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BLOCKCHAIN
AND INTERNATIONAL TRADE

New Technologies for a Bigger and Better
Latin American International Insertion

IDB INTAL

INDEX

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AND INTERNATINAL TRADE
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Latin American International Insertion

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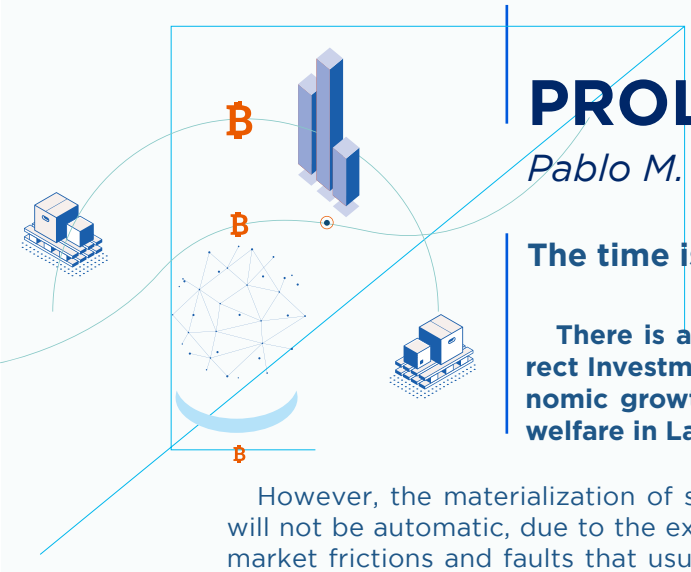


PROLOGUE

Pablo M. Garcia · *IDB - INTAL DIRECTOR*

The time is now. There is no time to lose.

There is ample evidence that international trade and Foreign Direct Investment have the potential to increase productivity and economic growth, and as a consequence, induce a rise in income and welfare in Latin American countries.

However, the materialization of such gains will not be automatic, due to the existence of market frictions and faults that usually translate as what we call **trade costs**, which are quite high in our region.

These costs manifest in a variety of ways. On one hand, we experience high transport and logistical costs that are practically double the world average; at the same time, information costs, which are related to consumer preferences (such as standards, and quality certifications) and a lack of knowledge regarding our economies' capacities, range between 6 and 13% of total production costs. On the other hand, regulatory costs of international trade in the region make up about 10% of production costs and arise primarily from the proliferation of divergent disciplines within our free trade agreements. Lastly, foreign trade financing costs are pivotal, given the heterogeneity of financing access in LAC countries.

An effective, inclusive, and sustainable internationalization will require that we define and execute a trade and investment policy agenda centered around the reduction of such costs. We believe that the incorporation of new technologies such as **Blockchain** can make a substantial contribution in all of these areas. Moving this agenda forward has become more essential than ever, given the challenges that Latin American and Carribean countries are facing in the current pandemic context.

The effects of the crisis on Latin American firms ask and obligate that we implement new and better instruments for trade recovery and integration as driving forces of the region's economy. A recent survey of LAC export companies conducted by the IDB-INTAL shows that 8 out of 10 companies have reduced exports due to the pandemic, illustrating the magnitude of this phenomenon's impact.

However, this global context also presents us with new opportunities. Latin American firms are reinventing themselves: 5 out of 10 companies use some form of electronic trade platform to coordinate their exports. Likewise, telework has become a new normal among export firms, obviously, in positions that permit it. Sights are set on how to restart activity using available technology and digital commerce tools.

In this context, accelerating the adoption of new technologies in production and employment has become crucial for finding a way out of the crisis and recovering economic activity. Along the same lines, bolstering the use of new operational tools for foreign trade seems necessary in order to take on a world that will demand greater security and trust following the pandemic.

This is the topic we will address in this edition of the Integration & Trade Journal. How Blockchain technology can be used to manage international trade, a process that has become increasingly relevant in the current context. Blockchain allows for the secure digitalization of procedures — including smart contracts, inventory management, and traceability of goods, among other things — reducing the number of intermediaries in foreign trade management, and making interactions more secure and transparent. All of these features reduce not only the transaction costs of commercial operations, but also the need for personal contact between agents, in times when low-touch activities and operations have become particularly relevant.

In conclusion, this journal will illustrate the advantages of Blockchain application in different spheres of international trade operations, from the moment that an SME or large company decides to export a product or service, to the moment that product or service reaches its destination, taking a look at the most diverse and complex stages (from financing to distribution, to customs and transport, etc.).

I invite you to enter this new world.

INTRODUCTION

Magdalena Barafani · *IDB-INTAL*

Pablo M. Garcia · *IDB-INTAL*

Ricardo Rozemberg · *IDB-INTAL*

The world is experiencing unprecedented productive changes brought about through the use of disruptive technologies. Robotics, the Internet of Things, Artificial Intelligence, Cloud Computing, 3D Printing, Augmented Reality, and Big Data are some of the new tools being increasingly adopted in the private sector and in governmental policy agendas that promote a greater incidence of digital platforms in productive techniques.

This phenomenon is not just limited to manufacturing, but extends throughout all economic sectors. The lines between different types of activities are becoming increasingly blurred, given that knowledge, technology, and digital systems are spreading across all of them.

The development of **Blockchain** adds an additional tool to the box of new applications being used to supplement and strengthen business. **Blockchain** is a technology that was first used in 2009; but the stage set by the Covid-19 pandemic will increase its incorporation into companies due to its effectiveness at eliminating the need for physical signatures in the finalization of transactions and certifications, and its ability to provide more security in operations, according to the study "Perspectiva del Covid-19: Tecnología e innovación contra el coronavirus" (Covid-19 Outlook: Technology and Innovation Against Coronavirus), which was carried out this year by the consulting firm Grant Thornton.

Blockchain is a secure, virtual database, which provides information related to the transactions that take place within a group, such as a corporation, a supplier network, a mutual fund, or an international supply chain. This platform offers a distributed and unalterable record which is encrypted and extremely secure, and at the same time, transparent and accessible to everyone involved.

Blockchain is a decentralized record, where each node of the network stores a copy of all the actions executed within the context of the chain or group, guaranteeing the availability of information at all times. If an attacker were to attempt to implement a denial of service attack, they would have to override every single node of the network, since only one of them has to be working in order for the information to be available. This gives it a degree of security that is highly valued in all kinds of interactions.

Originally applied in financial systems for the development and launch of the virtual currency Bitcoin, **Blockchain** has expanded into various activities over the last decade, including energy, health, education, and security. Foreign trade, logistics, transport, and procedures associated with international transactions are other areas with potential for streamlining their processes through the adoption of this technology: product traceability, payment and financing security, real-time information, and public and private services.

The use of this tool presents opportunities and challenges for foreign trade, and, in particular, for Latin America and the Caribbean. In the articles included in this publication, this phenomenon will be analyzed from diverse viewpoints. Although the advancement of this technology has already been visible and necessary, the incorporation of **Blockchain** in the region's trade operations may be accelerated within the new context brought about by the pandemic, given that the advantages of applying it are amplified. In a global context with increasingly complex supply chains, **Blockchain** can streamline processes: the possibility of tracing the path of each product, from manufacture to target market, will be essential in the post-pandemic world, where health safety and quality will be crucial for trade. Additionally, the cost reduction and security benefits that **Blockchain** allows could contribute to competitive improvements in companies, especially SMEs, who will see an increase in ease of access to new markets at more competitive prices.

Aside from the aforementioned benefits, this technology presents huge challenges related to logistics, interoperability, and regulation. Some of the most notable challenges include **Blockchain's** limited scalability, due to the predetermined size of blocks, and the problem of the huge amount of energy consumption that it requires, as well as potential security-related problems that could arise with the advancement of quantum computing. Interoperability will be a challenge due to the fact that numerous platforms are being developed that use different interfaces and technical algorithms, and therefore cannot "communicate with one another." And finally, there is the need for a regulatory framework that recognizes the legal validity of **Blockchain** transactions, clarifies the applicable laws and responsibilities, and regulates the way in which information can be accessed and utilized.[1]

Blockchain and Regional Trade

In this publication we will address the possibilities that **Blockchain** offers for integration and trade in Latin America and the Caribbean. The goal is to provide knowledge that is both useful and applicable, and that helps policymakers, enterprises, and civil society to become informed regarding these developments, and plan integration strategies for new markets and products.

To this end, Kati Suominen provides in her article a guide for applying **Blockchain** in the different stages that a company must move through in the process of undertaking foreign trade activities, and illustrates how this technology will allow for improved processes.

On her end, Virginia Cram Martos analyzes the subject of trade facilitation and possible uses and cases in which **Blockchain** could be implemented in order to reduce costs and promote the enhancement of foreign capital flows. In particular, she explores the advantages of this technology for observing the traceability of goods, logistics monitoring, port management, and transport and handling of goods, guaranteeing the security of the transaction from start to finish.

One of the two articles included in this publication that were put together jointly by the WEF and IDB, analyzes the challenges of the region's foreign trade single windows (FTSW) and how **Blockchain** could contribute to improving their function and reducing transaction costs. From this standpoint, it explores the effect of this technology on cross-border payments and finance.

Sandra Corcuera and Michelle Moreno describe their experience with the CADENA program, a case in which **Blockchain** is being applied in customs operations in Latin America and the Caribbean, implemented by the IDB within the framework of LAC-Chain.

In the second of the articles to come out of the IDB-WEF collaboration, Rafael Cornejo analyzes the benefits that using **Blockchain** to digitalize the integral origin process (IOP) would have. To this effect, he argues that through the use of such technology, it would be feasible to modernize and customize the processes of declaration, certification, and origin control, which would be a fundamentally important step towards leveraging the region's existing trade agreements.

Finally, Ignacio Carballo analyzes the relationship between financial inclusion and **Blockchain** in general, and proceeds to detail how this tool can be used to improve companies' access to international trade financing, a realm in which the region lags behind.

Blockchain offers us an opportunity to expand Latin American and Caribbean international trade. The different articles included in this publication give an account of how its application in different segments and stages of the export process could contribute to cost reduction, ensure product traceability, and guarantee secure logistics and trade operations. All of these are fundamental assets for improving the competitiveness and international insertion of the region's countries.

We are at a crucial juncture. It urges us to accelerate the incorporation of these types of innovation that will allow more and better Latin American and Caribbean goods and services to reach world markets, offering quality, health, and safety for the new normal that the pandemic has thrust upon us. We hope that this publication will contribute to that.

1. Ganne, E. 2018, Can Blockchain Revolutionize International Trade? World Trade Organization.

1

ARTICLE

PAVING THE WAY FOR OPTIMIZED REGIONAL TRADE

Kati Suominen · *CEO, Nextrade Group LLC*

The utilization of **Blockchain** promises to increase efficiency and productivity in logistics, customs operations, trade financing, and cross-border payments. This technology would have a positive impact on our region's companies, but will present challenges in terms of regulation, infrastructure, and standards adoption.

In a recent report, IBM experts affirmed that our world is made up of eleven key elements, two of which are transportation and healthcare.[2] Each system or ecosystem comprises many organizations, in both the public and private sectors, which manifest diverse branches of activity. For example, the health ecosystem includes, among other things, doctors, hospitals, pharmacies, health insurance, laboratories, and regulatory authorities. And just like the other ten key ecosystems, it suffers serious inefficiencies. Let's think about paper-based medical records — some of the problems that exist include repetitive ente-

2. Korsten, P. and Seider, C. "The World's 4 Trillion Dollar Challenge," IBM Global Business Services, Executive Report, 2017. https://www.ibm.com/ibm/files/Y067208R89372O94/11The_worlds_4_trillion_dollar_challenge-Executive_Report_1_3MB.pdf. See also the argument presented in Suominen, K. Revolutionizing World Trade: How Disruptive Technologies Open Opportunity for All (Stanford University Press, 2019).

ring of the same information, appalling duplication of efforts, and lack of digitalization or means by which to share information. Although difficult to assess, these inefficiencies are systemic in the sense that they affect all parts of the ecosystem, including health insurance companies and medical office staff, as well as patients themselves. IBM estimates that the cost of inefficiencies in these eleven central systems amounts to 15 trillion US dollars, a number equivalent to 28% of the global GDP.[3]

Just like that of healthcare and transport services, global trade is a complex system. It also suffers appalling inefficiencies. For example, the banks that finance trade duplicate procedures and data entry and even tend to process letters of credit by hand. The logistics providers, ports, international shipping agents, and customs brokers who play a role in every shipment, exchange the same information multiple times, while the ships, ports, and trucks that carry goods to and from ports are usually unsynchronized, resulting in thousands of working hours wasted on wait times and the cross-linking of the millions of logistics processes carried out daily across the globe. Very simple matters, such as errors or illegible handwriting on cargo manifests (which are still usually drawn up by hand) and the subtle misunderstandings that occur between exporters and their foreign clients, can generate entire days of unnecessary work.

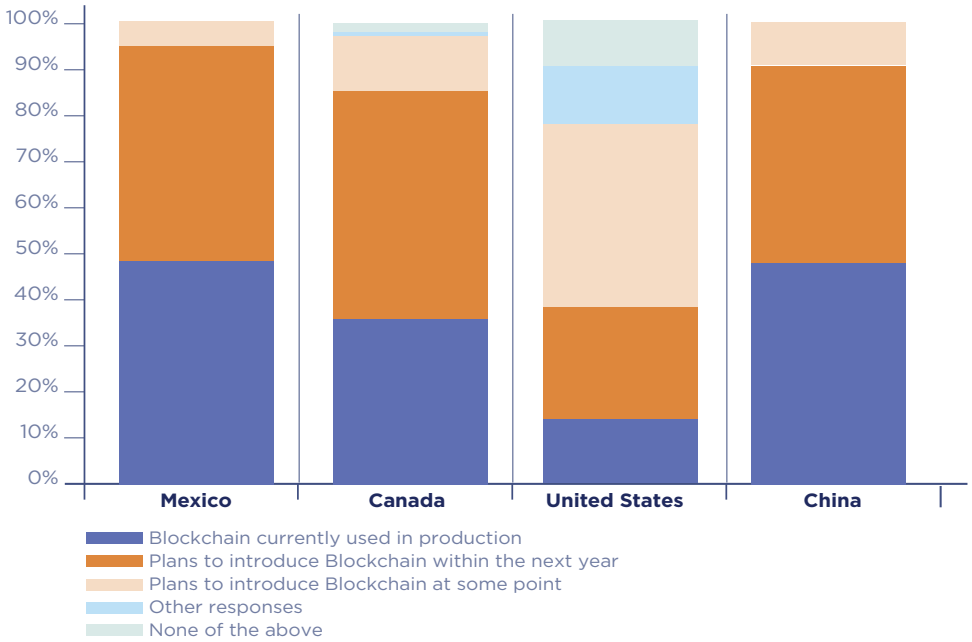
Nowadays, this scene is changing. New technologies like **Blockchain**, Artificial Intelligence (AI), and the Internet of Things (IoT) are streamlining the way we do trade: part of the global trading system is becoming more symbiotic, and the exchange of information is becoming digitalized.

Blockchain is uniquely promising as a tool to overcome many of the inefficiencies that affect the mechanics of global trade in terms of trade logistics, value chain management, customs and border administration, international payments, and trade financing. For example, it allows all parties involved in an accounting process to make the same information visible at the same time, which reduces the huge quantity of paperwork and duplication of entries that interfere with logistics, compliance with trade requirements, and trade financing. It also provides security and transparency: when all members of the value chain — including suppliers, manufacturers, logistics and stockyard companies, and trade finance banks, among others — input data into the same **Blockchain**, each participant has end-to-end visibility of any shipment, as well as the quality, status, and movement of products, which can make value chain management and financing, cargo tracking, and customs clearance easier. **Blockchain** also allows for the immediate compensation of transactions, which reduces international payment delays to days or even mere seconds. And smart contracts based on this technology can significantly speed up fulfillment of commitments made in said transactions: if the importer and exporter sign a smart contract, the importer's bank pays the exporter automatically once their client has verified possession of the shipment. No intermediary is necessary in order to prove that X event has occurred, in order for the contractual action Y to then occur.

In short, **Blockchain** can help the world get closer to the holy grail of world trade: integration, interoperability, and automation of the physical value, information, and financial chains that obstruct commercial transactions. Various governmental organisms and corporations are investing in this technology, along with many venture capitalists, who in 2015-2017 alone allocated 1.7 billion US dollars to **Blockchain** start-ups.[4] A recent Deloitte survey suggests that Mexican executives are just as keen on investing in this technology as their Chinese peers, and in fact show more enthusiasm than Canadian and US American executives (Graphics 1 and 2).[5]

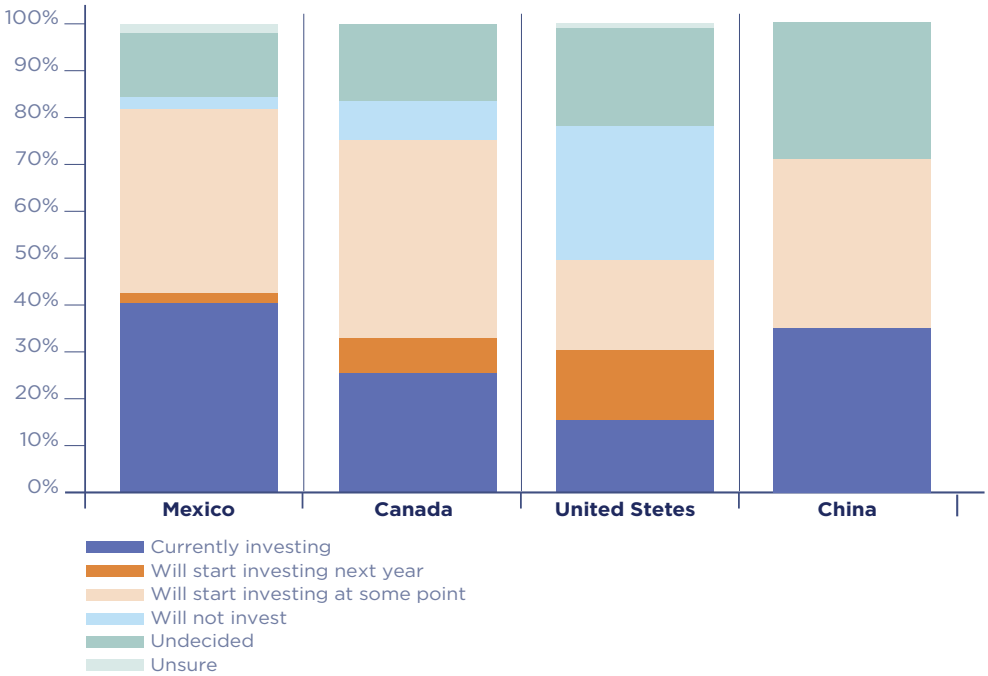
3. Ibid.
4. CB Insights, "Blockchain Investment Trends in Review," CB Insights Research, April 13, 2018, https://www.cbinsights.com/research/report/blockchain-trends-opportunities/
5. Pawczuk, L., Massey, R., and Schatsky, D. "Breaking Blockchain Open: Deloitte's 2018 Global Blockchain Survey."

Figure 1.
Has your company ever used **Blockchain** in its production process, or plan on introducing **Blockchain** in its production process?



Source: Study carried out in 2018 by Deloitte, in which 1,053 executives from around the world were surveyed.

Figure 2.
Is your company making investments toward replacing parts of its systems, or all current systems with **Blockchain**-based improvements?



Source:
Study carried out in 2018 by Deloitte, in which 1,053 executives from around the world were surveyed.

The **Blockchain** revolution is already transforming trade in Latin America. In the following section we will explore how. Below, Chart 1 summarizes the selected pilot plans and use cases.[6]

Chart 1.
Blockchain: Use Cases and Pilot Tests

SECTOR	ORGANIZATION	BLOCKCHAIN APPLICATION
Logistic Management	**Port of Veracruz**	The Port of Veracruz is working with the Mexican Customs Administration to adopt **Blockchain** and smart contracts to transmit information and automate processes that involve port community members (such as terminal operators, railroad transporters, logistics providers, tax authorities, and port authorities).
	IBM-Maersk	Maersk and IBM's joint **Blockchain** venture began operation in June of 2016, focused on areas such as pineapple shipments from Colombia to Rotterdam[7]. Since then, the network has connected transporters, ports, customs administrations, banks, and other participants in Maersk's global value chains, in order to implement cargo tracking and replace redundant and time-costly paperwork[8].
Customs Administration	**Customs of Peru, Mexico, and Costa Rica with the IDB and Microsoft**	Peru, Mexico, and Costa Rica are working on a pilot project with the IDB and Microsoft called CADENA, which uses **Blockchain** technology to improve the security and efficiency of their customs' Mutual Recognition Agreements (MRA) and Authorized Economic Operator (AEO) programs.
	US Customs and Border Protection (CBP)	In September, the CBP put together a team to research potential **Blockchain** use by the agency. This group has already identified 14 specific use cases, which range from license and permit tracking to certificates of origin[9].
	Korea Customs Service (KCS)	The shipping services company Malltail and the KCS signed a memorandum of understanding to launch a **Blockchain**-based customs platform. Its goal is to use this technology to accelerate customs clearance processes in seven Malltail distribution centered located in the US, Japan, and Germany[10].

6. For more details on these and other use cases, see: Suominen, K. 2018. "Harnessing Blockchain for American Business and Prosperity: 10 Use Cases, 10 Big Questions, Five Solutions." (CISS: November), https://csis-prod.s3.amazonaws.com/s3fs-public/publication/181101_Suominen_Blockchain_v3.pdf?M7hE6iv35xMwTqLIDEKgKP9t3E.Xb_eR
7. IBM, "Transform Supply Chain Transparency with IBM Blockchain", (Accessed June 18, 2018), https://www-01.ibm.com/common/ssi/cgibin/ssialias?htmlfid=93014193USEN&
8. Hackett, Robert, "IBM and Maersk Are Creating a New Blockchain Company", Fortune, (Accessed January 16, 2018), http://fortune.com/2018/01/16/ibm-blockchain-maersk-company/
9. Higgins, Stan, "US Customs and Border Protection Advisors Form Blockchain Research Effort", CoinDesk, (Accessed November 10, 2017), https://www.coindesk.com/us-customs-border-patrol-advisors-form-blockchain-research-effort/
10. Huillet, Marie, "Bitcoin Above $7,000 as Positive Momentum Continues Following Yesterday's Market Upswing", Cointelegraph, (Accessed July 17, 2018), https://cointelegraph.com/news/bitcoin-above-7-000-as-positive-momentum-continues-following-yesterday-s-market-upswing

Trade Financing	**BBVA**	In 2017, the Barcelona-based company Frime purchased over 25 tons of frozen tuna from Pinsa Congelados, of Mazatlán (Mexico), with the help of a letter of credit issued by the BBVA in Spain and processed by the BBVA Bancomer of Mexico.
	HSBC	In May 2018, the bank HSBC announced that it had finalized "the world's first commercially viable **Blockchain**-enabled trade financing transaction." [11]. HSBC's proof of concept involved a **Blockchain**-based letter of credit for a transaction with the firm Cargill.
	We.trade	The banks Santander, Deutsche Bank, HSBC, KBC, Natixis, Rabobank, Société Générale, and UniCredit have created a **Blockchain** consortium called "we.trade" to streamline trade financing transactions among them and expand trade financing for European SMEs.
Cross-border Payments	**Bradesco, Santander**	The MUFG group, based in Tokyo (Japan), and Bradesco, based in São Paulo, agreed to collaborate on the creation of a cross-border payments service based on the distributed accounting records technology Ripple. El Santander, in Brazil, launched a service called OnePay FX, for making cross-border company-to-company (B2B) payments using **Blockchain**.
	J.P. Morgan	JP Morgan Chase's new interbank information network, called Interbank Information Network (IIN), **Blockchain**-based method through which participating banks can make transfers in US dollars among various countries and institutions more efficiently than through the SWIFT network.

The Logistics Challenge

The level of logistics efficiency in Latin America and the Caribbean (LAC) is very low. According to the World Bank's Logistics Performance Index, the capacity of logistics services in the region's countries is lower than that of China, India, and South Africa. The only exception is Panama, which has a somewhat higher performance than India, but lower than that of China. Some LAC countries also lag behind certain African countries, like Nigeria.

However, the quality of logistics services is not the only challenge faced by the region; there are other systemic challenges and high transaction costs in trade-related logistics value chains. The transport sector giant, Maersk, has estimated that a small flower exporter would have to carry out 200 separate communications involving thirty participants — such as flower growers, international freight brokers, inland carriers, customs brokers, governments, ports, and shipping lines — in order to get a shipment to the Netherlands.[12] A ship arriving at port exchanges at least fifteen messages with the port operator, customs, and the exporter. It's also necessary to reconcile different databases and identify other sources of discrepancies, which often involves manually reviewing paper documents. In several of LAC's export sectors — such as the automotive, processed food, and electronics industries — shipments require twenty different documents, including the bill of lad-

11. Weinland, Don, "HSBC Claims First Trade-finance Deal with Blockchain", Financial Times, 13 de mayo de 2018, https://www.ft.com/content/c0670eb6-5655-11e8-bdb7-f6677d2e1ce8
12. IBM, "Maersk and IBM Unveil First Industry-Wide Cross-Border Supply Chain Solution on Blockchain," Press release, March 5, 2017, https://www-03.ibm.com/press/us/en/pressrelease/51712.wss

ing, the cargo manifest, and the customs declaration, all of which still tend to be printed on paper. What's more, the exporters fill out up to 75% of the same data fields time and time again, which takes up time and increases the probability of human error.[13] Ultimately, all of these cumbersome factors comprise up to 20 or 30% in additional transport costs that fall on companies.[14]

Blockchain could make an incredibly meaningful change in this complex arena: it allows for all of the necessary information to be entered into the **Blockchain** just once, and be visible to all participants in real time, which would reduce the amount of paperwork that is typically necessary in order to transport goods from one country to another.

The most promising pilot project is Maersk's new **Blockchain**-based platform, developed with IBM and tested in diverse scenarios, such as pineapple shipments from Colombia to Port Rotterdam, in Holland. Instead of employing multiple databases, suffering losses on paperwork, and doubling the data load, the parties using this system have the same general view of the processes involved in the trade transaction, the same access to all documents related to the transaction, and can instantly share that data and information with any other stakeholder. Entries in the accounting record are unchangeable and are updated in real time on the screens of everyone involved. Digitalizing and simplifying this process could reduce the exporter's shipping costs between 20 and 30%, and diminish the huge number of emails and documents that must be sent to various parties in order to organize said shipment.[15] Global companies are also applying **Blockchain** technology in their logistics operations. For example, the Korean firm Samsung SDS estimates that their **Blockchain** significantly reduces times between product launch and delivery, allowing them to reach markets faster than their rivals.

Blockchain is also changing LAC ports. Generally speaking, port automation could transform the region's trade: according to a study conducted in 2008, the costs for LAC economies to transport goods to the US market via ocean were 172% higher than those faced by the Netherlands, and a third of the costs faced by Latin American companies were due to differences in port efficiency.[16]

Ports across the globe are getting smarter, taking advantage of IoT, AI, and **Blockchain** technology to streamline their operations, expedite circulation of goods and transport operators, secure and improve data sharing and information flows between the involved parties of any shipment, further integrate with the logistics of neighboring cities, and improve environmental sustainability. Some ports have been automated to such a degree that they have virtually no human workers; Qingdao Port in China reduced the number of workers involved in ship unloading from 60 to

13. Williams, G., Gunn, D., Roma, E., and Bansal, B., "Distributed Ledgers in Payments: Beyond the Bitcoin Hype," Bain Brief, July 13, 2016. See also: IMDA Singapore, "International Trade and Logistics," November 28, 2016.
14. IMDA Singapore, 2016, "International Trade and Logistics," November 28, 2016, Williams, G., Gunn, D., Roma, E., and Bansal, B., "Distributed Ledgers in Payments: Beyond the Bitcoin Hype," Bain Brief, July 13, 2016, www.bain.com/insights/distributed-ledgers-in-payments-beyond-bitcoin-hype/
15. IMDA Singapore, 2016, op. cit.
16. See: Moreira, M., Martincus, B., and Martincus, V., Unclogging the Arteries: The Impact of Transport Costs on Latin American and Caribbean Trade, 2008, IDB.

nine people, who are mostly technicians who use remote controls to move cranes.[17] Labor costs have been reduced by 70%, while efficiency has increased by 30%, meaning the shortening of port layovers requested by large ships, eager to reach their next destination. Work accidents, incidentally, have been reduced to zero.

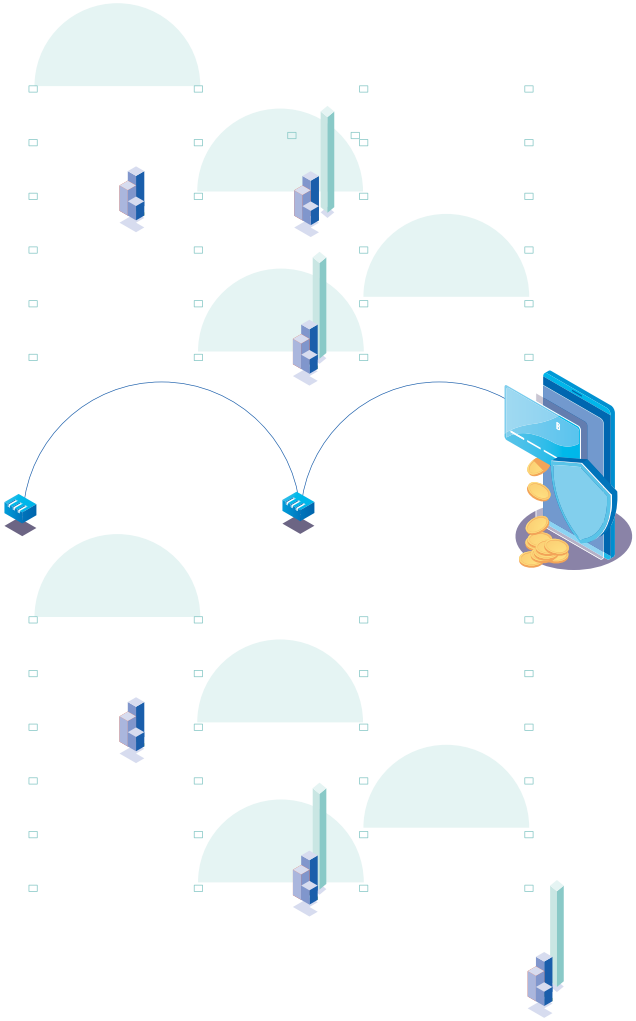
The family of smart port technologies is rapidly adopting **Blockchain**. In January of 2019, the world's "port of all ports" and pioneer in the application of new technologies, Rotterdam, launched a **Blockchain** pilot to streamline the multimodal transport of a container from a factory in Asia to the Netherlands, in which three companies, logistics operators, and port operators were involved. The Port of Valencia, in Spain, which is the second largest in the Mediterranean, is also considering becoming a paperless smart port using this technology. Similarly, LAC economies are putting this tool to the test: The Port of Veracruz, which celebrated its 500th anniversary in 2019, is working with the Mexican General Customs Administration to adopt **Blockchain** and smart contracts to transmit information and automate processes that involve port community players (terminal operators, railway haulers, logistics providers, tax authorities, and port authorities, among others) in order to build trust and optimize operations as a team.[18]

Customs: Digital and Efficient

Most trade experts would probably identify customs as the worst bottleneck for LAC countries in terms of trade, in a context in which improvements being achieved in such institutions are generating significant economic benefits. Recent company data released in Uruguay reflects that, if all shipments subject to physical inspection could leave port the same day they are inspected, exports would increase by almost 6%.[19] For time-sensitive products, a one-day delay to reaching their destination means a 6% drop in their country's trade, equal to adding 360 kilometers to the transport distance.[20] Of course, customs offices face their own challenges and must deal with problems such as fraud — undervaluation and underdeclaration of the contents of ships — as well as the complexities inherent in monitoring shipments, product codes, and origins of goods sent by partners to free trade agreements (FTA). But, by the same token, many border agencies being able to share data in real time could also pose challenges.

Blockchain changes the rules of the game for customs administrations. This technology could achieve the impossible: allow them to secure and simplify trade transactions, and wipe out fraud. Many of the world's customs administrations are already experimenting with this technology, including in the United Kingdom, Korea, Singapore, and a group of fifteen East African countries. In 2017, the U.S. Customs and Border Protection (CBP) agency rolled out fourteen **Blockchain** use cases, including a system for tracking licenses, permits, and certificates of origin issued by affiliated government agencies. The Korea Customs Service (KCS) is a pioneer in the use of this technology, and, recently, implemented a pilot program that includes more than fifty Korean exporting companies and ten importing firms based in Vietnam and Singapore.[21]

17. "Asia Enters Fully Automated Terminal Era," Port Technology, May 15, 2017.
18. "Nuevo puerto de Veracruz usará tecnología de bitcoin y contratos inteligentes," [New port of Veracruz to use Bitcoin technology and smart contracts], Méxicoxport, September 10, 2018, http://mexicoxport.com/nuevo-puerto-de-veracruz-usara-tecnologia-de-bitcoin-y-contratos-inteligentes/
19. Martincus, V., Carballo, J., and Graziano, A., 2016, "Customs," IDB Working Paper, Series IDB-WP-705, June 9, https://publications.iadb.org/bitstream/handle/11319/7689/Customs.pdf?sequence=1
20. Djankov, S., Freund, C., and Pham, C., 2010, "Trading on Time," Set of working papers, 3909, World Bank, https://openknowledge.worldbank.org/bitstream/handle/10986/8674/wps3909.pdf
21. Das, S., 2018. "Korea Customs Authority to Test Blockchain Clearance System for Imports, Exports," CCN, May 17, 2018, www.ccn.com/korea-customs-authority-to-test-blockchainclearance-system-for-imports-exports/



LAC customs agencies have also adopted this tool. Peru, Mexico, and Costa Rica achieved especially remarkable advances by applying **Blockchain** to their customs systems through a pilot project called CADENA, undertaken by the IDB and Microsoft, which uses this technology to enhance the security and efficiency of their customs-related mutual recognition agreements (MRA) and authorized economic operator (AEO) programs. Now is the time for these types of initiatives to be developed, given that LAC governments are actively seeking to finalize MRAs. In 2018, for example, the customs agencies of Colombia, Chile, Mexico, and Peru, who make up the Pacific Alliance, signed an MRA; they are also in the process of negotiating other MRAs among countries in Central America, The Andean Community, and MERCOSUR.[22] These agreements require that participants share data related to the most recent AEO certifications, something very difficult to accomplish, and that is typically done through email exchanges between customs administrations. With the use of **Blockchain**, these customs administrations will have access to the same information, stored securely, and uploaded just one time, from one place. This also assures trade operators access to MRA benefits from the moment that AEO certification is received.[23]

CADENA was designed as a pilot project primarily to allow all participants to become familiar with the workings of **Blockchain**, and to encourage them to consider implementing other possible use cases. Within this framework, members of the initiative discovered that CADENA could be expanded in order to automate the entire AEO certification process, and foster improved risk management within customs administrations. CADENA is also giving involved parties a chance to see how **Blockchain** guarantees the integrity of data received by customs and helps safeguard it, for example, by allowing different user access levels. Additionally, this project is benefitting the customs agencies that are participating in it, and other involved players are learning about **Blockchain**-related matters, such as interoperability of platforms, how to align incentives so that agents in a value chain will want to adopt this technology, and the administration of information shared among members.[24]However, there are still some questions as to what will be the best way to achieve interaction between **Blockchain**-based systems and the region's single windows, as well as questions related to whether small companies will be able to use this technology, and if customs will have the necessary capacity to operate systems based on this structure.[25]

22. Corcuera Santamaria, S., "CADENA, a Blockchain Enabled Solution for the Implementation of Mutual Recognition Arrangements/Agreements," WCO News 87, https://mag.wcoomd.org/magazine/wco-news-87/cadena-a-blockchain-enabled-solution-for-the-implementation-of-mutual-recognition-arrangements-agreements/
23. Ibid.
24. Ibid.
25. See: WEF & BID. Windows of Opportunity: Facilitating Trade with Blockchain Technology, https://publications.iadb.org/publications/english/document/Windows_of_Opportunity_Facilitating_Trade_with_Blockchain_Technology.pdf

Payments Without Borders

Global transborder payments reach stratospheric numbers, to the tune of 150 trillion US dollars, a number that is double the size of the entire global economy in 2015.

Companies all over the world, including those in Latin America, face very high fees for the processing of payments they send to international providers. One transfer typically costs between 50 and 75 US dollars, which discourages small transactions between buyers and sellers. Cross-border transfer payments using SWIFT can take several days and involve transaction fees of varying percentages of the original amount, easily reaching levels ranging between 1 and 3%, and, in some cases, up to 10%, given that each bank in the payment's value chain collects a share.[26] Every intermediary, then, is a potential point of failure: for example, 60% of B2B payments require some sort of manual task, each one of which takes between 15 and 20 minutes.[27] The process of settling payments takes quite a bit of time — between 3 and 5 days — which seems unbelievable to those who are used to operating with the instantaneousness of emails. Hence, it's faster for the exporter to take a plane to go visit the importer, who pays them in cash, than to wait for a bank transfer.

Latin American companies have devised alternative methods to avoid paying very steep fees, such as the pooling of multiple payments in a single transfer. But the use of **Blockchain** could change the rules of the game. Instead of utilizing the SWIFT system to settle the accounting books of each financial institution, an interbank **Blockchain** could track all transactions publically and transparently, and they would be paid directly instead of through corresponding banks.[28]

Almost all of the region's big banks have experimented with this technology for use with cross-border payments and trade financing, including for operations within LAC. For example, Tokyo-based financial group MUFG and São Paulo-based Bradesco, agreed to collaborate on the creation of an international payment service based on the accounting records technology developed and distributed by the company Ripple. And in 2018, Santander, in Brazil, launched a service called OnePay FX for making cross-border payments from business to business (B2B), which also used **Blockchain**.[29] This system's approach to value involved lowering costs and settling payments more quickly, with compensation either immediately, or, at the very most, in less than two hours. In contrast, this transaction would currently take 48 hours. According to Ripple — provider of the OnePay FX system — use of the **Blockchain** reduces transaction costs by one third.[30] The service was tested by Brazil, along with Spain, the United Kingdom, and Poland. Furthermore, Brazil's Central Bank, played a very active role in supporting and testing the use of **Blockchain** as applied to payments, and is considering carrying out pilot tests for cross-border payments.[31]

26. Higginson, M., "How Blockchain Could Disrupt Cross-Border Payments," The Clearing House blog, https://www.theclearinghouse.org/banking-perspectives/2016/2016-q4-banking-perspectives/articles/blockchain-cross-border-payments

27. CB Insights, "How Blockchain Could Disrupt Banking," CBInsights, December 12, 2018, https://www.cbinsights.com/research/blockchain-disrupting-banking/#:~:text=With%20global%20banking%20currently%20a,at%20lower%20fees%20than%20banks.

28. Ibid.

29. Santander, "Santander Launches the First Blockchain-Based International Money Transfer Service Across Four Countries," Santander Press Release, April 12, 2018, https://www.santander.com/csgs/Satellite/CFWCSancomQP01/en_GB/Corporate/Press-room/Santander-News/2018/04/12/Santander-launches-the-first-blockchain-based-international-money-transfer-service-across-four-countries-.html

30. Ibid.

31. Their first Blockchain proof of concept is what is called the Plataforma de Integração de Informações das Entidades Reguladoras or "PIER," a blockchain-based platform that facilitates data exchange with other institutions, like the Superintendencia de Seguros Privados (SUSEP), the Comisión de Valores Mobiliarios (CVM) and the Complimentary Pension Regulator (PREVIC). The system replaces a manual process in which one person from one of the institutions gets in contact directly with their peer in the other institution (for example, via email) in order to access the information they need, With blockchain technology, this process is automated and secured — all required data is registered using cryptographic signatures.

For Optimizing Trade

The objective of international trade financing is to ensure that the seller of a good from country A receives their payment once the buyer from country B has obtained the product. In this process, both buyers and sellers face serious difficulties. While sellers worry about whether or not the buyer will pay, and when they will receive their money, buyers are worrying about whether the seller will really go through with the shipment, and if the goods will be of the expected quality. Generally, the seller wants to receive their payment as soon as possible, while the buyer wants to make the payment as late as possible. These problems are the reason why buyers and sellers have delegated the management of their transactions to banks and insurance companies, whose staff can evaluate the buyer's ability to pay, and the seller's ability to deliver quality goods on time, track the products en route to the buyer and deliver the payments to the seller once the former has taken possession of the goods. The process is complex, and not without risk of fraud. For example, in 2008, J.P. Morgan Chase suffered a fraud that cost them almost 700 thousand US dollars. Fictitious purchase orders and falsified invoices were used to obtain loans for shipments of metals that didn't exist.[32] And around the world, 82% of executives claim to have fallen victim to some sort of fraud within their trade operations.[33]

In order to be safeguarded, for decades banks have undertaken long and arduous bureaucratic processes prior to issuing letters of credit. For higher-volume transactions, piles of paperwork can reach dozens of pages and the process can require several weeks dedicated to entering huge quantities of data and drawing up contractual provisions. 56% of bank costs for a letter of credit is the result of this tedious process of documentation and revision, often carried out by hand — a process that is repeated in every single one of the banks that participate in the transaction.[34]

One of the procedures necessary for compliance with regulations, and which is particularly costly in terms of time, is that of getting to know your client (KYC). Through this process, banks must request that their new clients (whether individuals or corporations) provide identifying documents every time they initiate a relationship with the bank (such as opening an account, requesting credit, or taking out an insurance policy), and they must monitor their cash flow in order to detect possible money laundering. Another factor that adds time and complexity, particularly in trade financing transactions, is the fact that each bank carries out their own KYC review, such that efforts are multiplied and clients end up having to provide the same information multiple times, to different institutions. For large-scale transactions, verifying the identity of the parties involved can take weeks. Trade financing for SMEs constitutes collateral damage: financing disparity in world trade is estimated to reach up to 1.6 trillion US dollars, and this largely reflects the huge difference in trade financing requirements for SMEs, which, effectively, is provided to them by banks. Due to fixed costs implied in KYC controls and other paperwork, which are excessively high in transactions carried out by smaller-sized companies, both banks and SMEs tend to consider a letter of credit for this client segment to be an uneconomical option.

Several banks are now trying to fix the problem of high processing costs for letters of credit. To this end, **Blockchain** technology was already tested in LAC: in 2017, the Barcelona-based company, Frime, bought over 25 tons of frozen tuna from Pinsa Congelados, a company in Mazatlán, Mexico, with the help of a letter of credit issued by the BBVA of

32. Chanjaroen, Chanyaporn, "Fraud in $4 trillion trade finance turns banks to digital ledger", liveMINTO, 23 de mayo de 2016 http://www.livemint.com/Industry/CXfxl1yePlwTDuokXU3c2K/Fraud-in-4-trillion-trade-finance-turns-banks-to-digital-le.html
33. Yee, Andy, 2017, "Blockchain Can Lift Asian Trade over Gaps in Trust", Nikkei Asian Review, 13 de julio, https://asia.nikkei.com/Business/Banking-Finance/Blockchain-can-lift-Asian-tradeover-gaps-in-trust
34. Bain & Company, 2016, "More than $150 billion in revenue at risk for banks that cannot overcome technical, adoption hurdles of digital currency", 15 de julio, http://www.bain.com/about/press/press-releases/150-billion-dollars-at-risk-for-banks-that-cannot-overcome-hurdles-of-digital-currency.aspx

Spain and processed by the BBVA Bacomer of Mexico.[35] The use cases suggest that the **Blockchain** reduces the time necessary for the issuance of a letter of credit approving a transaction from seven to ten days to a mere four hours, which means that they can now be issued 60 times more quickly.[36] Payments are also delivered faster: in a test carried out by one of the "primary correspondent banks," Standard Chartered used the Ripple platform to complete a transaction in less than ten seconds: some 17,280 times faster than the 48 hours needed for a typical trade finance banking transaction.[37]

Blockchain can also tackle challenges within the sphere of KYC controls. For example, in 2017, banks OCBC and HSBC, the IMDA, and financial group Mitsubishi UFJ (MUFG) became the first SouthEast Asian consortium to successfully complete concept testing of a **Blockchain** for KYC procedures. The main benefit is getting rid of duplications: clients only have to provide their information once, all parties can access the same data in real time through digital tools, and all of the information is stored securely and cannot be changed, reducing worries related to error or fraud, and the probability of criminal activity.[38]

Banks that must work together to finalize financial trade transactions have also joined together in **Blockchain** consortiums. In Europe, banks Santander, Deutsche Bank, HSBC, KBC, Natixis, Rabobank, Société Générale, and UniCredit have created a partnership called "we.trade" with the goal of streamlining trade-related financial operations as a team, and expanding trade financing for European SMEs. On their end, the Thailand **Blockchain** Community Initiative, composed of fourteen Thai banks in collaboration with three state companies and four corporations, has created a shared platform for letters of credit, in order to handle tens of thousands of millions of dollars in trade financing.[39]

According to some estimations, between now and 2022, **Blockchain** technology could reduce bank infrastructure costs by 15-20 billion US dollars per year, due to the elimination of intermediaries and improved efficiency. It's likely just a matter of time before pilot tests using this technology expand to include Latin American trade financing.

35. Patel, D., "BBVA, on the First Blockchain-based Trade Transaction Between Europe and Latin America," Trade Finance Global, December 1, 2017, https://www.tradefinanceglobal.com/posts/interview-bbva-first-blockchain-based-trade-transaction-europe-latin-america/
36. CB Insights, December 12, 2018, op. cit.
37. Das, S., 2016, "Standard Chartered Completes Cross-Border Blockchain Payment in 10 Seconds," CCN, September 29, https://www.ccn.com/standard-chartered-completes-cross-border-blockchain-payment-10-seconds/
38. Strzalek, A., 2017, "Asean Consortium in KYC Blockchain First," FStech, October 10, www.fstech.co.uk/fst/Consortium_Completes_First_KYC_Blockchain_PoC.php
39. Kasikorn Bank, 2018, "The First Thailand Blockchain Community Initiative," Kasikorn Bank News, March 19, www.kasikornbank.com/en/News/Pages/ThailandBlockchainCommunity.aspx

The regional agenda

Blockchain technology brings with it the unparalleled promise of being able to fix the biggest pitfalls affecting Latin American companies who wish to participate in global trade.

Pilot tests demonstrate that this system can help accelerate cross-border payments, as well as shipments and customs clearance; securing trade transactions and tackling fraud and money laundering, while reducing costs incurred through the use of intermediaries — and eventually, the costs faced by exporters, importers, and SMEs who take part in global trade, as well.

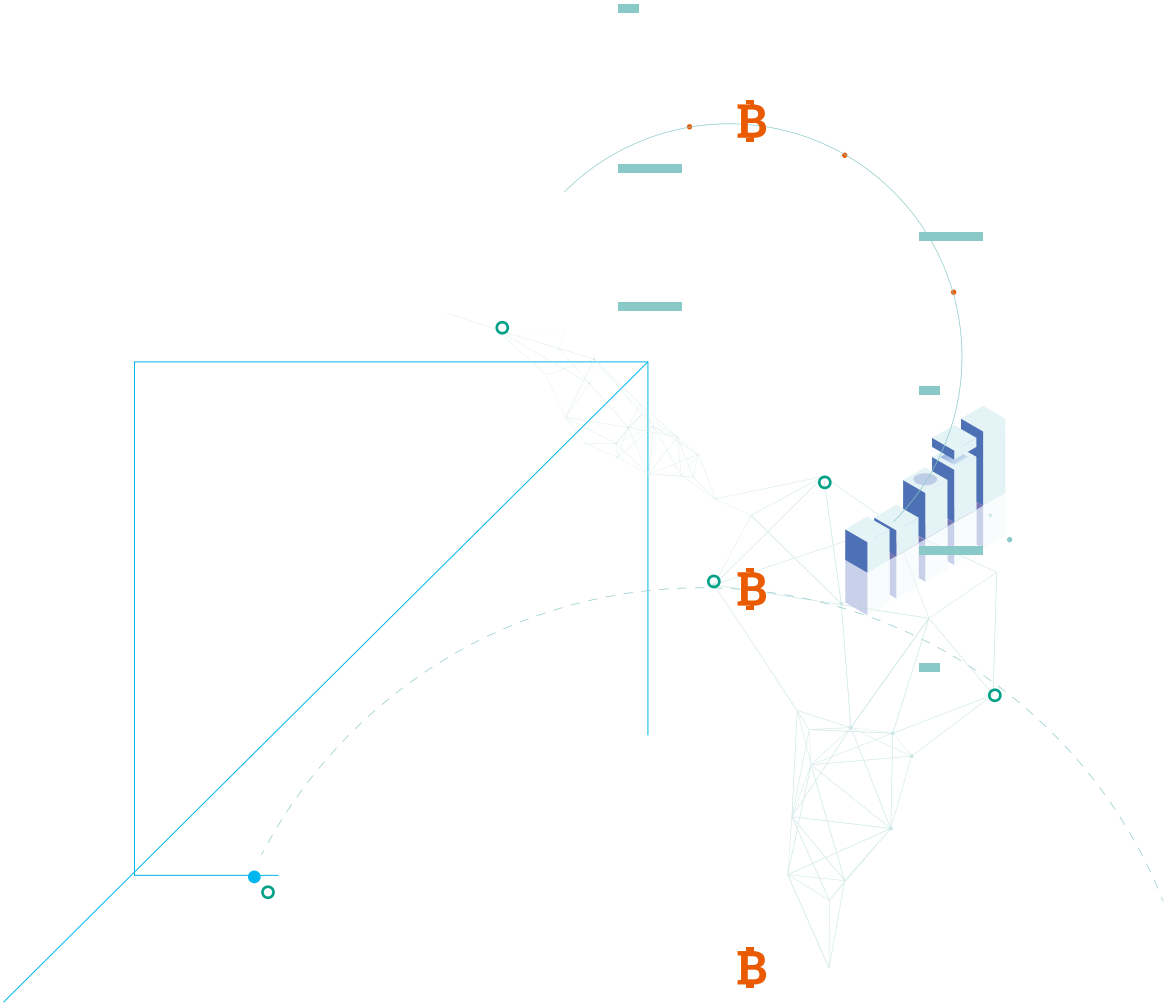
Blockchain is moving Latin America closer to the holy grail of global trade: integration and automation of the financial, logistics, and information value chains that underpin trade transactions. In fact, most LAC governments are already willing to test this technology. Here are some specific measures through which they could accelerate its adoption and broaden its benefits:

- · **Facilitate Blockchain-related use cases and experimentation through labs and test settings.** Since this technology is relatively new, many of its potential applications have still not emerged. Therefore, it should not be regulated too strictly. Additionally, national laws already apply to **Blockchain** through commercial data privacy and cyber security policies. On the contrary, governments should focus on cultivating use cases and ecosystems based on this technology. LAC governments could use private venture capital funds to finance start-ups that want to develop promising **Blockchain** applications, and create national laboratories dedicated to this technology, which can serve as incubators for **Blockchain** companies. Furthermore, they can assure a degree of regulatory flexibility that would encourage companies to test these applications. For example, LAC economies could introduce test environments or sandboxes in which companies rolling out **Blockchain** tests could bring their solutions to the market without having to go through all the red tape of regulatory approvals that would be required in other cases. This type of testing ground can be especially powerful if it is regionalized, in such a way that LAC businesses could bring their innovations to the entire regional market, and the regulators of each country could get together to discuss relevant issues and possible regulatory frameworks concerning this technology.

- · **Keep in mind systems and interoperability standards.** Due to the fact that the possibilities for expanding this technology's applications are in the hands of its network of users and interoperability between different **Blockchains** (for example, between two **Blockchain** systems applied to trade financing or between the accounting records of a port, a postal service, and a customs administration), it's important that LAC governments and all involved parties ensure the interconnection and interoperability of **Blockchain** used by different entities that play a role in trade — customs, ports, banks, logistics companies, exporters, and importers. This can be achieved in two ways. Firstly, LAC countries could design their regional **Blockchain** ecosystems in such a way so as to equip them with interoperability. The IDB has launched a Global Alliance to Promote the Use of **Blockchain** in Latin America and the Caribbean (LAC-Chain), with the explicit goal of stimulating the use of these authorized technologies and encouraging their interoperability in LAC economies and trade. Secondly, another solution would be the creation of interoperability standards that outline, among the participants and accounting records of a **Blockchain**, questions such as terminology and definitions, how different records should be integrated and how information and data should be shared among users, as well as the treatment said users should expect to receive. The International Organization for Standardization (ISO) is working on the development

of **Blockchain** standards for several spheres. Another entity, which the author of this article along with other stakeholders — including the Asian Development Bank — have founded in Singapore, called Digital Trade Standards (DTS), will also be facilitating the establishment of global standards for the application of **Blockchain** technology in trade. It is paramount that LAC economies incorporate these standards in order to achieve interoperability with their peers in the rest of the world.

- **· Measure the adoption and impact of Blockchain on LAC trade, especially SMEs.** In the spirit of "If you can't measure it, you can't improve it," LAC governments and other stakeholders must be able to properly scale the adoption of **Blockchain** technologies within their economies and trade-related applications, as well as their impact on Latin American trade. Particularly, they must be able to measure the impact on SME trading, in order to understand what the social, economic, commercial, and financial benefits are for companies of diverse sizes, from diverse sectors, and of different regions, and also to clarify what challenges said companies are facing as they adopt these new technologies. Furthermore, governments must be able to measure and assess policies related to **Blockchain**, as well as regulations and their effects both within the region and beyond, in order to be able to identify frameworks that ensure best practices. This information could be discussed in an annual forum on **Blockchain** in LAC, perhaps sponsored by the IDB, in which governments and businesses come together to examine the adoption of this tool in trade and other sectors, share use cases, give policy-makers and regulators a chance to learn about new **Blockchain** applications, and debate with companies about the best way to facilitate the applications of this technology in public and private sectors.



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2

ARTICLE

TRADE FACILITATION — AND WHAT IS THE ROLE OF BLOCKCHAIN TECHNOLOGY?

Virginia Cram-Martos · *CEO Triangularity SRL*

Blockchain is a technology that can strengthen trust between governments and the private sector. As such, it represents an excellent opportunity for improving trade facilitation, through the simplification of information flows, processes, and controls. The way to take advantage of this tool's potential is through education, and dialogue among the various stakeholders. Even though numerous projects and use cases currently exist within the sector, there is still a risk of increasing fragmentation of competing ecosystems, and the eventual erosion of the promise of efficiency and cost reduction.

What is Trade Facilitation?

To better understand the potential impact of **Blockchain** technology on trade facilitation, it is useful to first look at what trade facilitation is and why it is needed.

The United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT),[40] which started international work on trade facilitation in the 1960s by simplifying and harmonizing paper documents, defines trade facilitation as:

"the simplification, standardization and harmonization of procedures and associated information flows required to move goods from seller to buyer and to make payment."[41]

This definition covers a wide range of government-to-business and business-to-business activities, and implies that not only the physical movement of goods is important in a supply chain, but also the associated information flows. In fact, if goods arrive at an official control point before the associated information, the goods will stop until the information arrives.

Over the last 50 years, trade tariffs have been gradually reduced, and, as a result, procedural and other non-tariff barriers to trade have come into the spotlight as a major obstacle to trade. To address this issue, in October of 2013, the World Trade Organization (WTO) finalized negotiations on the WTO Trade Facilitation Agreement (WTO TFA) which came into force on February 22, 2017, after ratification by two-thirds of members.[42]

While the WTO Agreement does not contain a definition of trade facilitation, looking at the articles in the WTO TFA,[43] one can see that it is focused almost exclusively on government-to-business interactions, with some clauses on intergovernmental cooperation, and it is also very much focused on border and customs clearance. Therefore, the scope of trade facilitation within the WTO TFA is narrower than that defined by UN/CEFACT, which also covers business-to-business procedures and information flows. In this article, we will use the wider UN/CEFACT definition.

At the same time, the importance of trade facilitation is highlighted by the fact that the 164 WTO member countries were able to agree that trade facilitation is a critical issue for both developed and developing countries across the globe, and, furthermore, agree upon rules to support its implementation

Why Do Regulatory and Procedural Barriers to Trade Exist?

In order to understand how **Blockchain** could support trade facilitation, it is also useful to understand why the "procedures and associated information flows" which trade facilitation seeks to "simplify, standardize, and harmonize" exist. The fundamental reason often being a lack of trust.

Governments have created procedures to control imports and exports for a variety of reasons. These include ensuring government revenues, protecting the health and safety of citizens, and ensuring that domestic producers are not subjected to unfair competition; for example from foreign companies making products that are not in conformance with

40. United Nations Economic Commission for Europe, UNECE, http://www.unece.org/info/ece-homepage.html [Accessed April 15, 2020].
41. United Nations Economic Commission for Europe, UNECE, ¨Guía de implementación de facilitación del comercio: Introducción¨ [Trade facilitation implementation guide: Introduction], http://tfig.unece.org/SP/details.html [Accessed April 15, 2020].
42. World Trade Organization, ¨Trade Facilitation,¨ https://www.wto.org/english/tratop_e/tradfa_e/tradfa_e.htm [Accessed April 15, 2020].
43. Ibid.

domestic requirements. In addition, governments sometimes still seek to limit imports in order to protect domestic producers from competition – although this is a strategy that can backfire, hurting national competitiveness, given the high percentage of imported content in the average export.

Governments' procedures include controls because they do not trust businesses to pay the correct customs duties and to be in conformance with regulatory requirements. Governments also distrust, in general, the validity of documents, and, especially, official certificates and documents from the country of origin of imported goods (i.e. they are concerned that these official documents may be counterfeit, obtained through bribery, or, in the case of laboratory test certificates, issued by laboratories that are not qualified to do so).

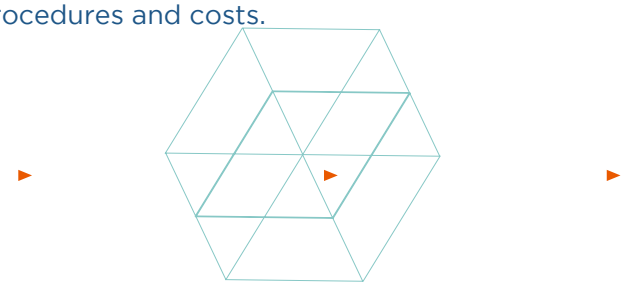
Financial institutions use third parties to validate the creditworthiness of companies, and have created procedures in order to reduce the risk of fraud, and to ensure that trade finance and payments are given to exporters based on verified contracts and delivery. They do this because they do not trust traders to be truthful about their financial situation and to provide error-free documents (errors which may be linked to fraud; or may be innocent and often the result of multiple transpositions of the same information onto different documents).

Traders, governments, and financial institutions require that transporters follow procedures to prove that all the goods were delivered (i.e. without any goods having "disappeared") and were delivered undamaged and in good condition (for time-sensitive, temperature-sensitive, or otherwise sensitive merchandise) to the importer's premises. They do this because traders do not trust one another (to not short ship or fraudulently claim short shipping); traders do not trust the transporters (to not damage and not pilfer goods) and financial institutions do not trust either traders (to ship all the goods being paid for or to purchase 100% of the goods being financed) or transporters (for the same reasons that traders do not trust them).

Importers and exporters sometimes contract with third parties (inspection companies, banks, customs brokers, and freight forwarders) to provide control and coordination services for trade transactions. They do this either to ensure correct behavior from trading partners, government agencies, and transporters (because they do not trust them) or to navigate what have become very complex and difficult to understand procedures – or both.

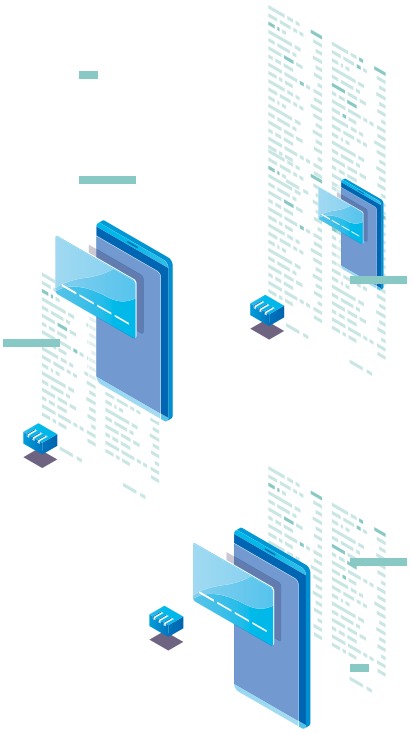
This "lack of trust," which exists to some degree in almost all business transactions, literally permeates the very fabric of international trade – and provides tremendous opportunities for **Blockchain** technology.

The financial impact of regulatory and procedural barriers to trade, created by a lack of trust, is a cumulation of all of the costs and delays that a product and its components are subject to. This cost is magnified by the fact that exported manufactures, on average, contain 25% or more of imported content (in countries for which the OECD has relevant statistics).[44] As a result, the costs linked to the import of components, which are already incorporated into the price of a product, are compounded when that product is exported and, in turn, subjected to export and import procedures and costs.



44. OECD, Trade in Value Added: United Kingdom, http://www.oecd.org/industry/ind/TIVA-2018-United-Kingdom.pdf [Accessed April 15, 2020], from the OECD website database on trade statistics related to value added [Database], http://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm. [Accessed April 15, 2020].

What Role Could Blockchain Technology Play?



Blockchain technology offers important avenues for reducing barriers to trade while improving productivity and competitiveness, because of its ability to:

1) Create electronic "originals" and to "notarize" any electronic document or agreement (with a timestamp and a "guarantee" that no changes have been made since that time). This means **Blockchain** can be used to either create original electronic documents such as contracts, certificates, licenses, etc; or to guarantee the validity of such documents, even if they are stored "off-chain," in a database that is not part of a **Blockchain** network. Two examples of using **Blockchain** technology for notarizing digital documents/ information are the companies Stamping.io and Khipus.io, which both use the LACChain[45] **Blockchain** to offer a service where users can "demonstrate that data series [including electronically recorded documents] have existed and were not altered from a specific moment in time."[46] Khipus is specifically designed for mobile phones, allowing a user to, for example, draft and sign a sales agreement, take a photo of the agreement with their phone and register its time and existence on a **Blockchain** so that it cannot be contested.[47]

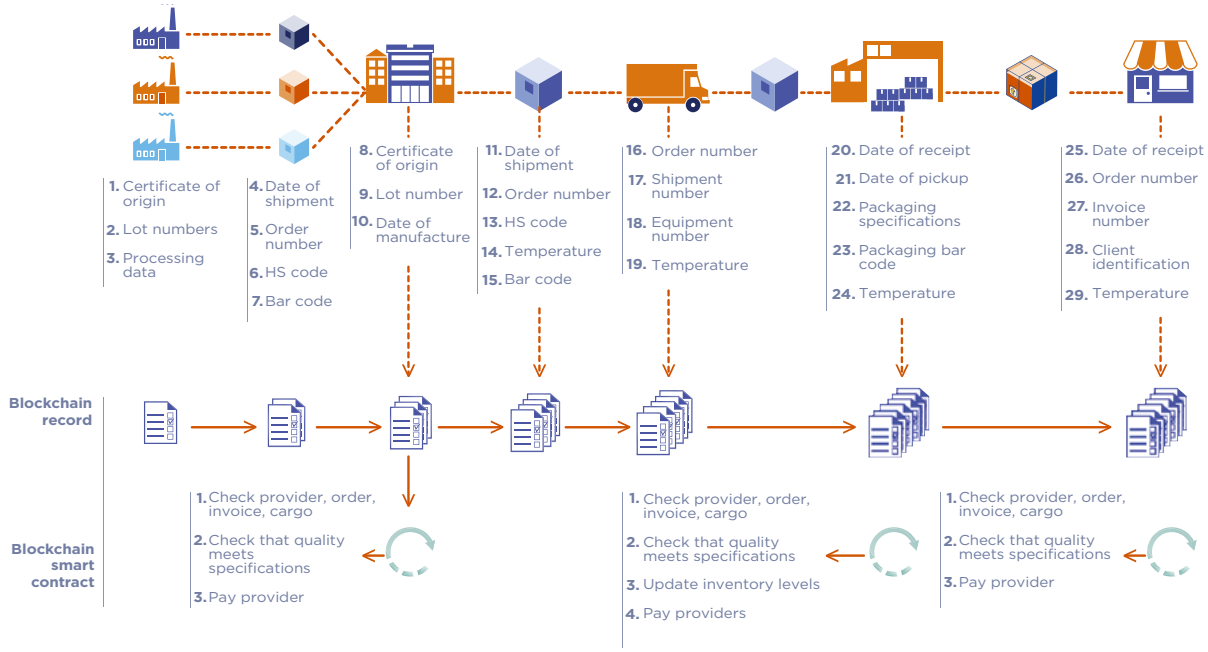
2) Create a trustworthy audit record of every transaction that an "electronic asset" has been used in; going back to the creation of the electronic "asset" (which may be an electronic representation of a physical asset such as a cargo or a document). This is analogous to a bitcoin which the bitcoin network can trace back from its current owner to its creation (that is how it knows who owns the bitcoin).

This same property, depending upon the design of an individual **Blockchain** and its associated applications, can be used to automatically create audit trails, even for complex, multi-party, multi-location transactions which are spread out over time. This possibility is already being tested for tracking and tracing the origin of various food products such as meat, wine, coffee, and coconuts. In a few years, it may be commonplace to be able to identify which farm in Colombia or Ethiopia your coffee came from.

3) Automatically reconcile transactions (for example, to ensure that all goods ordered were shipped; all goods shipped were invoiced, and all goods invoiced were paid, etc.). For a **Blockchain** network, this is the equivalent of knowing the balance of crypto-currency in a person's electronic "wallet," but instead, it is tracking goods and related financial transactions based on an electronic representation which is updated by each party in a supply chain. Today, the typically 40 or more participants in a trade transaction tend to use separate ledgers (sometimes even within the same organization), often resulting in time consuming and, sometimes, manual interventions to ensure that records are properly reconciled.

45. LACChain, ¿Qué es y en qué consiste la alianza global LACChain? [What is the LACChain global alliance and what does it entail?], https://medium.com/@lacchain.official/qu%C3%A9-es-y-en-qu%C3%A9-consiste-la-alianza-global-lacchain-4d37f35d9746 [Accessed April 15, 2020].
46. STAMPING.IO. https://stamping.io/index.html [Accessed April 15, 2020].
47. Khipus. https://khipus.io/ [Accessed April 15, 2020].

Figure 1
Blockchain use in supply chains.



Source:
https://resolvesp.com/blockchains-supply-chains-part-ii/

R.1

Facilitating Trade Finance with More Efficient Reconciliation

Banks are proverbially risk-averse organizations, and are reluctant to loan money unless they are assured of the value of the collateral, the creditworthiness of their borrowers, and the completion of underlying transactions.

For example, in the trade area, banks have a reputation for requiring that an extensive list of documents be submitted before they will pay exporters under trade letters of credit. The documents submitted must also be perfectly aligned, so the descriptions of the goods, the quantities and the delivery address must match across 5 to 10 or more documents (no typos allowed), and, due to human error in the preparation of paper documents where the same information is entered multiple times, this can turn out to be a small nightmare – especially for small- and medium-sized businesses. In addition, it often falls upon the exporter to ensure that the bank receives the required documents from a range of parties.

Short programs that work using a **Blockchain** (called smart contracts), when coupled with a range of secured data-input sources, could transform the processing of letters of credit. Today, armies of bank employees check and reconcile the many documents submitted – making errors as well as finding them. Tomorrow, this may be done by smart contracts, implemented on one **Blockchain** and using data that has been "notarized" by the same or other **Blockchain**.

A **Blockchain** can also help companies prove their creditworthiness by "notarizing" both invoices and the acceptance of invoices by the importer. This allows banks to loan money to exporters based on commitments that business partners have confirmed are valid, on a medium (a **Blockchain**), where it would be very difficult to counterfeit such information.[48]

48. Article on facilitating letters of credit using blockchain: Chang, S. E., Luo, H., and Chen, Y., 2019, Blockchain-Enabled Trade Finance Innovation: A Potential Paradigm Shift on Using Letter of Credit. https://www.researchgate.net/publication/338166700_Blockchain-Enabled_Trade_Finance_Innovation_A_Potential_Paradigm_Shift_on_Using_Letter_of_Credit. (Accessed April 14, 2020)

4) Cryptographically protect data, which allows either the network (through its rules) or a smart contract to control who can see what, down to the level of individual records (but also at the level of data sets), and, in authorized networks, who can do what (read, write, etc.).

Many of these functions can be provided by classic, traditionally centralized IT systems. At the same time, the level of trustworthiness is usually lower using traditional systems, and the ability of traditional systems to securely connect with, collect data from, and track the large number of parties to a trade transaction (many of whom are unknown at the beginning of a trade transaction's "journey") can be more limited (and more expensive to implement).

Today, a range of companies and consortia (in a variety of forms) are looking at how to use these **Blockchain** features in order to support trade processes. There are hundreds of examples of trade-related **Blockchain** projects under development, as well as many that are at some stage of "live" implementation. Below, we will explore some "trust areas" in the trade sector in order to illustrate the potential of **Blockchain** technology in trade facilitation.

Improving Trust Between Governments and Traders

In the trade sector, governments put in place regulations and procedures in order to: protect the health and safety of citizens; achieve revenue objectives; and enforce the law. Governments do not, generally, trust the private sector to support these same objectives.

As a result of this lack of trust, trade rules, regulations, and procedures have accumulated over the decades. Many are valid, but some conform with organizational requirements that are long forgotten, some are based upon outdated solutions or "the way we've always done it," some are created on the basis of misunderstandings (or a lack of understanding), some in reaction to exceptional emergencies, etc. And, in general, very few government export and import processes are founded on modern business process analysis or business principles for effectiveness and efficiency. This historical "growth" of import and export procedures, based on a lack of trust, lies at the root of many non-tariff barriers to trade.

At the same time, government administrations are, for the most part, genuinely concerned about fulfilling their responsibilities. As a result, authentication, security, continuity, and immutability are often important to them, whether relating to identity, licences, certificates, company registries, or other information created or used by governments. These are information characteristics that can be supported by **Blockchain** technology linked with existing or new information systems.

In addition, for governments, it is equally important that information be legally recognized. When information is exchanged between two or more private entities (whether persons or enterprises), it is up to the parties involved to decide how much risk they want to accept (from the standpoint of legality), and, under some legal systems, they can also explicitly or implicitly agree amongst each other to accept electronic information as legally binding, including **Blockchain** records. On the other hand, government agencies are held to a higher standard, so information used in their processes must be legally valid according to government legislation and regulations.

Therefore, one of the first and key steps in implementing **Blockchain**-based solutions in government trade-related processes is to ensure that the required legislation and regulations are in place. These must allow for legally valid electronic information/documents and signatures, including those saved and generated using **Blockchain** technology.

Governments often take on the societal

role of providing trusted and authentic information. Even now, in the trade sector in many countries, this information is often still based on and delivered using paper documents. Trade regulations and compliance rules are often still enforced by humans who physically review paper documents. This no longer works well, because of the increasing complexity of trade regulations and the increasing volume of transactions which must be processed, with no increase in resources. As a result, more and more trade procedures are being moved into information systems that use centralized databases. Nonetheless, for a variety of reasons, paper documents still play a major role in many systems. For example, bills of lading with hundreds or thousands of pages may be sent to ports and/or to customs administrations, and be processed electronically – but in many cases, traders are still required to submit supporting paper documents to authorities within a fixed timeline – and also to archive paper copies for 5 to 10 years. Truck drivers, at most borders, still have to provide customs authorities with paper documents at border controls, which are then checked against electronically received information, usually by hand, etc.

Blockchain technology, with its increased levels of trustworthiness, may finally allow governments to do away with their "paper chains."

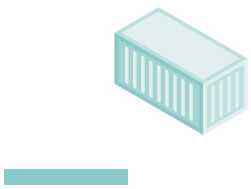
For example, **Blockchain** technology has the ability to ensure that digitalized documents are "originals" (and cannot later be changed), thus reducing the risk of fraud. This could allow, for example, border control authorities to quickly check the authenticity of documents provided by licencing and product-testing organizations, without the need for paper copies with stamps and signatures.

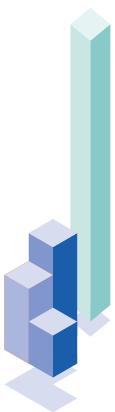
Government applications of **Blockchain** technology in the trade sector are taking off more slowly than business-to-business applications. This is not because of a lack of opportunities, but rather because of the legal constraints placed on government agencies with respect to what they can accept as "original" documents, and/or what they can accept from parties outside of their jurisdiction. For example, all documents for import declarations have to be submitted by the importer, even though more than half of them are actually generated by the exporter or foreign-based transport companies. This is because the government is only able to prosecute the importer if one or more documents are incorrect or false.

To illustrate this, if the exporter and other foreign stakeholders were to place the information required by an importing government on a **Blockchain** (such as the invoice, bill-of-lading, consignment note, phytosanitary certificates, etc.), then the importing government could be assured that the information has not been modified, and, depending on the system, also be assured that documents were issued by authorized organizations. However, depending on government policies and national legislation, the authorities in the importing country could still end up having to insist either that: 1) it be the importer who submits the information, thus requiring that it be copied, and, perhaps, re-entered (with resulting errors), or 2) paper documents be submitted or kept available for audit.

The flexibility of government policies and legislative frameworks in these areas is an important indicator of how much short or medium-term progress a country can be expected to make in the improvement of government efficiency and services.

Some of the primary areas for using **Blockchain** technology to support trade facilitation by improving trust between governments and traders include the following:





1) Authentication of documents including licences, certificates, bills-of-lading, invoices, etc. If an issuing organization placed a hash value (a sort of unique document "fingerprint") with an issuance date on a **Blockchain**, then government agencies could verify the content of the corresponding electronic document, without other parties having access to the content. This would also be in line with the general rule (true due to various factors) that the objective should be to store as little data as possible directly on a **Blockchain** – keeping in mind the impacts on security and privacy. Examples of documents issued by trusted institutions or authorities where such an application could help prevent the circulation of counterfeit or illegally modified documents are: certificates of origin; permits for trade of endangered species; phytosanitary certificates; transit permits; laboratory test certificates; verified gross mass certificates; import and export permits for waste and other controlled materials; etc.

2) Identities – this is complementary to authentication and is the issuance of trustworthy identifiers for organizations, companies, and individuals within them. A public **Blockchain** with digital IDs could make it easier to digitally sign information while making such signatures verifiable by everyone concerned. Common standards are needed, and the "application infrastructure" needs developing, but governments could play an active role in shaping this opportunity. The same infrastructure could also be applied to clarify the legal mandate/authority of persons within an organization, and in which contexts. For example, one person might be authorized to digitally sign for the importation of goods up to a certain value, while the digital signature of another person might be required for goods above that limit.

Blockchain can also create trustworthy identities for objects and goods, often referred to as "digital twins." These may be as simple as a number, or may be complex, such as QR codes, incorporating information about the producer, the location of production, and other data. These product IDs can then be used by other **Blockchain**-based applications for traceability purposes, as described below.

3) Traceability is where **Blockchain** can facilitate trade by facilitating the ability of governments and the private sector to ensure regulatory compliance, and to react quickly when things go wrong. **Blockchain** have the potential, when combined with Internet of Things (IoT) sensors or other identification technology such as RFID tags or QR codes, to trace physical goods from their source to their final customer – in the same way that a **Blockchain** can trace a crypto-coin from its creation to its current owner.

One example of the value of traceability is the ability to quickly identify the farm and/or factory that is the source of con-

taminated food, or a defective product. This would significantly improve customer safety, while reducing commercial risk for producers (since they will no longer lose their markets due to irresponsible actions by other producers), and reducing the risk for governments (because they will be able to react more quickly and effectively to public-health and -safety threats).

Traceability can also provide incentives for improved corporate behaviour because many consumers would also like to know that the wood in their furniture was legally harvested and sustainably grown, or be reassured that the cotton in their shirts, or the cane sugar in their soda, was not harvested using slave labor, etc. **Blockchain** traceability applications can allow consumers to identify if products have been certified as meeting social or environmental standards by scanning a QR code at the time of purchase.[49]

4) Tax and Charges Reconciliation could facilitate trade by, for example, reconciling VAT taxes collected on parts and exports containing those parts, thus expediting VAT tax refunds, reducing VAT fraud, and reducing the costs of current reconciliation processes for governments and the private sector. Smart contracts could also automatically release goods from Customs control based on the **Blockchain**-notarized completion of all procedures and payment of all charges and duties (including those to different services).

5) Improved inter-governmental confidence in information exchanges. One example of this is the IDB-supported CADENA[50] application for exchanging information between the Customs authorities of Chile, Colombia, Costa Rica, Mexico, and Peru. These countries have a Mutual Recognition Agreement (MRA) for Authorized Economic Operators (AEOs) which gives companies that have passed a rigorous certification process special privileges when exporting and importing. In the past, Customs authorities found it difficult to implement this MRA because they were never sure that they had the most recent and valid list of AEOs from the other countries (companies are added — and removed — on a weekly or even daily basis). With CADENA, the lists of AEOs are instantly, and securely, updated, with all participating Customs authorities having access. As a result, AEO trade between these countries has become much easier.

6) Improved citizen confidence in government information. In recent years, a number of governments have been rocked by corruption scandals linked to government procurement. The Inter-American Development Bank has been helping countries in its region use **Blockchain** applications to dramatically increase transparency in the publication of information related to procurement, and the confidence that citizens can have in that information. Countries where **Blockchain** procurement projects have been launched include Brazil,[51] Colombia,[52] and Peru.[53]

49. Gnetii, V., 2019, ¨Italian Retailers Use Blockchain and QR Codes for Food Supply Chain Traceability,¨ Bitnews Today, April 15, https://bitnewstoday.com/news/italian-retailers-use-blockchain-and-qr-codes-for-food-supply-chain-traceability/

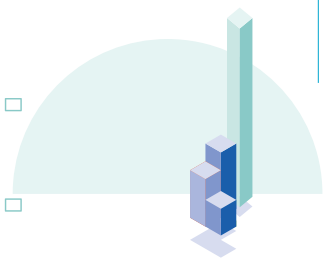
50. Corcuera Santamaria, S., ¨CADENA, a Blockchain-Enabled Solution for the Implementation of Mutual Recognition Arrangements/Agreements,¨ World Customs Organization Magazine, https://mag.wcoomd.org/magazine/wco-news-87/cadena-a-blockchain-enabled-solution-for-the-implementation-of-mutual-recognition-arrangements-agreements/

51. Boddy, M., ¨Estado brasileño lanza plataforma blockchain para licitaciones gubernamentales¨ [Brazilian state launches blockchain platform for government bidding], Cointelegraph, https://es.cointelegraph.com/news/brazilian-state-launches-blockchain-platform-for-government-contract-bids?_ga=2.137324472.966665911.1589842783-1163354294.1589842783.

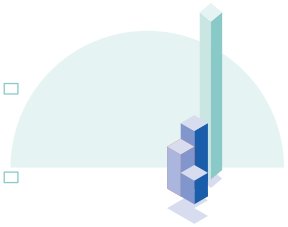
52. Barrera, C., Hurder, S., and Lannquist, A., 2019, "Here's How Blockchain Could Stop Corrupt Officials from Stealing School Lunches," World Economic Forum Blog, May 17, Accessed April 15, 2020. https://www.weforum.org/agenda/2019/05/heres-how-blockchain-stopped-corrupt-officials-stealing-school-dinners/

53. Observatorio Blockchain, 2019, Everis, entre las empresas elegidas por el BID para combatir la corrupción con blockchain en Perú [Everis, among the companies chosen by the IDB to combat corruption using blockchain in Peru], May 10, Accessed April 15, 2020, https://observatorioblockchain.com/everis-entre-las-empresas-elegidas-por-el-bid-para-combatir-la-corrupcion-en-peru-con-blockchain/.

Some examples of other **Blockchain** projects being developed either by governments or by the private sector to meet government requirements, are listed below:



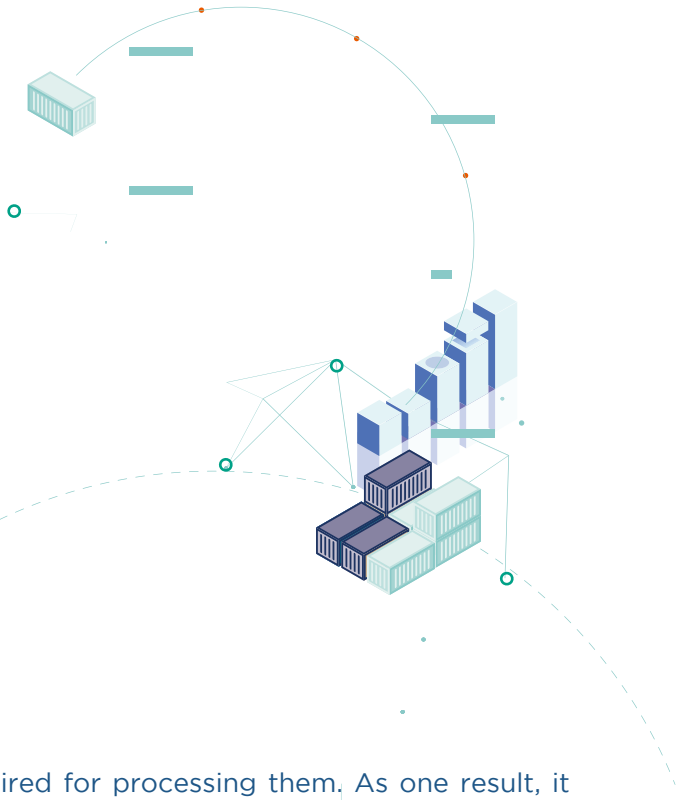
- Customs export clearance in Korea[54]
- Customs shipment tracking in the United States[55]
- Asset and document registration: land, documents, and vehicles in India;[56] land, shares, and bonds in the United States (Illinois, Delaware, and California);[57]
- Bonds in China[58] and from the World Bank[59]
- Supporting all government transactions in Dubai[60]
- Establishment of trustworthy personal identities: for refugees in Jordan;[61] homeless people in the United States (Austin, Texas);[62] and for citizens in Switzerland (in Zug)[63]
- Establishment of trustworthy corporate identities in Estonia[64]
- Proposals for use in EU VAT collection[65]



54. See that chart on page 16 of Windows of Opportunity: Facilitating Trade with Blockchain Technology, IDB and WEF, 2019, Washington: WEF, http://www3.weforum.org/docs/WEF_Windows_of_Opportunity.pdf.
55. Ledger Insights, 2019, "U.S. Customs to Trial Blockchain System for Shipping," August 7, https://www.ledgerinsights.com/us-customs-blockchain-shipping/
56. The Indian Express, "Andhra Government to Adopt Blockchain Tech to End Land Record Tampering," December 15, https://www.newindianexpress.com/states/andhra-pradesh/2019/dec/15/andhra-government-to-adopt-blockchain-tech-to-end-land-record-tampering-2076359.html and https://www.ledgerinsights.com/indian-state-maharashtra-blockchain-in-government.
57. Knowledge Warthon, "How the Blockchain Can Transform Government," July 5, 2018, Accessed April 16, 2020 http://knowledge.wharton.upenn.edu/article/blockchain-can-transform-government/
58. Kuznetsov, N., "La emisión de bonos en la Blockchain por parte de China es una señal de lo que está por venir," [Issuing of blockchain bonds by China is a sign of what's to come], Cointelegraph, December 24, Accessed January 11, 2019, https://es.cointelegraph.com/news/china-issuing-bonds-on-blockchain-is-a-sign-of-whats-to-come?_ga=2.162489524.966665911.1589842783-1163354294.1589842783.
59. Orcutt, M., "The World Bank is Still Loving its Blockchain-powered Bonds," MIT Technology Review, August, 2019, https://www.technologyreview.com/2019/08/20/133624/the-world-bank-is-still-loving-its-blockchain-powered-bonds/
60. Futurism, "Inside Dubai's Quest to be the First Blockchain-Powered City:
From energy to media, almost every sector is exploring blockchain technology," August 24, 2020, https://futurism.com/inside-dubais-quest-first-blockchain-powered-city.
61. World Food Program, Building Blocks Blockchain for Zero Hunger, https://innovation.wfp.org/project/building-blocks.
62. O´Brien, K., September 14, 2018, Austin, Texas Using Blockchain Identity System to Help the Homeless, Bitcoinist, https://bitcoinist.com/austin-introduces-blockchain-id-management-system-to-help-homeless-population/.
63. The Impact of Digital Identity, Accessed January 11, 2019, https://blockchainatberkeley.blog/the-impact-of-digital-identity-9eed5b0c3016
64. Jackson, E., April 18, 2018, "What We Can Learn From Estonia's Real-World Use Case of Blockchain," https://www.linkedin.com/pulse/what-we-can-learn-from-estonias-real-world-use-case-eric-jackson/.
65. Dulaney, C., September 30, 2019, "EU Inches Toward Blockchain in Fight Against VAT Fraud," https://news.bloombergtax.com/daily-tax-report-international/eu-inches-toward-blockchain-in-fight-against-vat-fraud-1 and a blog published in three parts: 1) CIAT, July 17, 2017, "BLOCKCHAIN: Conceptos y aplicaciones potenciales en el área tributaria" (1/3) [Tax-related concepts and potential applications] https://www.ciat.org/blockchain-conceptos-y-aplicaciones-potenciales-en-el-area-tributaria-33/

Improving Trust Between Governments

While we talk about "international trade," the reality is that courts and other governmental authorities that regulate trade only have jurisdiction over the citizens and residents of their own country. As discussed earlier, one result of this is that importers must be valid legal entities in the importing country, and submit all import declarations, as well as supporting documents. A number of these documents may have actually been issued by governmental authorities in the exporting country. For example: phytosanitary certificates, export permits and licenses, etc.



Sometimes the importing government authorities, for a variety of reasons, decide not to accept a document, such as a phytosanitary or product testing certificate, from the exporting country. As a result, these tests have to be repeated by institutions in the importing country, with the concomitant delays and additional costs.

By increasing the trustworthiness of documents and electronic information from exporting countries, in a quick and economical fashion, **Blockchain** technology could, eventually, underpin mutual recognition agreements for such documents between governments; for example, within or between trading groups like the Andean Community, the Asia Pacific Economic Cooperation (APEC), Mercosur, the Pacific Alliance, etc. — thus facilitating trade and reducing costs.

Improving Trust Between Transporters and Other Supply-Chain Stakeholders

The majority of shipping transactions, even today, involve a large number of paper documents such as sales contracts, invoices, transport agreements, bills of lading, consignment notes, port documents, and other documents related to the cargo, truck or vessel. In addition, many of these documents are passed along a chain of stakeholders as the goods move from the exporter to the importer's premises, and then back again, as the exporter seeks proof of delivery in order to be paid.

Goods can only move as fast as the information (and obligatory paper documents) required for processing them. As one result, it is fairly common for a vessel to arrive at port before all of the bills of lading for its cargo — thus delaying the clearance of goods through customs, and their departure from either the port ,or customs warehouses — and resulting in additional costs.

Among transport documents, Bills of Lading (BoL) are particularly sensitive because they confer ownership and can be used for sale or purchase of the goods they refer to. BoLs normally are sent by courier or mail from the issuing office to the shipper, the shipper's bank, the buyer's bank, the buyer, and finally, to the party releasing the goods.

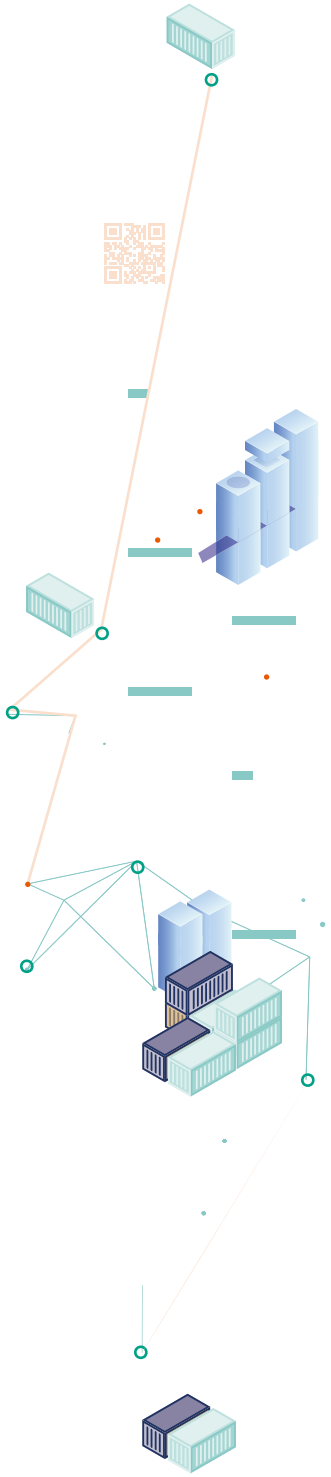
Each of these transfers of paper documents requires time for verification and forwarding. Depending on the distances involved, this process can take days, if not weeks, and result in multiple courier or postage charges. The complex process also opens up multiple opportunities for fraud. As a result, stakeholders often seek additional guarantees of the trustworthiness of BoLs.

Other documents, in addition to BoLs, such as certificates of origin, packing lists, dangerous goods declarations, customs bond documents, invoices, certificates, licences, and consignment notes, are sometimes required

as “proofs” by authorities and other agents, including customs, inspection, and tax authorities, as well as banks — who will also be seeking assurance of their trustworthiness.

A wide range of these documents, and particularly those used in business-to-business transactions (such as bills of lading, consignment notes, etc.) are now the subject of **Blockchain**-based projects for automating and increasing transaction efficiency.

Examples of possible **Blockchain** use cases include:



Information registered on the **Blockchain** by remote sensors to help carriers in disputes with shippers, sub-contractors, and insurance companies by providing trustworthy information about when and where an event, such as a crash or goods damage, occurred.

Blockchain technology to help in discouraging and greatly reducing some forms of cargo theft. Criminality in the transport and logistics sector is a major problem. Globally, losses from cargo theft are staggering. In 2015 alone, 22.6 billion USD was lost.[66] One common form of theft in European ports is for a criminal to identify a scheduled pickup time and show up two hours earlier, using the excuse that traffic was light. A dock worker, none the wiser, looks at the paperwork and it all appears in order, so the trailer is loaded, or the driver hooks up to a loaded trailer and no one suspects anything until the real carrier arrives a few hours later. By then, the thief and the cargo are long gone. **Blockchain** technology could make it much more difficult for such thefts to occur. A **Blockchain** could register information (about the goods and the pickup truck) that cannot be changed, and that is linked to the goods by a unique digital identifier. This could then provide the dock worker with a verified digital copy of what the paperwork looks like, and even a photo of the driver.

These same **Blockchain** characteristics can also reduce theft by providing a continual and transparent record of a shipment’s status. Digitally verified information about how many boxes were loaded into and unloaded from a trailer can be combined with GPS data and even door sensors that indicate when and where the trailer doors were opened. This data can then be used to quickly identify the exact point at which a theft occurred.

In the end, it comes down to trust. In the case of cargo theft, a trustworthy digital record could go a long way toward creating that trust.

In the maritime industry, there are countless services offered in a fluid and constantly changing environment, where supply and demand fluctuate hourly, making it very difficult to plan efficient usage of resources. **Blockchain** offers the maritime industry an opportunity to explore new options for managing these services, and related assets such as: authorization to pick up or drop off a container at a terminal, timeslots in customs terminals, warehousing space, parking places, etc.

66. Safety4sea, October 4, 2019, “Cargo theft: Trends and Countermeasures of a Billion-dollar problem,” https://safety4seAa.com/cm-cargo-theft-trends-and-countermeasures-of-a-billion-dollar-problem/

For example, a trucker could get a token from a terminal for a specific time slot for goods processing. If the trucker is not able to keep their timeslot, they could pass it on to someone else (via an online marketplace) — and/or procure another time slot for themself. Or a carrier could issue reservations for cargo space on a voyage as "securities." These securities could be traded or exchanged among different parties. Currently, changing such space reservations would require cancellations and re-bookings, and is tied to various sub-processes and actions required by multiple parties, making the process very inefficient — with the reoccurring issue of space ending up unutilized, even during peak seasons.

A small sampling of the many **Blockchain** implementations being developed in the transport sector includes the following examples:

- Managing containers in a port and preventing theft: Port of Antwerp **Blockchain** project[67]
- Cargo release in Shanghai[68]
- Container shipping and documentation: Global Shipping Business Network and TradeLens[69]
- Bills of Lading: Israel,[70] Cargo-X,[71] and International Port Community Systems Association (IPCSA) **Blockchain** BoL[72]
- Shipment status information: ShipChain[73]
- Obligatory Verified Gross Mass (VGM) Certificates for containers: SOLAS VGM[74]
- Consignment Notes (CMRs)[75] [76]

67. Port Technology International Team, "CargoSmart, COSCO, SIPG and Tesla Launch Cargo Blockchain Pilot," April 8, 2020, https://www.porttechnology.org/news/cargosmart-cosco-sipg-and-tesla-launch-cargo-blockchain-pilot/.
68. Port Technology International Team, "CargoSmart, COSCO, SIPG and Tesla Launch Cargo Blockchain Pilot," April 8, 2020, https://www.porttechnology.org/news/cargosmart-cosco-sipg-and-tesla-launch-cargo-blockchain-pilot/.
69. Ledger Insight, July 9, 2018, "Five of Top 10 Container Shippers Join New Blockchain Consortium," https://www.ledgerinsights.com/container-shipping-blockchain-consortium-cargosmart/; Maersk, July 2, 2019, "TradeLens Blockchain-Enabled Digital Shipping Platform Continues Expansion with Addition of Major Ocean Carriers Hapag-Lloyd and Ocean Network Express;" and Maritime Executive, February 27, 2020, "Nine Companies Sign Up for Global Shipping Business Network," https://www.maritime-executive.com/article/nine-companies-sign-up-for-global-shipping-business-network
70. Israports, March, 2020, "Israel Ports Company has Begun an Innovative Pilot for Transferring Bills of Lading, Using Blockchain Technology," http://www.israports.org.il/en/IPCS/Documents/IPCSA%20BOL%20BLOCKCHAIN%20INITIATIVE.pdf
71. Cargo X, https://cargox.io/
72. IPCSA, September 29, 2019, "IPCSA Blockchain Bill of Lading Initiative - Update September 2019," https://www.ipcsa.international/news/2019-09-29-ipcsa-blockchain-bill-of-lading-initiative-update-september-2019.
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73. SHIPCHAIN: The end-to-end logistics platform of the future: trustless, transparent tracking .https://shipchain.io/ (Consultado el 16/04/2020).
74. Lopez, E., September 14, 2018, "Kuehne + Nagel Adds Blockchain to Shipment Weight Portal," SupplyChain Dive, https://www.supplychaindive.com/news/Kuehne-Nagel-blockchain-VGM-portal-SOLAS/532392/.
75. Medium, February 7, 2020, e-CMR using blockchain, https://medium.com/@ayakopepito.kitahama/e-cmr-using-blockchain-a2435de974c3
76. Transmetrics, Blockchain in Logistics – Will it Change the Industry? (Part 2), http://transmetrics.eu/blog/blockchain-in-logistics-will-it-change-the-industry-part-2

R.2 Facilitating Transport Insurance by Combining Technologies

When **Blockchain** is combined with Internet of Things (IoT) sensors, it can:

- Dramatically reduce costs for companies who insure export and import cargos
- Much more accurately pinpoint the time and accountability of insurable events
- Expedite payments

For example, if there are temperature-sensitive goods in a container, an installed IoT device could broadcast to a **Blockchain** the time and location of the container when the temperature went out of its prescribed range, and for how long. A smart contract (a small computer program) on the **Blockchain** could then compare this event to the insurance contract for the goods and automatically pay the insured party (be it exporter or importer), even before the goods arrive at their destination.[77]

Conclusions

Blockchain technology holds a great deal of promise in those sectors where a lack of trustworthy information results in additional costs and inefficiencies. Trade is certainly one of those sectors, and, as a result, **Blockchain** technology has the potential to revolutionize trade practices and make a tremendous contribution to trade facilitation. Whether that potential will be realized is yet to be seen.

Over the last four to five years, many proof-of-concept (PoC) projects have been implemented (and continue to be implemented) in order to test the viability of various **Blockchain** solutions. These PoCs, along with academic and scientific work, have identified a range of areas for improvement and further development. As a result, while some of the world's brightest people work on making **Blockchains** better, the technology is evolving rapidly and becoming:

- Faster
- More scalable (able to handle large volumes of transactions)
- More environmentally friendly (less electricity consumption)
- Equipped with better user and application programming interfaces
- Even more secure (including more secure smart contracts and quantum computing resistant cryptography) and
- Available with more privacy configuration options.

This is normal, given that the technology is only 11 years old (the first **Blockchain**, for Bitcoin, was launched on January 3rd, 2009) and its use in applications outside of cryptocurrencies is even newer. At the same time, because there are so many different "flavors" of **Blockchain**, each meeting the needs of different groups of stakeholders, there is an increasing risk of fragmentation, and the development of applications that are "**Blockchain** islands," and less effective than they would be as "**Blockchain** worlds" (in a multi-world universe).

77. Here are three articles on Blockchain and maritime insurance companies using IoT [Accessed April 16, 2020]:
1) Imalloyds, December, 2017, Changing times for marine insurers with blockchain and IoT https://www.lmalloyds.com/LMA/News/Blog/Changing_times_for_marine_insurers_with_blockchain_and_IoT.aspx
2) Li, C. March 28, 2018, Maersk – Reinventing the Shipping Industry Using IoT and Blockchain, Harvard Business Review, https://digital.hbs.edu/industry-4-0/maersk-reinventing-shipping-industry-using-iot-blockchain/
3) Business insurance, September 23, 2019, Innovation Awards: Insurwave https://www.businessinsurance.com/article/00010101/NEWS06/912330544/2019-Innovation-Awards-Insurwavel

In addition to the above technical challenges, there are management and implementation challenges that may prove to be even more difficult to overcome. One such challenge is the need for developing scaled and interoperable economies. In trade, government authorities and businesses may find it impossible to communicate with hundreds of sectoral, regional, national, and even "corporate" **Blockchain**. As a result, there is a need for widespread implementation of:

- Open standards for technical interoperability,[78] to allow data exchange across **Blockchain**
- Open standards for data (syntactical) interoperability,[79] to ensure that the data exchanged across **Blockchain** can be interpreted correctly
- Sectoral and business coalitions of "cooperating competitors" around common **Blockchain** solutions, in order to develop scaled economies (and take advantage of the greater security that large-scale **Blockchain** offer)

In addition, there are significant challenges for large-scale global implementation, which include:

- Ensuring the quality of data written into to the **Blockchain**, and the use of appropriate "digital twins" to represent assets
- Securing the participation of all stakeholders, even when some stakeholders are unknown at the beginning of a transaction (which is often the case in transport chains or when working backward from exporters to third- or fourth-tier suppliers)
- Assuring the development of inclusive **Blockchain**-based systems that support participation by SMEs and developing-country enterprises in international trade
- Developing secure interfaces with existing legacy systems

Today, there is a massive need for trade facilitation in order to support economic growth and development – and, even taking all of the above caveats into consideration; **Blockchain** technology offers an immense opportunity for implementing trade facilitation.

The only way to fulfill this potential is through education and dialogue. Education is needed in order to ensure that everyone understands the opportunities and risks. Then, dialogue by sitting all stakeholders around the table to ensure that **Blockchain** environments which are built for trade at sectoral, national, regional, and international levels must reinforce one another, to be able to meet the needs of the widest possible range of stakeholders.

So, it is time, now, for governments, the private sector, and international organizations to hold round table discussions on how to use **Blockchain** technology to support their common objectives in terms of trade facilitation.

In the future, there is a risk that there may exist many large, competing **Blockchain** solutions, which operate in silos, providing very efficient solutions for small groups of stakeholders — while leaving out many others, and enjoying much less efficiency than they could have, had broader stakeholder dialogues taken place during their development.

Acknowledgements

The author would like to thank the nearly 100 individuals contributing to the work of the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) on **Blockchain** technology in trade facilitation, who have made her aware of many of the issues described here, and particularly, in the context of this paper: Gadi Ben-Moshe, Steve Capell, Thierry Grumiaux, Ad Kroft, Carlo Salomane, Lance Thompson and Rupert Whiting.

78. It's important for all standards to be open and free in order to encourage innovation and widespread use in developed and developing countries and by all people involved in society, especially the youngest. The internet has become a worldwide resource today thanks to open and free standards developed and preserved by the Internet Engineering Task Force (IETF).

79. The United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) has been working for several years to develop such common and standardized language. It's called the Core Components Library: United Nations Economic Commission for Europe, UNECE, "UN Trade Facilitation Implementation Guide," http://tfig.unece.org/contents/uncefact-ccl.htm.

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3

ARTICLE

WINDOWS OF OPPORTUNITY

Facilitating Trade with Blockchain Technology

IDB - WEF *

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.

The detail of the authors is at the end of the article. This work is the result of a joint effort between the WEF and the IDB.

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.

Ziyang Fan, Head of Digital Trade, World Economic Forum

Pablo M. Garcia, Director of the Institute for the Integration of Latin America and the Caribbean, Inter-American Development Bank

Introduction: Facilitating Trade with Blockchain

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.

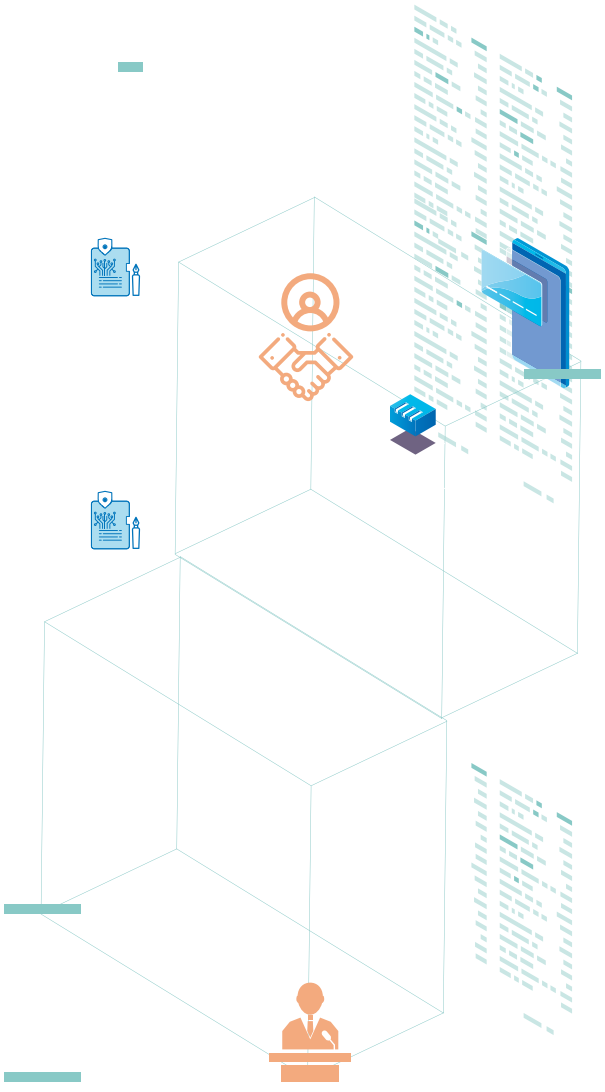
Single windows have proliferated in recent years; as of 2017, 27 countries had a full electronic single window and 36 had a partial single window. All 164 signatories to the Trade Facilitation Agreement (TFA), which entered into force in 2017, are encouraged to adopt an electronic single window. Their 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.



THE 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.[80]

By 2017, trade single windows had been adopted in full or in part in 63 countries (Figure 1).[81] 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.

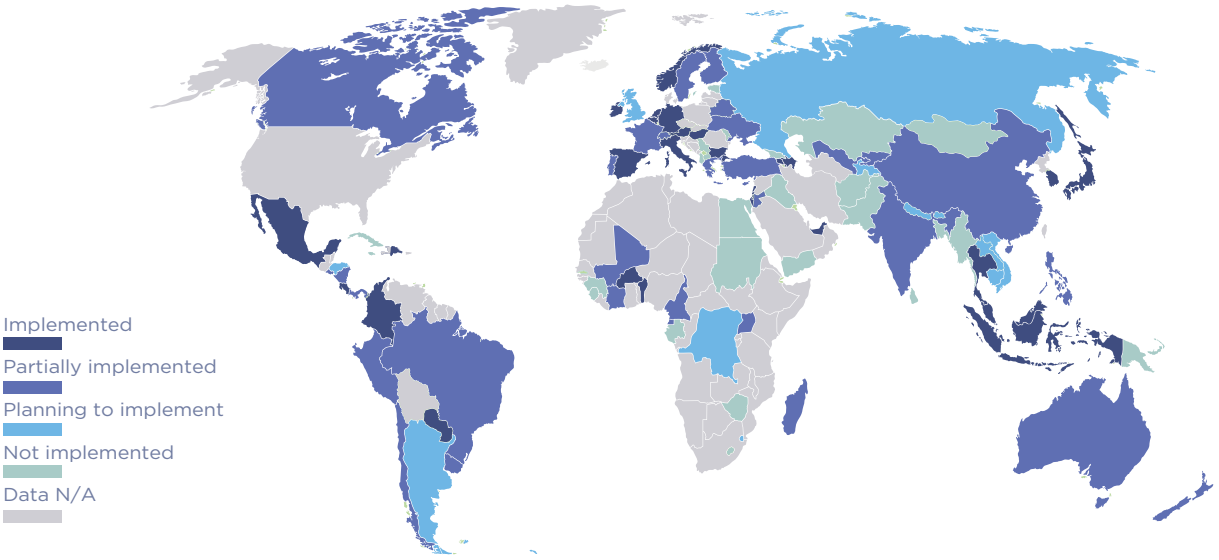
Single windows have delivered a notable return on investment in a wide range of countries, facilitating trade considerably and lowering companies' international trade costs (Table 1). Their benefits have been compounded by the digitization of trade documents: such "paperless trade" obviates the need 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.[82] 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.[83]

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

80. UNECE, "Trade Facilitation Recommendations," accessed July 10, 2020, http://www.unece.org/uncefact/tfrecs.html
81. UNECE, 2017, Technical Note on Terminology for Single Window and Other Electronic Platforms, accessed June 18, 2019, http://www.unece.org/fileadmin/DAM/cefact/cf_plenary/2017_Plenary/ECE_TRADE_C_CEFACT_2017_10E_TechnicalNoteSW.pdf.
82. United Nations, 2019, "UN Global Survey on Digital and Sustainable Trade Facilitation," accessed June 18, 2019, https://untfsurvey.org/world.
83. For example: UNECE & WEF, 2017, Paperless Trading: How Does It Impact the Trade System? http://www3.weforum.org/docs/WEF_36073_Paperless_Trading_How_Does_It_Impact_the_Trade_System.pdf.

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

Chart 1.
Selected impacts of digital technologies in border processes

DIGITAL APPROACHES	GENERAL OBJECTIVES	SELECTED IMPACTS	COUNTRIES THAT HAVE ADOPTED BY 2017 [84]
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 [85]. 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. [86].	**27**

84. WB. Trading Across Borders Technology gains in trade facilitation. In: Doing Business 2017. http://www.doingbusiness.org/~/media/WBG/DoingBusiness/Documents/Annual-Reports/English/DB17-Chapters/DB17-CS-Trading-across-borders.pdf (Accessed June 18, 2019).
85. Ibid. United Nations. 2019.
86. KENTRADE. 2016. Implementation of the Kenya National Single Window. Presentación de SlideShare. December 13. https://www.slideshare.net/Africanalliance/implementation-of-the-kenya-national-single-window-systemkentradeswc2016 (Accessed June 18, 2019).

	Permitir que las agencias procesen más rápido los documentos comerciales y, de ese modo, se acelere el despacho de las cargas en la frontera.	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 [87]. 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 [88].	
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. [89]. 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. [90].	**67**[91]
Digital payments of customs duties and fees	Reduce invoicing times by automating computation of duties and fees. Reduce corruption in customs.	In Tanzania, digitization of customs clearance and duties cut import clearance times from nine days to less than one day [92].	**53**

87. GUCE. 2017. The single form for foreign trade operators - GUCE GIE. SlideShare presentation. March 22. https://www.slideshare.net/Africanalliance/the-single-form-for-foreign-trade-operators-guce-gie-cameroon (Accessed June 18, 2019).
88. Ibid. WB. Trading Across Borders Technology gains in trade facilitation. In: Doing Business 2017.
89. How does trade respond when borders are simplified via single-window systems? https://blogs.iadb.org/integration-trade/en/how-does-trade-respond-when-borders-are-simplified-via-one-stop-systems/ (Accessed June 18, 2019).
90. Doing Business: Data Base. http://www.doingbusiness.org/en/data (Accessed June 18, 2019).
91. Ibid. UNECE & WEF. Paperless Trading: How Does It Impact the Trade System? 2017.
92. Acceptance of paper or electronic copies of supporting documents required for import, export or transit formalities.

	Reduce time for importers to make payments online Accelerate reconciliation and thus customs clearance		
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.[93] 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.[94] 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.[95]

— 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.[96] 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

93. BTCA. 2016. Person-to-Government payments: Lessons from Tanzania's digitization efforts. https://btca-prod.s3.amazonaws.com/documents/237/english_attachments/Tanzania-Case-Study.pdf?1515010379 (Accessed June 18, 2019).
94. Ibid. United Nations. 2019. ¨UN Global Survey on Digital and Sustainable Trade Facilitation¨.
95. 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.
96. UNESCAP. 2018. Cross-border single window interoperability: a managerial guide. https://www.unescap.org/sites/default/files/CROSS-BORDER%20SINGLE%20WINDOW%20INTEROPERABILITY.pdf (Accessed June 18, 2019).

data and coordinate actions such as risk management and inspections with each other.[97] 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.[98] 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.[99] The persistence of paper is caused by sheer inertia, limited budgets and staff concerns about the impact of digitization and automation on jobs.

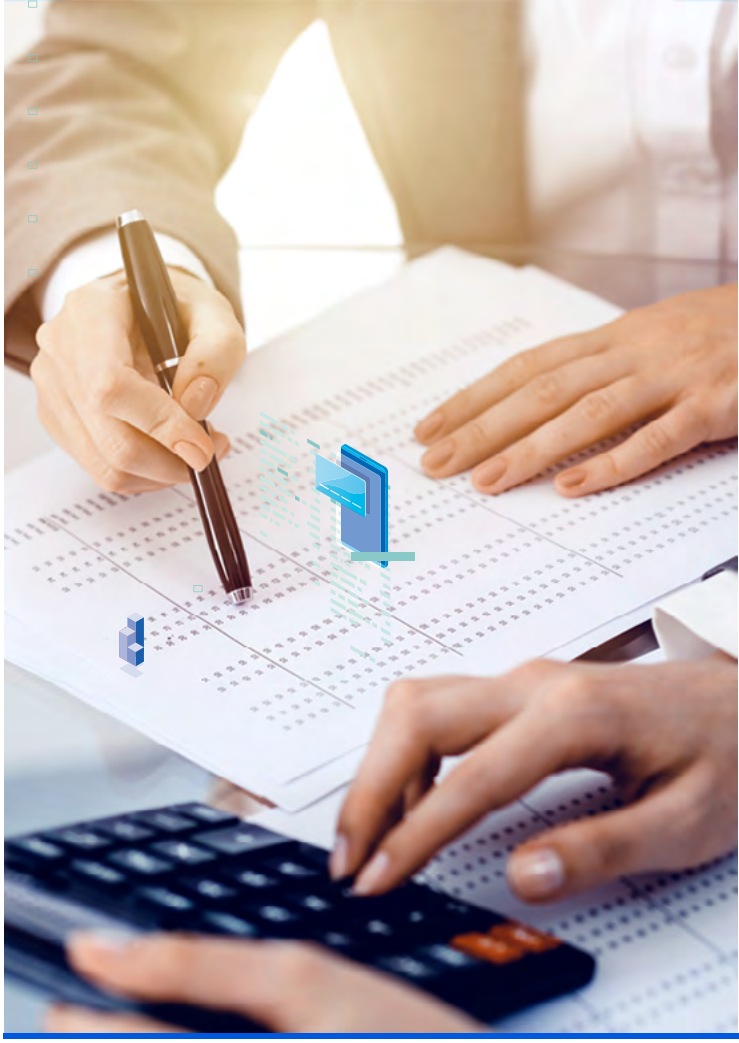
— Businesses are unfamiliar with digital processes and lack information and communications technology (ICT) skills to perform digital filings. Companies can also impede paperless trade. Even in advanced countries, some companies are set in their ways and continue to use paper-based documents; in developing 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.[100]

— 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.

97. 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.
98. 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).
99. Interviews with customs and single window operators in the Americas; and https://www.slideshare.net/Africanalliance/challenges-for-an-implementationof-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).
100. Ibid. United Nations. 2019. "UN Global Survey on Digital and Sustainable Trade Facilitation".



— 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.[101] 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.[102] 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.[103] 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.

101. 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 June 18, 2019).
102. Ibid. United Nations. 2019. ¨UN Global Survey on Digital and Sustainable Trade Facilitation¨.
103. M. H. Abeywickrama and W. A. D. N. Wickramaarachchi. Study on the Challenges of Implementing Single Window Concept to Facilitate Trade in Sri Lanka: A Freight Forwarder Perspective. Journal of Economics, Business and Management, Vol. 3, No. 9, September 2015. http://www.joebm.com/papers/302-BM00027.pdf (Accessed June 18, 2019)

— 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.

Chart 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.

MAIN PAIN POINTS	SELECTED REASONS	MAIN IMPACTS
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**.[104]

R.1

Blockchain

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.

104. AAEC. 2017. Challenges for an implementation of an electronic single window. SlideShare presentation. March 22. https://www.slideshare.net/Africanalliance/challenges-for-an-implementation-of-an-electronic-single-window-guichet-unique-de-la-cte-divoire

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.[105] 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.[106] 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,

105. 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).
106. For a good review, see https://www.weforum.org/whitepapers/inclusive-deployment-of-blockchain-for-supply-chains-part-1-introduction (link as of June 18, 2019).

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.

Chart 3.
Single windows use-cases and blockchain's potential

MAIN PAIN	SELECTED REASONS	USE-CASE	BLOCKCHAIN'S POTENTIAL	ALTERNATIVE/ COMPLEMENTARY TECHNOLOGIES AND ACTIONS
Limited interoperability	National single windows disconnected from each	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 prearrival 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

MAIN PAIN	SELECTED REASONS	USE-CASE	BLOCKCHAIN'S POTENTIAL	ALTERNATIVE/ COMPLEMENTARY TECHNOLOGIES AND ACTIONS
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	Data standards; data-security protocols; AI to detect fraudulent and erroneous data entries

MAIN PAIN	SELECTED REASONS	USE-CASE	BLOCKCHAIN'S POTENTIAL	ALTERNATIVE/ COMPLEMENTARY TECHNOLOGIES AND ACTIONS
	Limited trustworthiness of data entered on single windows	Improved reliability of data entered on single windows	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,[107] align **Blockchain** implementations with their respective cross-border data-transfer regulations and establish robust collaboration with the private sector.[108] 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.[109] 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).

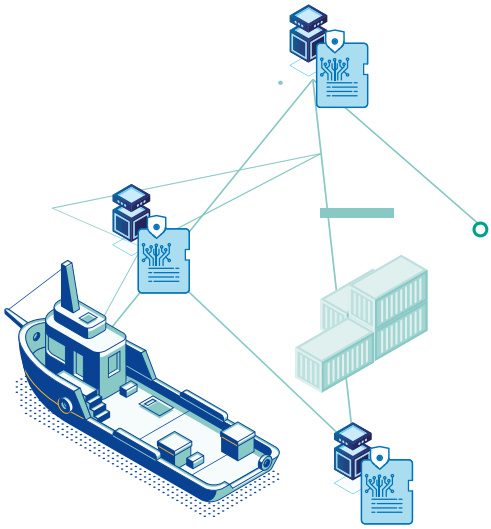
Interoperability among border agencies that form part of a single window. One of the main pain points facing single windows is the friction in sharing data among trade agencies that form part of that window. **Blockchain** can make a significant difference in this setting: Used in a way analogous to 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.[110] 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.[111]

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"

107. 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.
108. For example, in line with the World Customs Organization (WCO) Data Model.
109. See also: McKenzie, Baker. Blockchains and laws. Are they compatible? https://www.bakermckenzie.com/en/-/media/files/expertise/fig/br_fig_blockchainsandlaws_jul17.pdf (Accessed June 18, 2019).
110. IMDA. 2019. Sectoral transformation group trade & connectivity cluster request for information: imda(rfi)-002. Tradetrust digital infrastructure. https://www.imda.gov.sg/-/media/imda/files/industry-development/call-for-proposals/trade-trust-rfi_002_final_march21.pdf?la=en (Accessed June 18, 2019).
111. Suominen, Kati. Blockchain to Accelerate Transatlantic Trade. CISS. 2018, https://www.csis.org/blogs/future-digital-trade-policy-and-role-us-and-uk/blockchain-accelerate-transatlantic-trade (Accessed June 18, 2019).

programmes for small firms that have a solid track record of compliant trade transactions but which do not necessarily qualify for traditional AEO status.[112] 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.



R.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.[113] 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.

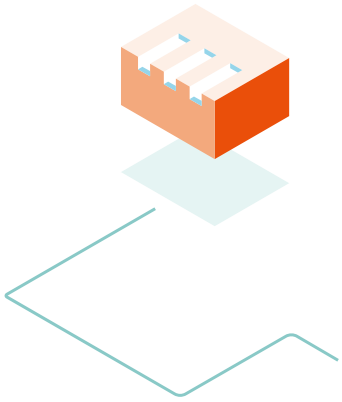
112. https://cryptoslate.com/uk-customs-service-halts-blockchain-border-project-with-brexit-looming/ (link as of 18 June 2019).
113. https://mag.wcoomd.org/magazine/wco-news-87/cadena-a-blockchain-enabled-solution-for-the-implementation-of-mutual-recognition-arrangementsagreements/ (link as of 18 June 2019).

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.[114] **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.[115]

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.[116] 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.



114. https://docs.wixstatic.com/ugd/25efdb_ddca049eff6b45bcaab793f8b20223c1.pdf (Accessed June 18, 2019)
115. For example, https://csis-prod.s3.amazonaws.com/s3fs-public/publication/181101_Suominen_Blockchain_v3.pdf (link as of June 18, 2019).
116. 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.

R.3

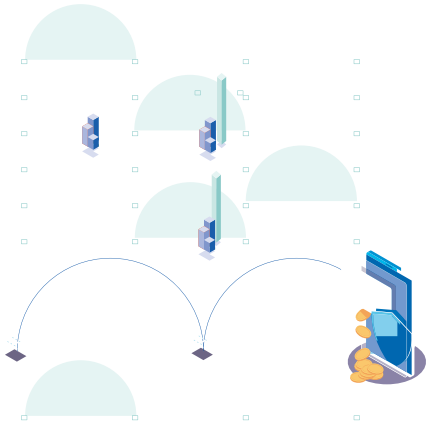
Technologies to Complement Blockchain in Single Windows

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.[117] 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.[118]



117. 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-bethe-cornerstone-of-paperless-trade/ (link as of 18 June 2019).

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

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).

Chart 4.
Guidelines for operationalizing blockchain use-cases in single windows

ACTIONS					
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**
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					
4/4	4/4	2/4	2/4	3/4	3/4
KEY QUESTION 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 takeholders 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

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.[119]

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.

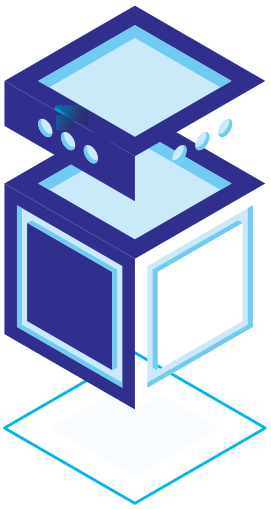
119. https://www.wto.org/english/res_e/reser_e/session_2c_4_zahouani_saadaoui_dg_taxud_blockchain_v1.0.pdf (link as of 18 June 2019)

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.**



R.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.[120] **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.

120. 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.

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.[121]

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 data storage needs. 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.[122]

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 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 im-

121. http://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/tools/data-model.aspx (link as of 18 June 2019).
122. For encryption-related concerns, see existing discussions in the context of bitcoin, such as https://bitcoin.stackexchange.com/questions/88/is-bitcoinfuture-proof (link as of 18 June 2019).

provements 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.[123] 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.

R.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 testnet using the software Quorum, and, in 2019, will release a second test using Pantheon.

123. 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

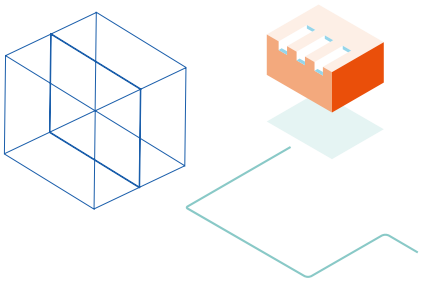
Next Steps

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.

Chart 5.
The experience and stages of the IDB 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 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 **Blockchain** was identified as the technology to be validated to create efficiency and security in the exchange of data The project was branded "CADENA" ("Chain") 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	The pilot project was crafted collaboratively during the workshop, by first learning about **Blockchain** as the proposed technology, and then developing commonunderstandings of the business challenges to be tackled This resulted in the definition of the functionalities, technical requirements and data management requirements for the solution, and were included in RFP specifications 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 Interaction and constant feedback among the IDB, countries and the technology vendor were established during the design and implementation phase throughout 2018	Together with the selected technological vendor, an ad hoc **Blockchain** architecture was adopted for validating the exchange of data Beneficiary customs opted out of integrating CADENA with legacy systems during the pilot, to keep the focus on the exchange of data 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	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 Portability of user identities and data is explored in future	Approach developed in phases 1 and 2 allowed for a fast and measurable pilot over the pilot project. Among gains: · Accelerated process of granting benefits to new AEO-certified firms in the countries of destination for their cargo operations · Increased transparency and traceability of cross-border data · 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 · Increased knowledge of the application of new technologies among customs and the broader trade community	The pilot project resulted in a globally innovative customs management system and in everal 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 CADENA v.1 will catalyse synergies with LACChain, a region-wide nitiative facilitated by the IDB to develop a regional **Blockchain** ecosystem in Latin America and the Caribbean 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

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4

ARTICLE

CADENA:

Innovating Customs Management with Blockchain

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CADENA is a **Blockchain**-based proof of concept project lead and developed by the IDB in collaboration with the customs administrations of five of the region's countries, to try and solve management problems posed by the exchange of cross-border company data. Initiated in 2018, CADENA is a project that seeks to facilitate and secure logistics chains and trade in Latin America and the Caribbean. How the initiative was carried out, what technology was used, and how challenges related to security, privacy, integration, and scalability were overcome. Next steps, and recommendations for similar use cases.

In order for a consumer in country A to have access to a product produced in country B, said product must be physically moved through a supply chain, but financial movements and countless information exchanges between private companies and public entities also must occur.

Optimization of the modes and means of transport, the infrastructure of ports, airports, and highways, as well as broad and complex distribution networks, have allowed for an improvement in the potential for physical movement of goods. In the same way, advances in financial systems and communication meth-

ods have allowed for the expedition of financial transactions, even though there are still a wide variety of opportunities for improving efficiency, by improving financial system access to supply chain members, and improving interoperability among systems.

Within this context, the challenge becomes even more pressing if we focus on information exchange among the customs authorities responsible for the export and import of said goods. In many cases, the lack of a secure, real-time mechanism for customs information exchange, allows for situations in which declared export values — in terms of weight, harmonized system goods classification, and value — don't match the import values declared for those same goods. These findings have been verified in mirror studies carried out between customs administrations, that reveal the scope of the issue.

These deficiencies and limitations go beyond customs declaration information exchange. In fact, there are other types of cross-border data that are very important for customs management, such as certificates of origin, phytosanitary certificates, data pertaining to trusted companies who hold Authorized Economic Operator (AEO) certifications.

Today more than ever, with the impact of Covid-19 on trade and supply chains, we must be able to rely on traceability, visibility, security, and interoperability in customs management. The good news is that, with the dawn of the Fourth Industrial Revolution, and the development of countless new technologies, we have an opportunity to get ahead of this recent tipping point, through the application, validation, and implementation of **Blockchain** and other tools (among others, Artificial Intelligence and Big Data) in customs management.

Since February of 2018, the Inter-American Development Bank (IDB) has been rolling out an innovative proof of concept called CADENA. Through the application of **Blockchain** technology, it seeks to facilitate the exchange of data related to trusted companies — also called AEO companies, which have been certified through the Authorized Economic Operator Program — among various Latin American customs administrations.

In the first section of this article, we will introduce the context, the problems involved in data exchange, and the reasons why the project opted for **Blockchain** technology and LACCHAIN's technological infrastructure. In the second section, we will explore the objectives, methodology, and architecture chosen for CADENA. In the third section, we will present CADENA's findings, both in terms of benefits and lessons learned. And finally, in the fourth section, we will include a series of goals for the future and recommendations for taking on **Blockchain**-based projects.

The Challenge

The AEO program is a program of voluntary cooperation between customs administrations and private sector companies.[124] Some countries have also involved other government agencies, such as phytosanitary and health authorities. The companies that participate in the program receive a certification of trustworthiness from their customs administrations, which generates a strategic alliance in order to jointly take on challenges related to the security of trade and supply chains.

To obtain and maintain this certification, the companies must present an application and prove that they comply with the security standards that are internationally recognized within the World Customs Organization's (WCO) SAFE Framework of Standards, as well as customs regulations, and, in some cases, the tax and financial requirements stipulated by their respective countries. This certification allows AEO companies to access a series of foreign trade facilitation benefits that include, primarily, the reduction of physical and document inspections, and priority treatment in the event that their cargoes are selected for review.

Additionally, the customs administrations sign Mutual Recognition Agreements (ARMs) with the countries that have implemented AEO programs, with the goal of securing and facilitating international supply chains. As a result, AEO-certified companies receive ben-

124. OEA Compendium, http://www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/instruments-and-tools/tools/safe-package/aeo-compendium.pdf?db=web.

efits in both the origin and destination countries, with respect to their foreign trade operations.

The main challenge for the implementation of ARMs is the lack of a mechanism or tool for undertaking AEO certificate data exchange in an automated, standardized, and secure fashion, in real time. [125]

The implementation of ARMs involves a series of challenges for customs administrations, that can translate into deficiencies in the issuing of customs benefits to AEO-certified companies. These challenges multiply as the number of ARMs grows, and also as a new generation of plurilateral or multilateral ARMs are brought into effect.[126]

For the aforementioned challenges, it is necessary:

- To have a solution for data exchange that is aligned with the WCO's international standards, and that uses the WCO's data model and employs Trader Identification Numbers (TINs).[127]
- To have an automated and trustworthy mechanism for AEO data exchange between customs administrations.
- To have a tool that enables real-time sharing of AEO certification updates.
- To integrate AEO data with customs administrations' risk management systems.

Blockchain and LACCHAIN as a Solution

Blockchain is an emerging technology that consists of a digital and chronological record of all transactions, that is shared and distributed, and available for viewing and verification by all participants in a network.

Its features are unbeatable for allowing electronic transmission of transactions in real time, generating transparency and trust thanks to its inability to be altered, guaranteeing traceability through indisputable auditing processes, as well protection and security of data and access through a cryptographic system that uses public and private keys. It also allows actions to be automated and executed through smart contracts. Additionally, it provides resilience due to the fact that it doesn't have any central point that would be vulnerable to a breach or system failure, because transactions and data are replicated and backed up in a distributed way among the participating nodes, but without compromising the independent administration of the data of each stakeholder. Finally, it allows for scalability in order to incorporate new participants, both public and private.

With all of these features, **Blockchain** is a perfect fit for meeting needs within the realm of trade, where public and private entities must be interconnected in order to facilitate the implementation of regional and binational agreements. In this particular use-case, **Blockchain** supports customs administrations as a mechanism of cross-border data exchange, in order to provide supply chain visibility and facilitate the trade flows of the trusted companies that are part of the AEO program.

The European Union, as declared in the De-

125. Currently, in order for companies to receive benefits within the framework of MRAs, data exchange is carried out via email by those persons in charge of AEO-program management within each customs administration. In this email, an Excel file will be attached with the AEO company information, which is exchanged periodically, usually once a month. The data received are incorporated by the customs officers into their risk management systems, so that AEO importing companies, whose trade partners in exporting countries are also AEO-certified, are marked as low risk in customs' risk systems.
126. In the Americas, there are currently four multilateral MRAs within the sphere of the Pacific Alliance, Central America, the Andean Community, and MERCOSUR. Given the importance of these agreements for regional integration, the IDB has facilitated their negotiations. Additionally, an MRA is being negotiated between Pacific Alliance and MERCOSUR, also backed by the IDB, as well as another regional MRA.
127. Trader Identification Number (TIN) is the foreign trade operator's identification number, which consists of a single worldwide format for cross-border data exchange. This number is made up of a two-digit alphanumeric ISO country code and the national tax ID number.

cember 2018 European Parliament resolution on **Blockchain** and trade policy,[128] supports the potential of this technology for the implementation of AEO program MRAs. And various organizations, including the WCO, the World Trade Organization (WTO), the World Economic Forum (WEF), and the OECD, have encouraged — through various events and publications — technical discussion on the use of this tool for the implementation of MRAs.

Once the benefits of **Blockchain**, and the potential to achieve international support for its use in tackling the challenge of customs data exchange — based on binational and international agreements — has been illustrated, we will explore the value of LACCHAIN, a crucial part of CADENA's foundation.

LACCHAIN[129] is a global public-private alliance promoted by the IDB's Innovation Laboratory (IDB Lab) in order to develop the **Blockchain** ecosystem in Latin America and the Caribbean. The purpose of this initiative is to foment the region's integration and socioeconomic development through the use of this technology.

LACCHAIN provides us with a single **Blockchain**-based ecosystem, built and maintained by the private and public sectors, which facilitates a regional technological infrastructure with universal standards, and which promotes policies for national use, regarding data privacy, and user identification and authentication through a **Blockchain** network.

For the aforementioned reasons, LACCHAIN offers autonomy and sustainability to its participants, and allows for the scalability and interoperability of the solutions it offers, and provides the **Blockchain** infrastructure necessary to develop and strengthen the design of applications like CADENA, while also facilitating the inclusion of other users.

As opposed to public **Blockchains** — such as Bitcoin — or private ones, LACCHAIN is a third channel that gives the option of a permissioned public **Blockchain** that combines the best features and functions of the other two models (see Figure 1). It is: open, public, decentralized, low-cost (because it's not based on transaction costs), transparent, and able to be regulated without the use of cryptocurrency.

LACCHAIN is a kind of regional interstate with several central nodes, called "cores," whose function is to weave to-

Figure 1.
Types of Blockchain

PERMISSIONLESS	PRIVATE PERMISSIONED	PUBLIC PERMISSIONED
Public (open to everyone) ✓	Public (open to everyone) ✗	Públicas (abiertas a todos) ✓
Decentralized ✓	Decentralized ✗	Decentralized ✓
Transparent ✓	Transparent ✗	Transparent ✓
Low commissions per transaction ✗	Low commissions per transaction ✓	Low commissions per transaction ✓
Not cryptocurrency based ✗	Not cryptocurrency based ✓	Not cryptocurrency based ✓
No anonymity (can be regulated) ✗	No anonymity (can be regulated) ✓	No anonymity (can be regulated) ✓
Offers privacy ✗	Offers privacy ✓	Offers privacy ✓

Source:
The IDB on the basis of ISO/TC 307

128. European Parliament Resolution # P8_TA-PROV(2018)0528 tituled Blockchain: A Forward-Looking Trade Policy, https://www.blockchainwg.eu/wp-content/uploads/2019/01/getDoc.do-7.pdf
129. https://www.lacchain.net

gether **Blockchain** infrastructure. These are the nodes that execute the cryptographic function, commonly known as "hash,"[130] in order to store and validate transactions, as well as create copies.

There are also satellite nodes, which include nodes that write or that observe; while the former are the only nodes capable of writing, or entering transactions into the network, the latter are only able to consult said transactions. These nodes correspond to all public, private, and academic entities, or even individuals who wish to operate using the LACCHAIN infrastructure. In the case of CADENA, each one of the region's participating customs agencies requires a writing node that generates transactions through the application.

This structure secures the infrastructure necessary for operation. On one hand, "core" nodes are maintained by the entities that participate in LACCHAIN. On the other, the independence and autonomy with which customs administrations can operate using their satellite nodes, is also secured. And those satellite nodes can also be used for many other **Blockchain** applications beyond CADENA. This allows the functionality of **Blockchain** use in customs to be scaled. The structure is also flexible in the sense that it allows additional customs agencies to join in as additional MRAs come into effect. LACCHAIN is an opportunity that provides sustainability, scalability, and additional features for CADENA, and customs operations in general, for the facilitation of transnational data exchange.

CADENA As a Proof of Concept

CADENA is a solution based on **Blockchain** technology that helps facilitate and secure international trade through the efficient exchange of data between customs administrations — and, potentially, other government entities — and the private sector.

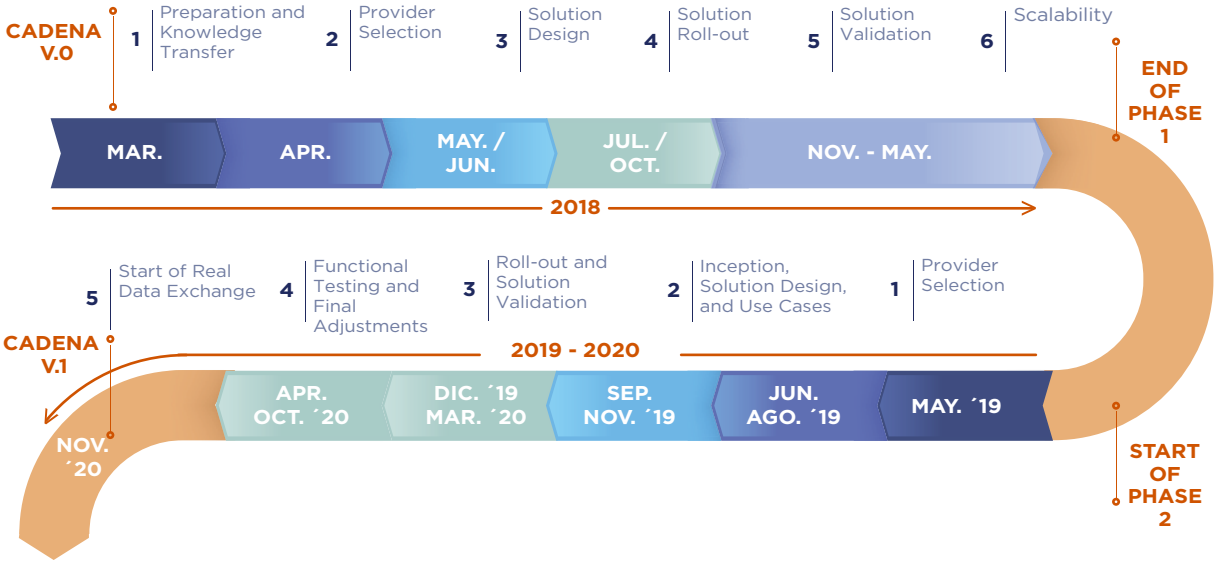
CADENA came about in January of 2018, as a proof of concept promoted, facilitated, and financed by the IDB in collaboration with several customs administrations in the Latin American region. The objective was to validate the use of this technology for taking on a challenge in the realm of customs — cross-border data exchange — and to assess the practical potential and feasibility of a **Blockchain**-based solution to this challenge.

CADENA is empowering the customs administrations that participate in MRAs by allowing them to share a single view of Authorized Economic Operator certification statuses in real time, and with the highest standards of security, traceability, and data confidentiality. This gives customs offices more effective capacity to grant corresponding benefits to AEO-certified companies, in real time.

CADENA was developed in two phases (see Figure 2). In the first phase, from January to March of 2018, CADENA v.0 was rolled out, with participation from the customs administrations of Mexico (SAT), Peru (SUNAT), Costa Rica (DGA), and Chile (SNA), and technical support from Microsoft. In the second phase, from April of 2019 to July of 2020, CADENA v.1 was rolled out, with the participation of the same administrations as the first phase, with the addition of the Colombian customs administration (DIAN) and support from the company Everis. A third phase will begin in December 2020, in which customs administrations from Bolivia, Guatemala, and Ecuador will join CADENA v.1.

130. This is a mathematical algorithm that transforms any arbitrary data block into a new series of characters with a set length. Regardless of the length of entry data, the hash value of the exit data will always have the same length.

Figure 2.
Timeline of CADENA v.0 and v.1 Execution



Source:
IDB

Objetives

The objective of the proof of concept was to determine the feasibility of using **Blockchain** technology to resolve the challenge at hand — cross-border data exchange — and to promote knowledge and training in the technology within customs administrations. Below are the aspects of reaching this objective that were taken into consideration:

- Verifying the functionality of the solution, its design, and the technological infrastructure that supports it.
- Conferring and developing knowledge about **Blockchain** technology within customs administrations.
- Receiving user opinions and feedback in terms of usability and functionality of the solution.
- Testing and validating the usefulness, efficiency, effectiveness, and security of the solution and the technological infrastructure.
- Verifying that the solution complies with functional requirements and that it is viable and stable.
- Confirming preliminary results and developing a projection of future sustainability.
- Possessing an automated and trustworthy mechanism for AEO data exchange between customs administrations.
- Possessing a tool that allows for real-time sharing of AEO certificate updates.
- Achieving integration of AEO data with customs administrations' risk management systems.

Methodology

It was considered that the proof of concept would serve as a way of conferring knowledge about **Blockchain** use. This was conceived collaboratively by the IDB and customs teams from the start of the project, and played a role in both phases.

To achieve this, a working group was established that included AEO program working area representatives in each customs office, as well as representatives from the areas of technology and systems, and in some cases, law. This group of customs officers actively participated along with an IDB team — also made up of trade and technology specialists — and teams from the companies that provided the technology, who took part in each phase of the proof of concept.

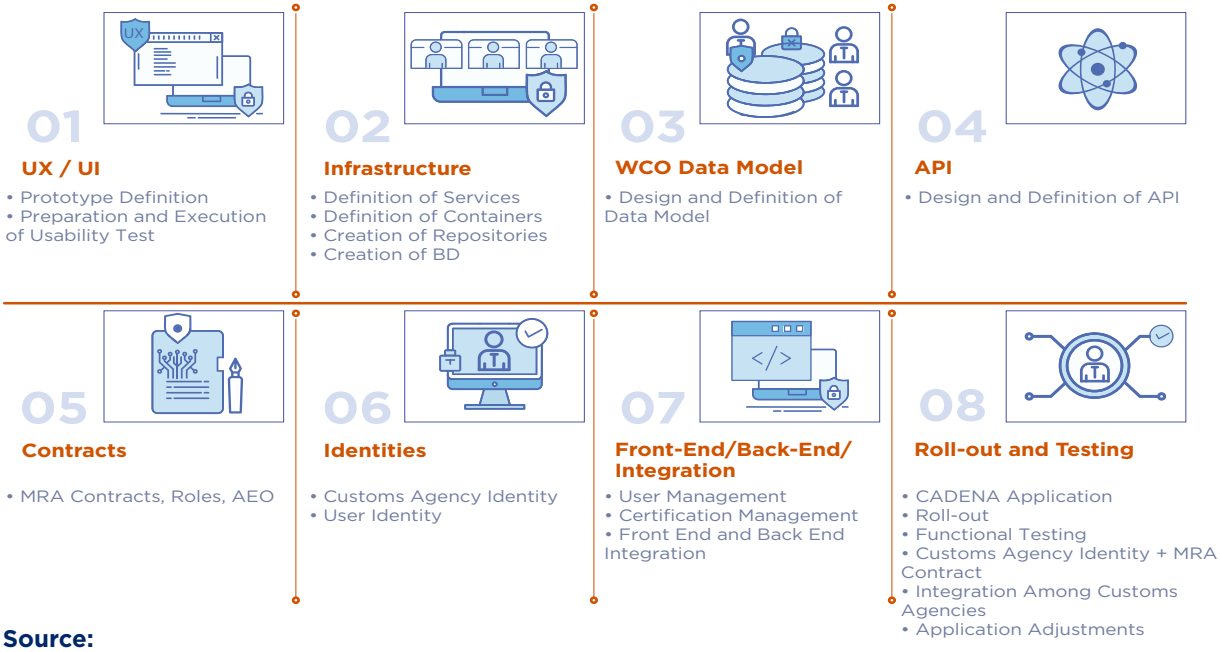
This team — which included 25 people in phase 1, and 40 in phase 2 — was active in all stages of the proof of concept.[131] These phases

131. The proof of concept started in a design thinking workshop in Costa Rica in February 2018, and continued in two on-site workshops during phase 1, in Mexico and in Washington D.C., USA. During the second phase, practically all of the work happened remotely, with weekly virtual meetings through the Teams tool, with only one on-site activity occurring in the final phase of the proof of concept, in Peru, in March, 2020.

involved defining the CADENA solution's functionalities, the technical specifications for recruitment of the companies that would provide the technology to support definition and implementation, the design of the solution, the usability and user experience testing, the developments for integration of the technological infrastructure, the roll-out of the solution, and the functional and security testing of the application. This collaborative approach was guaranteed to level out knowledge among everyone involved, in order to maximize their contribution, while also ensuring that the system designed and implemented would be useful and sustainable for users, given that each customs team would be acquiring the knowledge necessary for its future maintenance.

In both phases, a work schedule was developed with stages and milestones that allowed each team to plan out their level of effort and participation in each stage (see Figure 3).

Figure 3.
PHASE 2 | Key Milestones of Project Execution



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Architecture

The entirety of the application's architecture is based on open source components which facilitate the evolution of the application to include participation from all customs administrations. It has three main components (see Figure 4):

Application: a web-based application, developed using Angular (an open source tool). Through this solution, end users interact with CADENA according to roles defined by customs administrations. This involves a generic client responding to a user-centered design that can be customized by each customs office. The CADENA application includes company management and user management modules that must be authenticated in accordance with the roles established in their AEO program management, in order for them to access and generate transaction flows. This feature is offered using a set of services, detailed below, that are available through an integration layer known as API.[132]

Backend: This involves an API[133] component and a set of services that sustain the operation, storage, and monitoring of the application. These APIs handle the security of the consumption of services housed in containers. At the same time, the containers are identified according to their usability and integration with the solution's services.

132. An Application Programming Interface (API) is a set of functions and procedures that fulfill one or many functions with the purpose of being used by another software.
133. API, Application Programming Interface

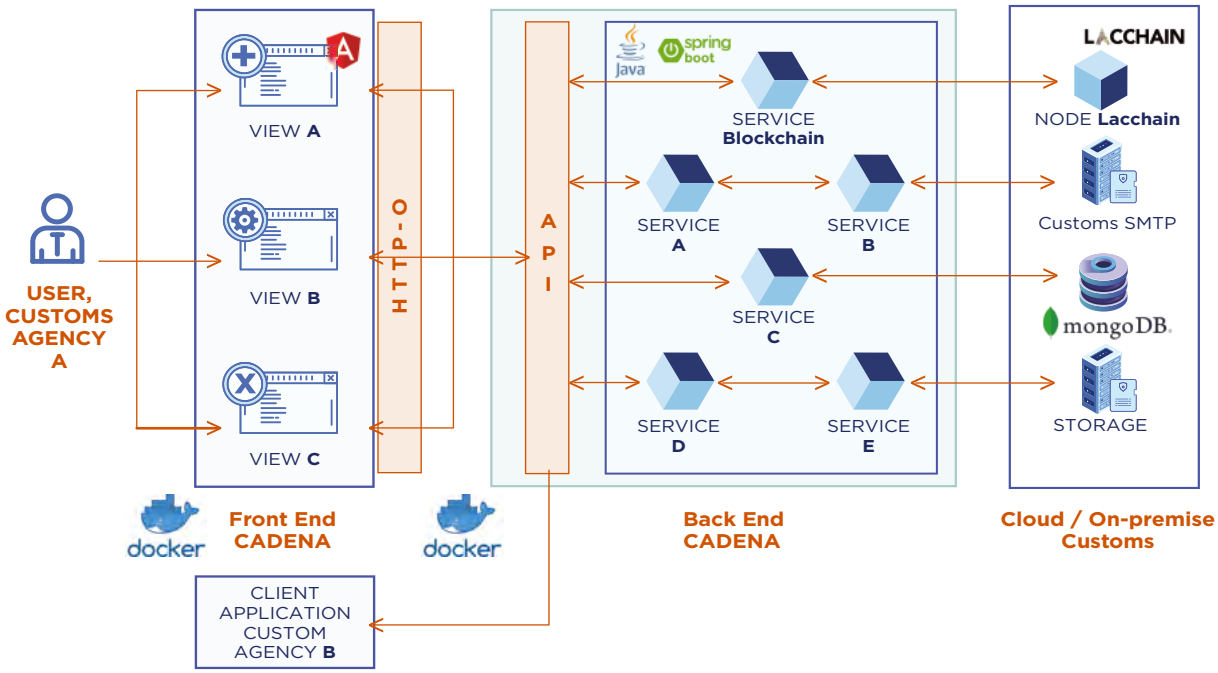
LACCHAIN Node: Here we find three main subcomponents:

I. Hyperledger-Besu Client:[134] This client enables connection to the **Blockchain** network (LACCHAIN). The CADENA architecture is supported by the LACCHAIN network, which is based on the Ethereum infrastructure. Therefore, this client is necessary in order to connect to the network and request information on the network status (smart contracts, latest blocks, etc.). Each node keeps a synchronized copy of the entire record and works as a repository for existing smart contracts. Each node relies on validators to validate transactions and generate new blocks through a Consensus protocol.

II. Orion[135] — Private transaction manager: This service allows for the establishment of a private channel between the customs of countries that share an MRA. Private transactions travel directly (peer-to-peer) through this channel to and from two customs agencies who have a bilateral agreement.

III. Smart Contracts: Secure **Blockchain** processing is orchestrated through a set of smart contracts that establish the logic which allows for the establishment and verification of MRAs between two customs administrations, using sovereign identities.[136] The outcomes of the "hash" of transactions involved in AEO data exchange and the identity of the issuing customs administrations are only registered through the public channel. Encrypted information only travels through the established private channel, ensuring that only authorized entities who are parties to the agreement in question have access to the shared data through corresponding private keys.

Figure 4.
Technological Architecture



Source:
IDB

134. https://www.hyperledger.org/use/besu
135. https://docs.orion.pegasys.tech/en/stable/
136. Sovereign identity is nothing more than a type of digital identity in which the user has full control over their data. It also allows them to manage who can access their data and under what terms.

Findings, Benefits, and Outcomes

Before detailing the benefits, we'll explain how CADENA works. As soon as a company receives AEO certification in country A, their data is uploaded to the CADENA application following a flow of approval by various customs officials in country A. Customs in country B, with which the country A customs administration has signed an MRA, receives a notification via email from the officers assigned that role in the application. From that moment on, officers in country B are able to access the certified company's information on the CADENA application. Alternatively, customs agencies can link the AEO certification management module — even if it resides within a Foreign Trade Single Window — to work automatically with the CADENA application through direct use of APIs. And, in the same way, they can connect CADENA to their risk systems so that AEO company operations receive the benefit of a lower level of inspection.

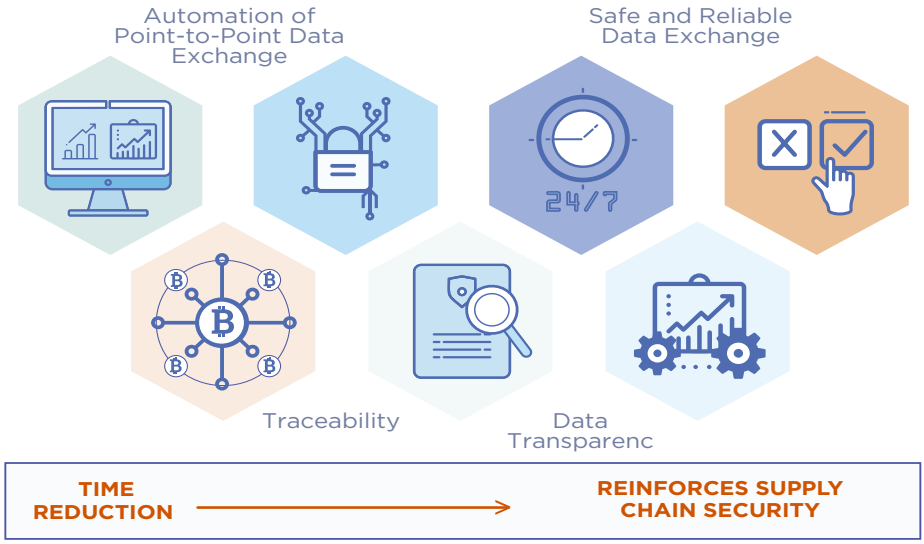
In general, CADENA provides three benefits:

1. Improving the operative implementation of binational or multinational MRAs.
2. Improving the management of AEO programs in each customs administration.
3. Helps strengthen the security of supply chains by ensuring that AEO certifications, suspensions, and cancelations executed by a customs administration are registered in real time.

Below are some of the specific benefits of CADENA (see Figure 5):

- Point-to-point automation of data exchange through the digitalization of AEO certificate statuses.
- Secure and reliable information exchange, with data integrity and controlled access to data through profiles with specific roles and authorizations.
- Traceability of AEO certificate status changes.
- Transparency of data associated with AEO certificates.
- Immediate access to benefits and potential time reduction in foreign trade operations.

Figure 5.
CADENA v.1 Benefits



Source:
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In phase 1 of CADENA, the following outcomes were confirmed:

•That data exchange can be carried out using **Blockchain**.

•Permanent availability of the information that is uploaded and exchanged.

•Secure and reliable exchange of information between customs administrations.

•Traceability of the information and the actions executed with respect to it.

•Transparency of data and control of access to it.

•Integrity of data within the application.

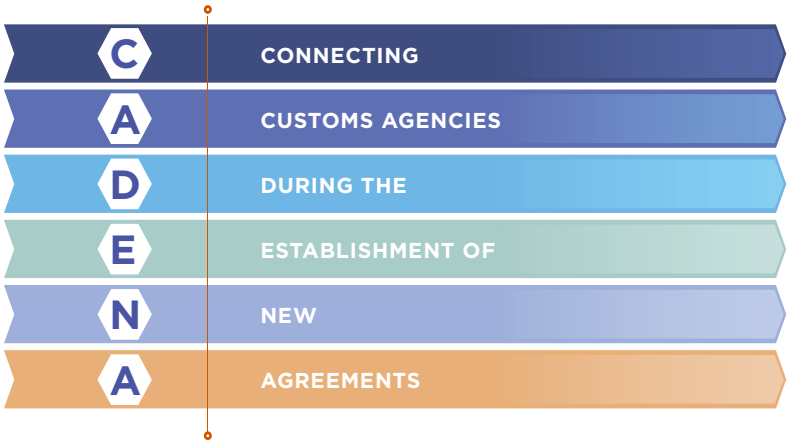
•Activation and suspension of MRA benefits more immediately.

•Digitalization and automation of data exchange between parties to an MRA.

•Creation of digital identities that give legitimacy as trustworthy and secure companies to the records uploaded into the solution.

As far as phase 2, after the completion of functional testing and final adjustments, in June of 2020, the final integration is expected to be carried out, with the accompanying exchange of real data, at which time the final outcomes of the proof of concept will be confirmed. The expected outcome is a robust, sustainable, and secure solution within the new LACCHAIN infrastructure. This tool will allow customs administrations to have real-time information on certified companies, and thus be able to efficiently issue additional benefits to the imports of AEO-certified companies whose providers are AEO exporters in countries with which they have signed an MRA. The intrinsic benefit of CADENA, beyond improving the implementation of AEO MRAs, is confirming that we are dealing with an innovative and secure mechanism for real-time cross-border data exchange between customs administrations. In this way, more than just a PoC, CADENA is a solution that provides the architectural and infrastructural foundation for connecting customs offices in a way that is safe for the development of necessary use cases in the implementation of other binational and regional agreements. Herein lies the meaning of its acronym in Spanish (see Figure 6).

Figure 6.
CADENA Meaning



Regarding the costs of CADENA, the designed solution requires minimal economic resources to support its evolution and maintenance. As an entirely open source-based application, its maintenance is limited to the storage costs of its infrastructural components (LACCHAIN and application servers). Customs administrations can opt for a cloud-based solution on their preferred cloud, or house the nodes on-premise in the same servers that house their systems. With respect to the application's evolution, as part of the scope of the project, internal training has been carried out with the customs offices' technical teams, with the goal being that they be able to provide technical support to their business teams, both for the development of new features, and for making adjustments to existing ones. To facilitate this effort within the scope of the project, the group of customs participants has created a governing committee with representatives from the technical teams, which will be the custodial entity of this solution. Additionally, because CADENA uses the LACCHAIN network, the entire **Blockchain** infrastructure is maintained by LACCHAIN members, whose test-net is free.

Lessons Learned

One of the virtues of PoC iteration for developing and implementing technology is the ability to test, validate, and institute improvements in subsequent phases. CADENA benefitted from its iterative approach and two-phase development. Hence, evaluation of the CADENA PoC requires a comprehensive approach that includes the two phases developed.

CADENA v.0, the first phase, allowed us to successfully validate the benefits of **Blockchain** technology for data exchange between customs administrations. In this phase, four customs administrations used the CADENA solution to exchange information regarding their AEO-certified companies automatically, securely, and in real time.

However, in spite of CADENA v.0's success, from an evaluation standpoint, it was important to identify more long-term challenges. Primarily, these challenges were related to the technological infrastructure upon which the supporting architecture for the solution was designed. In the CADENA v.0 phase, we used an architecture supported by a private **Blockchain**, supplied by a provider.

CADENA v.1, the second phase, benefitted from the evolutionary process of the **Blockchain** technology itself. By harnessing the synergies of LACCHAIN, CADENA v.1 was able to transform and reinvent itself using a public, permissioned, **Blockchain**-based architecture. Or rather, a hybrid of the existing public and private **Blockchains**. In chart 1, you can see the main differences between CADENA v.0 and v.1.

CHART 1
Main differences between Cadena v.0 and Cadena v.1

CADENA v.0	CADENA v.1
Private **Blockchain** Network	Public-Permissioned **Blockchain** Network
Infrastructural components dependent on a specific provider.	Infrastructural components not dependent on a provider. Individual countries subscribe to their preferred cloud or local server.
Solution centrally managed by an entity.	Autonomous. Managed by each country.
Predefined smart contracts, changes require consensus among customs agencies.	Open code smart contracts for easy inclusion of new customs agencies.
Application updates based on consensus among participating customs agencies.	Ability to customize the application according to the needs of each country's customs agency.
User authentication at application level.	User authentication at application and node levels.
Application-level security and privacy (requires general administrator role).	Application- and **Blockchain**-level security and privacy (self-sufficient, general administrator role
Single application with two replica nodes.	Standard application with option to customize, one node for each customs agency, **Blockchain**-level
No option that allows customs agencies to interact with additional nodes or execute additional applications.	Easy development of additional applications and integration with addition nodes on the network. (Each customs agency has autonomy over their node).
Blockchain solution with limitations in terms of scalability (new modules must be incorporated into the application for each new participating customs	**Blockchain** solution with scalability potential (easy inclusion of additional customs agencies).
Blockchain with limited capacity for interoperabi-	**Blockchain** with potential for interoperable scalability.

Below, we will explain how we dealt with the challenges identified during the first phase:

- **Sustainability**

The public permissioned **Blockchain** does not rely on a provider for the development of its technological infrastructure. Each customs administration can permission a node within the LACCHAIN infrastructure,[137] and opt for CADENA roll-out via cloud, with the cloud provider of their choosing, or an on-premise roll-out using their own servers.

- **Governance and Administration**

CADENA v.1 only requires governance to be established at the level of the solution itself, with the participating customs authorities operating autonomously. The initiative of the customs administrations involved in CADENA has established a technical and functional coordination structure which is open to the participation of additional customs administrations who may eventually decide to use CADENA. Furthermore, the customs administrations' systems technicians have put together a shared repository structure with the purpose of documenting the entire evolutionary process of the CADENA solution, which contributes to the code co-creation process, and also will be useful for the incorporation of additional customs administrations into CADENA. Moreover, the LACCHAIN network administration is completely decentralized, with the members of the alliance being those responsible for offering support and maintenance of the network's infrastructure to all participating entities.

- **Adaptability**

The CADENA solution can be visually and functionally adapted to the needs of each customs administration. Only the central functions, and the structure of roles and data agreed upon during the design phase, in accordance with international standards, must be preserved. Customs administrations can incorporate other features and customize the solution's web-based application.

- **Privacy**

Administration of the new CADENA v.1 architecture is non-hierarchical. CADENA is the collective of network members; in this case, the network of participating customs administrations. Hence, each entity has complete autonomy over the administration of users and roles. This takes care of the question of data privacy, because no central administrator is needed. And additionally, data can be housed in the preferred location of each respective administration, for example in the cloud of its choosing, or in their own servers. Private, bilateral channels are established for data exchange, while the **Blockchain** only stores the results of the "hash" function, which is the manifestation of the existence of said data or transactions. LACCHAIN provides the service of replication and validation of said information.

- **Security**

One of the cornerstones that strengthens CADENA v.1, in terms of security, is the inclusion of an identity component in the network, based on international standards.[138] This way, each entity exercises sovereign control over each transaction, which can then be verified by its counterpart in order to establish contracts. And at the same time, each transaction is registered with a verified identity, in accordance with the system of roles that has been established and the features that have been authorized in the AEO program of each country.

Additionally, the active participation and contribution of customs administrations in the design and implementation process has allowed for testing to be carried out that ensures the solution's level of cybersecurity. For this, we have used black box and gray box testing methodology: OWASP Testing Guide v4 (OTG) and OWASP API TOP 10. The test identified vulnerabilities at the API level which were then resolved.

137. LACCHAIN has a free Test NET through which CADENA is being developed and implemented. Eventually, LACCHAIN will offer a Main NET service — on a subscription rather than transaction basis — the legal and financial viability of which is still being put together. According to the entities who sponsor the conception and development of LACCHAIN, the Main NET will operate not-for-profit, and the income from the subscription will be used entirely for support and maintenance of the infrastructure, with service and operation guarantees 24/7/365.

138. W3C De-Centralized Identifiers, https://w3c-ccg.github.io/did-spec/ W3C Verifiable Credentials Data Model, https://www.w3.org/TR/verifiable-claims-data-model/, and the Decentralized Key Management System (DKMS), https://github.com/WebOfTrustInfo/rwot4-paris/blob/master/topics-and-advance-readings/dkms-decentralized-key-mgmt-system.md

- **Integration**

CADENA v.1 comes with an API component that allows for the integration of data into customs systems. In addition to real-time information exchange between customs administrations, the possibility of automating the entry of said information into risk management systems completes the customs control process and provides facilitation benefits to companies.

- **Scalability**

The autonomy, independence, and adaptability of CADENA v.1 allows for quick and easy scalability for the participation of any and all customs administrations who wish to use CADENA, and, likewise, for other public or private users. Also, it allows different features to be developed for different types of cross-border data exchange between customs administrations, government entities, and private companies. For example, certificates of origin, phytosanitary certificates, and information regarding transits and import or export declarations, among other things.

Conclusions

Below, we will list a series of future goals for CADENA (see Table 2) and some recommendations to follow in **Blockchain** PoCs and pilot tests.

Among the goals set forth for CADENA, we would like to highlight the following:

I. Scalability

CADENA was intended as a solution for data exchange between AEO companies and customs administrations. CADENA also came about as a solution with potential for operational scalability; that is to say, for use with other types of data or certificate exchange, or scalability of participants, such as additional customs administrations (as additional MRAs come into effect), public stakeholders, government entities that are involved in the AEO program, or private stakeholders.

This goal is perfectly reachable in the short and medium term, since the technological conditions for scalability are already in place. In fact, the CADENA v.1 solution offers government entities and certified companies the option to request consultation. Similarly, the membership of new customs administrations in CADENA is perfectly feasible through a fairly simple process.

A third phase is about to start in which the customs administrations of Bolivia, Guatemala, and Ecuador are joining CADENA.

II. Integration and Interoperability

CADENA's potential is increased by its ability to integrate with legacy customs systems. From the beginning, CADENA was built with an eye toward facilitating integration with customs risk management systems. This will allow completely automated point-to-point transmission of cross-border data consumed by risk management systems. CADENA can also be integrated with other systems, such as automated AEO management modules, even where they exist in an Electronic Single Window (ESW), as in Mexican customs.

This capability can be achieved in the short or medium term, since a series of APIs have been developed that allow integration with said systems.

Regarding interoperability with other **Blockchain**s, this is an aspiration of many, because in a hyper-connected world, it will become increasingly important to have **Blockchain**s that can interoperate. A similar analogy would be, for example, the essential desirability to send emails between Yahoo!, Gmail, or Outlook users. Currently, CADENA is interoperable with other **Blockchain** solutions that use the LACCHAIN's infrastructure.

In the future, and as **Blockchain** technology evolves, it is expected that CADENA — like other existing networks — will be able to articulate further mechanisms for its interoperability. In CADENA, important measures have been taken for future interoperability, such as the standardized use of data following the WCO data model.

Recomendations

• Apply associated international standards, for example, in terms of the type of data to be exchanged.

• Pay attention to national procedures and regulations, as well as international guidelines.

• Narrow down the proof of concept to a specific challenge that requires the interaction of various stakeholders, with the goal of testing, validating, and achieving growth with additional features and stakeholders (start small to leave room for growth).

• Propose inclusive co-creation processes in which functional, technological, and even legal areas are involved, in order to ensure regulatory compliance, the workability of processes, and the technological feasibility of the solution.

• Approach the proof of concept as a learning and training process with respect to Blockcahin's potential, allowing it to be part of the universal technical discussion, with the aim of contributing to international efforts, and identifying additional capabilities outside of the proof of concept.

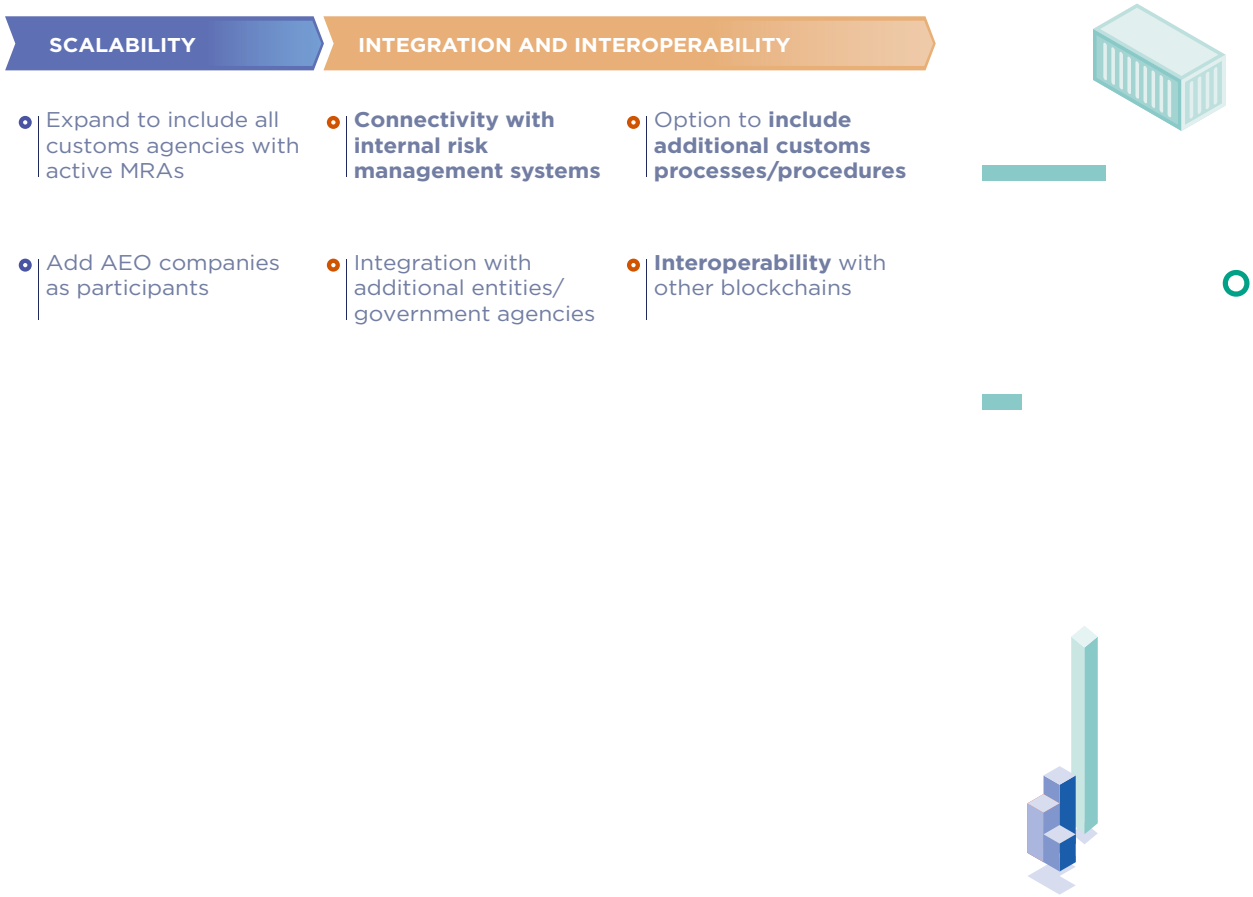
• Iterate and set milestones for functional testing and integration that allow areas for improvement to be identified.

• Opt for open source solutions and document them in shared repositories.

• Be willing to be flexible and take on a certain degree of risk in the proof of concept. Accept the challenge of validating stages while also finding and incorporating technical solutions that were not identified at the start of the proof of concept.

• Develop a strategy to verify the level of cybersecurity of the application and its components.

Chart 2.
Potential Capabilities,
Strategies to develop as part of next steps



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5

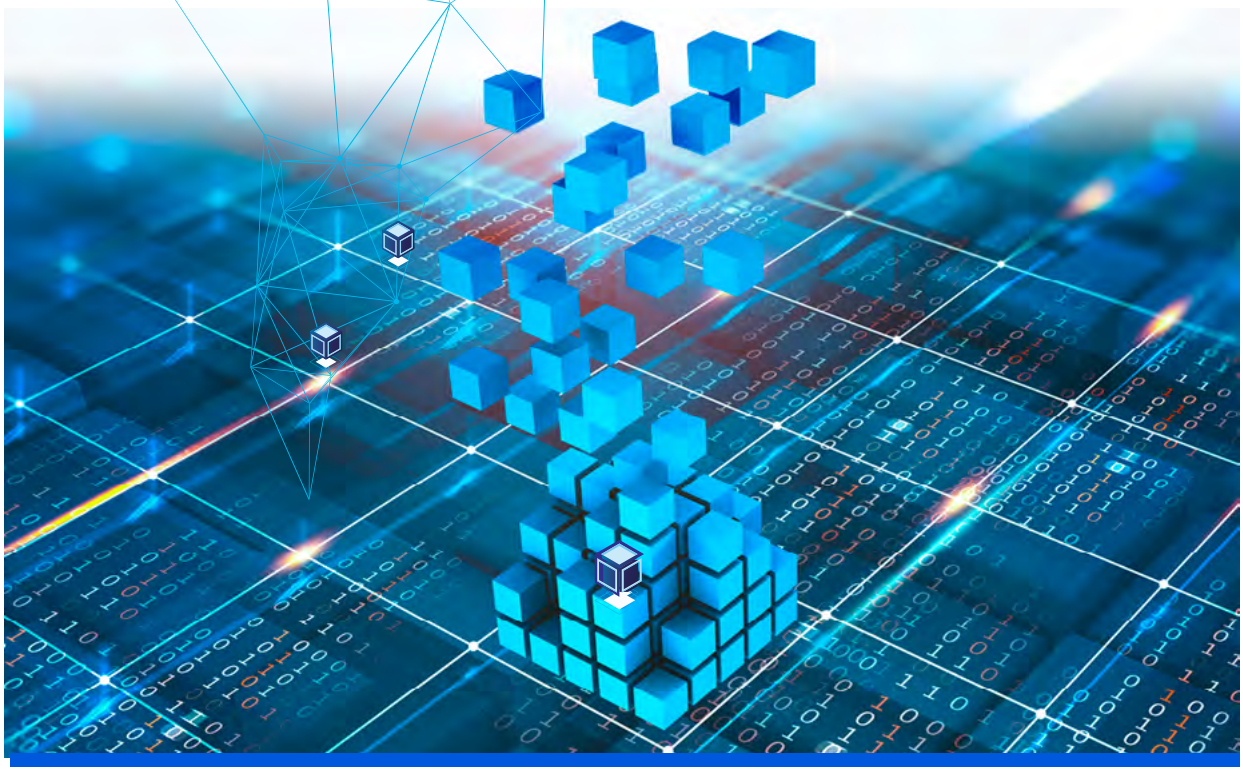
ARTICLE

TRACING FROM THE ORIGIN:

Facilitating Regional Trade with Blockchain

Rafael Cornejo[139] · *Foreign Trade and Integration Consultant*

For the countries of Latin America and the Caribbean, new information technologies are useful and necessary tools for tackling the challenges of the post-pandemic international economic arena, and streamlining the application of regional agreements. **Blockchain** technology allows for the adoption of an Integral Origin Process that vertically integrates the various origin activities involved in preferential trade transactions. Furthermore, it allows for improved traceability and security of such transactions, as well as improved application of risk management and expedited processes in customs offices. All in the interest of securing a more efficient and sustainable supply of the goods that make up regional value chains.



139. This chapter was prepared in the field of cooperation between the IDB and the WEF by Rafael Cornejo (rafaelcor3310@gmail.com). Consultant in Integration and Foreign Trade. Expert in rules of origin.

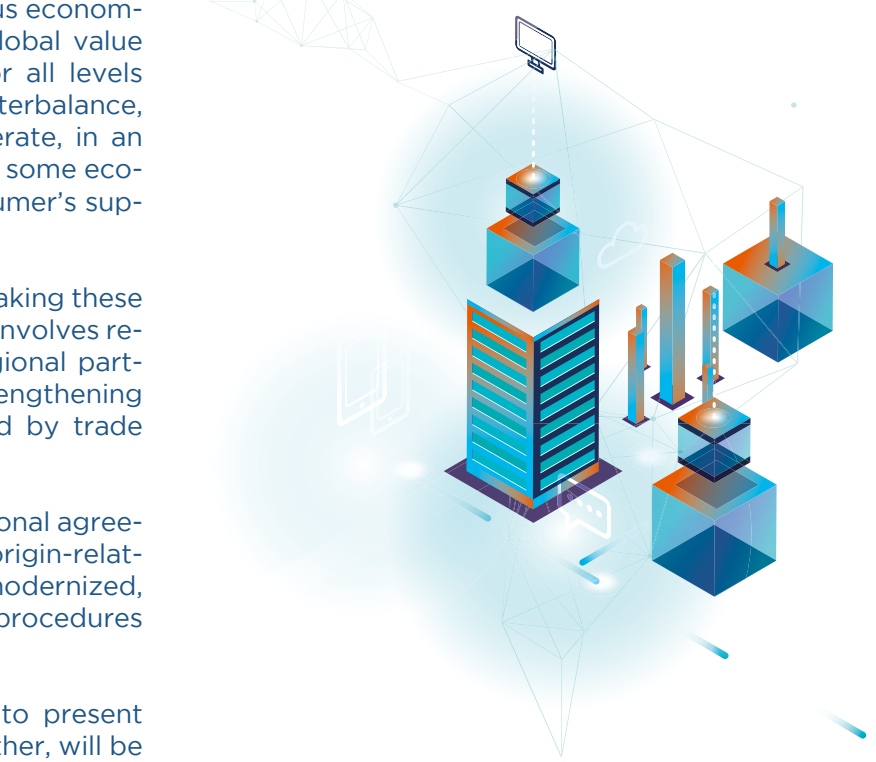
The quarantines imposed in many countries due to the Covid-19 pandemic, along with transport disruptions, have caused production and supply difficulties in various economic sectors, impeded the flow of global value chains, and created challenges for all levels of productive process. As a counterbalance, we have seen e-commerce accelerate, in an attempt to, where possible, sustain some economic activities, and the end consumer's supply, remotely.

A feasible mechanism for undertaking these supply difficulties in Latin America involves reconsidering the importance of regional partners for the development and strengthening of regional value chains leveraged by trade agreements.

To better take advantage of regional agreements, it is advisable that some origin-related operational processes be modernized, through the application of new procedures and technologies.

The objective of this article is to present three recommendations that, together, will be symbiotically complemented and reinforced. The first has to do with the modernization and adaptation of the declaration, certification, and origin control processes required for access to the preferential market. For this purpose, we propose a novel Integral Origin Process (IOP), with the interconnected participation of public and private stakeholders. The second involves the adoption of **Blockchain** technology for the implementation of this process. Finally, the third is based on the use of **Blockchain** for facilitating broadened accumulation, a mechanism which is essential for building broader and more efficient regional value chains.

Blockchain technology has the potential to improve and facilitate operating conditions for the exchange of priority imported products. The application of this process in the origin process of a product can provide greater security and assurance, help expedite controls with more reliable product origin data, and facilitate the application of risk analysis criteria. This innovation can also contribute to the implementation of more extensive origin accumulation, an area in which suitable and effective employment in the regional sphere is still lacking. Furthermore, it can increase the efficiency of trade transactions, thereby contributing to the development of preferential trade configurations.



The World Economic Forum's (WEF) Center for the Fourth Industrial Revolution's Digital Commerce team, along with the Inter-American Development Bank's (IDB) Integration and Trade Sector, through the INTAL, are working together to confirm the potential of **Blockchain** technology for improving efficiency, transparency, and interoperability in trade transactions. In July of 2019 they published the article "Windows of Opportunity: Facilitating Trade with **Blockchain** Technology," which serves as a guide for public sector stakeholders on the use of emerging technologies that facilitate trade, encourage economic development, and improve competition.[140]

This article uses the aforementioned publication as a reference, placing the focus on document exchange facilitation with regard to the issuance, transmission, and verification of origin.

140. This article draws on the experience of over 80 members of the project community, from all over the world, and diverse industrial sectors, government bodies, inter-governmental organizations, and academic institutions, as well as civil society. The article focuses especially on the case of Blockchain implementation in foreign trade single windows.

How the Pandemic is Impacting Trade

Regional Opportunity

The Covid-19 pandemic has had a notable impact on global value chains. As a consequence, various protectionist measures have been put in place, including: i.) increased export restrictions in certain sectors; ii) diversion of the transport operations of certain goods considered strategic for tackling the pandemic, at the hands of third party countries seeking to ensure their own supply; iii) the closing of borders and the resulting impact on human and product transportation services; and iv) the repurposing of existing production chains and facilities for the fabrication of essential products, such as medical equipment.[141] What all these behaviors have in common is that they impact the supply chain and flow of consumables and goods.

At the current trade juncture, certain global Latin American value chains that rely on extra-continental providers are encouraging onshoring through domestic activities, or are considering reinforcing the advantages of nearshoring in an attempt to prioritize or sustain their supplies of, for example, medical materials, food, and other basic goods, from neighboring or continental countries.

It's not the first time that these types of trade flow obstructions have occurred. The 2008 crisis prompted G20 leaders to abstain from putting up new barriers to investment and the trade of goods and services, or imposing restrictions on exportation that would infringe upon the rules agreed upon within the scope of the WTO.[142] In today's world, these kinds of plurinational decisions and agreements wouldn't be so easy to achieve, due to, among other reasons, trade problems between the United States and China, as well as the questioning of the actions of certain international organizations prior to Covid-19, nationalist reactions with respect to economic and migratory issues, and allegations and suspicions amongst countries regarding how the seriousness of Covid-19 should be disseminated, and even the recent difficulties faced by the European Union in terms of reaching the Brexit agreement, and how to respond to the pandemic as a community. Undoubtedly, there were already plenty of difficulties before Covid-19 when it came to coming to agreements or making decisions of a global nature, and in the last few months, these difficulties have multiplied.

Another aspect that disproportionately affects the supply of certain consumables, are asymmetries in the purchasing power of different claimants. It must be taken into account that the purchasing power of Latin American countries and their ability to access, in terms of quantity and quality of providers, is much less than the acquisition weight of more developed economies.

Similarly, these circumstances have also brought about cross-border commerce problems due to attempts by third party countries at diverting products in transit in order to intercept their passage, with the justification of securing their own supply, and to the detriment of the country that originally would have acquired the products.

It's difficult to estimate in the short term what repercussions the aforementioned aspects will have in Latin American countries. Although there will be variety in the extent to which each country is affected, there will certainly be considerable impacts in most countries, due to the unexpected and widespread nature of these events.

In any case, the aforementioned trade disturbances are going to encourage some companies to rethink their supply chains, now taking into account not only the costs associated with consumables, the benefits of specializations, and labor costs and their ability to access them, but also factors related to "the best guarantee of security of supply." This

141. For a description of the chain of sanitary products, and a compilation of some of the inconveniences that arise in the production and marketing of sanitary equipment, see: Matteo Fiorini, Bernard Hoekman, and Aydin Yildirim, "Expanding Access to Essential Supplies in a Value Chain World," en COVID-19 and Trade Policy: Why Turning Inward Won't Work, Richard Baldwin and Simon Evenett (ed, 2020).

142. These agreements were achieved in the following summits on November 14-15, 2008 in Washington, April 2, 2009 in London, and September 24-25 in Pittsburgh, United States.

last factor is one that hasn't always come into play as a priority, up until the crisis at hand.

From the early 60s to today, the region's countries have negotiated free trade agreements that have allowed industrialized products to achieve greater participation in regional trade than in global trade. For example, the robust framework of the current preferential agreements has allowed several South American countries to trade without any tariffs on some or all of their products, as depicted in tables 1 and 2.

In tables 1 and 2, nine countries were selected that uphold, amongst each other, 36 bilateral relationships that define 72 trade flows.[143] These charts demonstrate that, potentially, in almost all of these flows, trade is tariff-free. However, this doesn't mean that all trade operations are making use of tariff preferences. Goods that don't comply with origin demands are traded, but they don't have access to tariff preferences and they are subject

Chart 1.
Global view of tariff reduction - Scope of preferential tariff agreements, excluding automotive - year 2018

Countries	Beneficiaries								
Otorgantes	**ARG**	**BOL**	**BRA**	**COL**	**CHI**	**ECU**	**PAR**	**PERU**	**URU**
Argentina	0.0	100.0	93.9	96.7	100.0	97.4	93.9	99.9	93.9
Bolivia	100.0	0.0	100.0	100.0	4.7	100.0	100.0	100.0	100.0
Brazil	93.9	100.0	0.0	99.7	100.0	99.6	93.9	99.8	93.9
Colombia	96.7	100.0	99.5	0.0	100.0	100.0	99.5	100.0	99.4
Chile	100.0	99.9	100.0	100.0	0.0	96.7	100.0	99.9	100.0
Ecuador	97.4	100.0	99.7	100.0	96.6	0.0	98.4	100.0	92.1
Paraguay	93.9	100.0	93.9	99.5	100.0	97.8	0.0	99.8	93.9
Peru	99.8	100.0	99.8	100.0	99.9	100.0	99.8	0.0	87.2
Uruguay	93.9	100.0	93.9	99.5	100.0	96.0	93.9	87.2	0.0

Source:
Created by the author based on data from ALADI and the Andean Community

Chart 2.
Global view of tariff reduction - Average tariff preference settlement, excluding automotive - Year 2018

Grantor	Beneficiaries								
Countries	**ARG**	**BOL**	**BRA**	**COL**	**CHI**	**ECU**	**PAR**	**PERU**	**URU**
Argentina	0.0	100.0	100.0	99.4	100.0	99.3	100.0	100.0	100.0
Bolivia	100.0	0.0	100.0	0.0	97.9	100.0	100.0	100.0	100.0
Brazil	100.0	100.0	0.0	93.7	100.0	99.2	100.0	100.0	100.0
Colombia	98.7	100.0	91.1	0.0	99.4	100.0	99.1	100.0	99.1
Chile	100.0	100.0	100.0	99.9	0.0	100.0	100.0	99.9	100.0
Ecuador	98.7	100.0	98.6	0.0	100.0	0.0	94.5	100.0	89.8
Paraguay	100.0	100.0	100.0	99.3	100.0	95.1	0.0	100.0	100.0
Peru	99.1	100.0	99.1	0.0	99.9	100.0	100.0	0.0	100.0
Uruguay	100.0	100.0	100.0	99.3	100.0	90.5	100.0	100.0	0.0

Source:
Created by the author based on data from ALADI and the Andean Community
https://www.aduana.gob.ec/comunidad-andina-can/#)

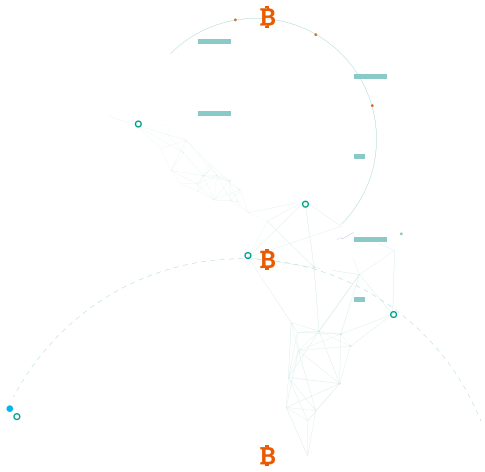
143. The selected countries are just an example, and are not the only case. A more or less similar situation is playing out in another group made up of Chile, Colombia, Peru, and the member states of the Central American Common Market and Mexico.

to the Most Favored Nation tariff. Nevertheless, the existing network, its scope, and the tariff freedom that has been achieved, make for a highly favorable context strengthening trade connections.

In effect, with the current turbulence of global trade, it would be prudent to consider integrating value chains with trusted and historically familiar partners to create an environment of sustained predictability.[144] To this end, one option would involve appropriating current supply systems centered on extra-continental providers, into a more diversified system. Certainly, such diversification of supply sources would strengthen chains, giving them greater resilience. Another feasible action would be aiming such diversification at the promotion of intra-regional trade, and, eventually, associated investment which could acquire greater relevance.[145]

A value chain is more efficient when the manufacture of a product takes greater advantage of consumables imported with tariff preferences, along with certain supply guarantees of such consumables, at reasonable costs.[146]

The impact that origin regulations have on a product's manufacture, and the tariffs to which it is subjected, is explained in box 1.



R.1 Rules of Origin and Tariffs: An Example of Their Impact on Products

I) Context:

• Product: Yogurt classified under subheading 0403.10, imported under an agreement between country A and country B.
• Rule of Origin agreed upon: a change from subheading 0403.10 from any other chapter, except subheading 1901.90.
• Implications of the rule in force: The demands of this rule imply that all consumables that are used for the manufacture of yogurt that are classified in chapter 04 in subheading 1901.90 must be originating.

II) Outcomes of the enforcement of the rule of origin in different production scenarios:

Production scenario 1 A company manufactures subheading 0403.10 yogurt using milk from domestic dairy farms that is classified in chapter 04, and subheading 1901.90 additives that are also developed in the country.
• In this production scenario, the yogurt complies with the rule because both the milk and the additives used are sourced from within the country.
• Because it is originating, the product has access to the benefits outlined in the agreement, and can be imported without tariffs.

Production Scenario 2 A company manufactures subheading 0403.10 yogurt using domestic milk, but the subheading 1901.90 additive is produced in country C, who is not a party to the agreement.
In this production scenario the yogurt does NOT comply with the rule, because the additive classified in the excluded subheading (1901.90) is non-originating.
Because it is non-originating, the product does not have access to the benefits outlined in the agreement, and cannot be imported without tariffs.

144. Article, *"La integración de América Latina, una necesidad frente al coronavirus,"* [Latin American integration, a necessity in the face of coronavirus], Pablo García, April 23, 2020, published in Más allá de las fronteras [Beyond borders], the IDB's Integration and Trade Sector's blog.
145. Regarding the impact on investment that could benefit developing countries, see: Beata Javorcik, "Global Supply Chains Will Not Be the Same in the Post-COVID-19 World," "Expanding Access to Essential Supplies in a Value Chain World," in COVID-19 and Trade Policy: Why Turning Inward Won't Work, Richard Baldwin and Simon Evenett (ed, 2020), https://www.svensktnaringsliv.se/bilder_och_dokument/covid-19-and-trade-policy-28-aprilpdf_774324.html/BINARY/Covid-19%20and%20trade%20policy%2028%20april.pdf#page=122
146. Guaranteeing more secure and familiar supplies from counties more nearby, can be a medium and long-term benefit that could even end up compensating price differences of some consumables.

The Potential of New Technologies and Regional Trade

The joint recommendations of the World Customs Organization (WCO) and the International Chamber of Commerce regarding Covid-19, highlight the importance of facilitation of operational factors in customs processing.[147] Additionally, the World Trade Organization (WTO) considers that some Covid-19 pandemic challenges require urgent solutions that could be addressed through continued implementation of the Free Trade Agreement (FTA), which came into effect in 2018.[148]

Technologies related to computing are playing an increasingly important role in trade agreements. One example of this is the agreement recently signed by Chile, New Zealand, and Singapore, called the Digital Economy Partnership Agreement (DEPA). The agreement outlines the need to actively assimilate technology and incorporate it in agreement procedures.[149] Article 2.2 regulates paperless trade, and in numeral 6 it establishes that: "The Parties recognise the importance of facilitating, where relevant in each jurisdiction, the exchange of electronic records used in commercial trading activities between the Parties' businesses."

The Inter-American Development Bank's opinion regarding Covid-19 public policy highlights "the need to prepare fiscal responses," as well as "the need to be pragmatic and flexible in the face of a shifting reality."[150] In this line of thinking, one option would be to leverage the region's free trade agreements in order to incentivize the integration of productive value chains built on regional consumables.

To this end, a more precise and accurate application of regulatory clauses, founded on technological innovations, will generate more security and certainty in productive chains, and, at the same time, improve application of agreements, and the fiscal situation, by limiting intentional tariff evasion. On the other hand, aligning the demands of agreements so that they work together interconnectedly, will flexibilize and increase the employment of negotiated tariff preferences, which will allow for more productive interrelation in value chains, and more efficiency in manufacturing costs. By strengthening regional value chains, both actions will contribute to their improved efficiency, and achieve scaled benefits.

This article is framed within the line of work and recommendations of various international and national organizations, who prioritize the use of technological tools in their trade agreements. To this end, this article suggests the adoption of certain innovations within the realm of rules of origin, a chapter which is a fundamental part of all preferential trade agreements. Advancements can be implemented through the adoption of **Blockchain** technology in the procedures and regulations listed below, which will be expounded upon in the subsequent sections:

147. According to the WCO and CCI's joint declaration regarding the coronavirus crisis, on April 23rd, it is assessed that: "This crisis is resulting in an unprecedented threat to supply chains in many sectors, with significant implications for the supply of goods and for employment. Effective trade facilitation - based on international standards - will play a central role in supporting businesses, including Micro, Small and Medium Sized Enterprises, towards enabling business resumption and renewed economic growth in the months and years to come," COVID-19: WCO and ICC issue joint statement and call for increased action on Customs and trade facilitation, http://www.wcoomd.org/en/media/newsroom/2020/april/covid_19-wco-and-icc-issue-joint-statement.aspx

148. For example, the TFA includes provisions for pre-acceptance of electronic documents in order to allow processing prior to the arrival of physical documents, and encourages the use of technologies in single windows. See: "WTO, E-commerce, Trade and the Covid-19 Pandemic Information," May 4, 2020

149. In its considerations, the members recognize (among other things): the need to harness the benefits of advanced technologies for all; the need to identify the growing range of barriers that relate to trade in the digital economy and the need to update global rules in response; that the digital economy is evolving and therefore this Agreement and its rules and cooperation must also continue to evolve; that effective domestic coordination of digital economy policies can further contribute to achieve sustainable economic growth; their interdependence on matters relating to the digital economy and, as leading online economies, their shared interest in protecting critical infrastructure and ensuring a safe and reliable Internet that supports innovation and economic and social development; a commitment to partnership cooperation on matters relating to the digital economy; and their inherent right to regulate and resolve to preserve the flexibility of the Parties to set legislative and regulatory priorities, safeguard public welfare, and protect legitimate public policy objectives.

150. "See the Inter-American Development Bank's publication, April 27, 2020: "Public Policy to Tackle Covid-19: Recommendations for Latin America and the Caribbean.

a) Innovations in procedures and new technology use. Improving and strengthening a product's integral declaration of origin process with the goal of offering greater certainty and guaranteeing compliance with origin requirements under a preferential agreement, using **Blockchain**.

b) Regulatory adaptation. Diagramming of operational mechanisms that allow for the interconnection of preferential agreements, in such a way as to allow that originating imported consumables, free of tariffs within the scope of an agreement, can also be recognized as originating in other trade agreements that involve the same parties.[151]

Integral Origin Process

Preferential Trade and Declaration of Origin

The certificate of origin is the document by which its issuer declares that the goods produced comply with all of the requirements laid out in the origin regime under which the operation is carried out. Products that have complied with origin requirements will benefit from the tariff advantages negotiated in the agreement.

We can identify three phases of a trade operation in which the origin-related regulations negotiated in trade agreements — which currently, from a documentational standpoint, function separately from the operation itself — come into play.

First phase: the manufacture process of the exported good

The manufacturer keeps a record of all information related to the manufacture of the good, inventory movements, and payments, along with other documents. They do this by means of an accounting and management control system, where all documentation supporting the claim that the product has been produced in compliance with the agreed-upon origin requirements is also recorded, in a scattered fashion.[152] This information is included in their accounting records, along with their productive forms and paperwork and/or cost calculations, and they are under legal obligation to keep it in their archives for a cer-

151. There are a variety of names to refer to this type of facility of connection among agreements, such as: broadened accumulation, third country accumulation, diagonal accumulation, extended accumulation, but aside from semantic differences, generally all of these terms, in essence, refer to instrumenting the transversal recognition of a consumable's origin status within a web of overlapping agreements among a group of partners who have agreements with one another.

152. This scattering is reasonable because none of these systems have been developed in order to attend to origin-related needs. On the contrary, their primary criteria involve compliance with other regulations, like for example, widely accepted accounting principles, internal management control reports, tax requirements, establishment of balance sheets, profit and loss calculations, etc.

tain amount of time, and to present it for origin verification.

Experience shows that sometimes, even when the exported good is originating, the producers don't always know how to bring this scattered information together in order to substantiate and demonstrate that, or they choose not to in order to avoid costs.

Second phase: the issuing of the declaration and the certification of the good as originating

The certificate created in this phase allows a product being traded under a preferential agreement to access a full or partial reduction in applicable customs tariffs. This phase plays a pivotal role in and is a fundamental mechanism for demonstrating the the good is originating.[153]

Until now, origin certification has involved a declaration in which the issuer assumes the responsibility of having complied with the established requirements for accessing the benefit; but the document does not provide proof that that which has been declared has actually been fulfilled.

Box 2 offers a synoptic view of the evolution of the origin certificate in the region's main agreements.

R.2

Evolution of the Certificate of Origin in Latin America

The certificate of origin is created along with the rest of the documents required for exporting/importing a product. Initially, Latin American countries would assign the task of its issuance to exporters/producers and third parties called certifying entities.

In NAFTA, and some subsequent agreements involving Mexico and other countries, these entities were done away with, and the task of certification was left solely in the hands of exporters and/or producers. Later on, the United States started adding importers to their agreements, on equal terms. More recently, in several agreements with Canada, Chile, and the European Union, they have left out the certificate, replacing it with a declaration of origin to be provided by the operator in the form of some other trade document (invoice, customs manifest/clearance, etc.). Aside from who issues the certificate, the way in which it is issued has been another dynamic factor in the evolution of the origin certification/declaration process. Initially it was issued on paper, then via digital file, and, more recently, an XML file signed and protected with a digital signature — as is the case for some of the agreements within the ALADI framework.

Third Phase: origin verification and control

The third phase, unlike the first two, is carried out in the importing country, and involves verifying that what was conducted and declared in preceding activities is true and accurate. In effect, trade agreements grant the customs administration of the importing country the capacity to perform a verification of compliance with all the demands established in the agreement's origin regime, in either of the two phases identified above.

This process, known as "origin verification," is carried out some time after the products have been nationalized in the importing country. This third phase requires the collection and transmission of data that support what was manifested in the certifications, with the purpose of being able to trace imported goods from the beginning of the production process.

This entire segmented origin process, for a variety of reasons, is not always carried out properly. Among other reasons, this can be due to the fact that the involved operators are not familiar with the requirements and rights laid out in the origin regimes, difficulties obtaining a certificate of origin of the right type or in the right timeline, and in some cases, lack of means or resources for implementing the appropriate and necessary control and verification of inconsistencies or errors from the first two phases, in order to possess accurate and traceable information. In some circumstances, such difficulties can result in the underutilization or incorrect application of trade agreement benefits.

153. Such distinctive importance of the certificate in certain circumstances has thrown off the focus of origin control, since it misguidedly relies almost exclusively on formal conditions and availability of the certificate, and not on the most important aspect of an originating operation, the fact of whether the product has actually been put together in compliance with origin terms — which doesn't always reflect what is declared on the certificate.

Innovations in Origin Procedures

The innovation put forward in this article involves the implementation of an Integral Origin Process (IOP) that interconnects and unifies the three aforementioned phases into a single process, allowing improved access to tariff preferences. Developing a process of this type is a challenge that can be taken on using new technologies. This single process would grant operators more security in preferential trade, and better information regarding the origin of goods; in the same way, all of this information would allow importing customs administrations to focus more of their energy on origin controls for less-trusted operations.

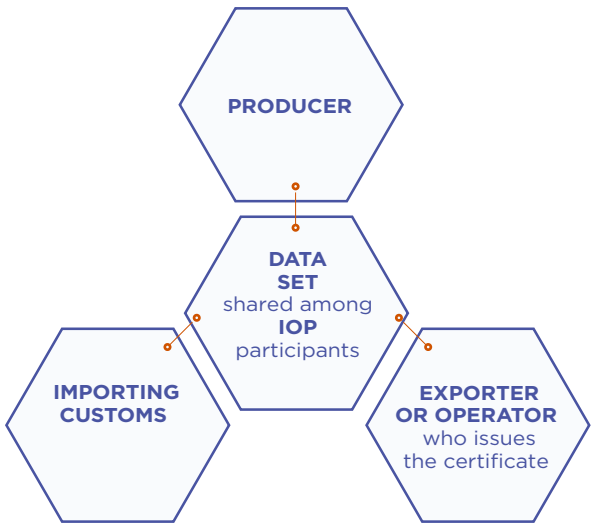
Operational integration can be achieved through the adoption of a technology that allows stakeholders to share necessary data related to the three phases, for the purpose of determining whether the operation is in compliance with the rules of origin. Information provided will include data provided by the producer related to the consumables used, which show that the finished product is originating; also, it will include other data related to the origin certification which will be provided by the issuing entity. On their end, the importing customs administration will have access to all of this data in order to corroborate that the product is in fact originating. This shared and controlled input and access can be carried out operationally through the application of **Blockchain** technology.

In order to determine whether or not a good is originating, it is fundamental and crucial to be able to access data and information regarding the background and origin of its consumables. As it were, this product might be made from an array of prime materials and parts, rather than fabricated from a single component. The more complex the product, or the more complex its rules of origin, the more important it is to be able to access data related to its consumables and productive process, in order to determine its origin. All of these situations can be resolved using a **Blockchain**-implemented IOP.

It is paramount that innovation in IOP procedures allow all involved operators not just the possibility to be accountable for compliance with the requirements necessary for access to the benefit, but also that they supply authorities with easy access to producer documentation that will allow them to check and demonstrate that what has been declared is reflected in the accounting/production documentation of the company that manufactured the good. At the same time, integral unification of the process will prevent situations in which the importer — who isn't always informed of the entire productive process of the product — is held accountable for things outside of their control. Instead, it is the producer/exporter/certifying entity who will be held accountable in the case of an incorrect application of the rules of origin.

The information that, for example, the producer provides regarding the product will vary from case to case. It could be a copy of the purchase invoice, or import manifests of the consumables that the product's rules of origin dictate must be originating, or a copy of the inventory sheets for those consumables, etc.

Figure 1.
Integral Origin Process data contributors and users



Operators and Phases of the Origin Process

The implementation of an integrated declaration and origin control system, as proposed by the IOP, is both public and private in nature and therefore requires the participation of both the private commercial operators involved in an export, as well are the government authorities who take part in its processing and control.

These users must provide and include all information in the **Blockchain**-based records network, and those who have access to this network will be able to review and corroborate information provided by its participants.

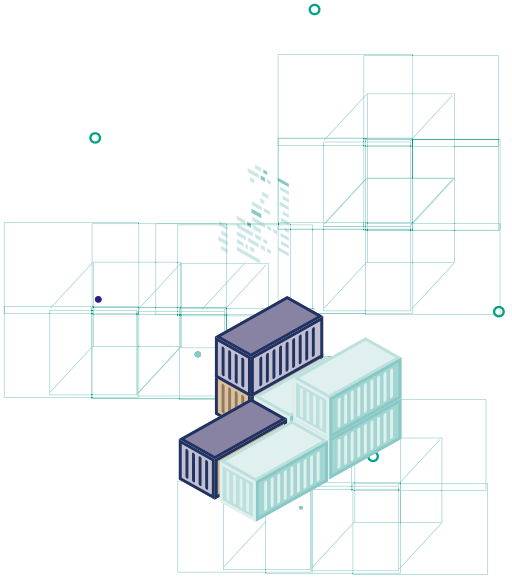
In summary, participation of eventual **Blockchain**-based IOP operators will fall into the following categories:

a) Essential participation: operators who fulfill the following roles: (i) product producer; (ii) operator who declares the product's origin, for example, the exporter, and (iii) the customs administration of the importing country.

b) Necessary and advantageous participation: (i) Foreign Trade Single Windows (FTSW) of the countries involved in a trade transaction, in cases where its processing would rely on the participation of a FTSW for transmission of origin documentation; (ii) certifying entity for those agreements which rely on them for the issuance of the origin certificate.

c) Other participants who may subsequent;y become involved: (i) the customs administration of the exporting country, and (ii) customs brokers or agents of the importing and exporting countries, and consumables providers.

d) Others whose participation is deemed beneficial: transporters, customs of a third country, and the product producer's providers. The participation of transport companies and third country customs administrations is beneficial when the transport of the products in question is not carried out directly between the exporting and importing country, but rather, a third intermediate stop is made



in a third country. In this case, the proposed system could be an ideal and accessible way to easily satisfy additional information requirements established in the origin regimes for preferential operations that pass through third party countries. Current requirements for exporters and importers are very difficult to obtain from a third party country's customs administration, and aren't always reliable.

One hugely important factor is related to the level of participation of FTSWs. There is still disparity in terms of the development, implementation, and performance of these tools in Latin American and Caribbean countries. For this reason, they can't be included as essential operators, since they are not fully set up in some countries, or have a very limited role when it comes to origin certificates. However, in countries that use FTSWs to exchange origin certification information, their participation is essential in order to comply with current regulations.[154] Such participation is in alignment with the WTO's most recent recommendations regarding trade and the pandemic.

Figure 3 offers a representation of possible participants in terms of their necessity and the intended scope of the Integral Origin Process. Similarly, figure 2 offers a succinct summary of the activities that would be necessary for implementation of the IOP using **Blockchain** technology.

154. An innovation such as the one proposed in this article would also be in line with the WTO's Trade Facilitation Agreement when it establishes in Article 10: Formalities connected with importation, exportation and transit, numeral 4: Single Window, subsection 4.4: "Members shall, to the extent possible and practical, use information technology to support the single window."

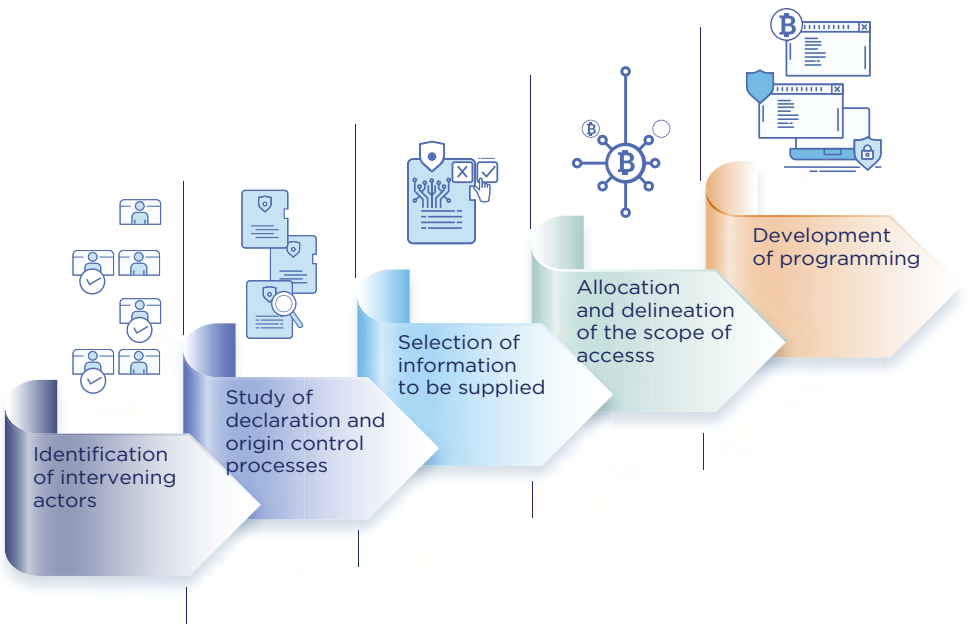
Chart 3.
Participants grouped by level of pertinence

Depending on the Scope and Depth of the Project	• Transporters • Third-party country customs • Providers to the product producer
Others for Incorporation Later On	• Brokers • Exporting country customs
Necesaria y Conveniente	• Certified entities (according to the agreement) • FTSWs (*)
Indispensables	• Entity which declares origin (products and/or exporter) • Entity requesting preferencial treatment • Importing customs • FTSWs (*)

Note (*):
The level of participation of FTSWs depends on their role, function, and development in the countries of the Agreement

Figure 2.
Sequence of key activities required for implementation of the IOP with Blockchain in a pilot project.

The IOP requires the execution of certain steps or activities in order to be implemented. These can be carried out sequentially or simultaneously. The synthesized sequence of the activities of this initiative are graphically represented below:



Blockchain in the Integral Origin Process

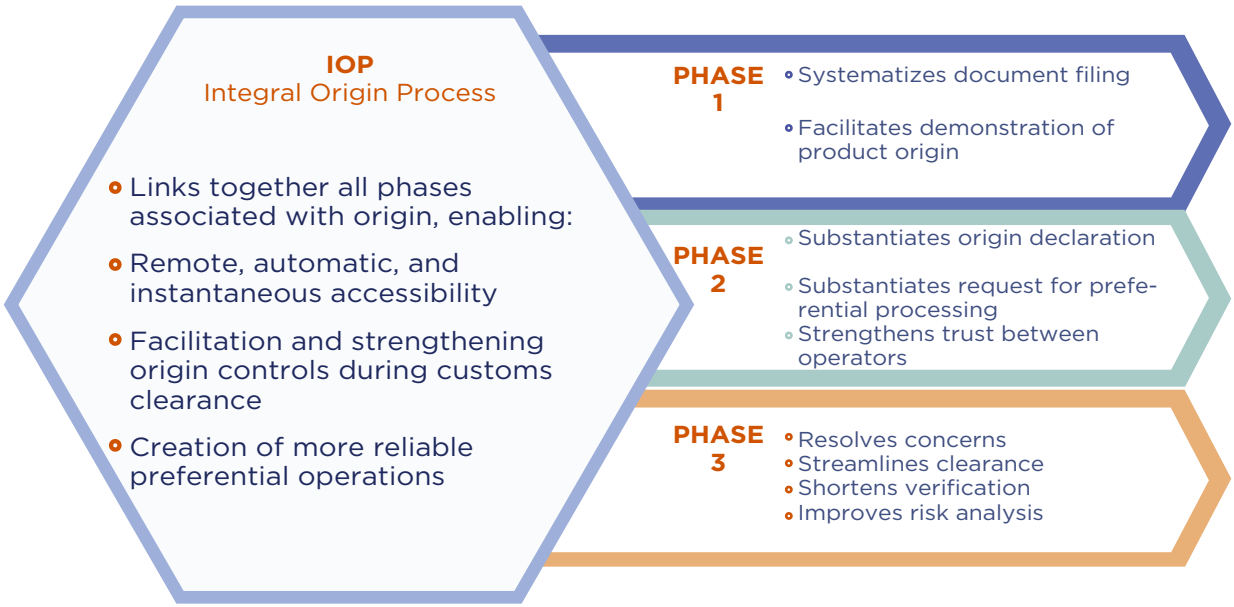
A Solution for Origin Traceability

In a context of transformation and technological innovation, **Blockchain** is emerging with the capacity to share, record, and finalize transactions that are secure and cryptographically protected, between parties associated with an asset or object. This technology is a tool for the automated, safe, and real-time emission and transmission of the information necessary in the integral declaration of origin process, between public and private stakeholders involved in supply chains and foreign trade controls. The use of **Blockchain** in origin procedures can expedite and ensure a better process of documentation and control in preferential trade operations, improving supply chains, and, at the same time, making the correct application of tariff preferences more effective.

Blockchain's properties allow for the bringing together of various public and private agents that provide data and information automatically and instantly in a shared setting and record. Such data are shared both for the processing of imports and for the corresponding control or origin verification processes. In addition to linking all of the data together in a secure fashion, **Blockchain** allows for sufficient regulation of access to said data, ensuring its confidentiality, while also deterring the repudiation of what is declared by each operator.

Figure 3 offers a synoptic representation of the three associated phases, the activities involved in each phase, and the advantages of the IOP.

Figure 3.
Advantages of a Blockchain-based Integral Origin Process (IOP)



By certifying the origin of a product, exporters will be able to operate within a more secure context because they will have a larger pool of supporting data regarding the product's origin, something which they currently lack. On their end, importers will feel more confident applying for preferential access, since responsibility for any shortcomings in the declaration of origin will not fall on them, since their application will be supported by information previously provided by the producer. Importing customs offices, since they will have to allow the entry of the product without tariffs, will have information that allows them to immediately and more accurately validate the declared originating status of the product. In this way, access to regional markets is simplified, and trust among trade operators is strengthened. Additionally, **Blockchain** can deter possible instances of alteration and prevent situations in which any party lacks the information necessary for their role in the operation.

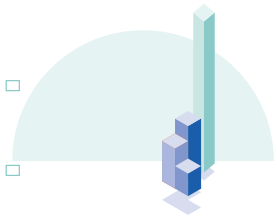
Benefits of Blockchain in the Origin Process

The putting into operation of an origin process like the one stipulated in the **Blockchain**-based IOP creates several benefits, including the following:

a) Reduction of scams in preferential trade. A more efficient application of preferential benefits by reducing scams and/or errors in declaration/origin certification processes for preferential trade.

b) Helps identify trusted operators. Allows for more accurate profiling of the economic operators participating in a commercial transaction, because those who use this technology would be credibly demonstrating that their product is originating. This will contribute to an improved application of risk analysis criteria when it comes to origin, a mechanism advocated for in the Doha Declaration on Trade Facilitation.

c) Encourages and expands the use of risk analysis criteria in preferential trade. In current practice, preferential origin isn't always included in the computational risk analysis developments used to select operations that require closer scrutiny, through a system of green, yellow, or red channels.



d) Trade facilitation. The tasks that must be performed by authorities for the application of trade agreements are made easier, since these authorities will be able to have access to the entire productive process history of goods imported as originating, which is something that is not currently available.

e) Increases trust among operators and makes operations more accurate. Using this technology, importers can operate with more confidence and trust, because the tariff benefit that has been accessed will have been obtained based on data and information provided by the producer, corroborating and establishing what has been declared by the issuer of the available declaration or certification.

f) Encourages the use of other mechanisms prescribed in trade agreements and in the TFA, which as of now are underutilized. Producers and exporters will be better trained and more familiar with what data is required, both for demonstrating product origin and taking advantage of other trade facilitation mechanisms, such as the Advance Origin Rulings instituted by the TFA, which are not currently being utilized.

g) Deters repudiation of the data provided. Helps decrease misrepresentation in declarations of origin, since operators will not lack necessary information or reject any of the information that has been entered.

h) Encourages the use of ICT. Modernizes the procedures involved in the processing of trade operations, through the use of new technologies that streamline and facilitate trade.

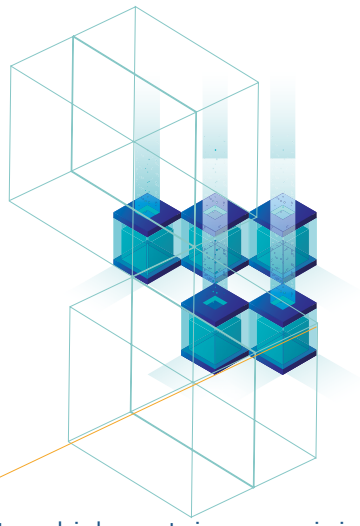
i) Develops a traceability system that does not yet exist. By recognizing and identifying all participants in the productive process, the **Blockchain** record helps reduce informality. Additionally, this traceability can serve as a model to be replicated in other procedures and documents, such as, for example, sanitary certificates.

j) Strengthens the operation of FTSWs. Improves foreign trade and origin data generation. Customs administrations and foreign trade ministries who participate through FTSWs will possess quality origin informa-

tion by means of novel computer processes, for use in public policy decision-making and to support negotiation of trade agreements.

Furthermore, this technology will give governments access to micro-level mapping of the formation of value chains and the origin of the consumables of its products being traded with foreign markets.

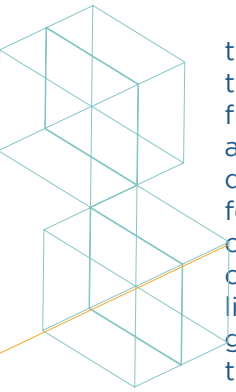
This incomplete and case-by-case mapping, which is constantly updating, is a secondary objective of the IOP that could be useful from a Free Trade Agreement negotiation standpoint, since having this data available will provide negotiators with a realistic view of the consumables utilized in productive chains, the producers involved, and their various backgrounds. This information is basic and essential for negotiating product rules of origin, because it serves as validation of whether or not companies are able to comply with a rule of origin that has been proposed or is under negotiation in a new origin regime.[155]



Accumulation and Value Chains

The Current Situation [156]

Today in Latin America, there is an intersectional overlapping of bilateral and plurilateral trade agreements that have achieved total freedom from tariffs on negotiated products; also, almost all of these agreements apply different origin rules for the regulation of different preferential trade relationships. Each origin regime defines its own closed sphere of impact and influence, because its reach is limited only to the trade of the products negotiated by the countries involved; therefore, the preferential trade of a country ends up fractured into as many segments as there are origin regimes in that country.



In this sense, such division of preferential trade is an unforeseen side effect of the overlapping maze of regional agreements. The main consequence of this division is that certain originating products of one of the country's agreements, which contain non-originating consumables, are likely to be considered non-originating in other agreements. This is due to a lack of ability to transfer the origin status of a product from one agreement to another.

Table 4 shows, as an example, the most important current regimes between the nine countries included in the previous charts, which are those that move the most products in their bilateral trade. It is worth noting that several of these bilateral relationships are not the only ones in existence for those countries, which have additional regimes for certain types of goods, such as goods from free trade zones, the agricultural sector, automotive industry products, etc.

155. The scope and extension of each product's chain will be dependent on the type of participants included as informers on the Blockchain record. The more variety there is in terms of types of participants involved in the IOP, the greater its extension will be. To offer an idea of its size, see the detailed classification in the bullet point on what operators are authorized to access this system.

156. See: *"Estrategia y mecanismos para la convergencia de los acuerdos comerciales de América Latina"* [Strategy and mechanisms for convergence of Latin American trade agreements], Rafael Cornejo, Inter-American Development Bank, Integration and Trade Sector, March 2018.

Chart 4.
Twelve origin regimens in ACEs, PA, and CAN in effect among the 9 countries selected in Chart 1. Does not include origin regimens in effect in the automotive industry or agreements that ad

COUNTRIES	ARG	BOL	BRA	COL	CHI	ECU	PAR	PERU	URU
Argentina		ACE 36	ACE 18	ACE 72	ACE 35	ACE 59	ACE 18	ACE 58	ACE 18
Bolivia	ACE 36		ACE 36	CAN	ACE 22	CAN	ACE 36	CAN	ACE 36
Brazil	ACE 18	ACE 36		ACE 72	ACE 35	ACE 59	ACE 18	ACE 58	ACE 18
Colombia	ACE 72	CAN	ACE 72		AP y ACE 24	CAN	ACE 72	AP y CAN	ACE 72
Chile	ACE 35	ACE 22	ACE 35	AP y ACE 24		ACE 65	ACE 35	AP y ACE 38	ACE 35
Ecuador	ACE 59	CAN	ACE 59	CAN	ACE 65		ACE 59	CAN	ACE 59
Paraguay	ACE 18	ACE 36	ACE 18	ACE 72	ACE 35	ACE 59		ACE 58	ACE 18
Peru	ACE 58	CAN	ACE 58	AP y CAN	AP y ACE 38	CAN	ACE 58		ACE 58
Uruguay	ACE 186	ACE 36	ACE 18	ACE 72	ACE 35	ACE 59	ACE 18	ACE 58	
Number of Regimens	6	3	6	4	6	3	6	4	6

Sources:
Created by the author based on current commercial texts
PA = Pacific Alliance / CAN: Corresponds to decisions 416 and 417 which establish the Origin Regimen of the Andean Community.
Res 252: Resolution 252 which contains ALADI's current General Regimen of Origin

This web of agreements often requires companies to keep more than one inventory of a single consumable, in order to fulfill the origin terms of different agreements. This creates substantial administrative difficulties because it requires that companies be familiar with and apply several different origin regulations and criteria for the same product.

Such is the case in three countries (A, B, C) that have three agreements amongst each other (agreements A-B, A-C, B-C), and that, coincidentally, have negotiated in their three agreements, total freedom for a certain consumable. This consumable will be recognized as originating only within the scope of the agreement through which it carries out its first operation (A-B), since, when it is subsequently used as a consumable to manufacture a different product to be exported to the third country under a different agreement (B-C), it will be considered non-originating.

In this situation, it is very difficult to expand or open value chains created within an agreement, in order to include consumables from third countries, despite the fact that coinciding agreements exist among the three countries. In comparison, developing an efficient regional value chain involving the three countries in question, would practically be a utopia.

In an attempt to overcome this type of inefficient fragmentation, some countries' agreements permit a different type of accumulation called "broadened" or "extended" accumulation. This type of accumulation is a flexibility that allows, under certain specific conditions, the recognition of consumables originating in third countries as originating within the scope of an agreement to which the third country is not a partner.

To implement extended accumulation among all of the current agreements in wider regional arenas, such as the Latin American Integration Association (ALADI) or another group of countries, such as the Pacific Alliance, with Mercosur, or with Central American countries, it would be necessary to adopt a uniform set of criteria for applying this flexibility.

Extended accumulation, undoubtedly, is an ideal mechanism for strengthening and developing regional value chains, because it allows for an override of the restrictions resulting from overlapping origin regimes, by broadening the supply sources of tariff-free imported consumables beyond the geographic borders of an agreement, to include third party countries.[157]

157. Undoubtedly, the most effective option would be a single free trade agreement among all of the region's countries, but experience shows that ambitious multilateral initiatives like LAFTA, FTAA, and the Pacific Arc have not been feasible, and that those that seek to regionalize negotiations within a framework treaty, as in the case of ALADI, have been unable to advance in the process of negotiated bilateral agreement convergence. See: "Trading Promises for Results," edited by Mauricio Mesquita Moreira and Ernesto Stein, Inter-American Development Bank.

If we dismiss the option of a broad new agreement that includes all countries, are there other ways to advance in terms of implementation of extended accumulation?

To answer this question, we can imagine two paths: i) modifying all agreements to include a clause that permits and regulates such accumulation; but the problem with this answer lies in the complexity of coordinating it, not only in various countries, but also across the multiple agreements each country has, and, at the same time, the risk that varying criteria emerge that create hassles in its subsequent multilateral application in the regional sphere; and ii) all agreement-signing countries agreeing upon and enforcing an Extended Accumulation Regulation that uniformly enacts its use and regulates its application.[158]

A strong operational link can exist between the aforementioned Extended Accumulation Regulation and **Blockchain**. While the Regulation would create the regulatory and procedural framework for Extended Accumulation operations, **Blockchain** would be the computing tool that could put this flexibility into operation, by allowing information related to the origin of the consumable developed in the third country to be included in its network of records, along with all of the origin information for the product manufactured using that consumable.

In box 3, you can see a brief description of the concept, operation, and implications of accumulation within the realm of preferential trade between two countries.s.

R.3

What is Accumulation of Origin and Why Do We Need It?

What is Accumulation of Origin?

Accumulation of origin is the mechanism prescribed in trade agreements that allows originating consumables prepared in a country that is partner to the agreement to be recognized as originating in any other member country of that agreement. All agreements allow the possibility of accumulating products obtained or developed in their partner countries, and, in some cases, accumulation of processes is permitted as well.

Why Do We Need It?

Hypothetically, the consequence of not allowing accumulation is that companies must source their products only from consumables produced in their respective countries, in order to comply with the origin rules of their products. In this regard, trade agreements would be quite unfair and would make the signing of agreements between countries at different levels of productive development practically impossible. In effect, the manufacturers of less-developed countries would be significantly disadvantaged, and unable to reap agreement benefits, since certain consumables would not be available in their domestic markets.

This hypothetical absence of accumulation would have the following impact on the example in box 1 (page 91):

• Production without accumulation of origin scenario: A company produces subheading 0403.10 yogurt using milk from their country and a subheading 1901.90 additive entirely produced in "B."

• Due to the lack of accumulation, the yogurt would not be originating because the additive wouldn't be originating.

For this reason, an accumulation clause is always included in all agreements, with the goal of: i) leveling the playing field to give companies of all member countries, from any sector, the chance to comply with their product's rules of origin requirements; ii) include an incentive mechanism that encourages trade between countries in the agreement, and iii) establish a means by which companies from different countries involved in the agreement can interconnect their productive processes. This way, national value chains have the possibility to internationalize and begin to evolve into regional value chains, within the

158. On this, within the scope of ALADI there is, for example, the report, *"Propuesta de reglamento para la acumulación ampliada en el ámbito de la ALADI"* [Proposal of regulation for broadened accumulation within the scope of ALADI], Rafael Cornejo, November 2019, unpublished work for use by the Ministry.

scope of the agreement, through the exchange and utilization of intra- and inter-sectoral goods fostered by the agreement.
• Production with accumulation of origin scenario: a company produces subheading 0403.10 yogurt using milk classified in chapter 04, from dairy farms in its country, "A," and a subheading 1901.90 additive that is entirely produced in country "B."
• In this case, the product is originating through the application of accumulation, which allows the consumable produced in country B to be considered originating in country A.

Blockchain's Impact on Regional Trade Agreements

Blockchain technology applied to the IOP can promote and facilitate accumulation. Increased use of accumulation will contribute to the formation of value chains within the scope of an agreement.

On the other hand, it's worth taking into consideration that one of the biggest challenges for extended accumulation involves making it possible for customs to carry out the corresponding controls related to the origin of the consumable that was produced in the non-partner third country, utilized as originating. With what authority can they do this? What criteria will be used to determine originating status?

These types of questions must be addressed and resolved in the aforementioned Regulation. But, again, the use of **Blockchain** will undoubtedly significantly increase the ease of its functionality and operability. In effect, each time that extended accumulation is applied, there are at least two associated foreign trade operations. On one end, the components utilized to produce the consumable in the third country, and, on the other end, a second operation involving the use of this consumable, which allows it to accumulate from the third country. Because of how **Blockchain** records are linked together, they will contain the information related to the origin of these two operations, which will be available to all involved customs administrations tasked with verifying origin.

Blockchain allows for compilation of the information necessary for demonstrating the origin of the third-party country's consumable, along with the productive process information of the product that it was used to manufacture. In this way, the origin-regulating actions required by the customs administration in the country where the final product is imported, will be much simpler.

By combining **Blockchain** tools and extended accumulation, the benefits of both would be enhanced, and intra-regional trade would be encouraged and facilitated, making regional value chain development more achievable.

Box 4 explains, using the previous example of yogurt, the impact that applying Extended Accumulation would have, and how it would help this product's production value chain integrate the three countries and their respective traded consumables. This is possible because extended accumulation is a mechanism that allows for the interconnection of different agreements signed among a group of countries.

R.4 Application of Broadened Accumulation in Rules of Origin

I) Context:

• Existing agreements: there are three bilateral agreements between three countries, forming a triangle of agreements (agreements A-B, A-C, and B-C). In the context of the existing agreement, A and B decide to apply extended accumulation to consumables produced in country C, given that agreements exist between all of them that liberate all products.

• Product: yogurt classified under subheading 0403.10 that is imported under a bilateral agreement between A and B.

• Rule of origin established in the A-B agreement: a change to subheading 04.03.10 from any other chapter, except subheading 1901.90.

• Implications of the existing rule: the demands of this rule imply that all consumables used to produce the yogurt, that are classified in chapter 4 or in subheading 1901.90 must be originating.

II) Outcomes of the application of rule of origin in a production scenario in which extended accumulation flexibility is permitted:

• Production scenario: a company in country A produces subheading 0403.10 yogurt for export to country B. Its manufacture utilizes domestic milk, but the subheading 1901.90 additive is produced in country C, which is not a member to the agreement.

• In this production scenario, if conditions allow for the application of broadened accumulation, the yogurt complies with the rule because the additive classified under the excluded subheading (1901.90), despite being from a third non-member country, is recognized as originating by the broadened accumulation flexibility.

• By being originating, this product can access agreement benefits and be imported free of tariffs.

• The utilization of **Blockchain** allows for the compilation of all information necessary for proving the origin of the additive produced in C, along with the productive process information of the yogurt in A.

Conclusions

Taking into account the experience of emergency economic closures imposed by quarantines in Latin American countries, and the resulting changes to their national and international trade processes, the region could facilitate its operations by further incorporating widespread use of certain computing technologies.

The dense maze of existing regional trade agreements among Latin American countries is one of the mechanisms most-suited for a reconsideration of trusted and secure supply sources, in order to enable access to imported consumables free of tariffs.

In this context, the Integral Origin Process proposed in this article — that which integrates the production phases of the preferentially exported product with its declaration/origin certification and eventual subsequent origin verification at importing customs — is an operative tool that could facilitate and streamline preferential trade, create a more secure trading environment for trade operators, and facilitate risk analysis.

In order to address the challenges implicated by changes in the international economic arena, it would be advantageous to utilize technological innovations to reinforce regional trade agreements, and make their application more efficient. The IOP, powered by **Blockchain**, would allow for vertical integration of the origin processes involved in preferential trade operations, and, at the same time, the digitalization of such processes, for automaticity, security, and to prevent repudiation of what has been declared.

As we have analyzed in this article, there are various reasons why **Blockchain** should

be used to digitalize and automate this process, including its ability to provide traceability and coherence of what has been declared and executed by all members of a value chain; automaticity of the transmission of information required to comply with origin demands; controlled data access to an array of public-private operators who must authenticate and confirm the origin of a product, and a reduction in customs scams involving tariff duty evasion.

Finally, regulatory conformity of origin chapters through the uniform and synchronized adoption of broadened or extended accumulation, is a viable and necessary option for developing value chains beyond the scope of a regional agreement. The interconnection of tariff advantages across the region's web of existing agreements, to allow for this type of accumulation, could be effectively implemented through the adoption of this technology in the IOP.

For the purpose of validating the use of **Blockchain** in the IOP, it would be of interest to carry out a pilot project in the Latin American and Caribbean region, which would allow for confirmation of its impact on preferential access and accumulation of origin with respect to the strengthening of regional supply chains.

Colaborators

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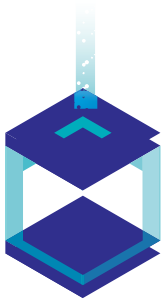

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6

ARTICLE

BLOCKCHAIN AND FINANCIAL INCLUSION:

Theoretical Nexus and Opportunities for Foreign Trade

Ignacio E. Carballo · *Director of Fintech Ecosystem and Digital Banking (UCA)*

Can Blockchain contribute to financial inclusion? The author examines the possibilities of this technology, but also calls attention to questions related to cybersecurity, access disparities, regulation, privacy, and real impact on economic development, as well as the need for investment in infrastructure and education.

Since at least the latter part of the 20th century, financial stability and integrity have been among the core goals of primary financial regulators and supervisors' economic policies. (Crockett, 1997; Marston, 2001; Rudd, 2009)

More recently, the theoretic contribution of financial inclusion (which seeks to bring formal financial services to those who don't currently have access to them) to the achievement of inclusive economic growth and Sustainable Development Goals earned global recognition, and it was incorporated into the aforementioned roadmap of goals. (De Sousa, 2015, Dema, 2015)

The adoption of this new objective has strengthened critical policy reforms that seek to assist in establishing a favorable financial environment. For example, through public-private alliances, with specific commitments by the States, to ensure that necessary resources and actions are put in place for the advancement of financial inclusion (e.g. National Financial Inclusion Strategies).[159]

159. See: World Bank, National Financial Inclusion Strategies Resource Center, http://www.worldbank.org/en/topic/financialinclusion/brief/financial-inclusion-strategies-resource-center

With the stage set for inward financial inclusion of the State, a global ecosystem has been created to foster digital financial inclusion. This global community includes the likes of groups such as the Bill and Melinda Gates Foundation, the Omidyar Network, the Consultative Group to Assist the Poor, the Better Than Cash Alliance, and other players who propose digital money as a more secure and advantageous option for clients, and a more efficient option for financial providers who will potentially be able to process more digital transactions with greater security (Scott, 2013).

In general, these groups aim for a world in which digital payments go beyond the limitations of cash, in order to allow for an expansion of trade opportunities. The tendency has been to consider new financial technologies (Fintech) as a force of financial inclusion and economic growth, whether in terms of providing the people at the "bottom of the pyramid" with a basic tool for avoiding difficulties associated with cash money, or to grant them access to the benefits of a digital economy from they are otherwise excluded.

It is within this context of boom, and the laying of the foundation for the phenomenon of global financial inclusion — which goes hand in hand with the digital financial revolution promoted by Fintech — that **Blockchain** is rising to prominence. This innovation, whose first appearances date back to the nineties (Haber and Stornetta, 1990), but that only in 2008 with the birth of Bitcoin (Nakamoto, 2008) garnered visibility, has inspired champions of digital financial inclusion to see it as a sort of mobile of extreme relevance.

So much so, that on October 30th, 2028, the Inter-American Development Bank's innovation laboratory (IDB Lab), along with representatives from primary global technology and consulting firms, announced the launch of an alliance to encourage the development of a Blockchain ecosystem in Latin America and the Caribbean (LAC-Chain). The words of its director, Irene Arias, clearly conveyed the aspiration of financial inclusion that many place in this technology: "***Blockchain*** *technology has extraordinary potential for providing access to financial and non-financial services, granting digital identity, and ensuring that vulnerable populations who have been excluded from the formal system have ownership over their own data.*" [160]

In the following article, we intend to analyze **Blockchain's** potential for financial inclusion. Specifically, we will attempt to convey the extent of the complexity inherent in this nexus. As you will see, given the number of variants and applications that could come into development using Blockchain, and given that it is still in its early stages of evolution, any current analysis in terms of its impact on the future of economics, financial inclusion, or any other development factor, is limited to a merely theoretic exercise. Nevertheless, we trust that the concepts and connections put forth in this document will facilitate the execution of such exercises in future contexts.

160. See: "Global Alliance to Promote the Use of Blockchain in Latin America and the Caribbean," October 30, 2018, https://www.iadb.org/en/news/global-alliance-promote-use-blockchain-latin-america-and-caribbean

1-The Complexity of Inclusion

In order to study **Blockchain's** impact on financial inclusion, it is necessary to have a clear understanding of both variables. Let's begin with the phenomenon of financial inclusion.

a. A Long Road

The concept of financial inclusion as a tool for development was affirmed on an international level by the United Nations General Assembly held in late 2015. Specifically, when the 2030 agenda put financial inclusion in a position of priority, mentioning the need for broader or universal access to financial services in five of its 17 Sustainable Development Goals (SDG).[161]

However, the road to financial inclusion is a long one, and it won't be achieved with the SDGs. Some early benchmarks have placed it gradually on the international agenda. For example, in 2009, with the foundation of the Alliance for Financial Inclusion (AFI), the regulation and policy-makers of 60 developing and emerging countries committed to making financial services available to millions of people who live on less than 2 dollars a day. That same year, Queen Máxima of the Netherlands was named as the United Nations Secretary General's Special Advocate for Inclusive Finance for Development.

One year later, Group of Twenty (G20) leaders launched the Global Partnership for Financial Inclusion (GPFI) in Seoul, naming three executive partners (AFI, CGAP,[162] and the International Finance Corporation) to move their action plan forward. In 2011, members of the AFI gathered in Mexico adopted the Maya Declaration (the world's first engagement platform for establishing concrete goals for financial inclusion). And that same year, the World Bank Group launched their first global analysis of the demand for financial services.

Likewise, and with more historical momentum, microfinancing (which has its roots in microcredit initiatives in Bangladesh and some parts of Latin America that came about in the mid-70s) was being used as a tool to reduce disparity through access to financial services for those excluded from the traditional financial system, especially those most vulnerable. Microfinancing then emerged as a methodological innovation for offering various financial services to impoverished populations, or those who lacked collateral. Nearly half a century of evolution, study, and development have resulted in microfinancing leaving us with important lessons regarding how to create effective financial inclusion by focusing on the most vulnerable populations. (Lacalle Calderon and Rico Garrido, 2008.)

For these reasons, some viewpoints understand financial inclusion as an evolutionary or breakthrough phenomenon of microfinancing. Generally, this is because they sustain that its applications go beyond poverty reduction, since it also takes into account the reduction of risk and bank costs, the growth of the formal economy, job creation, improved effectiveness of monetary policies, and the stability of the financial system, among other things.

b. What is Financial Inclusion?

The concept of financial inclusion has evolved over the years, and sometimes is defined differently by different countries, organizations, or stakeholders. (AFI, 2017).

For example, the G20's GPFI adopts a pragmatic viewpoint that defines financial inclusion as a condition in which "all working-age adults have effective and quality access to and usage of the following financial services provided by formal institutions: credit, savings (defined in general terms to include transaction accounts), payments, insurance, and investments." (GPFI, 2016)

On the other hand, organizations like the CGAP use a broader, more theoretic, and exhaustive definition of financial inclusion, which

161. See: UNIT, Economist Intelligence, Global Microscope 2015: The enabling environment for financial inclusion, New York, 2015.

162. The Consultative Group to Assist the Poor is a worldwide association of over 30 leading organizations that seek to promote financial inclusion. Housed in the World Bank, the CGAP combines a pragmatic approach to responsible market development with an evidence-based promotional platform for increasing access to financial services that people in poverty need in order to improve their lives. http://www.cgap.org/

defines it as a condition in which "both individuals and businesses have opportunities to access, and the ability to use, a wide array of relevant financial services that are provided responsibly and sustainably by formal financial institutions" (Burjorjee and Scola, 2015).

In general terms, there is a great deal of consensus when it comes to defining financial inclusion as the process that ensures access, usage, and availability of the formal financial system, to all members of an economy (Allen, et. al., 2016; Demirgüç-Kunt y Singer, 2017).

Clearly, it is important to convey that financial inclusion is a broad, polysemic, and multidimensional concept that is in constant evolution, construction, and debate. Its multidimensionality arises from the obligatory necessity to contemplate diverse factors and variables in order to reach its objectives. It is, therefore, an incomplete concept, whose development can be analyzed and furthered from various viewpoints (Carballo, I. E., 2018).

Consequently, and in spite of having entered emphatically into the policy agenda, there is no one single way to go about promoting financial inclusion. It is for that reason, and because of the diversity of possible processes for building financial inclusion, that it becomes necessary to define its primary facets. It is also for that reason that, as we will see, the relationship between **Blockchain** and financial inclusion must be analyzed according to its various facets, rather than as a whole.

c. The Facets of Inclusion

To think about the impact of **Blockchain** (or any other initiative) on financial inclusion, it's necessary to think about what facets will be altered by this technology. Below, we will present three useful approaches for this purpose. It's worth mentioning that, far from being mutually exclusive, these three approaches can be used symbiotically when it comes to the study of the phenomenon of financial inclusion, in all its complexity.

- **Access, usage, and quality:** The most commonly addressed facets are those relating to financial system access, usage, and quality: (a) access refers to infrastructure and availability of financial services and products; (b) usage alludes to the adoption, permanence, and extent of utilization of financial products and services; and (c) the quality and the relevance of the financial product or service within the lifestyle necessities of its users (Allen, et. al., 2016; Demirgüç-Kunt y Singer, 2017).

- **Supply, demand, and regulatory framework:** Another approach that is necessary for understanding this phenomenon entails identifying and characterizing the different variables that limit (or enhance) access and usage of financial products and services. In this case, the nature of the barriers to financial inclusion would be composed of variables arising from (a) supply (transaction and information costs) and (b) demand.

Following this logic set forth by Roa and Carvallo in 2018, the supply variable can be grouped by: (a.i) eligibility (which originates from associated costs of information disparities between the lender and the borrower); (a.ii) physical accessibility (originating from transaction costs tied to physical infrastructure); (a.iii) economic accessibility (managed by transaction costs tied to financial intermediation). Demand variables could include: (b.i) lack of financial education; (b.ii) lack of trust in financial institutions; (b.iii) lack of income or employment; (b.iv) social media pressure; (b.v) behavior biases, and (b.vi) cultural and/or religious factors (Roa and Carvallo, 2018).

Added to this analysis is the regulatory framework of each economy. Within this framework, supply and demand of financial services interact, and it is a fundamental facet which could lift barriers and promote financial inclusion (Carballo, 2018.)

- **Financial products and services:** Finally, an essential approach for studying financial inclusion is through categories of financial products or services. As was mentioned earlier, services provided by formal institutions can be grouped within the categories of: (a) credit, (b) savings, (c) payments and transfers, and (d) insurance (GPFI, 2016). [163]

All of these facets are useful when studying where changes could be brought about through **the implementation of some sort of Blockchain-based technology.**

d. How Can We Measure Financial Inclusion?

163. The previously proposed categories included investments. In actuality, savings-investment could be seen as a similar variable, given that there is product continuity in terms of the liquidity, risk, and profitability that turn savings into investments.)

Measuring and assessing financial inclusion is particularly difficult for two reasons: a) the lack of an absolute consensus with respect to a single applicable variable or indicator that can represent the entirety of its complexity, and b), the newness, and, to an extent, limitedness of the available information, given that only a short time ago, there did not exist any information at all on global financial inclusion that could be analogous.

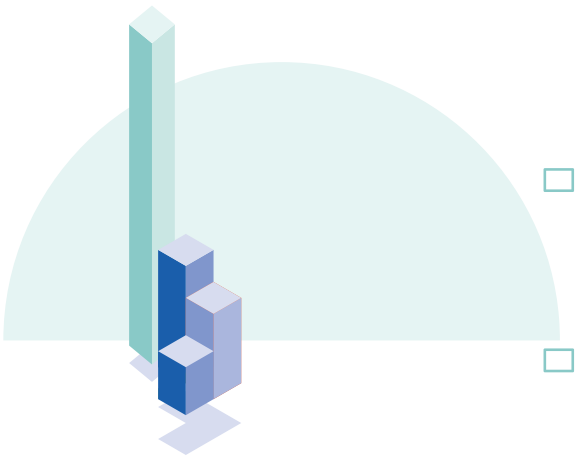
Only as of 2004, through the International Monetary Fund's (IMF) Financial Access Survey (FAS), was a broad database related to financial inclusion developed, with a focus on supply data. And this with information provided by regulatory institutions and entities. Even more recent and relevant is information focusing on demand. No comparable data had been obtained from the perspective of individuals, until the World Bank launched their first database, Global Findex, in 2011.[164]

Currently, Global Findex is considered the most exhaustive financial inclusion progress calibration instrument, and the only data source which allows for comparative analysis between countries at a regional and international level. On April 19th, 2018, the latest data, from Findex 2017, were published, changing the status of global knowledge regarding financial inclusion.

To offer a simple summary, the study found that worldwide, the adult population possessing a bank account in a financial institution, or through a mobile money provider, increased to 69% in 2017 (51% in 2011 and 62% in 2014). The advance has been astounding: while in 2011, the study revealed 2.5 billion adults without bank accounts, this figure declined to 2 billion in 2014, and, subsequently, to 1.7 billion in 2017. But despite the fact that 515 million adults opened some type of bank account between 2014 and 2017 (or 1.2 billion since 2011), there remains much to be done (Demirgüç-Kunt et. al., 2018).

The study clearly conveys the prominence of Fintech for financial inclusion, which justifies the process of boom and strengthening of digital financial inclusion in at least two ways. On one hand, the shocking use of mobile technology among the 1.7 billion people without bank accounts stands out. Globally, 1.1 billion, or two thirds of non-banking adults, possess a cellular phone (and 480 million have internet access). In India and Mexico, the ratio ascends to over 50% of non-banking people, and in China to 82%. On the other hand, the percentage of adults in developing economies who use digital payments rose 12 percentage points, to 44%. Thus, across the globe, 52% of adults — or 76% of account holders — report having sent or received at least one digital payment, using their account, in the last year[165] (Demirgüç-Kunt et. al., 2018).

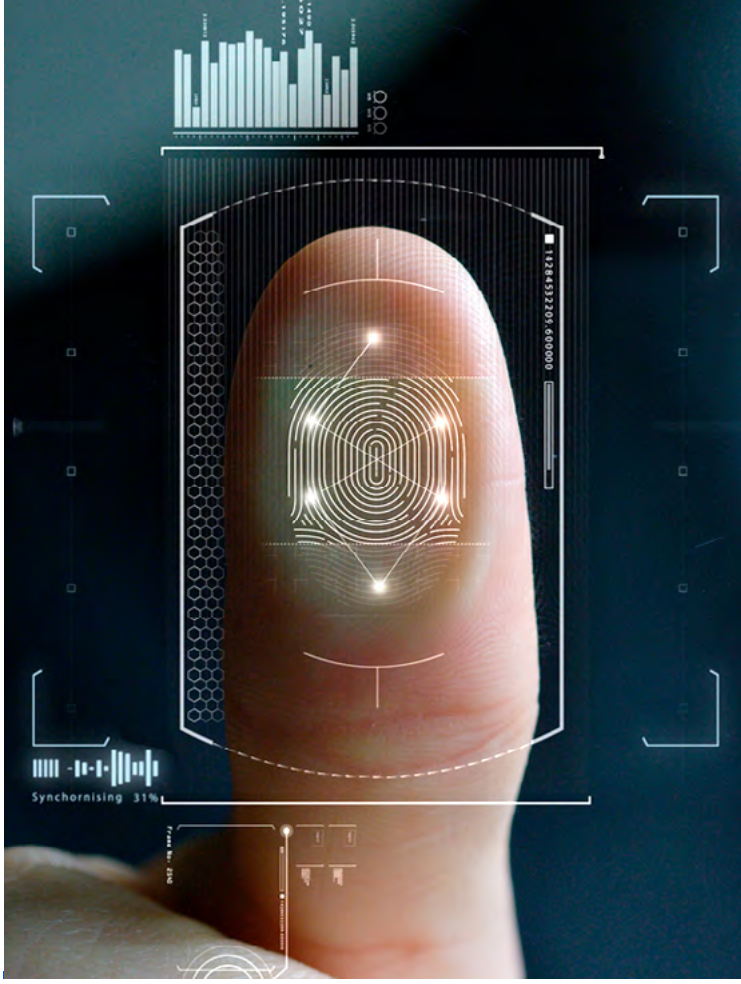
Finally, the most common reason reported by non-banking persons for not possessing an account was that they lacked sufficient funds. Almost two thirds indicated this reason among others, but one in five cited it as the only reason preventing them from having a bank account. Later, 30% reported that they didn't need financial services (but only 3% as their only answer), and 26% said that such services are too expensive. Distance, lack of documentation, and lack of trust, among other reasons, were also cited. These figures differ from region to region and from economy to economy. Even though in many cases, regulation has already taken down such barriers, offering services that are free or more easily accessible, it would seem that such cases have not been reflected in demand.



164. 150,000 interviews conducted with randomly selected and nationally representative adults, the Global Findex presents data from 143 countries over three years (2011, 2014, 2017) and collects information on 506 indicators from at least 1,000 individuals over 15 years old, within each country. See: World Bank, Global Findex Database, https://globalfindex.worldbank.org/

165. In high-income economies, 91% of adults participated (97% of account holders), in developing economics, 44% of adults participated (70% of account holders).

2- Blockchain and Finance Technology



New finance technologies (Fintech) make up a renowned field within innovation that presents opportunities and challenges to the supply, demand, and regulation of financial services (Rojas, 2016) As stated before, national governments and large institutions are becoming more and more committed to the digitalization of their financial entities and large government payment flows.[166]

Effectively, Fintech has begun to play a significant role in financial inclusion, which is also being supported by global standards and organizations, which are fundamental for financial inclusion.

Although, naturally, it is difficult to define categories within such a dynamic phenomenon, among the biggest technological trends that have emerged as disruptive to finance, we can differentiate three overarching groups or tendencies (that may overlap). One of them is related to **Blockchain** technology, and will be outlined in the following subsection of this section.

• **Big Data Analysis**: This is the science of examining "Big Data" in order to discover hidden patterns, market trends, customer preferences, and other useful information. It involves the use of artificial intelligence algorithms. One of the fundamental applications of financial inclusion with Big Data analysis is related to credit scoring — for example, through the analysis of social media behavior, location through georeferencing or intersecting additional information with contacts or frequency of mobile phone calls. Other more ambitious initiatives include — in addition to information from mobile phones, or the most famous social media, such as Facebook or Twitter — analysis of emails, connections overlapped with public databases, security questions, and even metrics on user personality through psychometric exercises. These alternative credit evaluation initiatives seek to generate a credit score that could allow a person to obtain a loan or other financial service. This normally is done only after a person has given explicit consent for their data to be accessed and analyzed (Mazer, Carta, and Kaffenberger, 2014).

• **Biometric Identification:** Biometric identification provides documentational proof of identity through the use of physical and personal traits such as fingerprints, voice analysis, iris patterns, vein matching, and gait analysis, among others, to identify an individual. It is particularly promising for providing vanguard protection to the consumer. One example of the application of this innovation on a massive scale is the "India Stack" (or Aadhaar Stack) project. This project involves a platform containing the banking information, addresses, employment records, and tax payments of any person in India. It is the biggest biometric identity project in the world that has been successfully carried out, showing interoperability of databases and financial and non-financial institutions related to financial inclusion.[167]

• **Mobile money:** This includes all technological services in which a mobile phone is used to access financial services. It encompasses mobile banking, transfers, and mobile payments. The use of cellphones combined

166. As an example, the "Better Than Cash" International Alliance already has over 50 members who have committed to the BTCA's digital payment principles: https://www.betterthancash.org/
167. For more information, see: IndiaStack, http://indiastack.org/

with branchless banking that utilizes retailers as agents, increases the scope of financial services, especially in remote rural areas (see the success stories in the Philippines and Kenya). The GSMA's State of the Industry Report on Mobile Money indicates that 2019 marked an important milestone for the industry, as the number of registered mobile money accounts surpassed one billion, with 1,040,000,000 cellular phones moving money worldwide.

• **Digital or virtual currencies:** This refers to a type of unregulated digital money that is issued and typically controlled by its developers, and utilized and accepted among members of a specific virtual community. It is different from national currencies, that use bills and coins, in that national currencies (known as fiduciary money) are legal tender, designated and issued by a central authority, which people are willing to accept in exchange for goods and services because it is backed by regulation, and because they have trust in that central state-operated authority (ECB, 2012; Suri y Jack, 2016). Although different kinds of virtual currencies exist, including those used in online gambling, the ones most important for financial inclusion are those which are used, or which aim to be used, as legal tender. This kind of currency can be bought and sold according to existing exchange rates, and can also be used for the acquisition of goods and services, both real and virtual. As we will see below, Bitcoin is a cryptographic virtual currency, a digital archive that lists all transactions that have occurred within the network, in its Distributed Ledger Technology, called **Blockchain** (Parker, 2014).

a. Blockchain and Distributed Technology

Blockchain is the technology behind Bitcoin and the cryptocurrency (virtual encrypted or cryptographic currencies) boom. It was developed by Satoshi Nakamoto[168] a few months after the Lehman Brothers collapse, which marked the beginning of the global financial crisis of 2008. Nakamoto published a document that presented a version of electronic money geared at using this pioneer technology to allow direct payments between individuals without the need for reliance on financial intermediaries.

Recently, **Blockchain** has been the object of much curiosity. We will define this technology in general terms, as a distributed and secure (through encryption) database that records blocks of information and ties them together (with prompters called "hash")[169] in order to provide for the recuperation and validation of information. In accordance with its consensus mechanism, there will be various users (nodes, or "miners" in the case of Bitcoin) that are responsible for validating transactions. The advantage is that it is a shared way of recordkeeping, where copies exist within the network (and in every computer of every participant) of any creation within or modification of the big archive, which no person can access or modify without the permission of the rest of the users, in accordance with the established consensus mechanism (Allende López and Colina Unda, 2018).

So, it's a transaction record that supports itself through a distributed network of computers, that doesn't need to be backed up by any central authority or third party, and that offers a transactional schema free of intermediaries, through the use of cryptographic algorithms.

These features allow for the existence of, on one hand, full integrity of the information or document. On the other hand, it makes it possible for all movements and changes that have been made to that information or document to be recorded and known. This is why Bitcoin and other cryptocurrencies that emulated **Blockchain** technology exhibit advantages such as savings on transaction costs, given that they do away with intermediaries, but also exhibit (at least theoretically) the possibility of offering improved traceability and security compared to traditional centralized information storage systems.

In reality, **Blockchain** is a particular instance of what are called Distributed Ledger Technologies (DLT). Meaning, even though **Blockchain** and DLT are commonly used as synonyms, **Blockchain**s are actually a specific subset of DLT. Many, though not all, distributed ledgers are in fact **Blockchain**s, a term that is frequently used inaccurately (and confusingly) to refer to all DLT technology (Walch, 2016)

A differentiation between the two terms is

168. It ought to be pointed out that Nakamoto is the pseudonym chosen by the author (or group of authors) of the famous founding document of Bitcoin, who remains anonymous to this day. Their foundational work, "Bitcoin: A Peer-to-Peer Electronic Cash System" (2018) can be found at this link: https://www.researchgate.net/publication/228640975_Bitcoin_A_Peer-to-Peer_Electronic_Cash_System

169. A "hash" is the fingerprint of a certain piece of information. It is generated using mathematical rules that convert any information into an alphanumeric chain of a predefined and fixed size.

not relevant for the argument presented here, which involves the study of theoretic impacts of **Blockchain** technology on financial inclusion. For this reason, and for the purposes of this article, despite their not being synonyms, the terms **Blockchain** and DLT will be used interchangeably.

Although initially this technology drew attention as a mechanism for creating and conducting transactions with non-fiduciary digital currencies (such as Bitcoin), essentially, it offers new methods for managing data and relationships between parties in settings of incomplete trust. As Nelson's work indicates, depending on how **Blockchain** application is implemented, improvements can be made in aspects such as:

- **Transparency:** Because of its design, data are visible to all parties.
- **Auditability:** Attempts to alter or falsify data are easier to detect (tamper evident).
- **Resilience:** Data are replicated throughout the entire network, which allows them to be preserved even if some nodes or participants are lost.
- **Simplification:** Complex relationships and processes between parties can be simplified or formalized.

By extension, **Blockchain** could transform areas beyond the realm of financial services, such as healthcare systems, agriculture, trade, supply chains, energy, or government, among others. However, according to Nelson, it's more likely that its impact will be most relevant in (a) settings where there is incomplete trust, (b) markets in which individuals or organizations are struggling to interact without error, delays, or undue frauds, or (c) contexts in which a certain level of digital infrastructure already exists (Pisa and Juden, 2017; Nelson, 2018.)

When we think about how **Blockchain** or DLT technology can encourage financial inclusion, it is crucial to keep in mind its properties and the diversity of developments that they make possible.

b. Blockchain Properties and Types

A consensus mechanism is a process used to update and preserve the integrity of **Blockchain** technology. It provides a distributed record that doesn't require trust between the different parties, but allows them to be sure

that the information that they share and accept is accurate, and that, what's more, they can reject any information that isn't, if inaccurate information were to somehow make its way into the network. Technically, it's the procedure through which a node (network participant) is chosen, in order to add a new block to the chain. Although the idea is that it be random, in order to avoid having a single person in charge, the assignment probability of methodology will change according to each consensus mechanism or protocol (Valkenburgh, 2017; Allende López and Colina Unda, 2018.)

There are two overarching categories of consensus mechanisms or protocols. In the first, nodes (individuals or entities) compete to be chosen in exchange for a reward (usually cryptocurrency). This protocol is called "Proof of Work." As is the case with Bitcoin, they are usually permission systems in which nodes don't necessarily have to know who the other participants are.[170] This type of **Blockchain** does not have any central authority.

The second variant involves distributing the probabilities of determining who will add the next block to the chain, whether proportionate to the number of assets, properties, or goods in the network of each participant. Here we find protocols like "Proof of Stake," in which a greater probability is assigned to those who have more assets in the network, and "Delegated Proof of Stake," in which nodes can nominate any other node, either to validate blocks or features, among many other variants (e.g. Proof of Importance, Proof of Burn).[171]

In summary, consensus protocols create incentives through effort or reputation. At least theoretically, they create an environment in which the most advantageous way for any

170. In Bitcoin, successful mining depends on employing computational capacity in order to find the hash code, and the first node to find it is rewarded with cryptocurrency.
171. See: "Consensus opportunities: Blockchain and beyond," https://home.kpmg/im/en/home/insights/2016/07/consensus-opportunities-blockchain-and-beyond.html

node in a **Blockchain** to act, is in alignment with what is most advantageous for the network, given that this network is also their own, and thereby granting it immutability (Walch, 2016).

On the other hand, we can distinguish at least three types of **Blockchain** networks. Public networks, where any individual or node has the same access and rights as every other participant. Federated **Blockchain**s, where a set number of nodes (individuals, entities, or companies) are in charge of administering the network and preserving copies of the **Blockchain**, and are therefore the ones who manage users' access and rights. And last but not least, private networks, which are the same as federated networks, except that they have a single responsible entity, and therefore are not decentralized.[172]

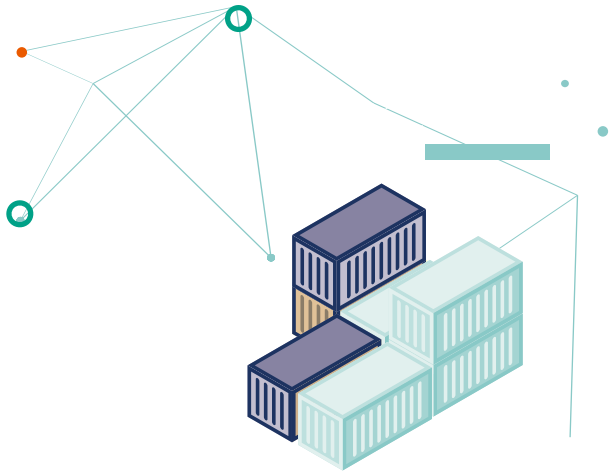
These properties allow a glimpse of the complexity inherent in **Blockchain** technology. On this subject, Ohnesorge recommends the exercise of studying different crypto asset developments and their associated **Blockchain**/DLT in order to comprehend the versatility of this instrument.

For example, the Ethereum network is more than just a cryptocurrency, due to its smart contract storage feature. And, as opposed to Bitcoin or Ethereum, Ripple is a federated **Blockchain** composed primarily of banks and public institutions, and uses a voting-based consensus mechanism. IOTA, on the other hand, uses a technology called "Tangle" which is different from **Blockchain**, because every transaction confirms two prior transactions (Ohnesorge, 2018).

So, it's clear that there is not just one type of **Blockchain**. For this reason, as a matter of principle, talking about **Blockchain** as a single technological typology for studying its impact on whatever type of phenomenon (for instance, financial inclusion) would be inaccurate, because there are as many types of **Blockchain** as there are combinations of detailed parameters (including those that haven't been detailed or have yet to be developed). Therefore, its corollaries for financial inclusion will have a lot of variation. A necessary step before speculating any plausible impact would be, then, to analyze its primary characteristics.

For example, transaction costs and timelines are variables that will significantly influence customer satisfaction. Transaction capacity is essential for considering the scalability of a development that aims to become a widespread payment mechanism. We should also analyze sustainability angles, such as energy expenditures incurred by "Proof of Work" or the tendency towards anonymity and the resulting incentives for illicit activities. Of course, alternative uses for **Blockchain** that could emerge beyond the realm of its cryptocurrency application would also be a variable to keep in mind (smart contracts, the Internet of Things, etc.).

Table 1, taken from Ohnesorge, recounts the immense differences in properties between **Blockchain**s of the ten most popular cryptocurrencies, in terms of capitalization.[173]



172. Allende López and Colina Unda (2018) include a fourth category consisting of large companies that offer Blockchain services on the cloud, like IBM with Hyperledger Fabric, Amazon with Digital Currency Group, or Microsoft with R3, Hyperledger Fabric and Quorum, among others.
173. To give an idea, in April of 2020, the cryptocurrency website CoinMarketCap already listed over 5,000 different crypto assets. See: Top 100 Cryptocurrencies by Market Capitalization, https://coinmarketcap.com/

Chart 1.
Primary Crypto assets and their properties

Cryptocurrency	Average commission per transaction in USD	Average transaction time	Capacity in transactions per second	Energy efficiency	Additional features
1. Bitcoin	7.32	9-10 minutes	7	Low (PoW Blockchain)	
2. Ethereum	0.22	14 seconds	20	Low (PoW Blockchain)	Enables smart contracts
3. Bitcoin Cash	0.32	9-10 minutes	50	Low (PoW Blockchain)	
4. Ripple	0.0000024 (+ comisión por IOU)[10]	3,5 seconds	1000	High (voting algorithm)	Enables IOU transactions in any currency
5. Litecoin	0.15	2 minutes	56	Low (PoW Blockchain)	
6. Dash	0.30	2, 3 minutes	(4000)[11]	Low (PoW Blockchain)	
7. NEO	Ninguna (+comisión variable)[10]	A few seconds	1000	High (voting algorithm)	Enables smart contracts
8. IOTA	Ninguna	Sin datos	500-800	Very high (Tangle PoW)	Especially compatible with IoT devices
9. Monero	2.43	2 minutes	1700	Low (PoW Blockchain)	Advanced privacy features
10. Nem	0.21	30 seconds	(3000)[11]	Low (PoW Blockchain)	Advanced privacy features

Note that this chart is based on data from November 20, 2017. It shows a static panorama that is liable to change significantly within short periods of time. Likewise, the precision of the data in terms of transaction time and capacity may vary, and, in some cases, this data is based on estimations. Nevertheless, it can give the reader an idea of the approximate values of speeds and capacities of the cryptocurrencies included in the list.
Source: Alfaroq (2017), BitInfoCharts (2017), Cyberblock (2017), Masterminded (2017), NEM (2015, 2016), NEO (2017c), Steemhoops99 (2017)

3- Blockchain and inclusion: opportunities and challenges

As explained above, the definition of financial inclusion encompasses a broad spectrum of facets. In the same way, **Blockchain** technology exhibits typologies and characteristics that turn it into something dynamic, with an inherent complexity when it comes to studying its impact on financial inclusion (which is also complex). As stated in the introduction, such context implies that any current analysis regarding this relationship is limited to being a mere theoretic exercise.

Notwithstanding, after having delved into both variables and their primary characteristics, we can set forth several theoretical scenarios (with empirical examples when applicable) that invite us to think about the areas of financial inclusion that could be strengthened by **Blockchain**. Subsequently, we will outline possible obstacles and challenges that would appear to limit, at least in the immediate future, a scaled implementation.

a. Opportunities

As mentioned above (see section 2.c), financial services can be grouped into four categories: savings, credit, insurance, and payments/transfers. **Blockchain** technology has properties and characteristics that could theoretically have an impact on all of these categories.

• **Savings and transaction accounts:** Cryptocurrencies continue to be the biggest development to come out of **Blockchain** technology. By definition, these currencies allow for value storage services. In other words, savings.

For example — at least theoretically, any individual who uses Bitcoin has the equivalent of an online bank account in the form of a **Blockchain**-based virtual wallet. Obtaining this wallet is free, and it is available to any

person who is aware of its existence and has internet access. Some wallet providers are even already working on SMS-based solutions. No legal identification is required, just an email address or phone number, and there are no maintenance charges or minimum balance requirements.

So, just as Nakamoto proposed in his foundational work, supply side access barriers could be, at least theoretically, eliminated.

• **Financing and alternative credit assessment:** The utilization of **Blockchain** presents virtues in terms of the automation of underwriting and disbursement of funds, reducing loan issue times and operational risks. Furthermore, storing financial details can facilitate real time approval of financial applications, create new financing structures, reduce counterparty risk, allow for quicker loan settlements, and provide benefits for peer financing (Ether World, 2017).

In the same way, the aforementioned credit scores or ratings can be reinforced, and are already being reinforced, through this technology (Bloom, 2017; Lee, 2017.). World Bank statistics show that public credit databases in many countries with emerging markets include less than 10% of the population.[174] If they were to come together in a shared **Blockchain** platform, a decentralized alternative to formal credit offices could be built. Borrower transaction histories could be recorded in a shared accounting ledger, which would give credit officers an idea of their history of loans and repayments, as well as any outstanding loans in their name.

• **Insurance and claims processing: Blockchain** technology could revolutionize the insurance industry through factors such as smart contracts, thereby promoting one of the facets of financial inclusion.

The ability to facilitate claims administration for property and accident insurance companies, using **Blockchain**, could automate their processes through the use of smart contracts, improve evaluation through claims background information, and reduce the potential for fraudulent claims.

Furthermore, it could eliminate errors associated with manual auditing activities, improve efficiency, reduce report filing costs, and, potentially, support a more in-depth regulatory supervision in the future. This technology is already driving new initiatives (See Lorenz et al., 2016.)

• **International payments and remittances:** Money or mobile banking and traditional electronic payments drastically reduce transfer costs by avoiding the fixed costs of branch banking. In turn, they provide obvious benefits in terms of convenience, and reduce transport costs, especially for more rural populations (people no longer have to go into the city to take care of financial matters). In this sense, **Blockchain** developments wouldn't appear to have too many advantages over traditional electronic payments when it comes to demand.

Now, undoubtedly, when we talk about international payments or remittances, the situation is quite different. The high costs of financial intermediaries in such cases mean that the disruptive potential of **Blockchain** technology and cryptocurrencies is much bigger than in the realm of local payments.

The explanation for this is that even remittance services that are online or use mobile money, rely on the banking system (usually correspondent banks) to settle cross-border transactions. They require several days to settle these types of transactions. Even when they offer near-immediate services for a higher price, it's the intermediary institution that advances the payment, and waits to receive the transfer once it is approved. This increases their capital costs.

With the use of **Blockchain**, this step is omitted. Capital costs and barriers to entry for new companies are reduced, which increases competition. Because of its design, **Blockchain** transactions don't have borders: the same minimum fee (just a few cents on the dollar) is charged, regardless of where the two sides of a transaction are residing.[175]

On the other hand, as we can see, this technology has the potential to make an impact on many facets and structures beyond those related to finance. These parallel developments can have direct corollaries in financial inclusion, thus opening our analysis to infinite possibilities. To provide an example, below we will describe three possible areas.

174. See: World Bank, Public Credit Registry Coverage (% of adults), https://data.worldbank.org/indicator/IC.CRD.PUBL.ZS

175. Of course, this will depend a lot on what technological development is being considered, seeing as the median transaction fee varies from over 6 dollars, to totally free, depending on the cryptocurrency (see ANNEX). Nevertheless, the median cost of traditional remittances starts at 7.6% worldwide , but can end up costing up to 20% depending on the sending and receiving countries. The World Bank Estimates that reducing costs by 5% could save 16 billion dollars per year (Hernandez, 2017).

• **Property registries and digital identities:** As an immutable, real-time record with time stamping, **Blockchain** is an attractive tool for proving property rights and/or holdings. There are already initiatives geared toward utilizing this technology to register plots of land and enhance property rights, like Bitfury in Georgia and Factom in Honduras.[176] Asset registry can allow people in developing countries to leverage their capital — of which, under the current system, they have no proof of possessing — in order to use as collateral.

This aspect of **Blockchain** wouldn't just apply to assets, but to individuals as well. **Blockchain** can provide digital identities with more privacy than traditional methods. According to the ID2020 project,[177] around 1.1 billion people worldwide live without an officially recognized identity. **Blockchain** offers a tamper evident mechanism for creating digital identities for low-income citizens who lack formal identification documentation.

In this way, citizens who lack sufficient access to the financial system could have more independence, and better welfare opportunities, through the creation of a digital identity in **Blockchain**. The solution could be built with the intent to integrate with external systems, to diminish the possibility of fraud and error in the delivery of monetary transfers to those excluded from the financial system.

In Barrio 31 (an urban settlement in the city of Buenos Aires, Argentina), the Inter-American Development Bank, in alliance with Accenture and the DECODES Civil Association (NGO Bitcoin Argentina), is undertaking an ambitious project to provide digital identities to the settlement's inhabitants. Another example is BanQu, a technological Economic Identity platform for the creation of digital personal profiles composed of various records of personal, financial, or other activities. This way, BanQu allows those who don't have bank accounts to develop a confirmed and verifiable personal and financial history by making transactions on their **Blockchain**.[178]

• **Development donations and financing:** With this technology, peer-to-peer (P2P) donations can be made without the help of intermediary organizations like NGOs, community organizations, or any other agent in the aid chain, including financial institutions. This could ensure that a greater percentage of donations and loans actually reach beneficiaries, and that smart contracts can be incorporated in order to ensure that the money is being used as anticipated (for example, sending children to school).

In these cases, smart contracts could develop bank accounts in the form of computing code with instructions that are automatically executed, automatically dispersing their funds once the terms established in the contract have been fulfilled. This could potentially streamline financing for outcome-based development.

Although these rigid ways of going about financing could make adaptation to complex contexts and problems even more difficult, funds could be released as objectives are fulfilled. Smart contracts could also help shorten response time in crises by automatically sending pre-set sums of money, for example, after a certain number of incidents, during an epidemic, or if a natural disaster of a certain magnitude occurs in a vulnerable country.

• **Trade, export, and logistics:** New technologies are a pathway to the disruption of logistical services and trade as we know them. From robotics to process and transport automation, to the Internet of Things or 3D printing, all these tools are carving out new paradigms.

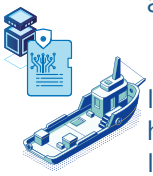
Blockchain is doing the same for trade in general. The World Trade Organization, for example, has put forth three general aspects in which this technology promises to revolutionize international trade: a) increasing trust and transparency in value chains, b) reduction of trade costs, and c) opportunities for MSMEs and small producers and manufacturers in developing countries (Ganne, 2018).

Effectively, this technology is being used more and more as a data system in supply chains due to the high levels of trust and visibility that it makes possible. Similarly, **Blockchain** is being implemented for smart con-

176. See: "The First Government To Secure Land Titles On The Bitcoin Blockchain Expands Project," February 7, 2017, https://www.forbes.com/sites/laurashin/2017/02/07/the-first-government-to-secure-land-titles-on-the-bitcoin-blockchain-expands-project/#362008754dcd
177. "An Alliance Committed to Improving Lives through Digital Identity," https://id2020.org/
178. See: BanQu, 2020, https://banqu.co/

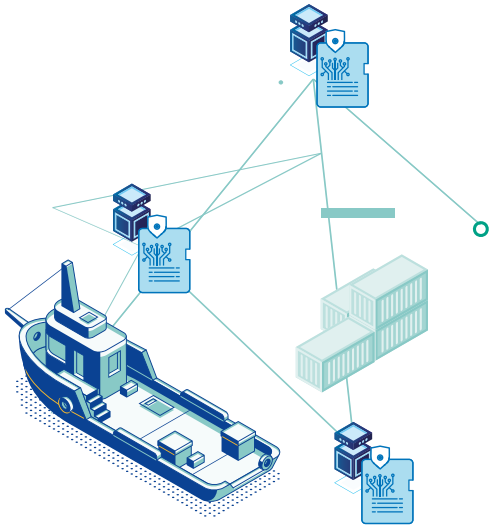
tracts that act automatically once an event (such as a final product delivery) has occurred. Such applications are encouraging for the promotion of its use in various aspects of international trade, logistics, and export.

To offer an explanation, as outlined by Manners-Bell (2019), we can mention the case of A.P. Moller-Maersk and IBM, who created a joint company to provide more efficient and secure methods of going about global trade, using **Blockchain**.[179] The goal is to offer a global trade digitalization platform developed collaboratively, using open standards, and developed for use by the entire global maritime ecosystem. Through this system, a channel of information on global maritime transport would allow all agents that participate in supply chain administration to exchange information on transport happenings in real time, in a secure and hassle-free way. The other basic capability it offers is paperless trade. This would digitalize and automate archives, allowing end users to securely present, validate, and approve documents across the boundaries of the organization, which would ultimately help reduce the time and cost of cargo movement and dispatch.



As a more specific case, in 2017, Pacific International Lines (PIL) — the operator behind PSA International (PSA) terminals — and IBM worked together on a test exercise built around IBM's **Blockchain** system. The exercise tested a **Blockchain**-based supply chain platform for tracking and localizing cargo movement from Chongqing to Singapore. Among the basic objectives of the test were real-time monitoring and tracking, transparent, faithful, and regulation-compliant execution of logistical, multimodal, reserve capacity procedures and access control to ecosystem participant permits. The test was considered a success by operating partners (Manners-Bell, 2019).

In this sense, the possibilities are numerous and varied. For example, a company can develop a closed **Blockchain** for administering supply chains within the firm. They can use it to manage providers and outside vendors with permissions that are established according to the role of the user. A **Blockchain**-based platform could also include the related documentation, such as certification, origin, and payment information that is in-



volved as products move through a complex global supply chain, with greater accuracy and reliability than with current technologies. With **Blockchain**, the participants in a supply chain, all the way from the smallest provider to the end consumer, can track and verify specific products.

In an attempt to cut down on theft and falsification, the company Everledger built a **Blockchain**-supported platform for tracking individual diamonds on their route through a supply chain. The members of this **Blockchain** are insurance companies, financial institutions, and diamond certification agencies, and each one is able to follow the path of an individual diamond throughout its production cycle. This system works in accordance with terms established in smart contracts, and regulators can view and supervise the entire supply chain. [180]

In a similar way, for monitoring the quality of products — such as perishable agricultural products, or for controlling the temperature of shipment — a **Blockchain** could include data obtained from different devices, such as a built-in sensor in a shipping container that can track location, and another sensor to ensure that a product is not tampered with. The possibility of tracking individual shipments could facilitate the withdrawal of a product form the market, should it be necessary, or help authorities identify the point in the supply chain at which a product may have been tampered with or otherwise adulterated.

179. See: IBM Press Release, "Maersk and IBM Introduce TradeLens Blockchain Shipping Solution," August 10, 2018, https://newsroom.ibm.com/2018-08-09-Maersk-and-IBM-Introduce-TradeLens-Blockchain-Shipping-Solution
180. See: EverLedger, https://www.everledger.io/industry-solutions/diamonds/

In this vein, the Walmart Food Traceability Initiative,[181] which was put into effect in September of 2018, tracks the supply of vegetables acquired by the company with the purpose of increasing consumer trust and the safety of a product that has been the source of multiple foodborne illness outbreaks in the United States. The company expects to broaden the initiative to include other food products, both domestic and international. Walmart is also a member of an industrial consortium that seeks to set up **Blockchain** infrastructure in order to offer capacity and scalability to providers, such as small agricultural producers who distribute products to multiple companies.

As mentioned earlier, **Blockchain**-based platforms can include smart contracts that are executed automatically according to a set of trade rules. SMEs, transporters, and other companies that participate in a **Blockchain** could conduct monitoring on individual orders, and use smart contracts to automatically activate payments once certain terms have been fulfilled, such as the receipt of a delivery, without the need for human intervention. These platforms could also open new markets, even in developing countries where trade financing is not so easy to obtain.

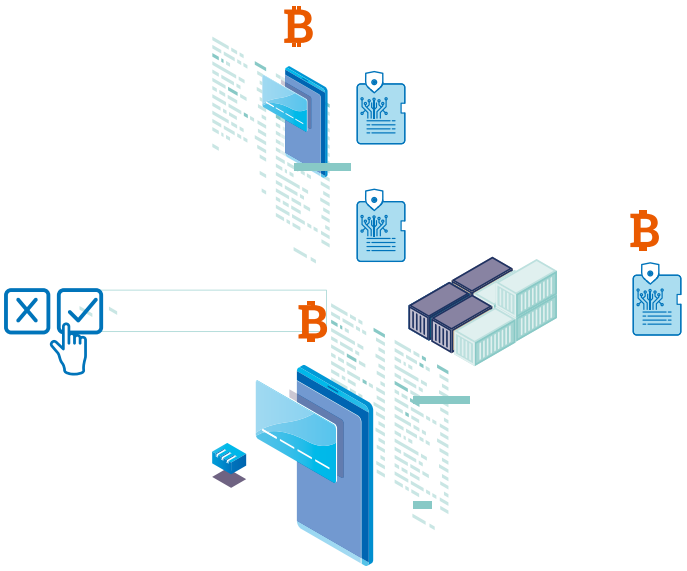
Through the adoption of this technology, banks could settle cross-border transactions in seconds instead of days, with fewer steps and less complexity. Several banks have developed pilot trade financing projects using **Blockchain** platforms. For example, the company We.Trade[182] relied on IBM's **Blockchain**, and has collaborated with 14 big European banks on the construction of a trade financing platform that offers services to facilitate international trade for SMEs.[183]

On a smaller scale, another example is the Argentine company Bitex,[184] which found in **Blockchain** an opportunity for improving international payments in general. By offering its users a quicker and less-expensive alternative to the SWIFT network for making international transactions, in February of 2019 they carried out the first export paid for entirely in Bitcoin.[185] This transaction was made between a company in Paraguay and a company in Argentina. The payment was made in guaraníes that were then converted to Bitcoin for processing, and the vendor company received the sum in US dollars, with a delay of less than an hour. Through this mechanism, payments are initiated in the local currency, and are converted to Bitcoin, to then later be received in another part of the world in a different currency. The commissions charged for Bitex transactions were 1% of the total amount, and there were no maximum limits, which could prove beneficial for SME insertion into value chains, given that they are typically curtailed by the fees imposed by the SWIFT network.

Likewise, we also note the possibility of **Blockchain** to facilitate trade flows by allowing companies to more easily send (and for regulatory bodies to receive) customs or other types of documentation, as well as payments for import tariffs, before the shipment even reaches the border. Some authorities are already testing **Blockchain** for this purpose.

On their part, the US Customs and Border Protection (CBP) service of the United States' Department of Homeland Security (DHS) is considering several options for **Blockchain** application[186] including for the processing of international trade documentation, and as an alternative to paper-based official records. One of the CBP's initiatives aims to implement monitoring of primary material imports, while another project is monitoring pipeline petroleum to ensure that it complies with the requirements for preferential trade established in the free trade agreement. The DHS is also testing out alternatives for securing US borders through pilot programs for storing data from cameras and other sensors using **Blockchain**, with the goal of preserving the data's integrity even if the devices are physically damaged.

180. See: EverLedger, https://www.everledger.io/industry-solutions/diamonds/
181. See: IBM, Food Trust, https://www.ibm.com/blockchain/solutions/food-trust/get-started
182. See: We Trade Platform, https://we-trade.com/banking-partners
183. See: Pollok, D., "Major Banks Buy Into Blockchain-Based Trade Finance Allowing SMEs To Profit," May 15, 2020, https://www.forbes.com/sites/darrynpollock/2019/05/15/major-banks-buy-into-blockchain-based-trade-finance-allowing-smes-to-profit/#4b1351af52c8
184. See: Bitex, https://bitex.la/
185. See, Cripto 247, "De Argentina a Paraguay, se realizó la primera exportación por aduana usando bitcoins" [The first customs export using Bitcoins was conducted, from Argentina to Paraguay], https://www.cripto247.com/comunidad-cripto/de-argentina-a-paraguay-se-realizo-la-primera-exportacion-por-aduana-usando-bitcoins-180416
186. See: Department of Homeland Security, Blockchain Portfolio, https://www.dhs.gov/science-and-technology/blockchain-portfolio



As we can see, the opportunities for trade, exports, and logistical services are immense. Generally speaking, **Blockchain** could provide greater levels of trust for all parties in a supply chain, due to its tamper immunity. It's cheaper than other existing systems, which encourages its use by small transporters, but also — and primarily — for international trade. It also provides transparency in supply chains, which is an increasingly important aspect for sectors such as food and medication production. At the same time, it improves efficiency and eliminates the possibility of repeat data entry, incorrect shipping cargos, or inaccuracies.

As an outcome, and in line with what Manners-Bell and Lyon have expressed, **Blockchain** has the potential to become an established technology for supply chains, that will lower costs and increase trust, visibility, and security within trade in general.

However, in order to achieve such outcomes, we must advance in certain fundamental aspects. For example, although emerging markets could be included among the primary beneficiaries of the implementation of **Blockchain** in trade, most current investment in this technology is happening in North American, European, and Asian markets. Bringing this technology to markets that are still struggling to access the internet will be a huge challenge (Blockchain Council, 2018.). For merchants in emerging markets to be able to access **Blockchain**, investments would have to be made in internet access or mobile technology in general. In turn, it would be necessary for governments to facilitate and support education and training in technical knowledge and technology.

Similarly, as we will explore in the following section, there are some barriers that could potentially limit its scaled adoption. Nevertheless, as Manners-Bell affirms, there is a high probability that by 2030, **Blockchain** will be widely adopted, although this depends on the development of its underlying technologies and the infrastructures that facilitate such developments.

b. Current Challenges

Aside from the promising applications mentioned above, as we started off this article by emphasizing, **Blockchain** is still in a premature stage of development. For this reason, concerns about its possible negative externalities, obstacles, and challenges, are still very prominent.

Below, we will describe several different (as of yet) unresolved problems that cast doubt on the idea of a scaled, short-term implementation of this technology, thereby limiting its theoretical impact on financial inclusion.

- **Financial integrity and regulation:** Quite probably, one of the main challenges will be related to security and legality. The privacy features offered by prominent **Blockchains** are ambiguous. As is the case with Bitcoin, most cryptographic transactions can be described as publicly visible but pseudo-anonymous (Meiklejohn et.al., 2013; Monaco, 2015).

For example, in Bitcoin and Ethereum, the entire general transaction ledger can be viewed by anyone, but instead of seeing the names of the senders, their cryptographic currency address is shown. Even developments like the cryptocurrency Monero respond to this need by offering advanced privacy features and non-traceable transactions (Monero, 2017).

Additionally, there are automatic currency systems that allow for the mixing and jumbling of transaction trails in any cryptocurrency. These "mixer" systems work well, as long as they aren't used to attempt to cover the tracks of very large sums of money.[187]

Another example of how **Blockchain** can maximize financial integrity risks are what are called Initial Coin Offerings (ICO), which in-

187. Read Buterin, 2013, "Trustless Bitcoin Anonymity Here at Last."

volve unregulated schemas that replicate the concept of crowdfunding, but through the use of virtual currencies. ICOs take place in a preexisting **Blockchain** (Bitcoin, Ethereum, etc.). It's worth mentioning that they allow firms and entrepreneurs — essentially, tech startups — to acquire resources without giving up control of the project or going through the rigorous and expensive process of traditional public bidding, which, among other things, requires the presentation of a legally binding prospectus.[188]

It is clear, therefore, that these privacy features could be inappropriately used for criminal activities which compromise financial integrity. To combat such illegal activities, there are regulations centered around the fight against money laundering (AML) and terrorism financing (CFT). Enforcing these regulations within **Blockchain** technology is difficult due to its lack of intermediaries.

It's not easy to balance the legitimate privacy needs of users with the need for security and the associated processing requirements of law enforcement bodies. Stances such as that of Australia, which deals with this by subjecting wallet providers to AML/CFT regulations, and their debates on how to regulate ICOs, are very interesting in this context, and ought to be considered by other regulatory bodies as well. [189]

There are many complex issues that regulators should consider, including which country should have jurisdiction across borders, and who has accountability, given that **Blockchain** are not limited to any specific location or controlled by any single party. Given that transactions are instant and can't be modified, regulators should also be concerned with the way in which errors or fraudulent transactions might be modified. If the issue of government regulation is not resolved, it will be an obstacle for **Blockchain** technology when it comes to widespread adoption by financial institutions.

Debates surrounding Libra, the cryptocurrency proposed by Facebook, which sought to conglomerate a large council of technological companies, is an example of this regulatory difficulty. The mere threat of creating competition against fiduciary currencies could incite States to limit developments in cryptocurrencies. Such analysis (while interesting) is beyond the scope of this article, but offers the valuable lesson that any decentralized proposal on the global level must be prepared to take on the wariness of States and nations, who are not willing to give up their monetary sovereignty. For more on this, we recommend works such as those by Mersch (2019) and Taskinsoy (2019a, 2019b y 2019c).

- **Energy consumption:** Most **Blockchain** developments use "Proof of Work" consensus protocols, including those of Bitcoin and Ethereum, which are the two most relevant. The extremely high levels of energy consumption of **Blockchain** that use "Proof of Work" consensus mechanisms, are another cause for concern.

To give an idea in terms of energy consumed, according to data offered by the website Digiconomist, the annual electricity consumption of Bitcoin alone is 72.28TWh, surpassing the 49.8TWh[190] which are required for the energy supply of all of Portugal within the same time period, and more than what was consumed by Bolivia, Chile, and Uruguay combined in 2018. Let's remember that Bitcoin and its **Blockchain** make up approximately 60% of the total capitalization of over 5,000 cryptocurrencies on the market, meaning these sums are only a minimum of what's being consumed.[191]

- **Interoperability and infrastructure:** **Blockchain** applications offer solutions that require significant changes to — or complete overhaul of — existing systems. In order to execute this shift, financial institutions must outline a transition strategy, especially smaller-sized entities that work within vulnerable populations.

For example, microfinance institutions that operate in many parts of Africa, Asia, and Latin America still use spreadsheets or even paper and pen to record transaction data. This lack of basic technological infrastructure obstructs the adoption of **Blockchain** solutions,

188. See: Ideas de peso, https://ideasdepeso.com/2018/05/10/criptoactivos-un-enfoque-de-supervision-microprudencial/#_ftnref5

189. See: "Regulating Digital Currencies Under Australia's AML/CTF Regime," in HYPERLINK "https://www.ag.gov.au/Consultations/Documents/AML-CTF/Regulating-digital-currencies-under-Australias-aml-ctf-regime.pdf" https://www.ag.gov.au/Consultations/Documents/AML-CTF/Regulating-digital-currencies-under-Australias-aml-ctf-regime.pdf and https://www.loc.gov/law/help/cryptocurrency/australia.php and also "Initial Coin Offerings, Issues Paper, January 2019" in https://static.treasury.gov.au/uploads/sites/1/2019/02/c2019-t353604-Issues_Paper.pdf

190. Data up to April 2020, See: Digiconomist, Bitcoin Energy Consumption Index, https://digiconomist.net/bitcoin-energy-consumption

191. As of April 2020, Bitcoin dominates 64.2% of all cryptocurrencies. See: CoinMarketCap, Top 100 Cryptocurrencies by Market Capitalization, https://coinmarketcap.com/

which require digital data as an essential foundation.

In an ideal world, this technology would allow multiple users and organizations to share information and make unlimited cross-border transactions. But with countless organizations all over the world working on creating their own **Blockchain**, interoperability and fragmentation could arise as barriers to its adoption.

• **Security, immutability, and privacy:** Even with the existence of private or federated **Blockchain**, and a strong encryption system, promises of security, immutability, and as a consequence, privacy, remain doubtful in the face of massively widespread attacks on cryptocurrency companies.[192] There are still cybersecurity problems that must be resolved before the general public will entrust their personal data to a **Blockchain**-based solution.

• **Adoption disparities: Blockchain** stands to cause a complete shift toward a decentralized network that requires the acceptance of its users and operators. Likewise, at least as of today, most developments are more complex than traditional mobile payments, and of course cash, which means that technical barriers to use are definitely bigger.

Prevailing digital inequalities mean that **Blockchain** could be less accessible to those who have less probability of internet access, whether because of connectivity, or knowledge of how to properly use digital services, thus widening the gap for demographics such as lower-income communities, or women (especially in developing countries).

If we don't take into account digital inequalities, we run the risk of further exacerbating these inequities (and, as a result, digital and social exclusion), or creating new ones, and opening the door to opportunist behaviors by powerful stakeholders that are able to access full usage of **Blockchain**. For a **Blockchain**-based solution to be inclusive, it must be designed with inclusion as a priority from the start.

• **Volatility:** Transaction costs and price volatility vary from one implementation to the next,[193] resulting in constraints in terms of scale and usability. When the price of Bitcoin reached almost 20,000 USD in late 2017, only to later start to fall in 2018, and today hover around 6,500 USD, the phenomenon was described as a "Bitcoin bubble," and served as a warning against the belief that Bitcoin prices only ever rise.

This condition of the leading currency leads to high levels of volatility in other cryptocurrencies as well. Such high fluctuation in cryptocurrency impedes functions two and three, and can also indirectly affect function one.

• **Real impact of financial inclusion on development:** Lastly, aside from the fact that this article presumes that a positive impact on financial inclusion, brought about by **Blockchain** technology, would be linked to the promotion of inclusive economic development within the framework of the 2030 Agenda, we must emphasize that controversies surrounding this relationship do still exist.

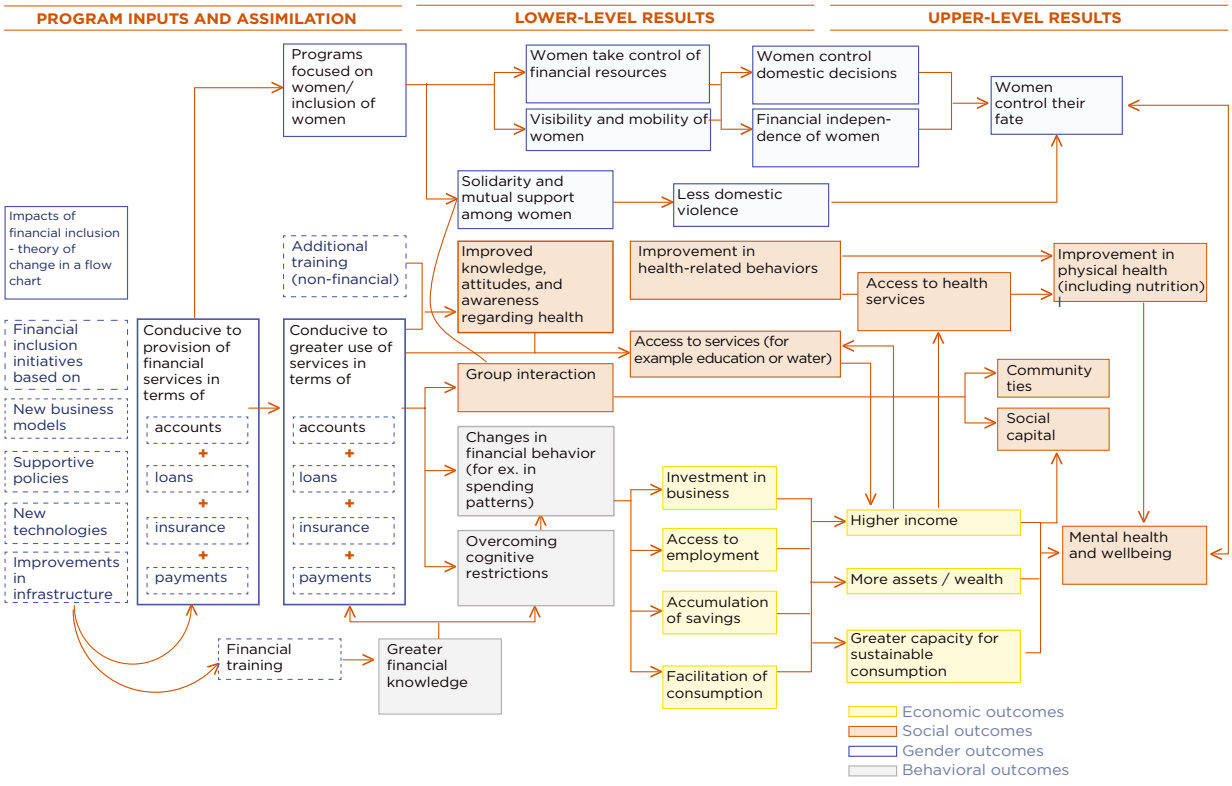
Duvendack and Mader, authors of the 2019 article, "Impact of Financial Inclusion *in Low- and Middle-income Countries: A Systematic Review of Reviews"* (likely the most exhaustive general study conducted on financial inclusion impacts), address the challenge of diagramming a Theory of Change to explain how financial inclusion could impact economic development areas. They go on to comprehensively summarize the empirical evidence that has sought to assess this complex maze of relationships (Figure 1 conveys the aforementioned complexity).[194]

In their article, the authors conclude that current evidence is mixed, given that some evaluations show positive impacts and others neutral impacts, but there are also others that show negative impacts. Therefore, it is still inconclusive to relate financial inclusion with inclusive development and SDGs, aside from the existence of some positive micro evidence. [195]

192. See: "If Blockchain is Unhackable, Why Have So Many Cryptocurrency Companies Been Hacked?" at https://www.quora.com/If-Blockchain-is-unhackable-why-have-so-many-cryptocurrency-companies-been-hacked
193. See: Box 1
194. For another approach to the complex maze of impacts of the multiple facets of financial inclusion, see: UNCDF, Financial Services Impact Pathways, https://impactpathways.azurewebsites.net/
195. To deepen these arguments, see: "Don't Fall for the World Bank's Bold Claims About Financial Inclusion and the SDGs", https://nextbillion.net/world-bank-claims-financial-inclusion-sdgs/

In short, considering the impact of **Blockchain** on financial inclusion as a positive one, by interpreting it as a means toward inclusive development, is at the very least debatable. Given that there exists no robust and overwhelming evidence, as of yet, on the (fuzzy and complex) connections that link financial inclusion with development factors, promoting **Blockchain** technology with the goal of strengthening financial inclusion lacks a sensible basis.

Figure 1.
Impacts of financial inclusion - theory of change flow chart



Source:
Duvendack y Mader (2019: pag 21)

4- Final Reflections

Blockchain can play a valuable role in providing financial services to those excluded from the traditional system. Additionally, developments outside of this sphere could also have significant repercussions when it comes to financial inclusion. Of course, within the broad spectrum of potential impacts, certain facets find themselves closer to development than others (such as international remittances).

A large-scale roll-out of **Blockchain** could offer enriching and exciting applications for financial inclusion. Smart contracts could allow for automation of many processes that today are carried out by hand. It would also provide data for analysis, which could be processed with Machine Learning or Artificial Intelligence in order to streamline loan amounts, terms, and interest rates, assess creditworthiness of non-banking clients, or identify fraudulent transactions.

However, **Blockchain** is still facing a slew of technical, regulatory, and practical challenges that limit the possibility of fully capitalizing on all its benefits. Given the huge variety of possible applications for this technology, the innovativeness of **Blockchain** comes with new sorts of challenges and risks. Potential dangers, such as the implications of the various anonymity features offered in cryptocurrency, must be contemplated and studied in depth.

Looking forward, it is crucial to compare the different variants of **Blockchain** technology in order to maximize efficiency levels while avoiding negative externalities. This way, keeping in mind its great potential, but also its risks, a proportional focus on regulation is essential. Regulating bodies must take into account the diversity of **Blockchain**s and the differences between the types of risks involved in each.

Careful coordination, research, and collaboration in order to resolve the problems mentioned in this article, and prepare the technology for widespread use in expanding responsible financial inclusion, will take time. Until then, institutions that promote financial inclusion must base their approach on the technology that allows them to serve the most clients in the best and most efficient way, even if it is not **Blockchain**.

Although this technology is hugely disruptive in a theoretical sense, there is still no proof that it will lead to social transformation. At the present moment, it's difficult to say whether **Blockchain** will fulfill the expectations projected onto it as an instrument for development and financial inclusion. What is clear is that it has the potential to add value, if its application is carried out in a strategic, creative, and responsible way.

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