

ARTICLES

Measuring the Electronic Readiness of the Islamic Republic of Iran Customs Administration to Implement Blockchain Technology in the Supply Chain

Neda Ashayeri, MD¹ , Mehdi Kazemi, PhD² , Mohammad Mehdi Poursaeed, PhD² 

¹ Department of Economics and Management, Shahid Bahonar University of Kerman, ² Department of Management, Shahid Bahonar University of Kerman

Keywords: Supply Chain, Blockchain, E-readiness, Customs, Analytic Hierarchy Process

<https://doi.org/10.55596/001c.144226>

Vol. 19, Issue 2, 2025

This research develops a novel, multi-dimensional model to investigate the electronic readiness of customs organisations for adopting blockchain technology. Recognising Customs' pivotal role in global trade facilitation, this model systematically assesses an organisation's preparedness across five critical dimensions: organisational, individual, technological, environmental, and managerial. This framework offers a robust tool for evaluating the key factors influencing the successful integration of blockchain within customs operations. The Islamic Republic of Iran Customs Administration serves as a specific case study, demonstrating the model's applicability in a real-world context. Employing a descriptive and exploratory approach, 44 customs managers and IT professionals and 17 blockchain experts participated in the case study. Data collection involved both literature reviews and field methods, with a researcher-designed questionnaire. The questionnaire data were analysed statistically. Literature reviews and interviews with blockchain specialists informed the dimensions and criteria for the questionnaires. Subsequently, paired comparison questionnaires gathered insights from blockchain community managers and laboratory experts of the Sharif Blockchain Laboratory. The Analytic Hierarchy Process (AHP) method was employed to analyse this data, determining the relative weights of each criterion and sub-criterion.

1. Introduction

1.1. The global supply chain

As observed by Jomthanachai et al. (2021, as cited in Jasrotia et al., 2024):

In the era of global supply chains, the focal firms¹, suppliers and customers are geographically dispersed, and forward and reverse supply chain processes become very complex.

As emphasised by Tse and Tan (2012, as cited in Jasrotia et al., 2024), 'visibility issues in tracking, traceability and transparency in the supply chains with an increase in the lengths of their tiers, intermediaries and

¹ A focal firm is the central, dominant company within a supply chain that exerts significant influence and control over its operations and direction.

markets'. A research report by Deloitte (2021, as cited in Jasrotia et al., 2024) highlights that 'the major obstacles presented by sustainability driven competitive advantage are fragmented and disconnected systems, and isolation among supply chain partners'. The report emphasises end-to-end, stage-wise collaboration among all the value chain stakeholders based on a data-driven and integrated approach to a sustainability footprint modelling in which sustainability impacts can be visualised. The stakeholders also become concerned whether the data shared with them are appropriate or not (Deloitte, 2021). A study by The World Economic Forum, The World Bank and a United States financial services firm found that reducing barriers to inefficient business processes could increase world trade by 15 per cent and global gross domestic product (GDP) by 5 per cent (Van Kralingen, 2017).

1.1.1. Customs: A critical gatekeeper

Customs plays a crucial role in facilitating faster movement of international goods passing through ports (Anderson et al., 2009). According to Anderson (2009, as cited in Caballini & Benzi, 2023):

It is widely recognised that port administrative procedures, including customs and security inspections, potentially affect time and costs incurred in shipping goods across borders, reflecting the competitiveness of the entire supply chain.

To make the global supply chains of the future more efficient, Smart Customs must minimise customs clearance time and costs, while intelligently managing inbound and outbound goods and vehicles. Disruptive technologies, in particular blockchain, the Internet of Things, artificial intelligence and machine learning, need to be used in combination to improve efficiency and transparency. Furthermore, numerous elements such as cybersecurity, data collaboration, and identifiers need to be considered when implementing innovative solutions (World Customs Organisation [WCO] & World Trade Organization [WTO], 2022).

1.2. Blockchain

For tracking along the supply chain of goods to connect documentation from one actor to another, blockchain is the preferred technology to fight information asymmetry (Francisco & Swanson, 2018). Blockchain technology is best known for its use as the basis for cryptocurrencies, but it has a variety of other uses (Fill & Meier, 2020). Wüst and Gervais (2018, as cited in Stopfer et al., 2024) define a blockchain network as 'a public (or private) decentralised and networked ledger with an interlinked and encrypted chain of records across an enterprise network'. Through this decentralised structure, no-one solely owns or regulates the public blockchain. Each record is considered as a unique block, due to a timestamp and a hash value of the previous block. According to Fill and Meier (2020,

as cited in Stopfer et al., 2024), ‘This makes the document incomprehensible to the public, but the authorized recipient can interpret and use the data’.

Another term to characterise blockchain technology is ‘smart contract’: a computer protocol allowing the execution of contracts without the involvement of third parties. As stated by Okazaki (2018), ‘The advantages of blockchain technology are: time and cost savings, more secure documents made even more robust through encryption, and sharing within the network’.

1.3. Transforming customs operations

Blockchain’s potential to facilitate customs processes is multifaceted, from customs clearance to interagency cooperation, certification, identity management, compliance management, revenue collection and post-clearance audit. Through this technology, the same copy of a ledger is instantly available to all parties at different nodes in the most updated, trusted, secure and immutable manner, obviating the need to maintain separate ledgers by each party as per the current practice. Considering the potential of blockchain, the WCO and the WTO have been exploring the use of this technology in the customs domain for the last few years (WTO and WCO, 2022). According to a report by the WTO and WCO (2022, p. 45):

...blockchain/DLT is still in an experimental phase for Customs, with around a third of customs authorities who responded to the survey testing it through proofs of concept (22 Members) and pilot projects (15 Members) using mainly private (permissioned) blockchains, while only two Customs administrations (Argentina and Uruguay) have reported a full deployment of this technology. Twenty-six Customs authorities have plans for this technology in the next three years, while another 45 Members have indicated that they have no plans in place yet.

It is inevitable that blockchains will soon become an integral part of Customs. According to Okazaki (2018), the impact of this on customs administrations will be that:

- (i) Customs will become more data-driven. Through their participation in the blockchain, Customs would be able to collect the necessary data in an accurate and timely way (all data tied to the commodity like seller, buyer, price, quantity, carrier, finance, insurance, status and location of the commodity, etc.).
- (ii) Customs may become part of the blockchain and become more embedded within trade processes. Data conveyed by the blockchain could be integrated automatically into Customs

systems and checked against the data submitted by traders and transporters. In a more integrated version, Customs could even automatically clear the goods within the blockchain itself.

(iii) Blockchain can enhance revenue compliance and cooperation between Tax and Customs. The automated access by Customs to data lodged in export countries' systems will encourage revenue compliance in import countries. This would help Customs with issues around valuation and transfer pricing and underpin further cooperation between Tax and Customs authorities.

(iv) Blockchain can help Customs to better combat financial crimes. Customs and relevant authorities would be updated regularly on events occurring within the banking system that could be misused to conceal illicit financial flows. The iterative comparison between trade data submitted by operators and a capital transfer recorded by financial institutions would lead to a greater probability of detecting financial crimes.

The blockchain technology represents a step forward for Customs as it offers several opportunities for them, from collecting accurate data to automatically detecting fraud and collecting taxes and duties.

1.4. Electronic readiness

Persons and Mackin (2020, as cited in Salvador-Carulla et al., 2024) observe that:

Identifying the readiness of implementation projects informs decision makers about the progress of projects towards maturity, facilitates funding decisions and resource allocation, as well as the design of risk mitigation plans. Regular assessment of the maturity of a project or program is considered best practice for program management through the use of defined processes, a knowledge-based approach and readiness standards.

1.5. A gap in knowledge

An analysis of reports from the WCO and various countries (Dubai, Singapore, China, the United States, etc.) reveals efforts to implement blockchain in customs operations (WTO and WCO, 2022). However, a scientific evaluation of their electronic readiness (e-readiness) remains absent. To address this knowledge gap, this study investigates the e-readiness of the Islamic Republic of Iran Customs Administration (Iran Customs) for blockchain implementation.

1.6. Research questions

This study aimed to answer two questions:

1. To what extent is Iran Customs electronically ready to implement blockchain technology?
2. How does the e-readiness of Iran Customs rank across various dimensions (organisational, individual, technological, environmental and managerial) in the context of blockchain implementation?

Specifically, how does the e-readiness of Iran Customs fare in terms of:

- organisational factors for blockchain adoption
- individual (personnel) capabilities related to blockchain implementation
- technological resources available for integrating blockchain technology
- environmental factors impacting the feasibility of blockchain use in Iran Customs
- management practices and support for adopting blockchain within the organisation.

2. Methodology

In line with its objectives and nature, the present study adopts both a descriptive and exploratory research design. Given that the study was conducted within a real, dynamic organisational setting and its findings have practical applicability, it also qualifies as applied research.

2.1. Data collection

Given the nature of the research problem and the broad scope of the subject, both library-based and field methods were utilised to ensure comprehensive data collection. During the field research phase, data were gathered through a researcher-developed questionnaire assessing customs e-readiness, as well as a pairwise comparison questionnaire used to evaluate the relative importance of the identified criteria. The dimensions and criteria included in the questionnaires were initially derived from an extensive literature review and subsequently refined through expert input obtained via interviews with academics, professionals and blockchain managers. The customs e-readiness questionnaire was administered to 44 IT experts at Iran Customs across several cities, including Tabriz, Zahedan, Bushehr and Khorramshahr. The resulting data were analysed using both descriptive and inferential statistical methods. Subsequently, pairwise comparison

questionnaires were distributed to 17 experts, CEOs and managers affiliated with the Iran Blockchain Association and the Sharif Blockchain Laboratory. The sample size for the indicator identification phase (the phase where the dimensions and criteria for the questionnaires were derived) comprised seven individuals, while 17 participants were involved in the pairwise comparison phase. Purposive sampling was employed due to the specialised nature of the research concepts. Questionnaires were distributed in coordination with participants' supervisors, ensuring their familiarity with the subject matter. The Analytic Hierarchy Process (AHP) method was used to analyse the pairwise comparison data, determining the relative weights of each criterion and sub-criterion.

2.2. Conceptual and analytical models

2.2.1. *Conceptual model*

To develop the research's conceptual model for evaluating the e-readiness of the customs organisation and promoting the implementation of e-government², we first employed a qualitative meta-analysis to examine the main dimensions of validated e-assessment models related to the customs organisation's mission, specifically e-commerce at the industry or organisational level. The aim of the qualitative meta-analysis was to provide a comprehensive and interpretative overview of the data and research that has addressed this specific topic. Qualitative meta-analysis seeks to integrate and synthesise the theories, methods, and findings of existing research, identify the fundamental elements of these studies, and conceptualise their overall results and directions within a new framework, ultimately interpreting and explaining these elements and findings. The significance and applicability of this research method are enhanced by its role in combining and integrating studies that have been conducted individually and geographically dispersed (Zakir Salehi, 2007). The dimensions used in this research to measure the e-readiness of the customs organisation are derived from the findings of 16 models (presented in [Table 1](#)) for examining e-readiness at the industry or organisational level. In the subsequent stage, the frequency of each criterion across the different models was examined, and after confirmation from senior management, the five dimensions with the highest frequency were selected as the main dimensions of this research's conceptual model. These dimensions are organisational factors, individual factors, technological factors, environmental factors and managerial factors, forming the research's conceptual model ([Figure 1](#)).

² E-government refers to the use of digital technologies, particularly the internet, by government agencies to deliver information, services, and interactions with citizens, businesses, and other arms of government efficiently, transparently, and responsively.

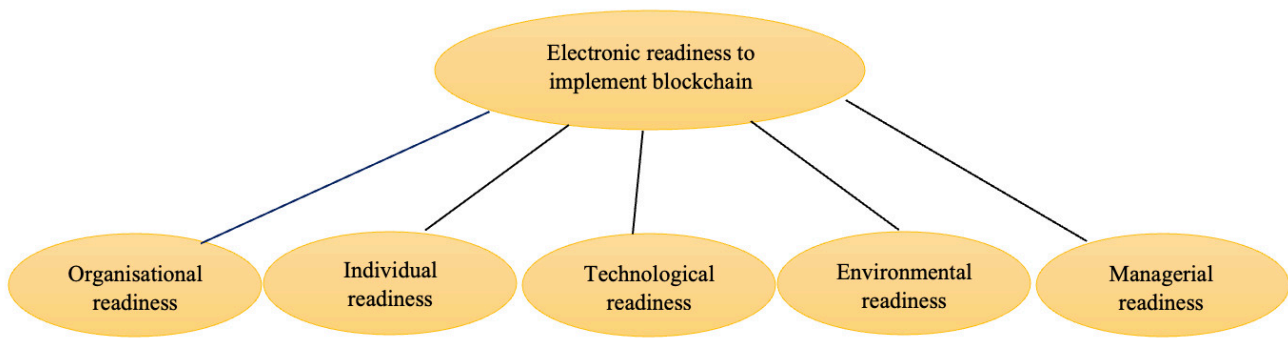


Figure 1. Conceptual model development.

Source: Authors.

2.2.2. Analytical model

Next, an analytical model ([Table 1](#)) was developed to define the proposed model's variables objectively and measurably. A pairwise comparison questionnaire was constructed, which included demographic and specialised questions ($n = 37$) on a 5-point Likert scale (1 = very low, 5 = very high). The questionnaire was administered in both face-to-face and online formats by blockchain experts. The analytical model of the study, along with the 16 models used, is presented in [Table 1](#).

Table 1. Analytical research model.

Concept	Dimensions	Index	Source
E-readiness	Organisational readiness	The organisation has a separate information management unit and information and communication technology (ICT) strategies	Van Akkeren & Cavaye, 1999 Huang et al., 2004 KPMG, 2000 Mutula & Van Brakel, 2006 Premkumar et al., 1997 Rashid & Al-Qirim, 2001 K. Zhu & Kraemer, 2002 Ling, 2001 Haghighi Nasab & Hassani Masouleh, 2006
		Information security and recovery programs	
		Effective and timely revision plans in the organisation's ICT strategy	
		Training programs and capacity-building initiatives for an e-readiness organisation	
		Execute online business transactions in the organisation	
	Individual readiness	Employee ability to manage and maintain information in the organisation	Molla & Licker, 2005 Mutula & Van Brakel, 2006 Choucri et al., 2003 Rashid & Al-Qirim, 2001 Ruikar et al., 2006
		Employee access to ICT skills	
		Adequate technical support for the organisation	
		Employees' tendency to use ICT to do business	
		Ability to access, analyse and use the information of international origin	
	Technological readiness	High bandwidth access to networks and the use of information systems in the organisation	Huang et al., 2004 Molla & Licker, 2005 Mutula & Van Brakel, 2006 van Heck & Ribbers, 1999 Ozer, 2005 Choucri et al., 2003 Rashid & Al-
		Network connection quality	
		Variety of communication channels available in the organisation to implement information systems	
		The quality of online transactions such as e-commerce in the organisation	
		The mechanism for analysing, designing and implementing information systems	

Concept	Dimensions	Index	Source
	Environmental readiness	The organisation's electronic business environment	Qirim, 2001 K. Zhu & Kraemer, 2002 Ruikar et al., 2006
		Government support and legal infrastructure, as well as legal mechanisms for implementing new information systems in the organisation	van Heck & Ribbers, 1999 Mutula & Van Brakel, 2006 Ozer, 2005 Premkumar et al., 1997
		Global access to implement information systems in the organisation	Rashid & Al-Qirim, 2001
		National ICT network security for business transactions	L. Zhu & Thatcher, 2010
		The level of e-readiness of neighbouring organisations for electronic communication and the use of software (such as a Single Window)	K. Zhu & Kraemer, 2002 Haghighi Nasab & Hassani Masouleh, 2006
	Managerial readiness	Support, emphasis and priority of ICT by managers in the organisation	Van Akkeren & Cavaye, 1999 Bagheri Dehnavi et al., 2012 Harrison et al., 1997
		Management change and up-to-date management to improve the ICT situation in the organisation	Huang et al., 2004
		Project management in various fields	Julien & Raymond, 1994 KPMG, 2000 Molla & Licker, 2005
		Level of risk-taking, logic, interaction and business decision-making processes	Mutula & Van Brakel, 2006 Ruikar et al., 2006

Source: Authors.

2.3. Data analysis

To assess the customs e-readiness questionnaire validity, the Confirmatory Factor Analysis (CFA) method was employed. In general, within the factor analysis technique, if most items designed to measure a specific component exhibit high factor loadings (typically greater than 0.30), the component is considered to have adequate construct validity.

To evaluate the reliability and internal consistency of the customs e-readiness questionnaire, Cronbach's alpha method was used, employing IBM SPSS Statistics version 19 software. The Cronbach's alpha coefficient was calculated using the following formula:

$$r_a = \frac{J}{J-1} \left(1 - \frac{\sum_{j=1}^n s_j^2}{s^2} \right) \quad (\text{Equation 1})$$

where: the number of item subsets in the questionnaire = J, the variance of the subtest J = s_j^2 and the total variance of the questionnaire = s^2 .

For this purpose, a pilot sample consisting of 30 pre-test questionnaires was administered. Using the data obtained from this pilot study and SPSS statistical software, the reliability coefficient was calculated using Cronbach's alpha method. Cronbach's alpha coefficients for the research variables and their dimensions are presented in [Table 2](#).

Table 2. Cronbach's alpha coefficient for the research variables

Research variables	Cronbach alpha value
Organisational readiness	0.834
Individual readiness	0.867
Technological readiness	0.896
Environmental readiness	0.852
Managerial readiness	0.888
All alpha questionnaire	0.951

Source: Authors.

Given that the Cronbach's alpha values for all research variables were above 0.80, the questionnaire was considered to have satisfactory internal consistency and reliability.

To assess the reliability of the pairwise comparison questionnaire, the consistency ratio (CR) was used. Based on the results obtained using Expert Choice software – a decision support tool built on the AHP and designed to facilitate structured, transparent, and efficient decision-making – the consistency ratios for the sub-criteria of organisational, individual, technological, environmental, and managerial readiness were 0.03, 0.10, 0.06, 0.03, and 0.04, respectively. The overall inconsistency rate for the pairwise comparisons was 0.05, which is below the acceptable threshold of 0.10. Therefore, the consistency of the comparison matrix was confirmed, and the data were considered reliable.

Bartlett's test and the Kaiser-Meyer-Olkin (KMO) index were used to confirm the sample size's adequacy for factor analysis. As shown in [Table 3](#), the Bartlett's test's significance level (p-value = 0.000) is less than 0.05, indicating a strong correlation matrix suitable for factor analysis.

Table 3. Bartlett's test and KMO index.

Statistic KMO	Test statistic	0.749
Bartlett's test	Chi-square test	703.656
	df	300
	p-value	0.000

Source: Authors.

Results

2.4. Sample demographics

This section provides an overview of the study participants. Among respondents (n = 44), seven (15.9%) were female and 37 (84.1%) were male. Similarly, experts (n = 17) included one female (5.9%) and 16 males (94.1%).

Educational attainment varied within both the respondent and expert groups. The highest frequency for respondents was a bachelor degree (21 people, 47.7%), while only one respondent (2.3%) held a doctoral degree or

higher. Likewise, most experts possessed a bachelor degree (six people, 35.3%), with the least frequent being an associate degree (two people, 11.8%).

Experience also differed across groups. Respondents most often had 10–15 years of service (15 people, 34.1%), while the least frequent category was less than five years of service (six people, 13.6%). Experts, on the other hand, had the highest frequencies in both the 5–10 years and more than 20 years of service categories (five people each, 29.4%), with the least frequent being 15–20 years of service (one person, 5.9%).

Expertise in specific fields varied among experts. The most frequent field was software engineering (five people, 29.4%), while the least frequent included accounting, engineering, architecture, veterinary medicine, blockchain, information technology, technology management, economics, mathematics, artificial intelligence, and security information systems (all one person each, 5.9%). Notably, all expert job positions had a single representative (one person each, 5.9%).

2.5. E-readiness of Iran Customs

The study found that Iran Customs has a low level of e-readiness for adopting blockchain technology. The overall e-readiness score was 2.65. An analysis using AHP ranked the five dimensions of e-readiness from highest to lowest:

1. Organisational readiness (score: 2.903, weight: 0.772): This dimension stands out as the most critical factor for overall e-readiness, boasting the highest score and weight derived from the AHP method. It emphasises the importance of a well-structured organisation with a dedicated information management unit, robust ICT strategies and strong training and capacity-building initiatives for employees. These elements lay a strong foundation for successful e-readiness.
2. Environmental readiness (score: 2.73, weight: 0.732): Ranked second in importance with a weight only slightly lower than organisational readiness, this dimension highlights the significance of external factors that support e-readiness. These include a supportive electronic business environment, government backing for technological initiatives, and a sound legal infrastructure with effective enforcement mechanisms. A strong external environment fosters conditions conducive to e-readiness adoption.
3. Individual readiness (score: 2.504, weight: 0.476): Ranked third based on its weight, this dimension focuses on the preparedness of the workforce for e-readiness. It emphasises employees' ability to effectively manage and maintain

information, alongside their access to and proficiency in using ICTs for business transactions. The score suggests room for improvement, and addressing individual readiness is crucial for successful e-readiness implementation.

4. Managerial readiness (score: 2.576, weight: 0.363): Ranked fourth, this dimension highlights the importance of leadership buy-in for e-readiness initiatives. It emphasises the need for managerial support for ICT initiatives, clear prioritisation of ICT within the organisation, and a management team that embraces change and stays up-to-date with evolving technologies. While its weight is slightly lower than individual readiness, strong managerial support is essential for driving e-readiness forward.
5. Technological readiness (score: 2.484, weight: 0.335): While receiving the lowest weight (indicating the least developed area), this dimension still holds importance. It focuses on the technological infrastructure in place to support e-readiness. Within this dimension, the mechanisms for analysing, designing and implementing information systems are most crucial. The score suggests a need for investment – a robust technological foundation is necessary for effective e-readiness.

3. Discussion

The overall results indicate that Iran Customs has a low level of e-readiness for blockchain adoption. This highlights the need to address weaknesses across all dimensions, particularly focusing on:

- Strategic planning: Strengthening the organisation's strategic planning methodology to facilitate change management, mitigate risks and optimise resource allocation
- Change management: Implementing effective change management strategies to reduce resistance and ensure user buy-in for blockchain adoption
- Human resource development: Developing training programs and capacity-building initiatives to enhance employees' ICT skills and knowledge in managing and maintaining information
- Managerial support: Fostering a culture of innovation and support for ICT initiatives within the organisation's leadership

- Technological infrastructure: Upgrading and investing in information systems to ensure robust analysis, design and implementation capabilities.

3.1. Potential benefits of blockchain for Customs

This study also explored the potential benefits of blockchain technology for customs organisations, as follows:

- Enhanced security: Private and permissioned blockchains can create secure networks for collaboration between customs authorities, law enforcement agencies, financial institutions and other relevant stakeholders. This facilitates information sharing, investigation and coordinated action against illegal activities within the global supply chain.
- Streamlined trade finance: Blockchain-based ecosystems developed by financial institutions can simplify and expedite trade finance processes, promoting a paperless environment. This provides participating organisations with real-time updates on banking activities, potentially preventing misuse for illicit financial flows.
- Smart contracts: Smart contracts enable secure and automated interactions between network members, even those who are unrelated or have different systems. This significantly reduces documentation costs associated with logistics and financing processes.
- Increased transparency: Blockchain technology provides a high degree of transparency for all participants involved in cross-border trade. Supply chain tracking, monitoring and connection are facilitated, leading to improved visibility into cargo movement, financial flows and international transactions.
- Automated customs clearance: Smart contracts can automate customs clearance processes based on predefined rules, reducing human error and manual intervention. This expedites customs clearance and eliminates unnecessary formalities, promoting agility within the supply chain.
- Improved information access: By integrating with blockchain platforms, customs organisations can improve access to and retrieval of information from the early stages of the supply chain, enhancing collaboration with supply chain stakeholders.

4.2. Limitations of the study

This study has some limitations that should be considered when interpreting the findings. Firstly, the study relied on a sample of 44 customs staff members from four Iran customs offices. While this sample provides valuable insights, a larger and more geographically diverse sample could increase the generalisability of the findings to other customs organisations.

Secondly, the data collection primarily relied on a researcher-designed questionnaire. While this approach facilitated efficient data collection, in-depth interviews with customs staff and blockchain experts could have provided richer qualitative data to further understand the specific challenges and opportunities related to e-readiness.

Finally, the study focused on a single customs organisation in Iran. The specific context of Iran's customs environment, including government regulations, technological infrastructure and cultural factors, may influence the e-readiness assessment. Future research could explore e-readiness for blockchain adoption in customs organisations from different countries to identify potential variations and commonalities.

4. Conclusion

This study revealed that Iran Customs has a low level of e-readiness for blockchain adoption. Focusing on strategic planning, change management, human resource development and technological infrastructure improvements could significantly enhance its e-readiness. Blockchain technology offers numerous advantages for Customs, including enhanced security, streamlined trade finance processes, increased transparency, automated customs clearance and improved information access. By addressing its e-readiness gaps and capitalising on these benefits, Iran Customs can achieve a more efficient, secure and transparent trade environment.

Submitted: September 14, 2024 AEST. Accepted: March 19, 2025 AEST. Published: September 25, 2025 AEST.



This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CCBY-4.0). View this license's legal deed at <http://creativecommons.org/licenses/by/4.0> and legal code at <http://creativecommons.org/licenses/by/4.0/legalcode> for more information.

References

- Anderson, C. M., Opaluch, J. J., & Grigalunas, T. A. (2009). The demand for import services at US container ports. *Maritime Economics & Logistics*, 11, 156–185. <https://doi.org/10.1057/mel.2009.4>
- Bagheri Dehnavi, M., Rezaei Noor, J., & Hani, S. H. (2012). Presenting a conceptual model for assessing the electronic readiness of government organizations using the Delphi Method. *2nd National Conference on Software Engineering, Islamic Azad University, Lahijan Branch*.
- Caballini, C., & Benzi, M. (2023). Fast Corridors: innovative customs processes and technology to increase supply chain competitiveness. The case of IKEA Italy. *Transportation Research Interdisciplinary Perspectives*, 21, 100909. <https://doi.org/10.1016/j.trip.2023.100909>
- Choucri, N., Maugis, V., Madnick, S., Siegel, M., Gillet, S., O'Donnell, S., & Haghseta, F. (2003). *Global e-readiness – for what?* (Paper No. 177). Report of the Group for Globalization of e-Business, Center for eBusiness at MIT, Sloan School of Management. <https://scispace.com/pdf/global-e-readiness-for-what-309d85bgru.pdf>
- Deloitte. (2021). *Data-driven sustainability: A new competitive advantage*. Deloitte Development LLC. <https://web.archive.org/web/20240415002556/https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/consumer-business/deloitte-nl-consumer-data-driven-sustainability-pov.pdf>
- Fill, H. G., & Meier, A. (2020). Blockchain kompakt: Grundlagen, Anwendungsoptionen und kritische Bewertung [Blockchain Compact: Basics, application options and critical evaluation]. In *IT kompakt*. Springer. <https://doi.org/10.1007/978-3-658-27461-0>
- Francisco, K., & Swanson, D. (2018). The supply chain has no clothes: Technology adoption of blockchain for supply chain transparency. *Logistics*, 2(1), 2. <https://doi.org/10.3390/logistics2010002>
- Haghighi Nasab, M., & Hassani Masouleh, M. (2006). مدل اندازه‌گیری آمادگی الکترونیکی برای پذیرش تجارت الکترونیکی در صنایع پتروشیمی ایران [Electronic Readiness Measurement Model for E-Commerce Adoption in Iranian Petrochemical Industries]. *Modern Economics and Trade Fall 2006 Issue 6*.
- Harrison, D. A., Mykytyn, P. P., Jr., & Riemenschneider, C. K. (1997). Executive decisions about adoption of information technology in small business: Theory and empirical tests. *Information Systems Research*, 8(2), 171–195. <https://doi.org/10.1287/isre.8.2.171>
- Huang, J. H., Huang, W. W., Zhao, C. J., & Huang, H. (2004). An e-readiness assessment framework and two field studies. *Communications of the Association for Information Systems*, 14(1), 364–386. <https://doi.org/10.17705/1CAIS.01419>
- Jasrotia, S. S., Rai, S. S., Rai, S., & Giri, S. (2024). Stage-wise green supply chain management and environmental performance: Impact of blockchain technology. *International Journal of Information Management Data Insights*, 4(2), 100241. <https://doi.org/10.1016/j.jjime.2024.100241>
- Julien, P. A., & Raymond, L. (1994). Factors of new technology adoption in the retail sector. *Entrepreneurship Theory and Practice*, 18(4), 79–90. <https://doi.org/10.1177/104225879401800405>
- KPMG. (2000). *E-government capacity check: lessons learned report*. Environment Canada, KPMG and the Enhanced Management Framework Division of the Chief Information Officer Branch, Treasury Board of Canada Secretariat. <https://www.tbs-sct.canada.ca/emf-cag/risk-risques/report-bilan-eng.pdf>

- Ling, C. Y. (2001). A Model for EC Adoption and Diffusion in SMEs: A Cross-country Study between Singapore and Australia. *ECIS Doctoral Consortium*, 24–26.
- Molla, A., & Licker, P. S. (2005). Perceived e-readiness factors in e-commerce adoption: An empirical investigation in a developing country. *International Journal of Electronic Commerce*, 10(1), 83–110. <https://doi.org/10.1080/10864415.2005.11043963>
- Mutula, S. M., & Van Brakel, P. (2006). An evaluation of e-readiness assessment tools with respect to information access: Towards an integrated information rich tool. *International Journal of Information Management*, 26(3), 212–223. <https://doi.org/10.1016/j.ijinfomgt.2006.02.004>
- Okazaki, Y. (2018). Unveiling the potential of blockchain for customs. *WCO Research Paper No. 45*, 1–24. https://www.wcoomd.org/-/media/wco/public/global/pdf/topics/research/research-paper-series/45_yotaro_okazaki_unveiling_the_potential_of_blockchain_for_customs.pdf
- Ozer, M. (2005). Online business: tailoring your business environment in order to compete. *International Journal of Information Management*, 25(2), 137–149. <https://doi.org/10.1016/j.ijinfomgt.2004.10.003>
- Premkumar, G., Ramamurthy, K., & Crum, M. (1997). Determinants of EDI adoption in the transportation industry. *European Journal of Information Systems*, 6(2), 107–121. <https://doi.org/10.1057/palgrave.ejis.3000260>
- Rashid, M., & Al-Qirim, N. (2001). E-Commerce Technology Adoption Framework by New Zealand Small to Medium Size Enterprises. *Res. Lett. Inf. Math. Sci.*, 2, 63–70. <https://mro.massey.ac.nz/server/api/core/bitstreams/4c8aa690-eb6f-459a-83ff-bfbc2cf6a98f/content>
- Ruikar, K., Anumba, C. J., & Carrillo, P. M. (2006). VERDICT – An e-readiness assessment application for construction companies. *Automation in Construction*, 15(1), 98–110. <https://doi.org/10.1016/j.autcon.2005.02.009>
- Salvador-Carulla, L., Woods, C., de Miquel, C., & Lukersmith, S. (2024). Adaptation of the technology readiness levels for impact assessment in implementation sciences: The TRL-IS checklist. *Heliyon*, 10(9), e29930. <https://doi.org/10.1016/j.heliyon.2024.e29930>
- Stopfer, L., Kaulen, A., & Purfürst, T. (2024). Potential of blockchain technology in wood supply chains. *Computers and Electronics in Agriculture*, 216, 108496. <https://doi.org/10.1016/j.compag.2023.108496>
- Van Akkeren, J., & Cavaye, A. (1999). Confusion with Diffusion? Unravelling IS Diffusion and Innovation Literature with a Focus on SME'S. *Australasian Journal of Information Systems*, 7(1), 60–67. <https://doi.org/10.3127/ajis.v7i1.288>
- van Heck, E., & Ribbers, P. M. (1999). Adoption and impact of EDI in Dutch SME's. *Proceedings of the Hawaii International Conference on System Sciences*, 273. <https://repository.tilburguniversity.edu/server/api/core/bitstreams/ba6f8b9c-a769-481a-bfc8-d38327b44939/content>
- Van Kralingen, B. (2017, March 5). *Lowering the Barriers to Global Trade with Blockchain*. IBM Think Blog. <https://web.archive.org/web/20170630160132/https://www.ibm.com/blogs/think/2017/03/trade-and-blockchain/>
- World Customs Organization & World Trade Organization. (2022). *WCO/WTO Study Report on Disruptive Technologies 2022*. <https://www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/instruments-and-tools/tools/wco-wto-joint-report/wco-wto-study-report-on-disruptive-technologies-en.pdf?db=web>
- Zakir Salehi, G. (2007). فرات‌حلیل مطالعات انجام شده در زمینه جذب نخبگان و پیشگیری از مهاجرت آنان [Meta-analysis of studies conducted in the field of attracting elites and preventing their migration]. *Journal of Iranian Sociology*, 8(1), 81–101.

- Zhu, K., & Kraemer, K. L. (2002). E-commerce metrics for net-enhanced organizations: Assessing the value of e-commerce to firm performance in the manufacturing sector. *Information Systems Research*, 13(3), 275–295. <https://doi.org/10.1287/isre.13.3.275.82>
- Zhu, L., & Thatcher, S. (2010). National information ecology: A new institutional economics perspective on global e-commerce adoption. *Journal of Electronic Commerce Research*, 11(1), 53–72.