

Digitalizing Customs Services to Enhance Public Service Quality with AI, Blockchain, GIS, And Web Portals in Pakistan: Prospects, Challenges, and Policy Options Compared with Developed Countries

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Abstract:

The global shift towards digitization is transforming public administration, particularly within Customs workflows. This study examines how Information and Communications Technology (ICT) is revolutionizing Customs operations through automation, digital declarations, and risk management. Emphasizing the role of digital Customs, the paper explores how ICT tools like big data, AI, and blockchain are improving efficiency in revenue collection and operational management. This research identifies key areas for improvement, such as advancing AI capabilities, expanding blockchain use, and fully integrating Geographic Information System (GIS) technology. Recommendations include enhanced staff training, better interdepartmental coordination, and improved technological integration. The findings aim to provide actionable insights for optimizing Customs operations and facilitating legitimate trade and border management.

Key words:

Digital Transformation, Customs Automation, Artificial Intelligence, Blockchain Technology, Geographic Information System (GIS).

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Introduction

The global digitization wave is driving a paradigm shift in public administration, with Information and Communications Technology (ICT) pervading Customs workflows. Digital transformation is replacing manual processes by leveraging ICT for automation, information dissemination, electronic declarations, and risk management. Digital Customs harnesses digital systems to optimize revenue collection, regulate the movement of goods and people, and prevent illicit activities. This shift from paper-based to electronic operations aims to create a more efficient and modernized Customs environment by leveraging technologies like big data and cloud computing to enhance facilitation and operational efficacy (Mikuriya, 2016).

The global digital transformation has enabled increased access to advanced data-driven technologies, presenting opportunities for Customs administrations to enhance reform and modernization efforts. However, this necessitates careful consideration of AI integration, data solution selection, and effective technological assimilation. AI implementation offers a profound opportunity for Customs organizations to revolutionize business processes through automation and enhanced operational intelligence but requires significant investment, a paradigmatic shift, and champion leadership to drive innovation and excellence (Kafando, 2020).

Blockchain technology facilitates a decentralized, distributed ledger, enabling trustless transaction recording and tracking via collective validation. This protocol enables intermediary-free contract execution, streamlining processes and enhancing efficiency. By leveraging encryption and distributed networking, blockchain ensures secure, tamper-resistant documentation, minimizing data manipulation risks. Its efficacy in reducing time and costs, combined with enhanced security, makes blockchain an attractive solution for optimizing transactional processes across industries (Okazaki, 2018).

The governance of land and maritime borders presents a unique set of challenges distinct from those at points of entry, with spatial dimensions exposing a significant constraint. Exploiting geospatial data, which correlates with specific coordinates, can provide Customs officers with actionable insights, enabling informed decision-making and strategic resource deployment. Recent advancements in computer technology and GPS integration have exponentially increased the utilization of geo-data,

empowering borderland governance with enhanced spatial awareness and informed resource allocation (Cantens, 2019).

Problem Statement

Pakistan's customs services suffer from inefficiencies and delays due to inadequate adoption of AI, blockchain, GIS, and web portals. However, developed countries have effectively utilized these technologies to enhance their customs operations, achieving higher efficiency and service quality. Therefore, it is crucial for Pakistan to bridge this technological gap to improve its customs services and align with global standards.

Research Questions

1. How does using AI, blockchain, GIS, and web portals in Pakistan's customs services affect efficiency and service quality compared to developed countries?
2. What are the technological and infrastructural challenges in integrating AI, blockchain, GIS, and web portals?
3. Which policy options can effectively address integration challenges and improve customs services in Pakistan using AI, blockchain, GIS, and web portals?

Scope of the Study

This study conducts a comprehensive analysis of digitalizing Pakistan's customs services using AI, blockchain, GIS, and web portals, investigating technological potential, implementation challenges, and deriving policy lessons from a comparative analysis with developed countries.

Review of Literature

Artificial intelligence (AI) replicates human intellect, simulating cognitive functions like learning, reasoning, and language processing. AI-powered machines learn, reason, and process language, analyzing vast customs data to detect patterns with enhanced accuracy and speed. AI applications in customs include predictive modeling, automated classification, anomaly detection, predictive targeting, enhanced image analysis, and intelligent chatbots, collectively optimizing processes and compliance (Koh, 2022). Some customs agencies around the world currently exploit big data analytics, AI, and machine learning, while others intend to adopt these technologies in the

future (WTO, 2022). Pakistan Customs, in collaboration with the World Customs Organization (WCO) and adhering to established best practices, has integrated artificial intelligence and machine learning algorithms into its Web-Based One Customs (WEBOC) system to enhance customs clearance processes (Batool, 2024).

Blockchain technology is a secure, decentralized ledger system ensuring data integrity and transparency through immutable blocks and consensus mechanisms. Key features include shared ledgers, permissioned access, smart contracts, and automated validation (Ashfaq, Riaz, & Iftikhar, 2022). The immutable nature of blockchain-based document information is crucial in facilitating the detection of illicit activities and ensuring the efficient facilitation of legitimate trade, thereby enhancing the integrity and transparency of global supply chains (Dawn, PSWC, TradeLens join hands to digitize external trade, 2021). Customs administrations have traditionally utilized geo-data for transit monitoring, tracking goods in real-time via GPS or RFID devices. However, the broader potential applications of geo-data remain underexplored, possibly due to a narrow focus on managing major flows between ports and airports, reflecting an economic vision of Customs' role prioritizing globalization's large-scale transactions (Cantens, 2019).

Pakistan Customs, recognizing its dynamic and vibrant nature, proactively embraced transformation by introducing computerization and digitalization in its processes to address the demands of free trade in the modern global landscape. This shift enabled the transition from manual to automated systems, significantly reducing clearance dwell time and enhancing the overall efficiency of Customs services, thereby fostering a more streamlined and technology-driven approach to trade facilitation (Memon, 2022).

Analysis

To understand the subject, situational analysis, SWOT analysis, and gap analysis have been conducted as follows:

Situational Analysis:

A situational analysis is crucial to assess the current status of Pakistan Customs services regarding AI, blockchain, GIS, and web portals, and to identify areas for improvement. AI is significantly transforming Pakistan Customs by enabling rapid and precise decision-making based on real-time data analysis. AI assists the WEBOC system in profiling traders and categorizing cargo into Green, Yellow, and Red Channels for clearance. It calculates duties and taxes and integrates WEBOC with other government departments for certification requirements. AI also supports the Anti-

Smuggling Module by forwarding seizure cases for legal action. However, AI integration is not uniform, leading to efficiency disparities. Blockchain technology, through the TradeLens partnership, enhances transparency and traceability in supply chains, facilitating digital documentation and combating trade-based money laundering. However, its implementation is still nascent, and customs officials need comprehensive training.

GIS and real-time logistics technologies have improved customs operations monitoring. Systems like vehicle telematics and RFID tracking provide essential data for tracking containers and cargo. GIS technology monitors transit cargo, with TPL Tracker offering real-time surveillance and alerting customs stations to any deviations or unauthorized stoppages. The WEBOC system, developed by Pakistan Revenue Automation Limited, has been a cornerstone in digitalization, facilitating paperless transactions, improving resource allocation, and enhancing trade facilitation. Despite its success in clearing about 99% of total cargo, WEBOC is aging and struggling to meet modern trade demands. The Pakistan Single Window (PSW) initiative aims to address these issues, but significant challenges remain.

SWOT Analysis

The SWOT analysis of the Customs Department of Pakistan has been conducted as follows:

Strengths

- Pakistan Customs has started integrating advanced technologies like AI and blockchain, enhancing efficiency in goods clearance and bilateral trade.
- AI helps in profiling traders and automating duty calculations, improving the accuracy and speed of customs processes.
- GIS technology is used for real-time tracking of transit cargo, enhancing monitoring and management of customs operations.
- Platforms like WEBOC and PSW facilitate paperless transactions, improve resource allocation, and enhance trade facilitation.

Weaknesses

- Blockchain technology is still in its nascent stages with limited integration and utilization in customs operations.
- The use of GIS is restricted to specific operations, limiting its potential benefits across all customs activities.
- Weak coordination between various customs divisions and departments hinders efficient operations.

Opportunities

- Expanding AI integration across all customs functions can enhance decision-making and operational efficiency.
- Full implementation of blockchain technology can improve transparency, reduce fraud, and streamline documentation processes.
- Broadening the application of GIS can improve monitoring of all containers and cargo, preventing smuggling and enhancing trade security.
- Digitizing auction data and making it accessible to anti-smuggling squads can improve verification processes and protect legitimate trade.

Threats

- Challenges in scaling and integrating new technologies with existing systems can hinder modernization efforts.
- Limited financial and human resources may delay the full implementation of advanced technologies.
- Resistance from customs staff and other stakeholders towards adopting new technologies could slow down the digital transformation process.
- Increasing reliance on digital systems may expose customs operations to cybersecurity threats, requiring robust security measures.

Gap Analysis of the Customs Services Provided in Pakistan:

Pakistan Customs has integrated AI and machine learning into its WEBOC system, but there are significant implementation gaps. AI aids the Risk Management System (RMS) by categorizing cargo into Red, Yellow, and Green channels, but the system is underdeveloped. AI does not verify the authenticity of trader documents, leading to inefficiencies. Seizure cases often end up with various officers due to incomplete AI integration. Additionally, the State Warehouse management and Anti-Smuggling Module lack AI support. Seized goods are stored centrally rather than in specific agency warehouses, and Special Customs Courts are disconnected from WEBOC, hindering access to the status of warehoused goods.

Blockchain implementation in Pakistan Customs, initiated through partnerships like TradeLens, is still in its early stages. There are gaps in the scalability and interoperability of blockchain with existing customs infrastructure. The Electronic Cargo Tracking System is not yet implemented, and there is no blockchain-based system for certifying documents. Collaboration with the WCO and regional customs departments is also lacking. Addressing these issues could improve transparency, reduce fraud, and enhance efficiency.

Geo-data and real-time logistics technologies, such as GPS and RFID, are underutilized within Pakistan Customs. Currently, these technologies are mainly used for Transit Trade with Afghanistan and major port flows, neglecting other areas that could benefit from enhanced geo-data applications. Pakistan Customs has implemented web portals like WEBOC, supported by PSW, but the creation of various Collectorates has led to a lack of unique codes, impeding the clearance and legal processes for seized goods. Seizure cases initiated by one officer are assigned to another, complicating legal disposal procedures. The Federal Board of Revenue (FBR) requires frequent reports on seized and cleared goods, but there is no integrated system to consolidate these reports, burdening field officers. The Electronic Import Form (EIF) is not thoroughly scrutinized, only deducting amounts without verifying goods' descriptions and values.

Impact Analysis

Positive Impacts Adopting AI, blockchain, GIS, and web portals significantly enhances the efficiency and transparency of customs operations. AI improves accuracy and speed by profiling traders and automating duty calculations. Blockchain ensures data integrity and traceability, reducing fraud risks. GIS enables real-time tracking of goods, enhancing monitoring and management. Web portals like WEBOC and PSW facilitate paperless transactions, improving resource allocation and trade facilitation. These technologies improve inter-departmental coordination, with blockchain creating a unified data-sharing platform, reducing delays, and streamlining customs clearance processes.

Negative Impacts Fully integrating AI, blockchain, GIS, and web portals faces technological barriers, requiring substantial investment in infrastructure and training. The current infrastructure may not support these advanced systems, causing potential disruptions. Resistance from customs staff and stakeholders to adopting new technologies is a challenge, necessitating comprehensive training and change management programs. Increasing reliance on digital systems exposes operations to cybersecurity risks, requiring robust security measures to protect data and maintain the integrity of customs processes. Any breaches could disrupt operations and undermine trust in digital customs services.

Best Practices:

The best practices of countries (India, Dubai, and Singapore) that have digitalized customs services with artificial intelligence, blockchain, GIS, and web portals are as follows:

India:

Indian Customs is leveraging advanced technologies like AI, blockchain, GIS, and web portals to improve transparency, data quality, and border management. The Central Board of Indirect Tax and Customs (CBIC) focuses on digitizing indirect tax administration to prevent revenue leakage and facilitate trade. Key initiatives include the Single Window Interface for Facilitating Trade (SWIFT) to streamline processes and the Advanced Analytics in Indirect Taxation (ADVAIT) project for AI-driven tax compliance and evasion detection. Other measures include the Anonymized Escalation Mechanism (AEM) for grievance redressal, the E-Cash Ledger for online payments, and pilot projects such as the pre-arrival customs data exchange with the Maldives and the blockchain-based Electronic Cargo Tracking System (ECTS) for secure transshipment. Additional efforts include using Body Worn Cameras (BWC) for transparency in seaport operations and a QR code-based Sampling Solution for monitoring sampling processes at ports, aiming to modernize customs procedures, enhance security, and improve trade facilitation (CBIC, April 2023).

The Paperless Customs initiative, part of CBIC's 'Turant Customs' program, digitizes the customs clearance process, eliminating the need for physical documents and enhancing the logistics network's efficiency. This initiative speeds up customs clearance, reduces interactions between trade and customs authorities, and is environmentally friendly. Key features include web-based registration of goods via ICEGATE, enabling electronic registration and Out of Charge (OOC) without hard copies, and Customs Compliance Verification (CCV), which delinks duty payment from compliance verification. The e-SANCHIT system stores supporting documents online, promoting paperless communication, while the ICETRAK mobile app provides live tracking of Bill of Entry (BE) and Shipping Bill (SB) status. The e-Gatepass ensures faster goods movement by providing advance information to custodians and shipping lines, and Indian Customs Tablets (ICETABs) enhance operational efficiency for officers. Overall, these technological advancements streamline customs processes, enhance transparency, and improve trade facilitation. The Indian Customs EDI System (ICES) is operational at 256 major locations, handling 98% of India's international trade. It automates customs clearance and interfaces electronically with trade, transport, banks, and regulatory agencies via ICEGATE, ensuring fully digital document submission and processing (Customs C. B., November 2023).

United Arab Emirates:

Dubai Customs is leveraging artificial intelligence (AI) to enhance trade facilitation and border control, establishing itself as a global leader in customs operations. AI technologies, such as robotic process automation and

predictive analytics, expedite declarations and improve overall efficiency by automating repetitive tasks and analyzing extensive data to detect fraud and anomalies. Initiatives like the iDeclare app for electronic customs declarations, the AI Munasiq tool for HS code lookup, and the Remote Inspection initiative using robots exemplify Dubai Customs' commitment to innovation. The Smart Refund System and post-clearance audit automation further streamline processes and enhance transparency. These AI-driven advancements position Dubai Customs at the forefront of modern customs operations, ensuring both efficiency and security in global trade (Musabih, 2023).

Dubai Customs has prioritized blockchain technology in its efforts to enhance efficiency and security in customs clearance processes. By implementing blockchain-based non-stop customs clearance systems, Dubai Customs ensures data integrity, stability, and traceability, significantly reducing delays and resource consumption in cross-border trade. The development of a blockchain-based Cross-Border E-Commerce Platform is central to transforming Dubai into a leading e-commerce hub. This platform increases efficiency, streamlines clearance processes, improves inventory reconciliation, and provides comprehensive transaction visibility and traceability (Musabih, 2020).

Singapore:

Singapore Customs adopts digitalization and automation to enhance trade efficiency and security, recognizing the evolving demands of the international trade landscape for adaptation and innovation. Through the ASEAN Single Window, the electronic exchange of trade-related documents is enabled, saving time and costs for traders. The ASEAN Harmonized Tariff Nomenclature and Customs Transit System further facilitate consistent classification and efficient transit of goods. Beyond ASEAN, bilateral initiatives like the Track & Trace service and Networked Trade Platform digitalize supply chain management and certification exchange, reducing risks and costs for traders. Simplified procedures and automation efforts with local agencies also save significant man-hours per month. Singapore Customs collaborates with international partners to combat illicit trade, participates in the Container Security Initiative, and pursues Authorized Economic Operator Mutual Recognition Arrangements to foster trust and recognition between customs administrations. Emphasizing innovation and partnerships with new stakeholders, Singapore Customs adapts to the dynamic trade landscape, ensuring revenue protection and security while facilitating trade. By harnessing digitalization, automation, and innovative approaches, Singapore Customs streamlines cargo clearance processes, strengthens border control, and enhances secure trade, remaining committed to its mission of facilitating trade while ensuring revenue protection and security (Customs S., 2024).

Issues and Challenges:

The following issues and challenges have been identified by studying the topic:

1. Incomplete integration of AI with WeBOC, hindering seamless verification of documents and seizure cases.
2. Lack of scalability and interoperability of blockchain systems with existing infrastructure, and non-utilization of blockchain technology for certifying the authenticity of documents and tracking cargo movement.
3. Limited application of geo-data and real-time logistics technologies like GPS.
4. Absence of unique codes for each Collectorate, impeding clearance and legal processes, and inefficient assignment of seizure cases to authorized officers, hindering legal procedures.
5. No integrated system for consolidating seizure cases and cleared goods, leading to unnecessary reporting burdens.
6. Inadequate scrutiny of Electronic Import Forms, neglecting verification of goods' descriptions and import values.
7. Non-availability of the WeBOC system for Frontier Corps working at the borders of Khyber Pakhtunkhwa.
8. Non-availability of integrated Warehouse Management with other WeBOC modules.
9. Non-integration of scanners with WeBOC at various terminals and ports.
10. Absence of digitization of Customs Auction data across the country.
11. Lack of inter-departmental coordination in Pakistan due to the absence of modern communication technologies.

Conclusion

The government of Pakistan has endeavored to extensively digitalize the structural framework of Customs services, aiming to enhance the efficacy of service delivery. The incorporation of Artificial Intelligence has yielded partial success in streamlining goods clearance processes, yet there remains a discernible scope for further augmentation and refinement. The partial implementation of Blockchain technology has yielded beneficial outcomes for the procedural framework of Customs services, facilitating enhanced efficiency in bilateral trade between Pakistan and its partner nations. However, this technological integration remains in its incipient stage, indicating a need for further development and expansion to fully harness its potential. Pakistan Customs has selectively utilized Geographic Information System (GIS) technology, limiting its application to Transit Trade and Transshipment operations. However, a more comprehensive and extensive

integration of GIS capabilities is required to fully leverage its potential and maximize its benefits across all Customs operations. Moreover, Pakistan Customs has implemented web-based platforms, notably WeBOC and PSW, which have transformative impacts on the clearance and disposal system. These digital portals have facilitated interdepartmental integration, enhancing operational efficiency and verification processes. Nevertheless, these systems remain in a state of ongoing development, with opportunities for further refinement and maturation to achieve optimal functionality and maximal benefits.

Recommendations

The following measures have been recommended for improving service quality through the use of AI, Blockchain, GIS, and Web Portals:

1. Customs staff faces significant capacity constraints in fully embracing the technological advancements of AI, Blockchain, GIS, and Web Portals, necessitating an enhancement of their capabilities to address contemporary challenges. To bridge this gap, targeted training programs in computer literacy, AI, GIS, and WeBOC/PSW are essential. Moreover, equipping Anti-smuggling and Appraisal staff with modern gadgets is crucial to leverage the benefits of these technologies and optimize their utility in customs operations, thereby ensuring effective utilization of their potential.
2. Pakistan Customs has selectively integrated Artificial Intelligence (AI) into its system, utilizing it to create trader profiles based on historical trade transaction data. The AI-powered WeBOC system automates duty and tax calculations for declared goods. However, a notable limitation exists in the system's inability to verify the authenticity of documents and establish direct connections with relevant departments, with the exception of a few certificate-issuing entities, thereby hindering the full potential of AI-driven efficiency and accuracy in customs processing. The clearance system, augmented by AI, necessitates comprehensive integration with various governmental departments to validate the authenticity of documents issued for import and export purposes.
3. While a total of 77 departments require integration, only 11 have been successfully linked to the system (PSW), highlighting a significant gap in the pursuit of seamless interagency collaboration and robust document verification. Full integration is essential to harness the potential of AI-driven efficiency and accuracy in customs processing. The WeBOC system should also be enhanced with modern technology, potentially incorporating artificial intelligence, to accurately identify Electronic

Import Forms (EIF) and Export Forms (Form E) associated with specific goods being imported or exported.

4. A notable lacuna exists in the interconnectivity between the anti-smuggling divisions and the comprehensive database of goods clearance. Upon receiving credible intelligence, anti-smuggling squads intercept and verify goods, but the subsequent process of document authentication is manual and time-consuming. The anti-smuggling division must physically transmit the documents to the relevant Customs unit in another province or city, leading to delays in verification, thereby hindering the efficiency and efficacy of anti-smuggling operations. An integrated system, augmented by AI, is essential for the Customs department to validate the authenticity of documents and goods, ensuring legitimate trade practices. This system should be implemented across various Customs formations, strategically located at entry and exit points, as well as areas where anti-smuggling squads operate. The system should be comprehensive, incorporating visual data, invoices, detailed descriptions, bills of lading, and other relevant information to facilitate real-time verification and efficient monitoring of goods movement, thereby enhancing the efficacy of anti-smuggling efforts.
5. Digitizing customs auction data, including images and bank receipts, should be integrated into a system accessible to anti-smuggling squads of Customs, Provincial Excise, and Local Police. This system will enable verification of the authenticity of auctioned vehicles and goods, thereby facilitating genuine ownership. Scanners integrated with AI should be installed at borders and airports to examine goods, containers, and baggage, facilitating legitimate trade and passenger movement without disruption. Additionally, the quota system embedded in WeBOC should be supported by AI to monitor the debit and credit of quotas for individual traders effectively.
6. The integration of Blockchain technology in Pakistan's customs services remains underdeveloped, yet it is essential for evidence-based decision-making. Implementing Blockchain would facilitate data exchange among various domestic agencies and intergovernmental entities, enhancing information sharing. This technology would enable airport staff to identify travelers involved in currency and gold smuggling by accessing detailed histories of travelers and traders related to imports and exports.
7. Currently, inter-departmental coordination in Pakistan is weak; adopting Blockchain would strengthen this coordination and lead to increased productivity. Lessons can be drawn from the successful implementation of Blockchain by customs services in Singapore, Dubai, and the United States. By adopting Blockchain, Pakistan's Customs Department could also address issues of under-invoicing of imported goods. Thus, Blockchain integration is crucial for enhancing the capacity, productivity, and efficiency of Pakistan's customs services.

8. The Geographic Information System (GIS) is currently utilized only in Transit Trade and select transshipments within Pakistan. It should be extended to all containers moving across different locations to safeguard legitimate trade. Border stations in Pakistan must be equipped with GIS and surveillance systems to monitor illegal movements of vehicles and goods. These systems should be supervised by Customs, Frontier Corps, and Border Security Forces within their respective domains to prevent smuggling before it reaches major cities.
9. Dubai Customs provides a model, having successfully implemented GIS to counter smuggling along borders and coastal areas. GIS can help identify frequently used smuggling routes, enabling enforcement agencies to target these areas effectively. Additionally, drone surveillance supported by GIS can enhance anti-smuggling efforts. Implementing GIS will also enhance the protection of customs offices and officials in remote areas through various surveillance methods.
10. Pakistan Customs has implemented web-portals such as WeBOC and PSW to facilitate transparent clearance of goods at borders, seaports, and airports. However, these systems have certain limitations. While 77 departments need integration with PSW, currently only 11 have been integrated to support trade and meet import/export requirements. Additionally, the sudden division of the main Collectorate into smaller units has created issues due to the lack of distinct WeBOC codes for each new Collectorate, hindering smooth operations. The Frontier Corps (FC), the primary anti-smuggling agency in the tribal areas of Khyber Pakhtunkhwa, still lacks a WeBOC ID and continues to manage seizure cases and warehouse records manually, which affects efficiency.
11. The Warehouse Management System should also be integrated with WeBOC, ensuring seamless connection with other WeBOC modules to easily track the status of warehoused goods. Establishing a unified, integrated system would allow for accurate assessment of the value of seized and warehoused goods at any given time.

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