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White Paper

Windows of Opportunity:
Facilitating Trade with Blockchain Technology

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Contents

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Preface

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The Fourth Industrial Revolution, driven by rapid technological change and digitization, is having a profound impact on global trade. By applying innovative new technologies to trade, "TradeTech" promises to increase efficiency, drive economic development and grow inclusivity. However, challenges and uncertainties remain on the policy governance of TradeTech. Public-private partnerships are needed to maximize the benefits and mitigate the potential downsides of applying new technologies to global trade.

Building on global developments and aspirations for TradeTech, the World Economic Forum's Centre for the Fourth Industrial Revolution, through its Digital Trade team, collaborated with the Inter-American Development Bank (IDB) to launch a new project. This project aims to guide public-sector stakeholders to make informed decisions about using emerging technologies to facilitate trade, drive economic development and improve competitiveness – particularly in the case of blockchain deployment in trade single windows. Given its prioritization of emerging technologies and having worked closely with Latin American and Caribbean (LAC) governments, the IDB has valuable experience and knowledge to help co-design and shape the trade agenda.

Within trade facilitation, trade single windows serve as the single electronic point for exporters and importers to submit regulatory and commercial documents to respective government ministries and agencies. However, promises of increased efficiency are hindered by pain points and challenges, such as the lack of interoperability among agencies, persistence of outdated processes and limited visibility and traceability of shipped goods.

By exploring the application of new technology – blockchain – in the trade single windows network, this White Paper outlines the current obstacles governments face in implementing and maintaining single windows, and the potential for blockchain to address those issues – while understanding the experimental nature of the technology. The White Paper draws on the expertise of more than 80 project community members globally across various industry sectors, government agencies, intergovernmental organizations and academic institutions as well as in civil society. The policy framework laid out in this White Paper is also intended to be applied in a proof of concept with the support of the IDB.

This project reflects the mission of the World Economic Forum's Centre for the Fourth Industrial Revolution: to provide an international platform of expertise, knowledge-sharing and public-private collaboration and to co-design and pilot innovative new approaches to policy and governance in the Fourth Industrial Revolution. This project will encourage proofs of concept within and outside of the project community, share and scale lessons learned using the World Economic Forum's platform on international trade and investment.

Introduction

Trade costs – the costs of moving cargo from one country to another – are a leading constraint for companies wanting to engage in trade. A significant share of these costs stems from the time and money that companies spend on paperwork and in multiple submissions of the same information, as required by various government border agencies to release goods for export and allow them to enter the importing country. Trade single windows have considerably improved this process, acting as one-stop electronic platforms for registered users to lodge the required import and export trade documents. Studies suggest that electronic single windows have helped halve document processing times in border agencies, cut trade compliance times to one-third, increased adopting countries' exports and gross domestic products (GDPs) and encouraged an overall improvement in transparency and user experience for border clearance.

Single windows have proliferated in recent years; as of 2017, 27 countries had a full electronic single window and 36 had a partial single window. All 164 signatories to the Trade Facilitation Agreement (TFA), which entered into force in 2017, are encouraged to adopt an electronic single window. Their benefits notwithstanding, single windows leave a good deal of room for improvement. Implementation has been challenging, especially for many developing countries; surveys have revealed such problems as agencies' long response times, a reliance on paper-based documents and a requirement to submit the same data multiple times to different authorities.

Such challenges undermine government progress in facilitating trade and enabling small- and medium-sized enterprises (SMEs) to engage in trade. It is also a good time to address such issues: Companies are digitizing their trade operations and thus demand automated processes, including those provided by governments. There is also a compelling case for improving single windows due to the growth of e-commerce: whereas previously border agencies mostly dealt with a limited number of large companies doing regular, container-based transactions, now they have to contend with an avalanche of parcel-based shipments and new traders with whom they are less familiar. In response, governments around the world are considering using new methods and the technologies of the Fourth Industrial Revolution to improve the operation, data quality, risk management and user experience in single windows.

The purpose of this policy framework is to help governments in these explorations by focusing on the potential for blockchain in single windows. Blockchain, a database that retains information on all transactions on a ledger visible to all stakeholders, is already being considered and piloted in various areas of world trade – such as trade logistics, supply-chain management, customs and border regulatory processes, cross-border payments and trade finance. This policy framework (1) analyses the main pain points in single windows around the world; (2) assesses specific use-cases where blockchain might alleviate some of these pain points; and (3) develops guidelines for governments to consider and apply blockchain in trade single windows. The policy framework is aimed at government agencies involved in border clearance; however, private-sector organizations engaged in trade can also use this report to consider how best to encourage governments to use this technology.

The following section discusses the importance of trade single windows in trade facilitation and reviews the main pain points experienced by single window operators and users. The next section assesses the value propositions of blockchain and analyses how these are best applied to remove the main pain points experienced by single window operators and users, while also developing a series of use-cases for blockchain in single windows. The section thereafter focuses on the considerations for operationalizing blockchain use-cases in single windows. The final section discusses what steps can be taken next.

State of single windows

Exploring blockchain's usefulness in single windows requires an understanding of the essential challenges facing single windows and their users. This section discusses the gains and pain points single windows have created, based on academic literature and structured interviews with single window operators in various geographic regions.

Benefits

Introduced in the late 1980s in Sweden and Singapore, where they reduced border clearance times from four days to 15 minutes, trade single windows have become a centrepiece of trade facilitation efforts around the world. The TFA encourages signatories to adopt electronic single windows – single windows powered by information technology. The United Nations Economic Commission for Europe has been instrumental in developing definitions, guidelines and standards for single windows, and several entities including development banks and the World Customs Organization have helped countries build and finance them.

By 2017, trade single windows had been adopted in full or in part in 63 countries (Figure 1). They typically bring together dozens of government agencies in charge of such areas as health, agriculture, quarantine, immigration and technical standards. For example, in Uruguay, the single window brings together 27 agencies such as tax and customs authorities and ministries of agriculture and

fisheries, environment, energy and mining, and enables traders to submit 127 different types of documents required by the various border agencies.

Single windows have delivered a notable return on investment in a wide range of countries, facilitating trade considerably and lowering companies' international trade costs (Table 1). Their benefits have been compounded by the digitization of trade documents: such "paperless trade" obviates the need for exporters and importers to spend time filling out paper documents, re-entering the same data multiple times and visiting government agencies in person to secure signatures and stamps.[3] Many governments have digitized customs clearance and duty payments; research suggests this has cut border compliance time for imports by one-third, and significantly reduced corruption in the customs process.[4]

Such efficiency gains can be even greater when trade single windows are combined with port community systems (PCS) that enable the exchange of information among players in port environments. For example, in Benin, Togo and Democratic Republic of the Congo, traders receive a "single invoice", where all costs at the port (such as terminal handling charges) and regulatory costs (for instance, duties and taxes) are combined into a single invoice that is automatically sent to the importer or relevant party. Once the full invoice is paid, the bank pays all of the individual stakeholders and goods are released.

Figure 1: Trade single window adoption among 120 analysed countries, 2017
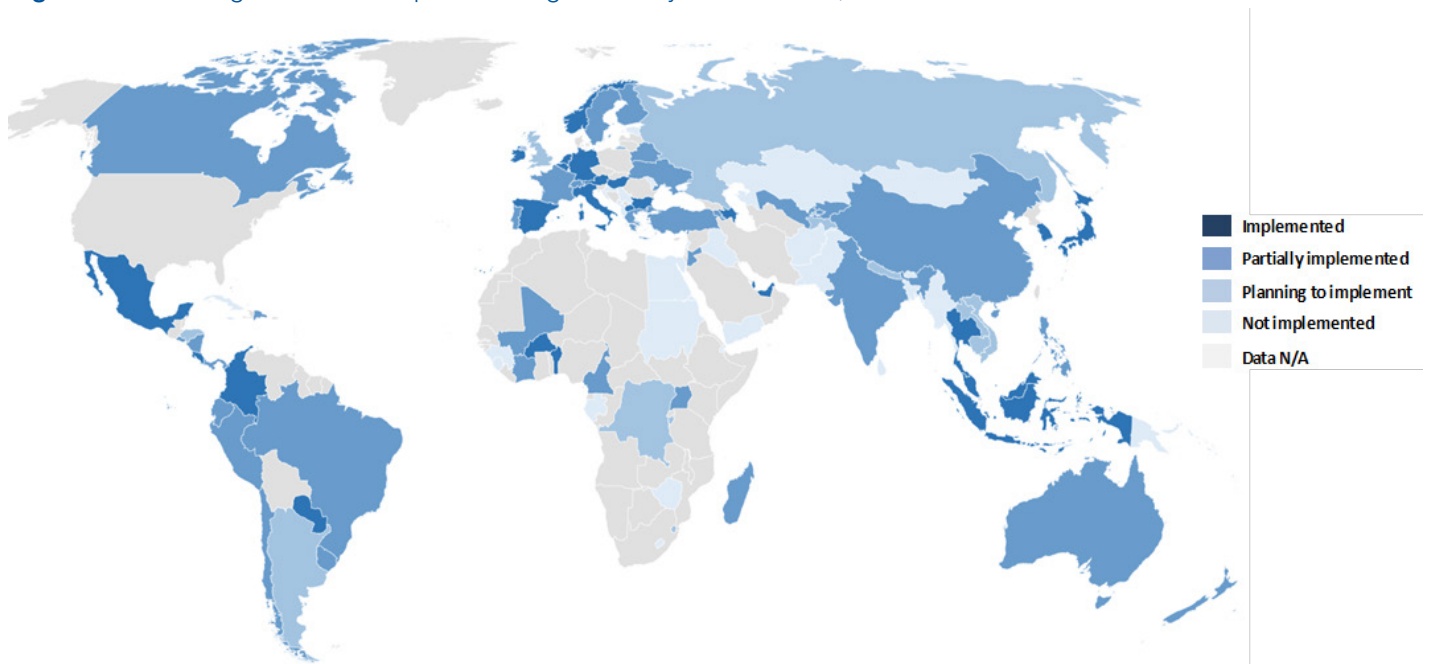
Source: Author processing from the UN Paperless Trade Database, 2017

Table 1: Selected impacts of digital technologies in border processes

Digital approaches	General objectives	Selected impacts	Countries that have adopted by 2017[5]
Digital single windows	Improve and accelerate trade compliance by enabling traders to submit all documents required for border clearance in one "window", typically electronically Enable agencies to process trade documents faster, thereby accelerating the clearance of cargo at borders	In Kenya, the average time spent on processing applications dropped by 50%, the number of documents required for processing halved and traders saved time previously spent on visiting various agencies.[6] In Cameroon, the time to import used cars fell from seven to two days, the time to lodge shipping manifests from seven days to one minute and the time to obtain import licences from eight hours to 15 minutes.[7] In Colombia, the time to import a container fell from 48 to 13 days and the time to export a container from 34 to 14 days in 2006–2011.[8] Costa Rica reaped $16 in economic gains from every $1 invested in the single window. Without the system, exports would have been on average 2% lower than they were between 2008 and 2013, or 0.5% of GDP.[9]	27
Digital trade documents, "paperless trade"	Reduce re-entry of same information on multiple paper-based documents Lower processing times for traders and staff at trade agencies that process documents Improve legibility of trade documents traditionally filled out by hand Reduce probability of error	Exporters and importers in countries with paperless trade spend far less time on paperwork for border clearance: Sub-Saharan African importers spend on average 98 hours on paperwork for a consignment, as opposed to only four hours in Thailand and one hour in Canada and Sweden where traders use digital documents.[10] In Costa Rica, exporters became able to fill out a single form online, which the single window distributed automatically across trade agencies to issue permits; trade in this channel grew 1.4% faster than exports processed via traditional methods. Paperless trade has facilitated global supply chains, such as by enabling just-in-time delivery.[11]	67[12]
Digital payments of customs duties and fees	Reduce invoicing times by automating computation of duties and fees Reduce corruption in customs Reduce time for importers to make payments online Accelerate reconciliation and thus customs clearance	In Tanzania, digitization of customs clearance and duties cut import clearance times from nine days to less than one day.[13]	53
Information on export and import processes available online	Make trade requirements easily accessible, including for new exporters and importers, and promote transparency of trade operations	Small and remote firms accelerating their access to trade requirements, information and documents in a single place reduces processing time and enables them to work without intermediaries.	64

Pain points

While they have delivered significant gains, single windows in many countries have yet to be implemented in full and thus work as seamless one-stop shops for traders to submit trade documents and accelerate border clearance. Research and interviews reveal several pain points in single window systems related to interoperability among the stakeholders, paperless trade, traceability of goods, document and payment processing and trustworthiness of data (Table 2). The following section details some of the main challenges.

Limited interoperability

– **National single windows are disconnected from one another.** The TFA calls for countries to coordinate their border procedures to facilitate trade. Such coordination is, however, still very limited – in the UN survey, only seven European countries and Canada reported full engagement in "trade-related cross-border electronic data exchange" while 48 had some partial exchanges.[14] For example, the ten members in the Association of Southeast Asian Nations' (ASEAN) single window enable electronic exchange of preferential certificates of origin, while the four members of the Pacific Alliance share phytosanitary and origin certificates.[15] The reasons for the fragmentation of national single windows include disparate national databases, lack of platforms for efficient exchange of data and differing regulations, such as tax secrecy, data privacy, transfer laws and different document formats. As a result, every country is worse off: Traders have to enter the same data on export and import declarations, risking mismatches and longer processing times; governments "fly solo" in interpreting data, managing risks and detecting anomalies; and each importing country has a more limited window to conduct pre-arrival processing that would otherwise accelerate the release of goods.[16]

– **Border agencies operate with isolated data.** The main value proposition of single windows to their users is that they aggregate trade processes in one window.[17] However, single windows are not that single: Border agencies that form part of a single window still often operate in isolation with regard to their respective data, struggling to share data and coordinate actions such as risk management and inspections with each other.[18] Single windows in some Latin American and Caribbean countries are also disconnected from customs, so that traders inherently need to deal with a "double window". Part of the problem is technical, with legacy databases impeding the sharing of data, while part is political, with agencies keen to protect their turf and modus operandi.[19] In some countries, corruption remains a problem: Players who monetize delays at the border have little interest in facilitating trade.

Persistence of paper

– **Border agencies still demand that traders file paper-based documents and visit agencies in person.** Despite pledges to introduce paperless trade, electronic single windows are not always that electronic: Many developing country border agencies and customs demand traders submit paper documents – by 2017, only 28 countries had adopted electronic application protocols for export permits, 25 had adopted electronic issuance of preferential certificates of origin and 45 had adopted electronic submission of both sea and air cargo manifests.[20] The persistence of paper is caused by sheer inertia, limited budgets and staff concerns about the impact of digitization and automation on jobs.

– **Businesses are unfamiliar with digital processes and lack information and communications technology (ICT) skills to perform digital filings.** Companies can also impede paperless trade. Even in advanced countries, some companies are set in their ways and continue to use paper-based documents; in developing countries, companies can lack confidence in the security of data submitted online and ICT skills or IT infrastructures to use digital interfaces – even though digitization of trade processes in principle should help especially small firms that have limited staff capabilities for trade compliance.[21]

– **Unstructured data embedded in trade documents are not converted into more easily analysable structured data, and data formats are not harmonized.** Governments have enormous amounts of useful data on traders and shipments that can be used for sophisticated predictive analytics, such as risk management. Yet this data cannot be efficiently analysed because it remains in unstructured formats, embedded in paper documents that have yet to be converted into digitized, structured databases. Moreover, data formats are not harmonized, limiting the scalability of data analytics.

Inefficient manual processes and lack of automation

– **Manual document processing and reconciliation of databases.** Errors are legion in trade documents, because many are still often handwritten and simply illegible, and because the same data is being re-entered manually multiple times into new documents and databases, a process prone to error. Even in more digitized settings, updates to agencies' databases can require manual interventions, which wastes staff time, increases the odds of error and stops agencies from allocating resources to more value-adding work such as sophisticated risk management. Even in countries with low labour costs, the inefficiencies of manual processes can raise personnel costs far above those with digitized documents and shared databases.

– **Inefficiencies in making and reconciling customs duty and fee payments.** While 53 countries have enabled electronic payments for customs duties and fees, the costs of making and reconciling these payments can be surprisingly high.[22] One reason is that, while invoicing based on a customs declaration is typically automated, customs payments in many countries require importers to first pay the sum in the invoice, and even physically present a document to customs to prove the duty was paid. In Sri Lanka, the customs platform computes the fees, taxes and duties

automatically, but traders still need to visit customs to submit paper documents that agents then process.[23] Furthermore, direct deposits and wire payments contain limited data, and customs then has to manually match an electronic payment to a given shipment, which decelerates customs clearance rates.

Limited traceability of goods in supply chains

– **Limited sharing of data across trade networks among border agencies and the private sector.** Digitization and sharing of data among border agencies themselves and with the private sector has increased visibility and advance knowledge about incoming shipments. For example, in the United States, the Air Cargo Advance Screening (ACAS) enables customs access from airlines' advanced air cargo information regarding shipments arriving in the United States. However, sharing of data among governments and the private sector is still limited, impeding agencies' ability to trace goods to their origin, verify certificates of origin and recognize anomalous patterns and manage risks, ultimately resulting in potential risks to end users of shipped products.

Concerns about data trustworthiness and security of data

– **Limited trustworthiness of data entered on single windows.** Border agencies and traders' processes involving the re-entry of the same data multiple times while reconciling different agencies' databases undermine the trustworthiness of data in single windows. Data trustworthiness diminishes if data provided by the agencies and trader differ.

– **Companies are concerned about the security of their sensitive commercial and financial data submitted online.** This problem is exacerbated in countries where the government has misused corporate information, and/or has limited cybersecurity protections, electronic signature laws and centralized management of data.[24] There are no contracts between firms that use single windows and border authorities. Thus, the former has little control over how their data may be used or shared and by whom. This contrasts with port community systems where parties enter into a contract and have recourse if their data is misused.

– **Companies are unable to access and reuse their identities and data in single windows.** Companies that use single windows often need to enter their identity and other datasets multiple times to access government and commercial services, as well as being forced to use a variety of identifiers when dealing with different stratas of government. They are unable to use data, such as their records of compliance, authorized economic operator (AEO) certifications and trade transactions, in single windows. This level of data could be very useful for commercial purposes, such as enabling banks that provide trade finance to carry out due diligence or insurance companies to offer better rates to companies with a strong record of trade compliance.

Solving these pain points can have significant payoffs; for example, the dramatic difference in the number of hours spent on regulatory paperwork between countries that have implemented paperless trade and countries that are still using paper-based documents. But even countries that have the world's most digitized single windows and are the top performers in trade facilitation struggle with lack of interoperability and inefficient processes; they are still seeking to further reduce border clearance times and gain new capabilities.

Table 2: Selected pain points in electronic trade single windows

Main pain points	Selected reasons	Main impacts
Limited interoperability	National single windows disconnected from each other	Duplication of efforts, delays and lack of end-to-end visibility of shipments: traders have to enter the same data on export and import declarations, risking mismatches and longer processing times; each government "flies solo" in interpreting data, managing risks and detecting anomalies; each importing country has more limited opportunities to conduct pre-arrival processing.
Persistence of paper	Border agencies still demand traders file paper-based documents and visit agencies in person	Increases data re-entry, probability of errors and mundane, repetitive processes that consume traders' and agencies staff resources.
	Businesses are unfamiliar with digital processes and lack ICT skills to perform digital filings	Perpetuates use of paper in regulatory filings, wastes firms' time in mundane processes.
	Unstructured data embedded in trade documents are not converted into more easily analysable structured data; and data formats are not harmonized	Limits opportunities for sophisticated data analytics to detect anomalies and fraud in shipments, and scalability of data analytics.
Inefficient manual processes	Manual document processing and reconciliation of databases	Increases overheads as staff in each agency need to reconcile respective databases with those of others.
	Inefficiencies in making and reconciling customs duty and fee payments	Wastes customs staff's time in mundane reconciliation processes; decelerates the release of goods from customs, costing traders time and money.
Limited traceability of shipments	Limited sharing of data across the trade network among border agencies and the private sector	Limits agencies' ability to verify origin of goods, trace goods in supply chains and detect anomalies and fraudulent patterns in multi-country supply chains, resulting in possible risks to end consumers of shipped products.
Limited trustworthiness and portability of identities and data	Limited trustworthiness of data entered on single windows	Undermines the credibility and usefulness of data held by any one border agency.
	Companies are concerned about the security of their sensitive commercial and financial data submitted online	Makes companies reluctant to use single windows and electronic documents and filings, where these are optional; process devolves back to paper.
	Companies are unable to access and reuse their identities and data in single windows	Forces companies to re-enter data across government services and forego opportunities to use valuable transactional data for other commercial purposes.

Potential use-cases with blockchain

Blockchain has several useful properties for settings that characterize single windows – multistakeholder systems in which users struggle to share data with each other are forced to continue performing manual processes and question the trustworthiness of their data. For example, blockchain can help diverse stakeholders interoperate by enabling them to access the same data at the same time (hence the term "distributed ledger"); smart contracts built on a blockchain can automate stakeholders' compliance with various contractual obligations; and blockchain data is a stream of reliable information on past transactions as they are immutable once entered (Box 1). This section assesses potential use-cases to alleviate the pain points in single windows using blockchain.[25]

Box 1: What is blockchain?

There are a great many definitions and descriptions of blockchain. For the purposes of this paper, blockchain can be defined as a shared, distributed ledger of records or transactions that is open to inspection by every participant, such as countries' trade agencies that form part of single windows.

To understand blockchain's various properties, it is useful to think of a typical trade transaction. It involves several documents and bilateral interactions, such as between importers and trade finance banks, exporters and shipping lines and exporters and importers and their countries' regulatory authorities. These interactions amount to a significant waste of time: Parties fill out numerous documents, often entering the same data multiple times; they email and call each other to verify and often correct information that was entered; they check on each other's processing times, often bilaterally in each individual transaction.

Each of these bilateral messages and interactions holds its own version of "truth" about the product's journey from seller to buyer. The multiple bilateral "truths" often lead to error, fraud, delays and inefficiency, including in border clearance.

Blockchain can reduce the number of steps and processes among the network of players involved in any one trade transaction and give every player a bird's eye view of any one shipment. As a distributed ledger technology (DLT), blockchain can slash the number of bilateral communications and informational linkages and leakages by providing a single ledger that records the transactions as they occur and enables all parties, such as trade agencies, to access this data in real time. Blockchain enables transactions to be recorded in "blocks" of data that are visible to all stakeholders – and thus enables disparate parties in a network to access the same data in real time, reducing all parties' transaction costs and enabling stakeholders to share data and interact more fluidly.

Why is blockchain useful?

Blockchain also holds promise for authenticating data and improving the trustworthiness of data. Shortly after each transaction occurs, it is put into a block on the blockchain. These blocks are mathematically "chained" together. The blocks are verified and managed by the network nodes (computers or users participating in a blockchain network) via a shared governance protocol; each node contains a complete record of all of the transactions ever recorded in that blockchain. No single node can change or delete a block – which means data on blockchain is immutable and tamper-evident. With immutable blocks of data, blockchain also enhances a party's ability to trace transactions, such as shipments in world trade.

Blockchain can also automate the fulfilment of contractual obligations via smart contracts built on a blockchain, and thereby reduce intermediation costs.

Who can use blockchain?

Often, blockchain is thought of as a database anyone can use – and it is the case that blockchains can be "permissionless" like bitcoin, where anyone can join the network of users. But in most commercial applications, they are permissioned, meaning that users need permission to join.[26] Though permissionless networks are open, transparent and decentralized, they are also anonymous, unregulated, usually crypto-based and have high transaction fees. Meanwhile, permissioned blockchains are not decentralized or open to all, but they have low transaction costs and identifiable participants, and they can be regulated. This paper focuses on permissions ledgers – bearing in mind that there is a continuum of blockchain applications falling between the permissioned and permissionless models, with different governance and revenue models.

Challenges

Before going further to assess blockchain's value added, it is important to consider some challenges in analysing blockchain's potential in single windows.

First, data on blockchain's impact is still very limited: Piloting and testing is needed to understand blockchain's full potential. Governments have been adopting digital single windows and paperless trade over the past 30 years, and by now there are significant amounts of data and analysis data on the impacts of digitization of single windows, trade documents and payments. However, no systematic data currently exists on blockchain's impacts: We essentially know the "digitization premia" but we still cannot, in a similar, rigorous way, capture the "blockchain premia" in border clearance.[27] However, blockchain pilots in trade and other domains are compelling enough to suggest that it could have significant new value and thus merits exploring and piloting.

Secondly, it is premature to determine blockchain's unique potential with regard to other technologies in border clearance. This report does not claim that other digital technologies could not solve many of the pain points in single windows: Digital documents, payments and data sharing via application programming interfaces (APIs) have already done a great deal of good. Many developing countries would score enormous gains if they implemented single windows as successfully as Singapore, Korea or Mexico have done. This report is not a "battle of technologies" intended to compare technologies side-by-side or seek to persuade governments that blockchain is a superior technology. The evidence is still much too limited to make such claims, since blockchain technology (like many other technologies) is maturing, and fierce debates persist.

What can be said is that blockchain is not a silver bullet that cures all ills in world trade –what it can and cannot do well can be defined only through further testing and piloting. Many governments that have been successful in automating their border processes – such as the United Kingdom, Korea, Singapore, Mexico and the United States – are today the most avid experimenters with blockchain in customs and single windows, precisely to assess the technology's potential in offering new efficiencies and capabilities. Also, many leading logistics companies and banks are exploring blockchain for streamlining their operations.

This report seeks to help governments consider where and how to apply blockchain in border clearance, and to operationalize blockchain use-cases in single windows.

Use-cases

Table 3 and the following discussion lay out several potential use-cases to address selected pain points in single windows for which blockchain could be a particularly useful solution, along with further complementary technologies and policy measures.

Table 3: Single windows use-cases and blockchain's potential

Main pain point	Selected reasons	Use-case	Blockchain's potential	Alternative/ complementary technologies and actions
Limited interoperability	National single windows disconnected from each other	Interoperability and data share among two or more national single windows	Improve all national single windows' visibility into supply chains, ability to manage risks and recognize patterns and conduct pre-arrival processing; share data on Authorized Economic Operator certifications Distrubuted database	Big data and AI; harmonization of national documentation requirements, agreements to share data across borders
	Border agencies that form part of a single window operate in isolation	Interoperability and coordination of actions among agencies making up the single window	Improve all border agencies' ability to share data and coordinate actions, gain 360-degree visibility of transactions and manage risks, improve user experience Distrubuted database	Inter-agency collaboration and APIs to share data; big data and AI
Limited traceability of shipments	Limited sharing of data across the trade network among border agencies and the private sector	End-to-end visibility into shipments and supply chains	Enable more complete data on shipments and supply chains and audit trails on traders by bringing together single windows and/ or private-sector trade intermediaries on a common blockchain with immutable streams of data Distrubuted database Immutability	Internet of things applications; agreements to share data with private sector and across borders; machine learning to detect anomalous patterns in data
Inefficient manual processes	Inefficiencies in making and reconciling customs duty and fee payments	Automation of processes to make and reconcile duty and fee payments	Automate payments and their reconciliation; accelerate revenue collection Smart contracts Auditability	Robotic process automation; deferred duty payments; information-rich electronic payments
Limited trustworthiness and portability of identities and data	Limited trustworthiness of data entered on single windows	Improved reliability of data entered on single windows	Make data entered into single windows immutable and unauthorized modification to the data traceable Distrubuted database Auditability Immutability	Data standards; data-security protocols; AI to detect fraudulent and erroneous data entries
	Companies are unable to access and use their identities and data included in single windows	Authentication of identities and portability of identities and data across service providers, including for commercial purposes (e.g. access trade finance)	Provide single window users with a unique identity and enable users to apportion relevant parts of their identities and transactional data to third-party service providers Digital identity Auditability Immutability	Development of a unique ID such as Global Trade Identity (GTID); government regulations to encourage or demand portability of data

Pillars for blockchain in single windows: electronic signatures and transactions laws, solid IT Infrastructures, mobile-enabled interfaces

Interoperability among national single windows.
Interconnected, interoperable national single windows would have various benefits. They could enhance national border agencies' oversight of traders and transactions; help countries tackle fraud, such as the undervaluation of shipments by the importing country's customs; and reduce the number of data entries and document submissions from exporters and importers. Governments adopting blockchain to connect their single windows would need to integrate processes within their own single windows, build trust with each other, standardize data elements,[28] align blockchain implementations with their respective cross-border data-transfer regulations and establish robust collaboration with the private sector.[29] One novel solution is Infocomm Media Authority of Singapore's effort to develop an interoperability framework, TradeTrust, for the secure exchange of electronic trade documents in cross-border trade.[30] Piloting can help countries work together while discovering mutual benefits. For example, with IDB's support, Latin American customs agencies have successfully piloted a blockchain scheme to share data from their respective AEO programmes (Box 2).

Interoperability among border agencies that form part of a single window. One of the main pain points facing single windows is the friction in sharing data among trade agencies that form part of that window. Blockchain can make a significant difference in this setting: Used in a way analogous to Google Drive, blockchain can enable the myriad trade agencies to access the same data at the same time, gain greater visibility of shipments and manage such critical issues as food safety and intellectual property compliance while reducing staff time spent on reconciling agencies' respective databases. It could also be used to drive interoperability between a single window and PCS. However, operationalizing data-sharing among agencies will take serious political leadership for agencies to work together – yet this work is already being done. For example, the UK government has piloted a blockchain scheme to share data and coordinate actions among the country's 28 border agencies.[31] A recent proof of concept established that blockchain can be used to securely share the results of sensitive risk checks involved with granting firms AEO status.[32]

End-to-end visibility of shipments and supply chains.
As changes are made on the blockchain, new blocks are added over time, forming a chain of data that can serve as an audit trail for border agencies to detect fraud and suspicious patterns, manage AEO certifications and possibly also establish new categories of trust, such as "trusted e-trader" programmes for small firms that have a solid track record of compliant trade transactions but which do not necessarily qualify for traditional AEO status.[34] The end-to-end visibility will be even greater as a larger set of players in the trade networks, such as lines and logistics firms, adopt blockchain. More generally, blockchain could help agencies move from a transactional (shipment-based) risk-management approach to an entity-based approach, thereby enabling audit trails of companies and allowing companies themselves to better reuse their data included in single windows.

Box 2: CADENA: Blockchain in AEO mutual recognition agreements in Latin America

During 2018, the IDB, together with the customs administrations of Mexico, Peru, Costa Rica and Chile, and with technical support from Microsoft, designed a solution using blockchain technology called CADENA v.0.[33] It facilitates the sharing of the data associated with Authorized Economic Operator (AEO) certificates among customs administrations as specified in their mutual recognition agreements (MRA). While AEO programmes enable companies to facilitate their trade and save time and money in their trade transactions, CADENA helps to secure and facilitate supply chains globally.

CADENA has been designed, first, to find a solution to a customs and border management challenge – the sharing of cross-border data – and secondly, to enable customs to learn about blockchain in order to consider possible further use-cases. Blockchain enables different national customs authorities to access the same verified, tamper-proof and real-time data. This ensures that traders can receive MRA benefits both at the countries of origin and destination of their exports as soon as they are granted their AEO certification.

During the pilot project, customs validated the benefits of the technology for sharing cross-border data, providing timely information about the level of compliance of traders to feed risk-management systems. Furthermore, they found that CADENA could next be expanded to automate the entire AEO certification process, and to other customs functionalities that require engagement with different stakeholders, both public and private.

To build on the findings made during CADENA and to incorporate new developments in blockchain technology in 2018, a new phase is proposed to develop CADENA v.1 during 2019. CADENA v.1 will scale to other countries, such as Colombia, and will benefit from the synergies of LACChain (see Box 5) to address further issues related to governance, administration, data privacy, sustainability and scalability.

Automation of workflows and customs duty and fee payments. Smart contracts can be built on a blockchain to do x when y happens and thus automate what, in many cases, are still manual processes involving costly intermediaries. Smart contracts could be applied in single windows to automate customs fee, duty and tax payments. For example, smart contracts could trigger advance payment from the importer when customs authorities have completed pre-arrival processes for the importer's consignment. Automating payments would reduce importers' shoe-leather costs of making payments and presenting paper-based proofs that payments had been made and reduce customs' payment reconciliation costs. It could possibly also reduce legal disputes and litigation costs and increase trust and confidence in the supply chain.

Improved trustworthiness of data entered into single windows. Once entered into blockchain, the data cannot be modified. Data records on all entries and transactions

are timestamped and any changes and additions will be visible on the chain to all stakeholders, as the one and only version of the "truth". As such, blockchain can improve the trustworthiness of data entered into single windows and used by border agencies. Granted, like any database, blockchain is only as useful as the data included in it; the veracity and quality of data can be increasingly assessed with AI-driven tools – and by making machines rather than humans impute data on ledgers when possible.[35] Blockchain's security is also still debated. The companies developing blockchain technologies are strongly encouraged to improve blockchain's security. Much ultimately depends on the security architecture built around blockchain implementations.

Authentication of identities and portability of identities and data across service providers, including for commercial purposes. Blockchain can help users to authenticate and control their identities and data. Blockchain-based identities can be "self-sovereign", administered by the identity holder and based on the decentralized identifiers (DIDs) that are much like a secure website. Each DID can be assigned to different parts of a user's identity; one DID could be a company's name; another, its federal identification number; still another, its Harmonized System (HS) codes, and so on. Single window users could be encouraged to access and carry these pieces of their digital identity and use their DIDs and transactions authenticated by blockchain for commercial purposes. For example, companies that have managed to secure an AEO status could use that data point to negotiate better cargo or corporate insurance rates, and small companies could use their blockchain-based trade compliance data to better access trade finance.[36]

The concept of a Global Trade Identity (GTID) – to reduce supplier and customer risk in supply chains by enabling any supply chain partner to validate the trustworthiness of a legal entity with which it looks to do business – can, in the blockchain environment, offer a commercially and politically neutral identity infrastructure.[37] It would help develop the concept of a trade data pipeline, in which commercial, logistics and regulatory trade data associated with an operation "travels" through a pipeline that could be read and used by public and private stakeholders according to their level of access to the data.

Box 3: Technologies to complement blockchain in single windows

Blockchain has several potential use-cases for single windows – and can also be usefully complemented by other technologies. For example, machine learning can be a powerful complement to blockchain in border agencies' risk management and fraud prevention, helping agencies predict risks and invest resources in high-risk shipments while facilitating licit trade. Artificial intelligence (AI) can help agencies transform unstructured data in trade documents into structured data that enables data and information on trade documents to be used for pattern recognition and risk analysis.

Robotic process automation can further streamline well-functioning single windows' workflow by automating mundane and repetitive processes, enabling agency staff to invest their time in serving users and performing other higher-value work, and reducing the odds of human error. Internet of things (IoT) applications can further border agencies' and single window users' visibility of shipments end-to-end – for example, IoT-enabled physical tamper detection with edge-computing and sensors can enhance the integrity and availability of data for border agencies on the blockchain and enable ledger updates and payment transactions.

Single windows can gain when blockchain is adopted in the broader trade ecosystem. Gains from blockchain in single windows can also expand as blockchain becomes more widely adopted in the trade network, and as banks, ports, terminal operators, logistics providers and tax authorities adopt blockchain solutions to streamline their operations. Bringing the various players that "touch" a trade transaction on a common blockchain could drastically reduce re-entry of data in trade transactions, enhance intermediaries' visibility of shipments end-to-end and enable border agencies to access more diverse and reliable supply-chain data – which can help optimize their risk-targeting and verify the origin of products, for example. Multistakeholder blockchains will have a critical need for common understandings on governance and data, and IP rights.

Such multistakeholder solutions are already being developed, including the Maersk-IBM TradeLens platform for logistics, the we.trade platform for trade finance and a range of national initiatives. For example, Mexican customs, customs brokers, Hutchison Ports, and the Port of Veracruz are together piloting a blockchain solution that provides them with common, real-time data on the location and documents associated with a given export shipment. The Korean Customs Service has worked with the logistics community to explore blockchain's usefulness in the accuracy and transparency of data on certificates of origin; more than 50 Korean companies on the export side, alongside five working groups and ten companies based in Viet Nam and Singapore on the import side, have participated in pilots.[38] The European Commission's Directorate-General for Taxation and Customs Union (DG-TAXUD) recently tested blockchain's value added in temporary admission and excise domains, finding that blockchain has significant potential in these specific areas of trade and revenue collection.[39]

Guidelines for operationalizing use-cases

Blockchain has the potential to generate new efficiencies and provide new capabilities, both for the agencies that form part of single windows and the businesses that use them. The biggest question mark for border agencies is to what extent blockchain adds new value in single windows, and what it actually takes to effectively pilot and operationalize blockchain. For staff at border agencies to champion blockchain requires compelling answers to these questions.

There are at least six key steps and considerations when introducing blockchain into single windows (Table 4).

Table 4: Guidelines for operationalizing blockchain use-cases in single windows

	Create vision and business case	Create governance structure, including for data, and implementation plan	Build technology architecture and integrate technology	Manage user identities and data	Measure impact and report on it	Iterate
Actions	Ensure political support exists for trade facilitation Establish a "grand vision" for blockchain in the single window and a business case for stakeholders Adopt blockchain in pilots and iterating to improve outcomes Bring together a multidisciplinary team to pilot and apply blockchain Define how to cover costs and how to engage development banks and donors	Establish a governance structure with mandate, scope, responsibilities and data-share rules Standardize data entered on blockchain and data-security protocols Define reward systems for staff in agencies to implement blockchain Define data-storage needs Assess compatibility of blockchain with existing regulations; consider regulatory sandboxes to fuel blockchain's development	Develop the technology architecture, acquire blockchain technologies and integrate blockchain with existing databases and technologies Retrain agencies' IT staff and acquire new capabilities with technical knowledge of blockchain	Test a single, interoperable identity for single window users and enable them to make their data portable Possibly develop a new identity for blockchain users, e.g. GTID Communicate technology improvements to users	Develop and track KPIs, e.g. time release indicators; operational efficiency in border agencies; and trade facilitation and SME trade growth Reward agencies' staff for meeting targets defined in steps 1 and 2	Assess the pilot and consider ways to improve and scale it Consider blockchain's emerging capabilities and rethink its governance Assess governance structure built into step 2 Consider range of applications in other niche areas in single windows
Who drives	Head of state, agency heads, private-sector users, focus groups	Agency heads, IT leads and users; international experts	Agency IT leads, experts	Agency heads, IT leads	Agency front-line staff, report to head of state	Implementors, private-sector users
Level of effort needed	● ● ● ● ●	● ● ● ● ●	● ● ○ ○	● ● ○ ○	● ● ● ○	● ● ● ○
Key questions to address	What is the outcome to be attained by using blockchain? What is in it for each stakeholder? How are costs covered? How could development banks and donors best support via technical advice and funding?	Where is blockchain managed from? What are the responsibilities of the different stakeholders and what are stakeholders rewarded for? How are data and document-sharing governed among stakeholders? How to define and differentiate access privileges? Which international data standards should be considered?	How does the new solution integrate with the current solutions (process and technology)? Can IT create a functionable "digital twin" of a trade? Does blockchain provide a trusted interaction layer for sharing events and information/data? Does blockchain also need to account for and support wider supply chain business models?	Could users make their data portable and for what purposes, and how is off-chain data shown to outsiders certified as "real"? Are data-storage needs an issue? How to best communicate the benefits of blockchain to firms that use single windows?	What is the improvement from baseline and last measurement? What are the weakest links in implementation and why? How does my country compare to others that are also working on trade facilitation, before and after blockchain was adopted?	How to improve on the process and outcomes in steps 1-5? What new properties of blockchain technology and other technologies could be employed? What is the optimal governance structure if pilot is scaled or replicated? In which other areas of trade facilitation could blockchain be tested?

1. Create a 'grand vision' and make the business case

Ensure high-level political support exists for trade facilitation. Single windows work best in countries in which the leadership is firmly committed to trade facilitation. The same is true for blockchain applied in single windows: It has a fighting chance to work if its adoption and implementation are supported by the highest levels of government.[40]

Establish a "grand vision" and make the business case for stakeholders. The decision to use blockchain requires a vision of the benefits that it can generate for border agencies and trade facilitation. This initial vision will inform further steps, such as specific key performance indicators (KPIs), blockchain's governance model and technology architecture and agencies' reward systems. Since the main impediment to blockchain's adoption tends to be defining a business model in which all stakeholders perceive benefits, blockchain champions need to spend time and energy to develop compelling value propositions for each stakeholder group – in this case, border agencies and the private sector (Box 4). Focus groups are a useful way to quickly understand players' pain points and preferences. Activities and games in which players are encouraged to work together can also be useful – such strategies have been used to train agencies to use customs software and for port ecosystem actors to use a PCS.

Adopt blockchain in pilots and iterating to improve outcomes. It is useful to define the initial steps towards the grand vision as pilots that enable stakeholders to test the blockchain technology and explore its benefits in various specific use-cases, rather than being locked into using it indefinitely. Experimentation is also important in that blockchain is a nascent technology in which the benefits have yet to come to full view, and stakeholders need to be socialized into using it.

Bring together a multidisciplinary team to implement pilots. Implementing blockchain in single windows will require multidisciplinary teams of technology experts and domain experts in trade facilitation, as well as input from private-sector users.

Define how costs are covered. Questions related to funding and burden-sharing should not derail a blockchain project before it gets started. It is important to define early on how the blockchain project is paid for and articulate that to stakeholders.

Partner with development banks for technical advice and funding. Developing countries can tap development agencies to bring valuable technical knowledge and financial resources into blockchain pilots. Multilateral development banks and donors are starting to increase their experience in blockchain implementation and can also help developing countries learn from each other, cooperate and measure blockchain's effects on trade costs and trade flows. For their part, development organizations could condition their support on recipient governments' actions to digitize trade documents and processes and report on KPIs from the blockchain pilots.

> **Box 4: Lessons learned from piloting blockchain in Korean customs and trade ecosystem**
>
> The Korean Customs Service (KCS) has been highly active in piloting blockchain. In 2018, KCS conducted three pilot projects: the E-clearance Blockchain Project; the Blockchain Cross-Border Project with Viet Nam, aimed at enhancing the reliability of shared certificates of origin data via blockchain; and the Export Logistics Blockchain Project with Samsung, Hyundai Glovis, Busan Port Terminal, Shinhan Bank and more than 60 Korean companies, aimed at exploring whether blockchain could enhance the accuracy and transparency of data generated by the logistic community.
>
> To pave the way for the pilots, KCS created a dedicated division for blockchain's adoption, and selected as project managers staff with a strong understanding of blockchain technology. These staff had gained the necessary knowledge through training, participation in forums and seminars and capacity-building provided by blockchain service providers. To develop the pilots, KCS worked extensively to interact and engage stakeholders, holding many meetings and workshops at which the stakeholders could define the data that could be shared, and share information related to export logistics and their respective business processes.
>
> KCS's ICT Development Division led the technology's adoption; the blockchain platform was developed by Samsung and KCnet. It was geared to generating and sharing information such as trade documents, export declarations, bills of lading and letters of credit among others. The platform minimized manual work in the trade process and greatly improved the transparency and reliability of data, as the data is collected from multiple sources and is immutable.
>
> The main driver of success behind KCS's effort was its early realization that the most important challenge in using blockchain is not the adoption of the technology, but (1) consensus-building on the need for, and benefits of, blockchain with internal staff and external stakeholders; and (2) extensive dialogues on how blockchain will be applied – especially how stakeholders' business processes ought to be updated to best facilitate trade when blockchain is used.

2: Create a governance structure, including for data, and an implementation plan

Establish a governance structure around blockchain. Blockchain's governance architecture needs to be sorted out early on, as many subsequent decisions flow from it. This includes the mandate, scope and responsibilities of each participating stakeholder, as well as understanding how data is shared and which technologies are used. It is also important to define from where the blockchain application will be managed, a particularly important question in multi-country and/or multi-ledger implementations. Important approaches include standards

and solutions such as IDB's LACChain where countries can plug the blockchains in their single windows as nodes into an interoperable regional blockchain architecture (Box 5). Governments that are interested in making their single windows interoperable with each other will also need to review the interoperability of their regulations and standards.

Standardize and secure data. The use of standardized data (data semantic, data format and data access protocol, perhaps as in the WCO Data Model) ensures that any stakeholder's systems interface seamlessly with the blockchain network.[41] Blockchain's governance structure should inform how data on a blockchain is secured; for example, agency staff's access to review the data on a blockchain is a vulnerability to be managed. Encryption techniques used today may be compromised in the future, and thus the security management needs to continually evolve. Implementations will also need to consider how stakeholders' off-chain data is integrated with on-chain data in a secure manner. Mitigating these types of risks will introduce some moderate cybersecurity costs. The ISO 27000 series of standards regarding the security of IT systems can provide general guidance.[42]

Define reward and accountability systems for blockchain adoption. Blockchain pilots need to be co-owned by stakeholders in the agencies that are responsible for their implementation. In particular, a sense of co-ownership among two IDB departments and beneficiary customs was vital to CADENA's shift and successful implementation. Primary staff need to coordinate work through weekly meetings, and be rewarded when meeting milestones and KPIs, and for transparently measuring impacts.

Define needs for data storage. Whether data is stored directly on the ledger or off-chain with hashes on the ledger, the storage costs will need to be covered. Data storage costs can be roughly based on typical data storage costs.

Consider blockchain's compatibility with digital regulations and establish regulatory sandboxes for blockchain. Ultimately, legal frameworks on electronic signatures, data privacy and transfer, and internet intermediary liability need to be made compatible with aspirations for digitization and use of technologies such as blockchain. For example, smart contracts, if used, need to be embedded in laws that make digital signatures and smart contracts enforceable in courts and, if used among players from two different countries, are understood in the same way in these countries' legal frameworks. It will also be useful to consider a regulatory sandbox approach to blockchain, for companies to bring new blockchain applications to market without having to comply with the gamut of regulations that might otherwise apply.[43]

3: Build technology architecture and integrate technology

Develop the technology architecture, acquire blockchain technologies and integrate blockchain with existing databases and technologies. Blockchain deployment requires unique upfront costs to develop the IT

Box 5: Enabling blockchain development in Latin America and the Caribbean

Over the past five years, different blockchain-based solutions have been attempted in the LAC region. Even if some of them have been successful at a pilot stage, few have scaled. In 2018, IDB Lab, the innovation laboratory of the Inter-American Development Bank, launched the Global Knowledge Alliance for the Development of the Blockchain Ecosystem in Latin America and the Caribbean (LACChain).

LACChain is aimed at accelerating the development of the blockchain network in LAC. It solves several specific challenges to blockchain's scalability in the region: limited coordination among network stakeholders in exploring an alternative to governance structures; limited infrastructure capabilities; lack of standards for scalable and interoperable solutions; and high transaction costs. LACChain works in four areas: (1) partnerships between public-private stakeholders, (2) the technological infrastructure, (3) the marketplace of applications, and (4) data analytics to measure social impact.

LACChain is creating a hybrid public-permissioned network that combines the features of public and permissioned blockchains. It offers networks that are decentralized, while requiring that users are authenticated and comply with the law, as the blockchain will be regulated and there are no transaction fees. In late 2018, LACChain launched its first public-permissioned test-net using the software Quorum, and, in 2019, will release a second test using Pantheon.

architecture and to integrate existing systems with the newly developed blockchain system. However, these fixed upfront costs may be offset by the increased efficiency and lower variable costs over time, comparable to conventional IT systems.

Train IT staff and acquire new technical capabilities to operationalize blockchain in agencies' day-to-day work. Optimizing blockchain in single windows takes both domain expertise and technical know-how. It requires the training of agencies' existing IT personnel – Korea Customs Service set up a dedicated team that had to undergo training to manage blockchain pilots. For non-IT personnel and businesses that use single windows, the impacts are minor, as front-end interfaces can remain the same or show little change.

4: Manage user identities and data

Test a single, interoperable identity for single window users and enable them to make their data portable. A blockchain pilot can enable a government to test, perhaps in partnership with various public- and private-sector entities, the concept of a single digital identity for single window users. Enabling companies to make their transactional data portable and use it for commercial purposes, such as for securing insurance or trade finance, could be tested as a standalone use-case or in the context of any one use-case to understand how the stakeholders respond.

Communicate technology improvements to users and ask about their user experience. Single window users need to be educated about the benefits of blockchain, and their views need to be included in assessments of pilots and implementations.

5: Measure impact and report on it

Develop and track KPIs of single windows powered by blockchain. Blockchain's impact on single windows and trade costs needs to be measured for governments to identify improvements enabled by blockchain, make the business case for scaling the solution, harvest lessons learned and keep agencies and blockchain champions accountable. Important KPI measures should at least include impacts on border agencies' operations and expenditures and a range of second-order economic outcomes, such as impacts on trade facilitation, SME trade and trade growth. They could also include the granular indicators in the WCO Time Release Study.[44] Baseline measures should be established before blockchain is adopted, and investment in KPI management and reporting needs to be made upfront, not after blockchain has been piloted. To the extent that several countries adopt blockchains in single windows, it is useful to collect similar data points – development banks can produce such common data.

6: Iterate

Assess the pilot and consider ways to improve and scale it, including by considering blockchain's emerging capabilities and rethinking its governance. Often, blockchain models and governance discussions are "frozen in place", anchored in a certain understanding of the technology when it was first tested – even though blockchain and its user base are rapidly evolving, offering and demanding different functionalities. As they experiment with blockchain and other technologies, single windows need to keep up with how the technology is maturing, what new providers are emerging and which new players are adopting blockchain – and ask themselves whether the governance and IT architectures that were initially put in place continue to optimize outcomes.

Next steps

This policy framework has presented real-life problems in single windows, taken a sober look at how and whether blockchain could solve them, and offered useable guidelines for governments to adopt blockchain in single windows.
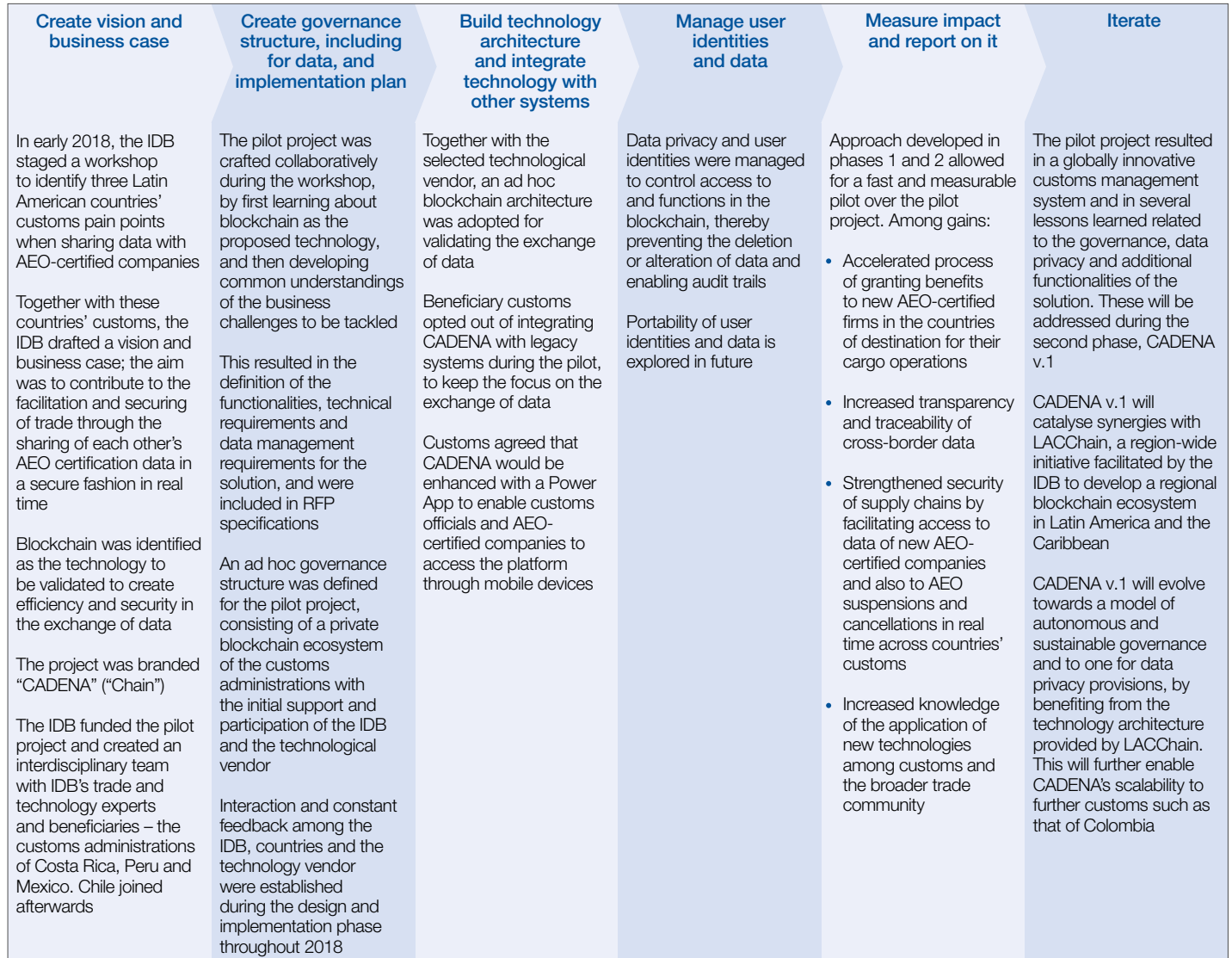
This framework has found that blockchain has the potential to solve various pain points facing single windows and bring new efficiencies and capabilities to border agencies. For example, it can be useful in enhancing interoperability of national single windows and of agencies within a country's single window, automating contractual obligations such as payment of customs duties and fees, enabling traceability of products across supply chains, and attenuating agencies' concerns about the trustworthiness of data at their disposal.

However, blockchain's benefits, just like the benefits of single windows, will critically hinge on the rigour of its implementation. Governments that want to pilot and test blockchain in single windows should have a clear vision of how blockchain can advance the attainment of trade facilitation objectives; understand stakeholders' pain points and develop a compelling value proposition for each stakeholder to adopt blockchain; build a governance structure and an enabling legal environment and technology architecture while providing clear targets and KPIs for blockchain implementation; be flexible to change course and iterate to improve outcomes; and, in particular, secure high-level political support and collaboration with the private sector.

This framework is intended to pave the way for blockchain pilots around the world. The World Economic Forum and the Inter-American Development Bank will be working to implement proofs of concept with a subset of LAC governments to pilot blockchain use- cases, use the implementation guidelines discussed here and build LAC governments' capacity to understand and apply new technologies on border clearance while sharing the lessons learned.

Appendix

The graphic below walks through an example of how the guidelines for operationalizing use-cases (see the earlier section on this subject) can be applied. The example refers to the Inter-American Development Bank's CADENA project.

Create vision and business case	Create governance structure, including for data, and implementation plan	Build technology architecture and integrate technology with other systems	Manage user identities and data	Measure impact and report on it	Iterate
In early 2018, the IDB staged a workshop to identify three Latin American countries' customs pain points when sharing data with AEO-certified companies	The pilot project was crafted collaboratively during the workshop, by first learning about blockchain as the proposed technology, and then developing common understandings of the business challenges to be tackled	Together with the selected technological vendor, an ad hoc blockchain architecture was adopted for validating the exchange of data	Data privacy and user identities were managed to control access to and functions in the blockchain, thereby preventing the deletion or alteration of data and enabling audit trails	Approach developed in phases 1 and 2 allowed for a fast and measurable pilot over the pilot project. Among gains:	The pilot project resulted in a globally innovative customs management system and in several lessons learned related to the governance, data privacy and additional functionalities of the solution. These will be addressed during the second phase, CADENA v.1
Together with these countries' customs, the IDB drafted a vision and business case; the aim was to contribute to the facilitation and securing of trade through the sharing of each other's AEO certification data in a secure fashion in real time	This resulted in the definition of the functionalities, technical requirements and data management requirements for the solution, and were included in RFP specifications	Beneficiary customs opted out of integrating CADENA with legacy systems during the pilot, to keep the focus on the exchange of data	Portability of user identities and data is explored in future	• Accelerated process of granting benefits to new AEO-certified firms in the countries of destination for their cargo operations	CADENA v.1 will catalyse synergies with LACChain, a region-wide initiative facilitated by the IDB to develop a regional blockchain ecosystem in Latin America and the Caribbean
Blockchain was identified as the technology to be validated to create efficiency and security in the exchange of data	An ad hoc governance structure was defined for the pilot project, consisting of a private blockchain ecosystem of the customs administrations with the initial support and participation of the IDB and the technological vendor	Customs agreed that CADENA would be enhanced with a Power App to enable customs officials and AEO-certified companies to access the platform through mobile devices		• Increased transparency and traceability of cross-border data	CADENA v.1 will evolve towards a model of autonomous and sustainable governance and to one for data privacy provisions, by benefiting from the technology architecture provided by LACChain. This will further enable CADENA's scalability to further customs such as that of Colombia
The project was branded "CADENA" ("Chain")				• Strengthened security of supply chains by facilitating access to data of new AEO-certified companies and also to AEO suspensions and cancellations in real time across countries' customs	
The IDB funded the pilot project and created an interdisciplinary team with IDB's trade and technology experts and beneficiaries – the customs administrations of Costa Rica, Peru and Mexico. Chile joined afterwards	Interaction and constant feedback among the IDB, countries and the technology vendor were established during the design and implementation phase throughout 2018			• Increased knowledge of the application of new technologies among customs and the broader trade community	

Acknowledgements

Endnotes

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8. World Bank's "Doing Business", various years.

9. https://blogs.iadb.org/integration-trade/en/how-does-trade-respond-when-borders-are-simplified-via-one-stop-systems/ (link as of 18 June 2019).

10. World Bank "Doing Business" database, http://www.doingbusiness.org/en/data (link as of 18/6/19).

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12. Acceptance of paper or electronic copies of supporting documents required for import, export or transit formalities.

13. https://btca-prod.s3.amazonaws.com/documents/237/english_attachments/Tanzania-Case-Study.pdf?1515010379 (link as of 18 June 2019).

14. https://untfsurvey.org/world (link as of 18 June 2019).

15. To be sure, governments have sought to exchange information in certain regions: They have exchanged information in the ASEAN, as well as some data from customs declarations; Australia and New Zealand share electronic information on SPS certificates; and the ministries of transport of Japan, China and Korea have a common cargo status to track and query requirements. Some good strides have been made. For example, Nordic and Baltic countries have shared data to gain a fuller picture of such patterns as Chinese supplier networks of wood products, to better enforce the EU's timber regulations.

16. https://www.unescap.org/sites/default/files/CROSS-BORDER%20SINGLE%20WINDOW%20INTEROPERABILITY.pdf (link as of 18 June 2019).

17. This is not a new theme: One-third of countries in the UN paperless trade survey have a national legislative framework and institutional arrangements to ensure border agencies cooperate with one another.

18. National single windows do not necessarily have the same level of integration. See UNECE recommendation and guidelines on establishing a single window: https://www.unece.org/fileadmin/DAM/cefact/recommendations/rec33/rec33_trd352e.pdf (link as of 18 June 2019).

19. Interviews with customs and single window operators in the Americas; and https://www.slideshare.net/Africanalliance/challenges-for-an-implementation-of-an-electronic-single-window-guichet-unique-de-la-cte-divoire, https://www.researchgate.net/publication/276605029_Study_on_the_Challenges_of_Implementing_Single_Window_Concept_to_Facilitate_Trade_in_Sri_Lanka_A_Freight_Forwarder_Perspective, http://www.joebm.com/papers/302-BM00027.pdf and https://commons.wmu.se/cgi/viewcontent.cgi?article=1648&context=all_dissertations (links as of 18 June 2019).

20. https://untfsurvey.org/world (link as of 18 June 2019).

21. These challenges are quite common in developing nations. See, for example, https://commons.wmu.se/cgi/viewcontent.cgi?article=1648&context=all_dissertations and http://www.joebm.com/papers/302-BM00027.pdf (links as of 18 June 2019).

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25. For excellent analyses of the use of blockchain in single windows, see https://www.unece.org/fileadmin/DAM/cefact/cf_plenary/2019_plenary/CEFACT_2019_INF03.pdf and https://www.wto.org/english/res_e/booksp_e/blockchainrev18_e.pdf. For broader analysis of blockchain and technologies as enablers of trade, see https://www.amazon.com/Revolutionizing-World-Trade-Technologies-Opportunities/dp/1503610713/ref=sr_1_1?qid=1559683158&refinements=p_27%3AKati+Suominen&s=books&sr=1-1 (links as of 18 June 2019).

26. For a good review, see https://www.weforum.org/whitepapers/inclusive-deployment-of-blockchain-for-supply-chains-part-1-introduction (link as of 18 June 2019).

27. Granted, blockchain's security is still debated: Some argue that blockchain is a more secure database than others; others claim that it is increasingly susceptible to hacking; and still others think that risks could arise if the blockchain network were to be outsourced by the government to a private third party or if on-chain data is exported to an off-chain database that then is no longer immutable. Companies developing blockchain technologies are strongly urged to improve the security around blockchain, so the security is evolving and improving; much ultimately rests with the security architecture surrounding blockchain implementation.

28. For example, in line with the World Customs Organization (WCO) Data Model.

29. See also https://www.bakermckenzie.com/en/-/media/files/expertise/fig/br_fig_blockchainsandlaws_jul17.pdf (link as of 18 June 2019).

30. https://www.imda.gov.sg/-/media/imda/files/industry-development/call-for-proposals/trade-trust-rfi_002_final_march21.pdf?la=en (link as of 18 June 2019).

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32. https://cryptoslate.com/uk-customs-service-halts-blockchain-border-project-with-brexit-looming/ (link as of 18 June 2019).

33. https://mag.wcoomd.org/magazine/wco-news-87/cadena-a-blockchain-enabled-solution-for-the-implementation-of-mutual-recognition-arrangements-agreements/ (link as of 18 June 2019).

34. https://docs.wixstatic.com/ugd/25efdb_ddca049eff6b45bcaab793f8b20223c1.pdf (link as of 18 June 2019).

35. For example, https://csis-prod.s3.amazonaws.com/s3fs-public/publication/181101_Suominen_Blockchain_v3.pdf (link as of 18 June 2019).

36. Such portability of data across domains would be akin to the open banking practices whereby small companies can access and carry their various transactional data, such as from online platforms and financial services, to help lenders underwrite their loans, thus opening access to finance for the long tail of "thin-file" users. Trade single windows could also become the first-movers and incubators of new national blockchain-based corporate identities, simplifying companies' interactions with national, state and local governments.

37. GTID could as such be recognized across the whole government-business network and eliminate the need for intermediaries' services providers to certify and recertify a business or individual. It would also make it more feasible to designate full data ownership to the trader, which could then share all or some relevant information on a transaction to selected stakeholders, such as share the invoice with the buyer and the bank, packing list with freight forwarder, compliance documents with government agencies and so on. See https://www.weforum.org/agenda/2019/05/global-trade-identity-can-be-the-cornerstone-of-paperless-trade/ (link as of 18 June 2019).

38. https://www.ccn.com/korea-customs-authority-to-test-blockchain-clearance-system-for-imports-exports/ (link as of 18 June 2019).

39. https://www.wto.org/english/res_e/reser_e/session_2c_4_zahouani_saadaoui_dg_taxud_blockchain_v1.0.pdf (link as of 18 June 2019).

40. This may paradoxically mean that successful implementation of blockchain may be most feasible where its value add is quite low – single windows that are already digitized and where players are already interoperating well, as it is in those single windows where players have summoned the political wherewithal to overcome the problems that need to be solved for blockchain to be adopted and useful.

41. http://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/tools/data-model.aspx (link as of 18 June 2019).

42. For encryption-related concerns, see existing discussions in the context of bitcoin, such as https://bitcoin.stackexchange.com/questions/88/is-bitcoin-future-proof (link as of 18 June 2019).

43. For example, https://csis-prod.s3.amazonaws.com/s3fs-public/publication/181101_Suominen_Blockchain_v3.pdf (link as of 18 June 2019).

44. The Time Release Study is an internationally recognized tool to measure the actual time required for the release and/or clearance of goods, from the time of arrival until the physical release of cargo, with a view to finding bottlenecks in the trade-flow process and taking the corresponding necessary measures to improve the effectiveness and efficiency of border procedures: http://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/tools/time-release-study.aspx

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