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ECONOMIC EFFICIENCY OF ARTIFICIAL INTELLIGENCE IMPLEMENTATION IN CUSTOMS CONTROL: COST REDUCTION AND RISK MINIMIZATION IN INTERNATIONAL TRADE

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INTRODUCTION

In today's rapidly growing international trade environment, customs authorities worldwide face the challenge of handling increasing cross-border transactions while ensuring compliance with complex regulatory requirements. Traditional customs control methods, which rely heavily on manual processes and human factors, are becoming inefficient, leading to high operational costs, processing delays, and increased fraud risks and non-compliance[1]. In this context, artificial intelligence (AI) emerges as an innovative solution capable of radically transforming customs operations and enhancing economic efficiency through cost reduction and risk minimization in international trade. As confirmed by numerous studies and practical implementations, AI is now actively used to optimize customs procedures. The AI-based Regional Electronic Cargo Tracking System (RECTS) has enabled real-time cargo monitoring[2], significantly reducing fraud and losses. Such technologies contribute to resource savings and enhance trade transparency and security. AI can automate the classification of goods under the Harmonized System (HS), reducing customs clearance time and operational costs[3]. Additionally, AI has optimized customs declaration generation at the Guangdong-Hong Kong border, improving the accuracy and speed of document processing[4].

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The economic benefits of AI extend beyond cost reduction. The technology allows customs authorities to detect violations more effectively and predict risks by analyzing large datasets. Using AI-driven active learning in customs inspections improves fraud detection accuracy while reducing the need for manual checks[5]. Furthermore, AI integration with other technologies, such as blockchain, enhances transparency and trust in supply chains –essential in minimizing financial and logistical risks[6].

5.1. Innovative AI Solutions for Customs Control: Efficiency, Security, and Cost Savings

Artificial intelligence, as a field of computer science, opens new opportunities for developing systems capable of performing tasks typically associated with human intelligence, such as image recognition, big data analysis, and decision-making in complex situations. This technology is particularly significant in customs control as it automates routine processes and significantly improves the quality of work performed by customs authorities.

AI enables the verification of cargo, analysis of declarations, and fraud detection with high precision, allowing customs officers to focus on genuinely complex cases. Moreover, by automatically classifying goods, AI simplifies document processing and reduces the risk of errors, making it an indispensable tool in modern trade.

The use of AI in customs control covers several important areas, each playing a role in transforming this sector. Systems equipped with natural language processing and machine learning technologies can quickly verify trade documents, detecting errors or inconsistencies much more efficiently than humans. These solutions have proven their ability to speed up customs clearance while reducing inaccuracies[7]. Another area is risk assessment: AI can identify suspicious patterns that indicate fraud or smuggling by analyzing historical data, allowing customs authorities to focus their resources where they are genuinely needed. The U.S. Customs and Border Protection (CBP) has already adopted similar approaches for cargo screening, improving

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threat detection[8]. Equally important is image analysis: in Turkey and China, computer vision helps customs officers automatically process X-ray images, speeding up inspections and increasing accuracy[9]. In Brazil, the SISAM system uses machine learning for import declaration selection, enhancing inspection efficiency[10]. Hong Kong Customs implemented a big data analysis system that improves detection and covers 5,934 items. In the Netherlands, the real-time CRIS system utilizing machine learning aids in better risk management[11]. Dubai Customs uses AI for remote inspections, boosting efficiency by reducing the need for personnel[12].

Additionally, through predictive analysis, AI can forecast future trends or issues in logistics, which contributes to better planning and resource allocation. All these capabilities together create a solid foundation for cost savings and risk reduction. World examples of AI use are summarized in Table 5.1.

Table 5.1

Examples of AI Use in Customs Control

Country	AI Application	Key Results
China	Image analysis for detecting prohibited items	Improved detection, integrated into operations
Brazil (SISAM)	Import declaration selection via machine learning	Increased inspection efficiency
Hong Kong Customs	Big data analysis system	Enhanced detection, covers 5,934 items
Netherlands (CRIS)	Real-time machine learning system	Improved risk management
USA Customs (CBP)	Cargo screening	Enhanced detection of drugs and illegal goods
Dubai Customs	Remote inspections	Increased efficiency through reduced staffing needs

Source: compiled by the authors

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One of the key advantages of using AI in customs control is the significant reduction in operational costs. Traditional customs clearance methods require substantial human resources for document verification, physical inspection of goods, and data processing. According to the World Customs Organization (WCO), up to 30% of customs costs are related to manual information processing. AI enables the automation of these processes through machine learning and natural language processing technologies. AI systems can analyze declarations, detect discrepancies, and automatically classify goods according to HS codes, reducing processing time from hours to minutes and minimizing the need for manual labor, thereby saving on personnel costs.

eClear notes that such solutions reduce bureaucratic costs by minimizing fines or storage expenses. AI speeds up the clearance process by 40%, leading to faster movement of goods and fewer delays in supply chains. The technology also optimizes resources: identifying low-risk shipments allows inspectors to focus on more complex cases. AI further contributes to optimizing energy consumption and logistics resources. Demand forecasting algorithms and route analysis help reduce cargo downtime at borders, lowering storage and transportation costs. AI-driven logistics automation can reduce global logistics costs by 10–15%.

Thus, the economic effectiveness of AI in customs control is evident through direct cost reduction and increased labor productivity.

In the port of Qingdao, China, the AI system for scanning containers has reduced shipping costs by $100 per container, while in Dubai, the automation of audits through AI has gradually expanded the coverage of high-value declaration checks from 19% to 100% over five years, simultaneously reducing costs and increasing revenues. Additional data shows that AI can reduce logistics and storage costs by 25–40% and 5–10%, respectively, making it an economically viable solution. In Singapore, the TradeNet system, integrated with AI, has significantly reduced processing costs for individual shipments. In monetary terms, this amounts to an annual savings of approximately $50 million for the country. For countries with less developed infrastructure, such as Ukraine, similar technologies could yield savings of 15–20% of the customs service's operational budget if implemented gradually.

Another significant advantage of AI is the reduction of risks in international trade, as it helps combat fraud, smuggling, and other violations. By analyzing vast amounts of data, algorithms detect anomalies that might go unnoticed. In Brazil, AI has proven its effectiveness in detecting customs fraud with high accuracy. Real-time monitoring, enabled by the technology, allows customs authorities to respond promptly to suspicious activities – CBP in the U.S. uses

this to intercept illegal goods directly at the ports. AI's accuracy also reduces the likelihood of human errors, making risk assessment more reliable and facilitating targeted inspections without hindering legitimate trade. The World Customs Organization notes that the technology helps combat global issues, such as counterfeiting and human rights violations. All of this combined creates a safer trading environment.

5.2. Evaluation of Customs Control Effectiveness and Prospects for AI Implementation: Survey Results from Customs Control Participants

To evaluate the opinions of customs control participants regarding the effectiveness of implementing artificial intelligence in customs control, an anonymous survey was conducted with 173 respondents. The survey participants included customs service employees (48 individuals), representatives of logistics companies (62 individuals), importers and exporters (37 individuals), customs brokers (23 individuals), and others (3 individuals). The questionnaire consisted of 10 questions aimed at gathering respondents' views on the current effectiveness of customs control, the main problems, the prospects of AI implementation, and the associated risks and benefits. The survey was conducted online from February 1 to March 15, 2025. Table 5.2 presents the survey results.

Table 5.2

Survey Results of Customs Control Participants Regarding the Effectiveness of Implementing Artificial Intelligence in Customs Control

№	Question	Answer Option	Number of Respondents
1	2	3	4
1	Your role in the customs control process	Customs Service Employee	48
		Logistics Company Representative	62
		Importer/Exporter	37
		Customs Broker	23
		Other	3
2	How do you assess the current effectiveness of customs control in your country?	High	21
		Average	83
		Low	69
3		Yes, often	58
		Yes, sometimes	73

	Have you encountered delays or errors in customs procedures in the past year?	No	42
4	What do you consider to be the main problems in modern customs control?	High costs	87
		Long processing times	119
		Errors due to human factors	96
		Insufficient transparency	68
		Other	13
5	Do you support the implementation of artificial intelligence in customs control?	Yes, fully	67
		Yes, with reservations	84
		No	22
6	In your opinion, how can AI improve customs control?	Cost reduction	98
		Speeding up procedures	127
		Reducing errors	91
		Detecting violations	106
		Other	8
7	What risks of implementing AI do you consider the most significant?	Job loss	79
		Technical failures	66
		High implementation costs	93
		Other	17
8	Are you willing to undergo training to work with AI systems?	Yes	138
		No	14
		Not sure	21
9	How significant do you consider the potential cost reduction through AI in customs control?	Very significant	71
		Moderately significant	63
		Insignificant	27
		No impact	12
10	Do you think AI can reduce your personal/organizational customs costs?	Yes, significantly	59
		Yes, partially	78
		No, will not impact	24
		Not sure	12

Table 2 shows that most respondents assessed the current effectiveness of customs control as average, with 83 respondents choosing this option, or low, with 69 respondents, and only 21 respondents considering it high. This indicates general dissatisfaction with the state of customs procedures. Regarding delays and errors in customs procedures, 58 respondents indicated that they occur frequently, 73 noted that they occur occasionally, and only

42 respondents reported not encountering such issues in the past year. The main problems of customs control identified by respondents were long processing times – 119 respondents, errors due to human factors – 96 respondents, high costs – 87 respondents, and insufficient transparency – 68 respondents.

Regarding the implementation of AI, most respondents expressed support: 67 individuals fully support this idea, 84 support it with reservations, and only 22 individuals oppose it. The respondents expect that AI could improve customs control, particularly by speeding up procedures – for 127 individuals, detecting violations – for 106 individuals, reducing costs – for 98 individuals, and reducing errors – for 91 individuals. The respondents identified the principal risks of implementing AI: 93 indicated high costs, 79 cited job loss, and 66 mentioned technical failures. The vast majority of respondents, 138 people, are willing to undergo training to work with AI, while 14 are not, and 21 are unsure. Regarding the potential reduction in costs due to AI, 71 respondents believe it will be very significant, 63 think it will be moderately important, 27 consider it insignificant, and 12 respondents believe that AI will not affect costs. On a personal or organizational level, 59 respondents expect a significant reduction in costs, 78 expect a partial reduction, and 24 individuals believe that AI will not affect costs.

Thus, the survey revealed that respondents are generally dissatisfied with the current effectiveness of customs control due to long processing times, high costs, and errors. They support the implementation of AI, expecting faster procedures, cost reduction, fewer errors, and better detection of violations, though they express concerns about implementation costs, job loss, and technical failures. The majority are willing to adapt to new technologies through training and hope for a significant or moderate cost reduction due to AI.

Table 5.3 presents the distribution of survey results across different customs control participant groups.

Table 5.3 shows that the difference in responses across various groups – customs service employees, logistics company representatives, importers/exporters, customs brokers, and the "other" group – regarding the customs control survey questions and the implementation of artificial intelligence is evident in the percentage distribution, though it is not very significant. Starting with assessing the current efficiency of customs control in question 2, customs service employees are more likely to rate it as high – 18.75% chose this option. In contrast, only 11.29% of logistics companies did; among importers/exporters, 10.81%; and among customs brokers, just 4.35%.

An average rating of efficiency is chosen equally often by customs service employees and logistics companies – 50% each, while among importers/exporters, 43.24% chose this option, and among customs brokers, 47.83%. A low rating of efficiency is more commonly noted by customs brokers (47.83%), followed by importers/exporters (45.95%), logistics companies (38.71%), and customs service employees (31.25%).

Table 5.3

Distribution of Survey Results Across Different Groups of Customs Control Participants

Question №	Answer Option	Customs Service Employees	Logistics Companies	Importers/ Exporters	Customs Brokers
1	2	3	4	5	6
2	High	18,75%	11,29%	10,81%	4,35%
	Average	50,00%	50,00%	43,24%	47,83%
	Low	31,25%	38,71%	45,95%	47,83%
3	Yes, often	29,17%	30,65%	37,84%	39,13%
	Yes, sometimes	39,58%	43,55%	43,24%	43,48%
	No	31,25%	25,81%	18,92%	17,39%
4	High costs	47,92%	50,00%	51,35%	52,17%
	Long processing times	68,75%	66,13%	75,68%	69,57%
	Errors due to human factor	60,42%	54,84%	59,46%	43,48%
	Insufficient transparency	39,58%	41,94%	37,84%	34,78%
	Other	8,33%	8,06%	8,11%	4,35%
5	Yes, fully	37,50%	38,71%	37,84%	43,48%
	Yes, with reservations	50,00%	53,23%	43,24%	43,48%
	No	12,50%	8,06%	18,92%	13,04%
6	Cost reduction	50,00%	54,84%	62,16%	65,22%
	Speeding up procedures	77,08%	70,97%	78,38%	69,57%
	Reducing errors	54,17%	51,61%	51,35%	56,52%
	Detecting violations	66,67%	62,90%	62,16%	47,83%
	Other	4,17%	4,84%	5,41%	4,35%
7	Job loss	47,92%	41,94%	51,35%	43,48%

	Technical failures	37,50%	38,71%	37,84%	39,13%
	High implementation costs	52,08%	53,23%	56,76%	52,17%
	Other	10,42%	11,29%	10,81%	4,35%
8	Yes	81,25%	82,26%	89,19%	60,87%
	No	8,33%	8,06%	5,41%	13,04%
	Not sure	10,42%	9,68%	5,41%	26,09%
9	Very significant	39,58%	40,32%	40,54%	47,83%
	Moderately significant	35,42%	37,10%	35,14%	39,13%
	Insignificant	16,67%	16,13%	16,22%	8,70%
	No impact	8,33%	6,45%	8,11%	4,35%
10	Yes, significantly	33,33%	33,87%	35,14%	34,78%
	Yes, partially	45,83%	46,77%	45,95%	39,13%
	No, will not impact	14,58%	12,90%	13,51%	17,39%
	Not sure	6,25%	6,45%	5,41%	8,70%

Regarding the frequency of encountering delays or errors in customs procedures in question 3, the response "yes, often" was selected by 39.13% of customs brokers, 37.84% of importers/exporters, 30.65% of logistics companies, and 29.17% of customs service employees. The "yes, sometimes" option is almost equally distributed: 43.55% of logistics companies, 43.48% of customs brokers, 43.24% of importers/exporters, and 39.58% of customs service employees chose it. The absence of issues is most often reported by customs service employees (31.25%), followed by logistics companies (25.81%), importers/exporters (18.92%), and customs brokers (17.39%).

In question 4, regarding the main problems of customs control, high costs concern customs brokers (52.17%), importers/exporters (51.35%), logistics companies (50%), and customs service employees (47.92%) almost equally. Long processing times are most troubling for importers/exporters (75.68%), followed by customs brokers (69.57%), customs service employees (68.75%), and logistics companies (66.13%). Errors due to human factors are of more significant concern for customs service employees (60.42%), followed by importers/exporters (59.46%), logistics companies (54.84%), and customs brokers (43.48%). Insufficient transparency is noted most often by logistics

companies (41.94%), then customs service employees (39.58%), importers/exporters (37.84%), and customs brokers (34.78%).

The responses to Question 5 regarding the adoption of artificial intelligence (AI) indicate that full support is most strongly expressed by customs brokers (43.48%), followed by logistics companies (38.71%), importers/exporters (37.84%), and customs officers (37.50%). Conditional support is most frequently chosen by logistics companies (53.23%), followed by customs officers (50%), customs brokers (43.48%), and importers/exporters (43.24%). Opposition to AI implementation is highest among importers/exporters (18.92%), followed by customs brokers (13.04%), customs officers (12.50%), and logistics companies (8.06%).

In response to Question 6, which addressed the benefits of AI, cost reduction is expected by customs brokers (65.22%), importers/exporters (62.16%), logistics companies (54.84%), and customs officers (50%). The acceleration of procedures is considered the most crucial advantage by importers/exporters (78.38%), followed by customs officers (77.08%), logistics companies (70.97%), and customs brokers (69.57%). Error reduction is anticipated by customs brokers (56.52%), customs officers (54.17%), logistics companies (51.61%), and importers/exporters (51.35%). The ability to detect violations is most frequently cited by customs officers (66.67%), followed by logistics companies (62.90%), importers/exporters (62.16%), and customs brokers (47.83%).

The risks associated with AI implementation in customs control, as highlighted in Question 7, show that the loss of jobs is a significant concern for importers/exporters (51.35%), followed by customs officers (47.92%), customs brokers (43.48%), and logistics companies (41.94%). Technical failures worry customs brokers (39.13%), logistics companies (38.71%), importers/exporters (37.84%), and customs officers (37.50%). The high cost of implementation is noted by importers/exporters (56.76%), logistics companies (53.23%), customs brokers (52.17%), and customs officers (52.08%).

Regarding readiness for AI training in Question 8, the highest willingness is observed among importers/exporters (89.19%), followed by logistics companies (82.26%), customs officers (81.25%), and customs brokers (60.87%). The highest refusal rate comes from customs brokers (13.04%), followed by customs officers (8.33%), logistics companies (8.06%), and importers/exporters (5.41%). Uncertainty is most prevalent among customs brokers (26.09%), followed by customs officers (10.42%), logistics companies (9.68%), and importers/exporters (5.41%).

Expectations regarding cost reductions through AI in Question 9 indicate that significant cost reductions are most frequently anticipated by customs brokers (47.83%), followed by logistics companies (40.32%), importers/exporters (40.54%), and customs officers (39.58%). Moderate reductions are expected by customs brokers (39.13%), logistics companies (37.10%), importers/exporters (35.14%), and customs officers (35.42%). Minimal impact is perceived by customs officers (16.67%), logistics companies (16.13%), importers/exporters (16.22%), and customs brokers (8.70%).

When considering the impact of AI on personal or organizational expenses, significant reductions are expected by importers/exporters (35.14%), customs brokers (34.78%), logistics companies (33.87%), and customs officers (33.33%). Partial cost reductions are anticipated by logistics companies (46.77%), importers/exporters (45.95%), customs officers (45.83%), and customs brokers (39.13%). The absence of impact is most commonly reported by customs brokers (17.39%), customs officers (14.58%), importers/exporters (13.51%), and logistics companies (12.90%). Uncertainty levels are highest among customs brokers (8.70%), followed by logistics companies (6.45%), customs officers (6.25%), and importers/exporters (5.41%).

Thus, customs officers generally have a more positive view of the current system and face fewer issues, whereas importers/exporters and customs brokers report more delays and errors. Customs brokers are the most enthusiastic supporters of AI, expecting significant cost reductions, while importers/exporters express more concerns about risks and costs. Logistics companies hold an intermediate position. These differences reflect each group's distinct roles and interests in the customs process.

CONCLUSION

In today's globalized environment, customs control faces unprecedented challenges due to the rapid expansion of international trade. Traditional methods, heavily reliant on manual processes and human oversight, can no longer efficiently handle vast data volumes, leading to delays, high operational costs, and increased fraud risks. AI offers revolutionary solutions that can transform customs operations, enhancing cost efficiency and risk management in international trade.

By automating routine tasks such as goods classification and document verification, AI accelerates customs clearance, reduces the need for human resources, and minimizes errors. Case studies from China, the USA, Brazil, and the Netherlands demonstrate how AI optimizes logistics, increases transparency and security, and significantly reduces costs.

The economic benefits of AI adoption are diverse. AI not only lowers operational expenses through automation but also optimizes resource allocation, enabling customs authorities to focus on high-risk shipments. This reduces supply chain delays, as well as storage and transportation costs. A survey among customs stakeholders confirms these findings: most respondents rate current customs procedures as moderately or poorly efficient, citing lengthy processing times, high costs, and frequent errors as key issues. At the same time, the vast majority support AI implementation, expecting faster processes, lower costs, and improved violation detection. However, stakeholders also express concerns about implementation costs, potential job losses, and technical failures, emphasizing the need for a well-planned AI integration approach.

Therefore, AI is a key tool for modernizing customs control. Its economic efficiency extends beyond direct cost reductions to improving security, transparency, and global market competitiveness. To ensure successful AI implementation, it is essential to consider stakeholder opinions, invest in personnel training, and manage associated risks. All these factors contribute to an optimistic outlook: AI integration can make customs control faster, more cost-effective, and more reliable, facilitating the future growth of international trade.

ABSTRACT

Traditional customs control methods rely on manual processes in the rapidly evolving international trade environment. They are becoming increasingly inefficient, leading to high operational costs, delays, and an elevated risk of fraud. Artificial intelligence (AI) presents an innovative solution for optimizing these processes. This study highlights the successful implementation of AI in countries such as China, Brazil, the United States, the Netherlands, and Dubai, where the technology has accelerated cargo clearance and improved the accuracy of intervention detection. Specifically, AI automates cargo classification, document analysis, and risk assessment, reducing processing time and minimizing human errors while lowering operational costs by 15-40%, as observed in Qingdao Port in China and Dubai.

Additionally, a survey of customs control participants (173 respondents) revealed dissatisfaction with the current customs system and support for AI adoption despite concerns regarding cost and technical failures. By leveraging AI's ability to analyze large volumes of data and detect trade violations, international trade becomes more transparent and secure. The study emphasizes that the gradual implementation of AI technologies and personnel training are key to maximizing economic benefits.

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