and interoperable electronic customs environment with a unified data system to facilitate communication between economic operators and customs authorities and to enhance security at the EU's external borders (2023 E-Customs Annual Progress Report, 2024). *E-customs* should serve the vision of Europe that by 2040 customs services in the EU will have achieved such a degree of integration that they will function as a single customs service or organization of the Union. This will manifest itself in shared infrastructure, seamless cooperation, data exchange, common training and shared identity (Ghiran et al., 2020). In this regard, how artificial intelligence (AI) is applied in customs determines the *relevance and interest* of the study.

The **aim** of this research is to present the role, application and challenges of AI in the activities of customs. In the study have been used the *descriptive - analytical approach, the methods of comparison, analysis and synthesis*.

1. Digital Customs

The effects of shifting to a paperless environment in customs are huge. Digitalization provides a significant opportunity to simplify customs processes and reduce administrative burden. This represents an advantage for both economic operators and customs organizations. Therefore, the digitisation of customs procedures should be implemented consistently at all levels and always lead

to a reduction in bureaucratic requirements for economic operators. Furthermore, it facilitates a more efficient and targeted analysis of risks, which could reduce the workload of both customs control entities - customs authorities and economic operators - and thus improve operations (Digitalization and Reduction of Bureaucracy, 2021).

According to Collosa (2020), *IT is influencing the role of Customs* in a variety of ways and provides numerous opportunities to enhance connectivity between Customs, with trade operators and other border agencies, thereby increasing productivity resulting in higher economic growth. Other authors (Renizal et al., 2024) have also highlighted that the digitisation of customs is increasingly urgent, with the EU aiming, through the digitisation of customs control, to strike a balance between easing customs formalities for legitimate businesses and exercising effective control to safeguard the EU's financial and economic interests, protecting the environment, businesses and EU citizens. They summarize the overall impact of the digitisation process in the customs area - the automation of the processes for handling the main customs procedures, the automatic exchange of data between EU customs administrations and the processing, analysis and storage of data. Kavoya (2020) emphasizes that all customs officers need to be made aware of future developments, be trained and have their capacity enhanced to achieve the desired future state of customs. *Intelligence-based customs* contribute to the security and protection of the public, to the facilitation of legitimate trade, to the collection of government revenue in an efficient manner that ensures optimal allocation of resources.

In an interconnected and complex global economy, customs administrations are at a crossroads. As trade volumes increase due to *e-commerce*, supply chains are diversifying and illicit activities are becoming more sophisticated. Traditional customs operations are struggling to keep up, highlighting the urgent need for transformation. AI is at the forefront of this evolution and is poised to revolutionize customs by increasing operational efficiency, improving security and simplifying processes. In summaries (White Paper on the use of Artificial Intelligence, 2023), The United Nation Centre for Trade Facilitation and Electronic Business (UN/CEFACT) states that Artificial intelligence (AI) systems are software systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving the environment through data collection, interpreting the collected structured or unstructured data, reasoning on the knowledge or processing the information derived from that data, and deciding on the best action(s) to take to achieve the given goal. Artificial intelligence systems can use symbolic rules or learn a numerical model, and they can also adapt their behaviour by analysing how the environment has influenced their previous actions.

Customs and border controls are undergoing significant changes driven by geopolitical developments, the increasing flow of goods and the development of new technologies such as digitisation and artificial intelligence tools. These changes create new sources of risk, such as *cybercrime, and new opportunities for more effective intelligence and risk analysis, particularly in identifying and detecting sources of risk*. By exploring the main development trends in the field of customs risk management (CRM), the result of the study recognizes the importance of ICT and artificial intelligence for effective CRM in the context of globalization and economic integration processes (Karklina-Admine et al., 2024).

The analysis of the practice of using artificial intelligence in some foreign countries allows the authors (Chebotareva et al., 2021) to conclude that there are a number of unconditional advantages in the use of artificial intelligence in customs activities, a specific approach to the regulation of legal regulation issues. Practical experience in the application of intelligent technologies in customs activities allows them to give the following definition of the phenomenon under study: artificial intelligence in customs is a program that implements certain algorithms for processing large sets of customs information and data in a short time, which allows using mathematical methods (extrapolation, interpolation, calculation of variations) to predict, evaluate individual processes and prepare (or automatically make) decisions. For the authors, it also seems a

fair position that „artificial intelligence, like other technical electronic tools, remains a human assistant, but it does not fully replace it, epistemological, psychological and other characteristics inherent only in humans”. Therefore, they conclude that the knowledge, abilities, skills and competence of customs authorities should be organically integrated into the work of artificial intelligence, but it should be considered that regardless of the level of sophistication of information products, the role of the human remains the leading one.

2. Role and application of AI in Customs

Artificial intelligence is a branch of computer science that deals with the development of systems and technologies capable of performing tasks that require human intelligence, such as reasoning, learning, pattern recognition, and decision making. AI can process large amounts of data and recognize patterns in it. Based on these models, AI algorithms can interpret the data or take some predefined action, such as making predictions, classifying the data based on its features, or suggesting or performing some automated action.

Interest in artificial intelligence has been growing steadily since the start of the COVID-19 pandemic, particularly in terms of how AI systems can improve the efficiency and stability of the global supply chain and reduce the risks arising from our dependence on it. The pandemic has drawn attention to the fact that the scope and potential for using AI to further facilitate cross-border trade is much greater than previously thought, and some international participants have already begun to explore and use this technology, particularly in the customs field, to improve and make procedures more transparent and to better manage risk and profiling (White Paper on the use of Artificial Intelligence, 2023).

According to The United Nation Centre for Trade Facilitation and Electronic Business (UN/CEFACT), the number of current and potential applications of AI is large and generally refers to *three categories* (Table 1):

Table 1. Application of AI in Customs

Category	Activities
Compliance	- Automation in post-clearance audits and controls; - Detection of misuse of concessions (including tariff concession orders, by-laws, free trade agreements and origin masking); - Compliance risk scoring in commercial and trade activities; and - Detection of tariff misclassification and non-compliance with tariff advice.
Monitoring	- Enhancement of risk management processes (e.g., inspection results feedback loop, client segmentation, automatic assessment, upgrade of risk profiling); - Monitoring of service delivery performance in real time; and - Provision of historical insights into customs statistical information for future planning and forecasting.
Detection	- Detection of anomalies in high-revenue areas including excise equivalent goods (i.e., alcohol, tobacco and petroleum); - Detection of dumping and countervailing anomalies; - Detection of undervaluation and overvaluation anomalies; - Detection of prohibited goods; - Identification of low-value courier and postal shipments to improve risk assessment; and - Identification of low-risk individuals at borders

Source: White Paper on the use of Artificial Intelligence in Trade Facilitation, 2023

Those listed in Tab. 1 categories are presented using the impact of the three areas of advanced technology on customs areas: *blockchain*, *Internet of things* and *big data*, *Data analytics*, *artificial intelligence* and *machine learning* (White Paper on the use of Artificial Intelligence, 2023).

Yurevich (2023) discusses the *tasks* that are being assisted in performance using artificial intelligence:

- reducing time and financial costs;
- the separation of documental and factual control;
- standardizing approaches to customs declaration processing and goods clearance;
- the exclusion of direct contact between the declarant and customs officials (which in turn will reduce the risk of possible corruption);
- effective interaction between customs and business;
- the processing of large amounts of information;
- increasing the efficiency of customs control.

The author proceeds and represents the *types of systems* based on the functional capabilities of artificial intelligence:

- 1) an artificial intelligence program to classify goods according to the Harmonized Commodity Description and Coding System (HS);
- (2) an artificial intelligence programme for customs control using technical customs control tools;
- (3) an artificial intelligence programme for the control of weights and dimensions;
- (4) an artificial intelligence programme for radiation control;
- (5) an artificial intelligence programme for automatic release of goods declarations.

In a research paper (Cao & Zheng, 2024), the authors conclude that customs should consider incorporating artificial intelligence (AI) and other technologies to develop „*intelligent customs clearance and inspection methods*”. A team of authors (Luciano et al., 2008) explored the importance of AI in fraud detection in the Brazilian customs system, as fraud detection systems in customs operations are very important to minimize manual inspection of goods and increase the number of frauds detected. The main problems of these sophisticated systems, in their opinion, are for example: attributes with a high degree of cardinality, unbalanced databases and problems with spelling errors. In their study, they applied some artificial intelligence approaches used in the Brazilian customs fraud detection system. Their main contributions are: *the ability to help identify deviations (suspicious transactions)* and *the information system on products and foreign exporters* (including databases and tools to identify surpluses and to suggest a category for each product). The future work of these researchers also includes the development of some automatic outlier detection techniques that will be used in combination with visual techniques to show the user both the graphs and the probability values. These values, in turn, will constitute the system's confidence that, according to the current data set, a product is actually worth the amount declared by the importer.

Albarracín Vanoy (2023) analyses result from the application of AI in *customs operations and decision making*. According to the author, efficiency in the classification and verification of goods, identification of fraud detection patterns and optimization of processing time are key areas where AI has proven its positive impact. In addition, improvements in transparency and traceability of transactions are explored, which contribute to a more reliable customs environment. The application of AI in customs is also explored by Ulanov (2023), who writes that one of the core applications of AI in customs control is the use of *acute analytics*. By analysing historical data on trade flows and smuggling patterns, AI algorithms can generate predictions about which shipments are most likely to be at risk. This allows customs officials to focus their resources on the most problematic shipments, improving overall efficiency and reducing the risk of smuggling. Another application of artificial intelligence in customs control is the use of *machine learning algorithms to detect counterfeit shipping documents, correctly identifying the product code according to HS*.

These algorithms can alert to discrepancies between information contained in transport manifests and other documentation, allowing officers to investigate it and potentially identify instances of fraud or smuggling. With this as a powerful tool to increase the efficiency and accuracy of customs controls, AI systems are now able to process and analyse vast amounts of data, allowing customs officials to identify anomalies. AI algorithms can also learn and adapt over time, becoming more efficient when given access to additional data (Ulanov, 2023).

Different researchers (Stoica & Pica, 2024) believe that the application of artificial intelligence in combination with additional customs control technologies, such as drones, can contribute to *better tax compliance and fraud prevention*. For example, customs authorities can identify narcotics using cameras installed on drones, while operators optimize data processing in line with regulations to protect personal information. Artificial intelligence provides a number of advantages for customs agencies, increasing efficiency and accuracy in customs data management. In addition, AI allows agencies to *improve border control* procedures, more effectively detecting illegal activities such as smuggling and trafficking, and also ensuring compliance with trade regulations. Furthermore, AI has the ability to automate routine operations, allowing public institutions to redeploy human resources to perform more complex and strategic *risk management tasks*.

Customs operations in the context of the international supply chain involve complex border management structures, policies, legislative frameworks as well as administrative and operational systems. These systems can be optimized, controlled and predicted through innovations in technology, including *artificial intelligence (AI)*, *machine learning (ML)* and *data analytics (DA)*. According to Olomu (2023), AI, ML, and AD hold significant potential for improving cross-border customs operations, given the vast amounts of data generated by the movement of people and goods across borders. AI technologies provide access to a greater amount of information and intelligence for customs authorities, which speeds up decision-making processes in the area of risk management related to the cross-border movement of people and goods. AI's ability to effectively interpret and process significant and growing volumes of data helps to identify risk factors through AI-based tracking tools.

Kafando (2020) summarizes the main *disruptive technologies* that can be applied in the work of customs administrations (Table 2).

Table 2. Disruptive technologies in Customs

№	Type of technology	Examples of application
1	AI – machine learning	✓ AI-based risk management ✓ Post-clearance audit (PCA) and assisted case management ✓ Automated container images processing and objects recognition ✓ Cargo tracking geodata analytics ✓ Advanced predictive business intelligence (BI)
2	AI – natural language processing (NLP)	✓ Automated classification of products ✓ Optical character recognition (OCR) and data storage ✓ Advanced BI with text mining and NLP capabilities ✓ E-Customs platform with imbedded chatbots that provide 24/7 customer service
3	AI – robotics	✓ Repetitive tasks automation and human-like cognitive abilities ✓ Data robot – powered recommendation engine that produces dynamic suggestions ✓ Computer vision and automated object counting for visual inspection ✓ Virtual workforce to automate routine business processes

4	Blockchain	✓ Trade traceability and end-to-end visibility ✓ Smart contracts ✓ Blockchain-based e-commerce ✓ Container track & trace ✓ Electronic certification/authentication of LPCO ✓ Identity management (unique personal identity, tax identification number)
5	Internet of things (IOT)	✓ Cargo-tracking devices (such as RFID, GPS sensors, etc.) ✓ Geo-fencing technology to secure containers ✓ Smart port logistics processes (connected devices for logistics, traffic management) ✓ Other automatic identification systems linked to GPS.

Source: Kafando, 2020.

The application of AI technologies offers significant potential to optimize the functioning of customs services by adapting key tools for effective management of customs processes and border control. The **suggested tools** include (Olomu, 2023):

- *Automation and rationalisation*: the main benefit of AI technologies in customs is the implementation of automated systems and software that streamline regulatory compliance procedures, minimizing the burden of manual operations. For example, compliance management software automates data collection, report generation and documentation control, making it easier to comply with regulatory standards.
- *Revenue collection models*: developed revenue collection models ensure the right duties and taxes are applied at the border.
- *Classification of products through the Harmonized System (HS)*: AI technologies support the classification of goods through the Harmonized System, which introduces simplification for users and provides greater compliance and confidence for both customs authorities and the private sector.
- *Customs audits*: AI technologies have the ability to be used in audits to identify deviations, allowing customs inspectors to target areas of non-compliance.
- *Real-time monitoring and alerts*: AI technology provides Customs with the capability to continuously monitor compliance status. The system features real-time detection of regulatory deviations and activation of alerts for immediate response.
- *Risk-based targeting*: AI technologies can improve the targeting of commercial shipments by analysing data during inspections, using augmented reality glasses to identify counterfeit and smuggled goods. The data will also be available in real time, enabling officers to make decisions quickly, increasing the number of checks and the accuracy of analysis.
- *X-ray scanners*: using X-ray scanners to analyse images of cargo containers can increase the efficiency of inspections.
- *Logistics monitoring*: in particularly busy areas and customs warehouses, logistics monitoring can contribute to increased inspection efficiency.
- *Data analytics and risk assessment*: data analytics tools are used to assess risks, allowing Customs to identify patterns and anomalies that signal potential risks by processing large sets of information. Predictive analytics can anticipate regulatory changes and their impact on Customs operations, enabling proactive risk management.
- *Visual search and facial recognition*: through visual search and facial recognition technologies at borders, Customs can efficiently identify high-risk travelers and vehicles, and generate intelligent analytics to predict future events to improve risk management.
- *Chatbots and robots*: the deployment of chatbots in the public sector can significantly optimise communication between government, businesses and citizens, allowing interaction through

natural language. Chatbots can speed up the processing of user queries and manage information, freeing up resources and manpower for more complex tasks.

- *Self-payment services*: creating mobile apps at the border that enable self-payment of customs fees provides an innovative way to economically and efficiently conduct customs transactions (Olomu, 2023).

This integration of AI technologies has the potential to transform customs operations, increasing their efficiency and the effectiveness of the services provided.

By going into the theoretical constructs underlying the merge of 5G and AI, Yang (2023) clarifies the synergistic effects of these technologies. He demonstrates how the convergence of 5G's high-speed connectivity and AI's analytical capabilities can revolutionize traditional customs operations. Using theoretical underpinnings as a guide, the author provides insights into the intricacies of their integration, highlighting the potential to overcome long-standing limitations and inefficiencies in *customs security checks*.

Summarizing the authors' research, it can be concluded that the **application of AI in customs is multifaceted** and offers a number of advantages that can facilitate and improve the processes of control and management of customs operations. The activities that can be covered are:

➤ **Data analysis**: AI has the ability to process significant volumes of data related to trade and the movement of goods. Through machine learning algorithms, these systems can extract and identify patterns and anomalies that signal potential violations or risks associated with smuggling activities.

➤ **Process automation**: by automating routine activities such as document verification and data processing, customs officials can focus their efforts on more complex and critical inspections. AI-enabled systems can generate preliminary risk assessments and classify goods, which in turn helps goods move through customs procedures more quickly and efficiently.

➤ **Image recognition and video analysis**: systems integrating computer vision offer the capability to analyse images obtained from cameras and scanners. This provides automated identification of suspicious goods or persons posing a potential threat to national security.

➤ **Improved communication and coordination**: AI can assist in the development of information sharing platforms between different customs authorities and other agencies, such as police and border authorities. Such an integrated solution improves coordination and speed of response to potential threats.

➤ **Predictability and planning**: through predictive analytics, customs officials can optimise their resource management by anticipating peak periods for cargo movements and streamlining workflow.

➤ **Risk management**: AI has the potential to help assess the risks associated with specific containers or shipments. Through algorithms that analyse trade history, declarations and other relevant parameters, these systems can identify risky cargo before it enters the country.

Risk management is a key area where the application of AI can have a significant impact. Through improved pre- and post-control opportunities, there is a positive impact on ongoing controls, particularly in the area of inspections carried out by customs officers by reducing the number and time spent on them. This results in improved overall customs control while saving resources.

3. Challenges for AI in Customs

AI does offer significant potential for improving customs operations, but adapting customs administrations to new technologies is a challenge. In the context of *outdated IT systems*, many customs administrations are unable to process and analyse information effectively, making it difficult for them to identify potential risks and fraud. These problems are compounded by fierce competition for the skills needed to experiment with emerging technologies (Figure 1).



Figure 1. Challenges in Customs

Источник: Chowdhary. R. et al., 2024

Currently, many customs administrations are exploring AI through fragmented, isolated efforts, such as experimenting with machine learning for risk management or using automation for document processing. While these isolated use cases may offer local benefits, they do not provide a coherent strategy for unleashing the full potential of AI when applied across the *entire customs value chain* (Chowdhary et. al., 2024). The author team (Renizal et al., 2024) points out the digitalization of customs is a complex multi-layered transformation, which on the one hand provides plenty of opportunities to optimize the work and structure of customs, but also confronts administrations with numerous challenges in the digital transition process. They discuss the potential challenges in activities related to the European Customs Union. **The first aspect** is the automatic exchange of data, where the main difficulty is the connectivity between the different customs information systems of the Member States and ensuring their continuous functionality. This requires customs to implement uniform business models, regardless of the differences in architecture, interface and functionalities of their own systems. **The second aspect** is the processing, analysis and storage of data where there is a risk of unauthorised access leading to manipulation or theft of information. It is therefore essential that Member States and DG TAXUD invest in adequate measures to protect against cyber-attacks and to ensure internal data security to avoid possible breaches by customs officials. **The third aspect** concerns the automation of the import, export and transit processes, which on the one hand offers efficiencies, but on the other hand risks reducing the number of staffs in customs administrations due to the replacement of the human factor by automated computer systems.

This is confirmed by other authors (Julius & Christabel, 2020), who agree that several challenges need to be overcome to introduce AI. These include **factors** such as:

- *change management over expected job losses;*
- *skills shortages and lack of AI researchers;*
- *capital investment in AI research;*
- *AI legislation and limited infrastructure* - to name but a few.

These challenges need to be overcome by both industry and customs administrations to unlock the significant benefits that AI offers.

One of the main challenges in customs control is the potential *bias* of AI algorithms, especially if they are trained on biased datasets. This can lead to certain groups of people or regions being unfairly blamed. There is also a need for *human oversight* of AI systems. Overall, the use of AI in customs control has significant potential to improve efficiency and reduce the risk of smuggling. However, it is important that these technologies are developed in a *responsible and transparent manner*, with appropriate security measures to ensure that they are used fairly and effectively (Ulanov, 2023). Similar opinions on the challenges are also expressed by other authors. Olomu (2023) considers challenges such as:

- *building technical trust;*
- *skills shortages in artificial intelligence;*
- *investment requirements for AI technologies;*

- *software failure;*
- *artificial intelligence technologies replacing any customs task; and*
- *higher expectations.*

Difficulties identified in relation to the application of AI also include: *data dependency for machine learning applications; lack of skilled staff; complexity of software and infrastructure; lack of government strategy and legal clarity* (White Paper on the use of Artificial Intelligence, 2023).

Customs are progressively using AI to increase efficiency, security and compliance, but much of the potential of AI remains unexploited due to gaps in the fundamentals. To unlock the power of AI, customs authorities need to create the fundamental mechanisms to turn technology into tangible value. Experimental proof-of-concept pilots focused on real-world impacts are essential to determine how AI can best adapt to customs operations. ***Better innovation management with an agile workflow that includes end-user*** involvement is critical. While rapid results should remain a priority, the broader reach of AI should not overlook the greater role of AI in driving digital transformation, including improvements in data management and technology infrastructure. Creating joint AI teams that combine data specialists, risk managers and other departments will improve engagement and participation across the organization, reducing the risks of siloed initiatives. In addition, improvements to customs legislation to allow for standardization of data will make AI a more effective and versatile tool for Customs. By building a foundation for better coordination, stakeholder engagement and a results-oriented mindset, customs administrations can use AI to deliver safer, more efficient and reliable processes for themselves and for end users (Chowdhary et al., 2024).

In trying to summarize the **challenges** of using AI in customs based on the research, they would include:

➤ ***Complexity of legislation:*** customs rules and regulations are often complex and variable. AI systems need to be able to process and interpret this complex data, which can be difficult;

➤ ***Handling large volumes of data:*** customs processes huge amounts of information, including declarations, documents and vehicle data. AI must be able to analyse and extract useful information from this data efficiently;

➤ ***Cybersecurity:*** customs data is sensitive and susceptible to cyber-attacks. Protecting the information stored and processed by AI systems is essential;

➤ ***Training models:*** developing effective AI models requires a large amount of qualitative training data, and the availability of such data may be limited or inadequate;

➤ ***Integration with other systems:*** AI systems need to be integrated with other software platforms and technologies, which can be challenging due to differences in standards and protocols;

➤ ***Legal and ethical issues:*** the use of AI in customs work raises issues of traceability, accountability and fairness in decision-making, especially in automated handling of complaints or disputes;

➤ ***Staff training:*** customs staff need to be trained to work with new technologies. Lack of sufficient training or experience may limit the effectiveness of AI systems;

➤ ***Need for human supervision:*** despite advances in AI, human supervision remains important, especially in situations where complex interpretations are required or when important decisions are being made;

➤ ***Ethics and trust:*** establishing trust in AI systems is important, especially when they affect citizens' rights and freedoms. There is a need to ensure that AI operates transparently and fairly.

These challenges highlight the need for careful planning and deployment of AI technologies in customs to ensure their effectiveness and safety.

Conclusion

Artificial Intelligence offers new and ***different opportunities*** to optimise the work of Customs, improving efficiency, speeding up procedures and enhancing security. Implementing AI

technologies in customs operations can not only help fight smuggling and law breaking, but will also improve the overall trade environment and increase the confidence of businesses and citizens in customs services.

AI application techniques are based on *various mechanisms* and they find their place in the *three forms of customs control* - *pre-, ongoing (current) and post-clearance*. Despite the advantages, the relevance and role of AI for the work of customs authorities should be *well analysed* for specific application and considering the constantly evolving technologies and the challenges they provide for the performance of customs control.

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