Original: **Spanish**

www.cepal.org/transporte

number 3 / 2021 / ISSN: 1564-4243

FAL

BULLETIN 387

FACILITATION OF TRANSPORT AND TRADE IN LATIN AMERICA AND THE CARIBBEAN

Blockchain implementation opportunities and challenges in the Latin American and Caribbean logistics sector

Background

COVID-19 has placed several restrictions on value chains, creating a complex scenario in many areas of international trade, especially in distribution logistics. However, this period has also served as a real digital catalyst, accelerating an already developing trend that is expected to continue even after pandemic-related

→

This *FAL Bulletin* continues the Reflections on Disruptive Technologies in Transport that ECLAC has been publishing through this medium. The present edition analyses the potential opportunities and challenges of the implementation of blockchain technology for competitiveness in the region.

The document highlights the importance of blockchain as one of the key technologies of the fourth industrial revolution, owing to its potential to redefine logistics chains and the functioning of the transport industry and logistics activities.

The document was prepared by the consultants Rodrigo Mariano Diaz and Luis Valdes Figueroa, and by Gabriel Pérez, Economic Affairs Officer of the Infrastructure Services Unit of ECLAC. For further information on this subject, please contact gabriel.perez@cepal.org.

UNITED NATIONS

ECLAC

restrictions are lifted, shaping a new logistical reality. The adoption of new technologies and the innovation that this usually brings may also be a good alternative for the recovery from this crisis, through the creation of better quality jobs and safer and more efficient services.

Society is in the midst of the fourth industrial revolution, characterized by a range of new technologies that are combining the physical and the digital, leading to paradigm shifts in all disciplines, economies and industries with even more dramatic impacts than previous revolutions. In this new scenario, information is an organization's greatest asset, and together with developments such as big data and machine learning, it not only has the potential to allow organizations to significantly improve their efficiency and provide value added services that set them apart from competitors, but also to regenerate the natural environment and undo the damage of previous industrial revolutions (Schwab, 2017).

In trade and logistics specifically, the digital transformation is bringing about significant changes in business models, with increasingly indistinct boundaries between both actors and countries, and competition focused more on the quality of services than on prices (Barleta, Pérez and Sánchez, 2019). As highlighted in *FAL Bulletin*, No. 381, to address this process, logistics governance must include coordinated actions that promote digital transformation and favour collaborative arrangements between the different actors of the logistics industry, both public and private, as well as the creation of technical-political advisory bodies for this transformation process (Pérez and Valdés, 2020).

According to the World Economic Forum (WEF), blockchain, which is one type of distributed ledger technology (DLT), is one of the most promising technologies of the fourth industrial revolution. This is because, regardless of the size of the logistics actor or its position within the value chain, there is a good chance that its processes or the data generated will soon use this technology either directly or through applications that incorporate blockchain technology (WEF, 2019).

The use of blockchain technology in logistics activities aims to reduce the handling of paper documentation, improve checks, reduce dispatch error rates and allow smart contracts to be automatically executed when the conditions set by the parties are met. In addition, proper implementation of this technology is expected to substantially reduce trade disputes related to cross-border checks, making trade logistics operations simpler and cheaper (WEF, 2018).

However, there are also significant technological challenges and difficulties in the implementation of blockchain that could not only hinder the potential benefits of this technology (Pedersen, Risius and Beck, 2019), but could also exacerbate existing problems relating to areas such as free access to markets, integration of actors and asymmetries in the treatment of small and medium-sized enterprises (SMEs).

The main issues of concern in the implementation of this technology are the complexity of implementation, the lack of trained professionals, processing times and cybersecurity (Knight, 2017). One problem to bear in mind is that, given the heterogeneity of existing information systems, as well as the big differences between implementing blockchains that are open and closed to a particular vendor, additional costs could be generated to achieve interoperability between systems, and this could have an impact especially on SMEs. The mass use of blockchain associated with a single technology provider could also create entry barriers to certain markets or even strengthen the concentration of the sector with the resulting challenges this represents for free competition.

This bulletin analyses the potential benefits and challenges of blockchain for Latin American and Caribbean countries and is divided into six sections. The first section presents a conceptual and theoretical background to the development of blockchain. Section two describes specific solutions that blockchain could provide in international trade. The third section complements section two by analysing the current technological, organizational and regulatory challenges of this technology. Section four analyses the main applications of blockchain in the logistics sector. Section five presents background information to help actors in the port logistics industry decide whether to use blockchain technology based on technical and functional considerations. Finally, the sixth section of the document presents recommendations on blockchain for both public and private actors.

I. General background on blockchain

From a purely technical perspective, the term “blockchain” refers to a data structure that stores information in blocks that form a chain in which new blocks are linked to previously formed blocks. The term was coined on 31 October 2008 by Satoshi Nakamoto, creator of the bitcoin cryptocurrency, in “Bitcoin: A Peer-to-Peer Electronic Cash System”. He explained that the purpose of blockchain technology was to create a digital version of cash that could be transferred between two entities without the need for the involvement of a third party acting as an intermediary and attestor of the transaction (Nakamoto, 2008). This was a radical change from the prevailing transactional model, in which a trusted third party (typically a bank) was essential to validate the legitimacy of a transaction and the ownership of the asset exchanged.

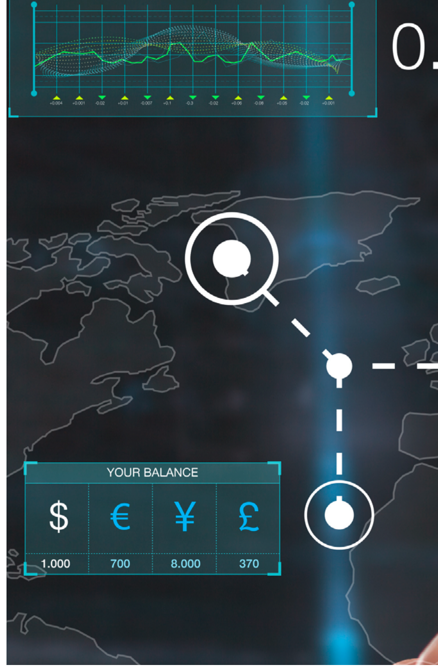
Blockchain proposes a transactional model based on collective knowledge and trust between the participants themselves, without intermediaries, which allows them all to view the existing information and therefore give legitimacy to transactions and also to validate and then record the transactions.

Each block is digitally signed by the owner and includes the relevant data of the transaction, a timestamp and the hash of the previous block, in order to link all the blocks that make up the chain (Nakamoto, 2008). It is important to understand how the algorithm that produces the hash[1] of each block works.

Regardless of the data content (it can be one word or an encyclopedia), the algorithm applies a mathematical function that transforms that content into a hash that is 256 bits in length. This hash has two very important characteristics, namely, non-repetition (the probability of finding the same fingerprint for different data is very low) and the uniqueness of the fingerprint, i.e., the result of applying the algorithm will always be the same each time the same data set is applied. If there is any change in the data, the algorithm output will change and therefore the fingerprint will be different, as shown in diagram 1.

Bearing this in mind and considering that the hash of the preceding block is added to each block of data before calculation, the hash of the preceding block cannot change either, as it would change the result of the hash being calculated. Each block is thus linked to the previous one. Running this iteration systematically over a period of time produces

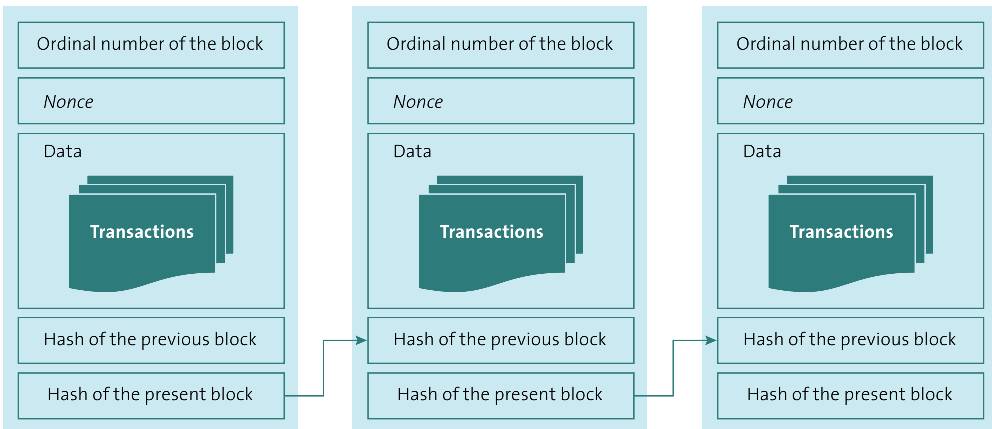
[1] The result, output or fingerprint of a set of data to which a given function is applied.



consecutively linked blocks identified by their ordinal number. To establish control of ownership of a digital asset and prevent the risk of double-spending, the date of the transaction is also recorded in each block to establish which transaction was made first.

The operating model of a blockchain allows for the involvement of many participants, where each is able to store and share information from the blocks in the network and is referred to as a node. These can all work at the same time with little coordination and do not need to be identified, since the messages are not routed to any particular place. This gives rise to a distributed network without intermediaries that control it, which makes the model more solid. However, as these blocks are replicated across different nodes, modifying a completed block would, in theory, require applying the change for all stakeholders across the network, which is why blockchain data are usually considered secure and immutable (Brownworth, 2016).

Diagram 1
How a blockchain is built



Source: Prepared by the authors on the basis of A. Brownworth, "Blockchain 101: A Visual Demo", Boston, Massachusetts Institute of Technology (MIT), November 2016 [online] http://blockchain.mit.edu/how-blockchain-works.

While the use of hash algorithms makes it extremely complicated for an attacker to change the data, since they would have to control most of the processing power of the network to overcome the accumulated capacity of the honest nodes, this is feasible when the nodes are limited or extremely vulnerable. The technical cybersecurity term applied to this phenomenon is "Sybil attack" (Binance Academy, 2020).

When every node in the chain can view the information freely, the blockchain is "open". When nodes require authorization to read the blocks, the blockchain is "closed". The nodes participating in a blockchain can read, write and commit transactions, depending on their permissions. Table 1 describes blockchains on the basis of permission models (Hileman and Rauchs, 2017).

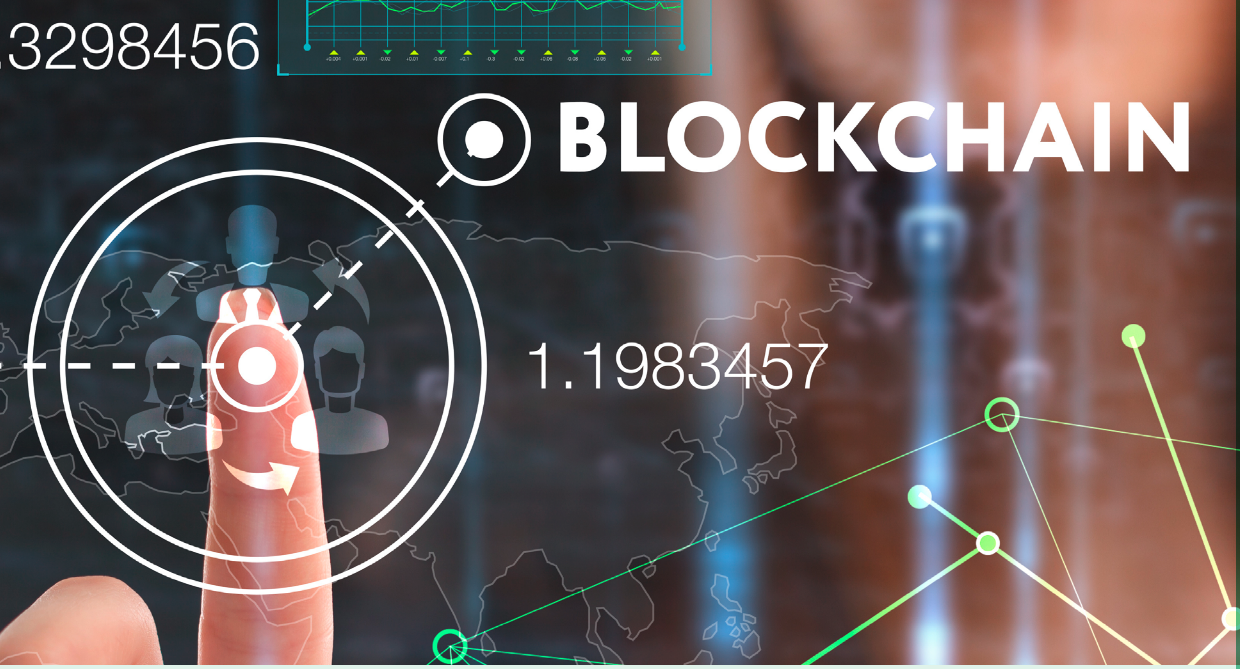


Table 1
Types of blockchains based on permission models

	Type of permission	Read	Write	Commit
Open	Public permissionless	Anyone	Anyone	Anyone (high computational power required)
	Public permissioned	Anyone	Authorized participants	All or subset of authorized participants
Closed	Consortium	Authorized participants	Authorized participants	All or subset of authorized participants
	Private permissioned	Private participants	Network operator only	Network operator only

Source: Prepared by the authors on the basis of G. Hileman and M. Rauchs, "Global Blockchain Benchmarking Study", Cambridge Center for Alternative Finance, University of Cambridge, 2017 [online] https://j2-capital.com/wp-content/uploads/2017/11/GLOBAL-BLOCKCHAIN.pdf.

Finally, a consensus algorithm allows each member of a group to take and support a decision that favours everyone. Consensus is required to ensure equity and equality in the blockchain. The first algorithm used by the bitcoin network is called proof of work (PoW) and it involves solving a highly complex mathematical puzzle, which once solved, is very easy to reproduce in the rest of the nodes. While PoW is a very useful consensus algorithm, it requires significant computational power (hardware) to run in a reasonable amount of time, which makes it inconvenient in chains with high transaction rates and short transaction commit times. For this reason, a variety of consensus algorithms have been developed to solve these issues, using mainly private networks, to reduce the complexity and thereby the computational power and time required (Ismail and Materwala, 2019).

II. Blockchain and the opportunities it provides for international trade

Each international trade operation triggers hundreds of processes and as they are carried out, they are registered in the systems of each participant. Throughout the logistics chain, these data are replicated in the systems of each participant, where they are often re-entered into a new system. In Latin America and the Caribbean, it is estimated that 75% of exporters re-enter data in their systems and then submit paper documentation to the respective trade authorities (IDB, 2020). The existence of multiple records often leads to errors, information time lags, delays and inefficiencies, and may even lead to fraud.

Given that the blockchain contains a single shared and verified version of the data, proper implementation of this technology can provide the same information to all participants, eliminating the need for a centralized authority and reducing the volume of paper used (paperless trade), time, costs and the complexities of bilateral trade communications. Moreover, if the storage of information in the blockchain involves advanced cryptographic techniques (blockchain data are by default not encrypted) in addition to encrypted electronic communication between the parties, much more secure services can be provided, allowing traceability and analysis of data dynamics (Perboli, Musso, Rosano, 2018).

The World Economic Forum developed a study on blockchain and its potential impact on supply chains, which involved more than 60 participants from 40 different countries. This analysis identified five generic blockchain use cases and their potential impact on international trade, as shown in table 2.

Table 2

Use cases relating to international trade and supply chains

Use case	Potential impact of blockchain
Product provenance and traceability	It would offer advantages and greater accuracy in the management of product certificates, reducing the risks of fraud and adulteration.
Streamlining of commercial operations	It would favour secure information-sharing, fostering secure and paperless trade. Traceability using this technology would favour better planning within processes.
Automation and smart contracts	It would increase transaction efficiency, through faster processes and lower administrative costs. When certain contract conditions are met, contracts are executed automatically.
Trade finance	It would make trade finance easier and more transparent, especially in terms of efficiency and security of processes.
Facilitation of the detection of discriminatory measures	It would encourage the auditing of processes and thus encourage businesses to be more transparent and ethical.

Source: Prepared by the authors on the basis of World Economic Forum (WEF), "Inclusive Deployment of Blockchain for Supply Chains - Part 1 – Introduction", White Paper, Geneva, March 2019.

Among these cases, perhaps trade finance could have a more quantifiable and visible impact for regional exporters, especially for SMEs that must face the high costs associated with this item, both for the financial transaction itself, and for the time taken and possible delays in the international banking process.

Therefore, proper implementation of blockchain could improve the efficiency and security of international trade. Some areas of trade in which this technology could bring about important changes are: achieving consensus and establishing international standards that allow the interoperability of systems associated with certification of origin; and traceability of sensitive trade data through blocks, starting with the genesis block —ensuring the immutability of data and their purpose— through the use of a single shared ledger to determine the ownership of an asset or the completion of a given transaction (Ahuja, Amir and Kunpeng, 2020).

On the basis of these characteristics, it is hoped that the logistics sector business model will change soon, and incorporate new applications, technologies and value added services, allowing the satisfaction of demand that is much more challenging in terms of security and traceability, and services with shorter delivery times and lower delivery costs.

III. Technological, organizational and regulatory challenges posed by blockchain

Like any new technology, blockchain has gone through different stages of development. From the initial phase of exploration of possibilities, to the development of the structure and content, to a state of maturity in which the market helps to define its practical usefulness. Today blockchain has reached a stage of technological maturity and therefore developers are beginning to strengthen its use to tackle new technological and organizational challenges.

Some of the main ones, for example, are the tendency towards excess in the applicability of the technology (everyone wants to use or says they want to use blockchain, although they do not really need it); the shortage of technical professionals specialized in this technology,[2] especially professionals who also know the logistics business; and last but not least, the high cost of implementing solutions, including not only hardware and storage capacity, but above all, the consultancy services to create and subsequently support the applications that use blockchain.

In order to quantify the IT resources required for blockchain, the bitcoin analogy will be used as a valid example owing to the related transactional volume, development time and experience of use. The bitcoin cryptocurrency is not only highly developed, but the size of the complete bitcoin blockchain has grown exponentially, to 288GB in August 2020 and then to 335GB by the end of March 2021, which means that each completed bitcoin block requires that amount of storage space at least in each node, and in June 2020 the total number of nodes was roughly 45,000 (Blockchain.com, 2020).

Another factor that helps to measure the demand for equipment is the IT processing time to generate new blockchain blocks. For example, another cryptocurrency that uses blockchain is ethereum, which doubled in size in 2020, with the size of an archive node —which stores the complete chain, the state of transactions and blocks completed since inception— amounting to five terabytes.[3]

With regard to organization, blockchain eliminates intermediaries, thereby causing paradigm shifts in some of the rules of business and traditional organizational cultures (Pawczuk, 2020) through the decentralization and democratization of information (Baldet, 2019). The use of multiparty models in organizations where peer-to-peer (P2P) communication was infrequent can lead to major paradigm shifts in areas ranging from the ownership and privacy of internal data to the analysis of the impact of these changes in terms of possible civil or criminal liabilities (Pawczuk, 2020). These elements are already being analysed by entities such as the World Economic Forum and the Community Research and Development Information Service (CORDIS) of the European Union.

As organizations adapt their models to the new structure, governments and international regulatory frameworks must also adapt their technical rules and regulations to the new digital context. One issue, undoubtedly among the most important, is information security.

Confidentiality, integrity and availability (the CIA triad) represent the basic principles of information security (*CambioDigital*, 2020). Although blockchain design includes elements associated with the integrity and availability of data, as mentioned earlier in this document, confidentiality (security) is not an intrinsic characteristic, despite the erroneous myth that blockchain data are secure because they are encrypted. It is important to bear in mind that blockchain data are not encrypted by default, but are available to all participants, and cryptography is used only to generate records immutably over time or in specific applications. For this reason, the security triad must be incorporated into blockchain technology as one of the specific functional requirements for both decision-making and the implementation of solutions.

IV. Blockchain applications in logistics

As discussed previously, some specific characteristics of blockchain make it an interesting technology to improve the confidentiality, integrity and availability of commercial information and of logistics processes, favouring cooperation between dispersed actors. Moreover, by dispensing with a central authority, and provided that the information is encrypted and replicated in the nodes of the participants, blockchain could favour technical solutions that promote transparency, auditability and functional equity of transactions (Tsiulin and others, 2020).

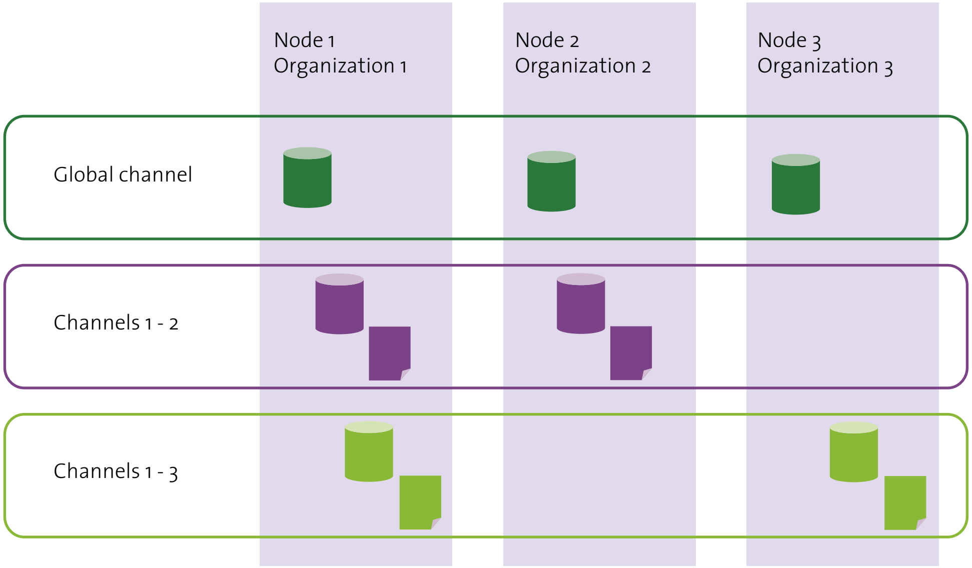
2 Only 56% of the world's top 50 universities offer courses on blockchain (Coinbase, 2019).

3 One terabyte (TB) is equivalent to one million megabytes (MB) or 1,000 gigabytes (GB), which is equivalent to the disk storage capacity of approximately four modern laptop computers (256 GB).

These potentialities have prompted blockchain developments and initiatives oriented especially to the logistics sector, such as CargoX, TradeLens, CargoSmart, dexFreight, CADENA and others, which aim to create digital solutions for cargo document management, traceability of certificates of origin of products, trade finance, leveraging of the Internet of Things (IoT) and contract automation, among other applications that are being developed and that are expected to be launched soon.

In 2016, the Linux Foundation established Hyperledger, an open source community focused on developing a suite of stable frameworks, tools and libraries for enterprise-grade blockchain deployments. It is a global collaboration involving the finance, banking, supply chain, manufacturing and technology sectors (Hyperledger.org, 2020a). Under this scheme, supported by the Linux operating system, tools and methodologies have been developed to manage the confidentiality of the data stored on the blockchain. Particularly noteworthy is the channel approach, whereby nodes can only access information in the channels to which they belong or to which they have been authorized access. Diagram 2 illustrates this architecture and the distribution of the blocks only in the nodes belonging to the same channel, thus protecting the confidentiality of the information from other nodes outside the channel.

Diagram 2
How channels operate in Hyperledger



Source: Prepared by the authors on the basis of the Hyperledger Fabric model.

In 2016, Walmart used the Hyperledger platform to develop a proof of concept project to analyse the benefit of food traceability technology in possible outbreaks of food-borne diseases. It took weeks to find the source using the "traditional" means of detecting and isolating potentially contaminated batches, while the use of blockchain allowed this to be done in a matter of minutes depending on the number of nodes and the complexity of the product value chain in terms of intermediaries (Hyperledger.org, 2020b). Similarly, in December 2019, KPMG, Merck, Walmart and IBM conducted a pilot programme on systems interoperability using blockchain technology to establish supply chain traceability for some prescription drugs regulated by the United States Food and Drug Administration (FDA). The programme met the expected reporting and traceability requirements and reduced the tracing time from 16 weeks to 2 seconds (Treshock, 2020).

Table 3 details the main blockchain solutions associated with international logistics and transport currently in use and the type of blockchain they employ.

Table 3
Features of blockchain solutions related to maritime and port logistics

Solution	Cargo registration	Traceability	Trade finance	Internet of things and automation support	Type of blockchain
TradeLens	X	X		X	Consortium
CargoSmart	X	X		X	Private
DataPorts		X		X	Public permissioned
Dexfreight		X	X		
Cadena				X	Public permissioned
CargoX	X				Public permissioned
Wave BL	X				Public permissioned
Cargochain	X				Public permissioned
Chain of Things				X	Public
Gatechain	X		X	X	Public
Open Trade Docs	X				Public permissioned
Provenance		X			Public
Skuchain	X		X		Public

Source: Prepared by the authors.

The following sections will analyse three initiatives that are relevant both in terms of their mass use and regional approach.

A. TradeLens

One of the projects that is currently furthest along in terms of maturity is TradeLens, a solution developed by A. P. Moller-Maersk and IBM in 2018. It is an operational platform used by groups in the global shipping network, employing a cloud-native approach with an application programming interface (API) that enables the exchange of electronic documents in the standard format defined by the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFAT). The platform uses microservices, which in turn use and send data to a lower layer of storage comprising various persistence technologies, such as object storage, document databases, relational databases and some data stored in blockchains. Although the reference to TradeLens here is directly related to the use of blockchain, the platform only stores some data using this technology. The rest are stored using different technologies depending on the nature of the information to be safeguarded and may not reflect the characteristics of blockchains.

The information stored in the blockchain is incorporated in a chain for each shipping line, and each chain is called a channel, in keeping with the Hyperledger Fabric standard. The data in one channel are not visible to the others (TradeLens, 2020). In other words, each shipping company vertically builds its channel in the data storage layer as an individual blockchain.

While the standard used by TradeLens is open source, participating nodes must be established within the IBM Blockchain Platform, a private cloud-based blockchain platform offered by IBM with permissions for access to information. This implies that all nodes belonging to a channel, or to the entire trade and logistics ecosystem involved, must be incorporated into the service platform of a single private company, which means that the theoretical concept of trust is not fulfilled as there is one blockchain network operator.

B. DataPorts

DataPorts is a system funded by the European Union and aims to provide advanced data services using artificial intelligence techniques for the next generation of cognitive ports.

It involves public and academic institutions from France, Germany, Greece, Israel and Spain, collaborating under the Horizon 2020 project of the Digital Agenda for Europe initiative (CORDIS, 2020). The project seeks to change the paradigm of collaboration with a focus on coordinated efforts in the regulatory and normative framework.

The consortium promises to interlink information from multiple data sources such as global shipping networks, port community systems (PCSs) and logistics operators. Hyperledger Fabric has been selected as the blockchain distributed storage platform because it best suits the context of the port community (DataPorts 2020). In this case, unlike in the previous example, the blockchain will be public, but access to global information, specifically relating to ports, will be restricted. Work is also being done to establish policies to exchange and trade data in an accurate, secure and reliable manner. The pilot test of this project involves the Port of Valencia and its PCS and the Thessaloniki Port Authority (THPA) for operations involving cruise ship passengers and containerized cargo.

Specifically, the aim is to observe the performance of blockchain technology in defining secure rules for the exchange of data to ensure privacy and security, and in the improvement and efficiency of services provided relating to the supply chain and passenger transport (Safety4Sea, 2020).

C. LACChain – CADENA

This initiative aims to develop an open ecosystem for the development of blockchain solutions in Latin America and the Caribbean, independent of the technology used, to promote greater regional interoperability and to encourage public-private collaboration in the exchange of cross-border data.

Within this framework, a proof of concept called CADENA has been in development since February 2018. It seeks to facilitate the exchange of data between several customs offices in Latin America on companies that are part of the regional authorized economic operator (AEO) programme. It is being developed by IDB and Microsoft, with the participation of the Chilean National Customs Department, the National Directorate of Taxes and Customs of Colombia, the General Customs Directorate of Costa Rica, the Tax Administration Service of Mexico and the National Superintendency of Customs and Tax Administration of Peru. Under this scheme in 2018, the four customs authorities that are part of the Pacific Alliance (Chile, Colombia, Mexico and Peru) signed a Mutual Recognition Agreement and a similar agreement is expected soon among the countries of Central America, the Andean Community and MERCOSUR (IDB, 2020).

Among the expected benefits of the project are the secure and reliable automation of data sharing between customs authorities, with data integrity and control of access through profiles with specific roles and authorizations, which facilitates traceability and transparency in the entire logistics chain. Although the channels and use cases included in the project correspond to AEOs, the project is based on Hyperledger Besu, which will establish permissions, with the possibility of extending these developments to other areas of the logistics chain while maintaining the development logic (LACChain, 2020).

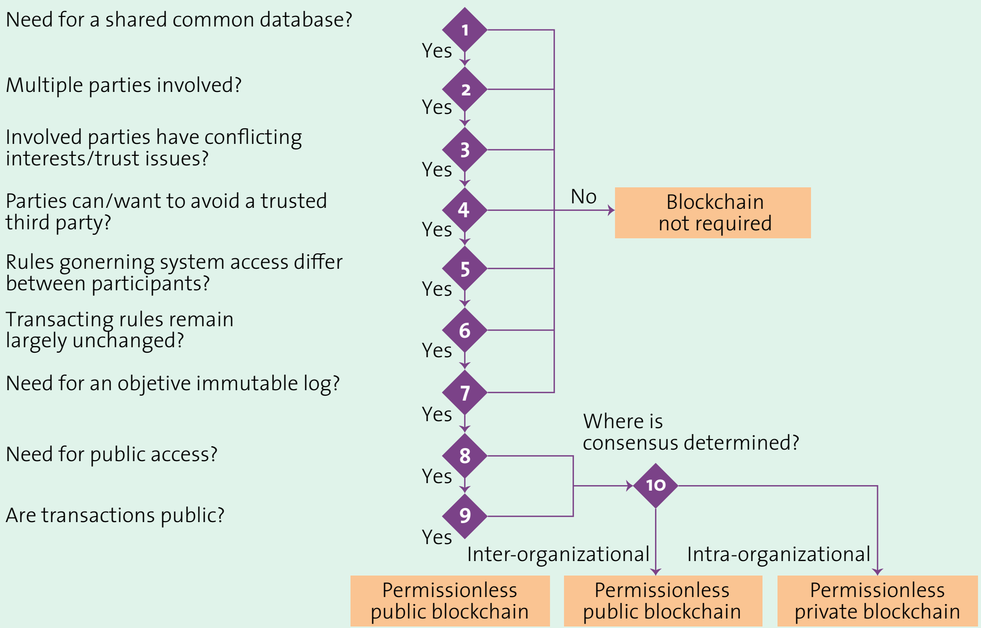
V. Is blockchain the right technology for my business?

As discussed in previous sections, blockchain technology is appealing because it eliminates the need for intermediaries and enables a range of public record-keeping services. However, as with any decision on technology, it is important to analyse which option is best suited to current requirements and possible future business scenarios.

The diagram 3 illustrates an analysis in 10 steps of whether blockchain is the technology most suited to requirements.[4]

Diagram 3

Blockchain decision path



Source: A. B., Pedersen, M. Risius and R. Beck, "A ten-step decision path to determine when to use blockchain technologies", MIS Quarterly Executive, vol. 18, No. 2, 2019 [online] https://aisel.aisnet.org/misqe/vol18/iss2/3.

If, as a result of the above analysis, it is determined that blockchain is the appropriate technology for a process to be digitized or made more efficient, it is still necessary to analyse the regulatory framework and the demand for computing infrastructure, before making a final decision.

However, there is still some confusion about the use of blockchain technology and much of the information on the market comes from technology providers, which often promote their own solutions over international standards that would favour greater interoperability. As a result of this disinformation, blockchain is attributed characteristics that are non-native or that can be achieved by other technological means at a much lower cost. Some examples include information security, ease of integration and contract automation.

Although each organization should be allowed to analyse its own processes to determine the applicability of blockchain, here are some general questions that must be answered to ensure successful implementation.

Considerations relating to the network structure

- How many nodes will make up the network?
- Is the network large enough in terms of the number of nodes and processing capacity to be secure?
- Should my organization have processing and storage capacity for network-wide transactions?
- Are there any restrictions and/or regulations related to data protection? Is there information that needs to be shared? Which information can be shared with the entire network?
- Who owns the original and network-generated information?
- Are there any restrictions on data persistence and storage?

[4] For more information see Pendersen, Risus and Beck (2019).

Considerations relating to implementation

- Are the cases being implemented in blockchain focused on transforming operating processes?
- Is my solution open and neutral? What does this mean for my business?
- Does it use agile development methodologies that allow incremental implementation to analyse the success of development and the eventual impacts on other areas and systems?
- If problems arise, do I have the option to undo actions? Can I correct errors quickly and inexpensively, without affecting my day-to-day operations?

Considerations relating to performance

- How much investment is needed to provide the level of storage and processing required to meet blockchain needs? Will this investment generate profits for the business?
- Are the response times projected by the solution in line with the nature of my business? This is especially important when transactions are sensitive to fluctuations in value over short periods of time, such as commodities, currencies and other internationally tradable securities.

Considerations relating to the rules of the logistics business

- What is the real cost and return on investment (ROI) of a blockchain project?
- Can expectations be met by using another technological alternative? For example, smart contracts are not exclusive to blockchain; they are also possible with other mature technologies at a lower cost.
- When is it too early or late to develop blockchain solutions?

Considerations relating to data management and information security

- Does sharing business data pose any risk to the company?
- Who owns the data recorded and stored in the blockchains, especially when they are open and public or hybrid?
- Who has the right to collect, access, modify, delete or market these data?
- When data are "owned" by the system, who is responsible for them?
- How can incorrect data be modified (deleted) in the blockchains? What are the accounting or business rule implications of this?

Considerations relating to market regulation

- Can the government promote a national/regional standard among the different logistics actors? Does my project meet those standards?
- How can blockchain be prevented from becoming a barrier to entry into certain markets? How can the participation of SMEs be protected and promoted in such projects?
- What incentives can the authorities provide to encourage this type of IT project?

VI. Recommendations

Blockchain technology is not widely used in the Latin American and Caribbean logistics sector. The documented experiences are limited to proofs of concept or implementation initiatives that target only a very small portion of the real operating volumes of the companies involved. Despite this, there is a lot of interest in the subject and in some cases, an urgency to participate without deeper analysis and merely to differentiate oneself from competitors (marketing). The lack of an exhaustive analysis of the characteristics and requirements of blockchain use, and the failure to consider the exponential growth in resource consumption by blockchain technology over time, may lead to incorrect conclusions.

One factor that has discouraged the use of blockchain technology is the need for a series of specific and ideal conditions that make use cases feasible, conditions that are often not favoured by the logistics sector's own rules or regulations for reasons of transparency, competition and market contestability. For example, the technology is not responsible for the authentication measures applied to participants. In a business environment, this means there must be an already established method to verify the digital identity of the participants in the chain. In this case, if a third party platform is used, the model would still be centralized, which is not in line with the aims of blockchain.

With regard to the adoption of the technology by companies, there are currently commercial platforms that claim to be "blockchain-based", meaning that they use the technology for processing and storage in some of their operations. Despite this, the strength of the distributed model proposed by blockchain technology is based on the number of actors participating in the network, and this advantage is lost when a single technological vendor is responsible for all the processing and data.

Considering the cases analysed, along with the current application and adherence of organizations to these systems, the technological challenges posed by blockchain platforms some years ago have evolved considerably. The standard established by Hyperledger now enables a blockchain network that can solve many of these problems through new access permission schemes, suitable consensus algorithms and channel architectures to ensure the distribution of information to nodes that have been previously authorized to gain access. However, to date, ecosystems have not scaled in the direction that is naturally expected through distributed ledger technology. The main advantage is the connection of nodes with absolute freedom of choice, i.e., through a cloud service provider or through a structure built and operated by the organization itself, especially for public or governmental institutions that are highly involved in port logistics. While the solutions currently available can solve many of the challenges related to the handling of cargo documentation, there is no evidence of a degree of maturity and use of the main features of blockchain that differentiates systems based on this technology from PCS systems based on pre-existing technologies.

Most solutions in the maritime and port industry that use blockchain technology and are up and running were developed by the major shipping lines, and the rest of the ecosystem participants have gained access as customers who pay an initial setup cost, plus an annual maintenance fee for Software-as-a-Service (SaaS). However, all these solutions exist in an environment in which policies and regulations do not necessarily favour collaboration among competitors, so many of these projects have reproduced the same operational and documentation silos. As a result, each institution must work hard to maintain multiple interfaces, with the consequent technological complexity, monitoring and maintenance, and is also potentially a source of a cybersecurity breach.

Given the scale of existing solutions and the new projects envisioned in the logistics and customs sector, it is appropriate that customs regulations, as well as trade and transport regulations, incorporate these new contexts to encourage new ways of operating, reduce costs and promote healthy competition.

It is essential to develop initiatives to support SMEs and to train workers in the sector, first to measure and understand this new logistics scenario and then to provide them with the necessary skills to participate actively in the digital economy. This involves not only resolving issues of access, cost and speed of broadband, but also providing digital and cybersecurity knowledge that allows them to fully leverage the potential of the digital transformation of the logistics sector, where blockchain is one of many elements changing the way business is done.

As with any technology, blockchain on its own is not a direct benefit to companies. Therefore, this technology must be analysed first on the basis of the needs of the business and not of its benefits, keeping in mind that blockchain is just one more technology among a group of solutions.

VII. Bibliography

Ahuja, M., G. Amir y L. Kunpeng (2020), "Blockchain and the supply chain", David Nazarian College of Business and Economics (CSUN), 7 April, California [online] https://www.porttechnology.org/technical-papers/blockchain-and-the-supply-chain/.

Baldet, A. (2019), "The world needs blockchains that blend idealism with pragmatism", *MIT Technology Review*, M. Reilly, 23 April, Boston, Massachusetts Institute of Technology (MIT) [online] https://www.technologyreview.com/2018/04/23/143690/the-world-needs-blockchains-that-blend-idealism-with-pragmatism/.

Barleta, E., G. Pérez and R. Sánchez (2019), "Industry 4.0 and the emergence of Logistics 4.0", *FAL Bulletin*, No. 375, Santiago, Economic Commission for Latin America and the Caribbean (ECLAC).

Blockchain.com (2020), *Blockchain Charts* [online] https://www.blockchain.com/charts.

Binance Academy (2020), "Sybil Attacks Explained" [online] https://academy.binance.com/en/articles/sybil-attacks-explained.

Brownworth, A. (2016), "Blockchain 101: A Visual Demo", Boston, Massachusetts Institute of Technology (MIT), November [online] http://blockchain.mit.edu/how-blockchain-works.

CambioDigital (2020), "La tríada CIA: definición, componentes y ejemplos" [online] https://cambiodigital-ol.com/2020/03/la-triada-cia-definicion-componentes-y-ejemplos/.

Coinbase (2019), "The 2019 Leaders in Crypto Education", 19 August 2019 [online] https://blog.coinbase.com/highereducation-c4fb40ecbcoe.

CORDIS (2020), "A Data Platform for the Cognitive Ports of the Future", January [online] https://cordis.europa.eu/project/id/871493.

DataPorts (A Data Platform for the Cognitive Ports of the Future) (2020), "D2.3–Blockchain design specification M09", September [online] https://dataports-project.eu/wp-content/uploads/2020/10/DataPorts_D2_3_Blockchain_design_specifications_M09_pu_v1_1.pdf.

Hileman, G. and M. Rauchs (2017), "Global Blockchain Benchmarking Study", Cambridge Center for Alternative Finance, University of Cambridge [online] https://j2-capital.com/wp-content/uploads/2017/11/GLOBAL-BLOCKCHAIN.pdf.

Hyperledger.org. (2020a), "About Hyperledger" [online] https://www.hyperledger.org/about.

___(2020b), *How Walmart brought Unprecedented Transparency to the Food Supply Chain with Hyperledger Fabric* [online] https://www.hyperledger.org/learn/publications/walmart-case-study.

IDB (Inter-American Development Bank) (2020), "Blockchain y comercio internacional: nuevas tecnologías para una mayor y mejor inserción internacional de América Latina", *Integración y Comercio*, No. 46, INTAL.

Ismail, L. and H. Materwala (2019), "A review of blockchain architecture and consensus protocols: Use cases, challenges, and solutions", *Symmetry*, vol. 11, Department of Computer Science and Software Engineering, College of IT, United Arab Emirates University [online] https://www.mdpi.com/2073-8994/11/10/1198/htm.

Knight, W. (2017), "The technology behind bitcoin is shaking up much more than money", *MIT Technology Review*, Boston, Massachusetts Institute of Technology (MIT), 18 April [online] https://www.technologyreview.com/2017/04/18/152503/the-technology-behind-bitcoin-is-shaking-up-much-more-than-money/.

LACChain (2020), "CADENA", January [online] https://www.lacchain.net/projects/CADENA?lang=en

Nakamoto, S. (2008), "Bitcoin: A Peer-to-Peer Electronic Cash System", October [online] https://bitcoin.org/bitcoin.pdf.

Pawczuk, L. (2020), "Blockchain's next frontier: shaping the business model", *MIT Technology Review*, Boston, Massachusetts Institute of Technology (MIT), Deloitte Consulting LLP, 14 May [online] https://www.technologyreview.com/2020/05/14/1001443/blockchains-next-frontier-shaping-the-business-model/.

Pedersen, A. B., M. Risius and R. Beck (2019), "A ten-step decision path to determine when to use blockchain technologies", *MIS Quarterly Executive*, vol. 18, No. 2 [online] https://aisel.aisnet.org/misqe/vol18/iss2/3.

Perboli, G., S. Musso and M. Rosano (2018), "Blockchain in logistics and supply chain: a lean approach for designing real-world use cases", *IEEE Access*, vol. 6.

Pérez, G. and L. Valdés, (2020), "Digital transformation in Latin American and Caribbean logistics", *FAL Bulletin*, No. 381, Santiago, Economic Commission for Latin America and the Caribbean (ECLAC).

Safety4Sea (2020), "Europe launches DataPorts project for digital ports of the future", 6 March [online] https://safety4sea.com/europe-launches-dataports-project-for-digital-ports-of-the-future/.

Schwab, K. (2017), *The Fourth Industrial Revolution*, World Economic Forum (WEF), January.

TradeLens (2020), "Solution Architecture" [online] https://docs.tradelens.com/learn/solution_architecture/.

Treshock, M. (2020), *How the FDA is Piloting Blockchain for the Pharmaceutical Supply Chain* [online] https://www.ibm.com/blogs/blockchain/2020/05/how-the-fda-is-piloting-blockchain-for-the-pharmaceutical-supply-chain/.

Tsiulin, S. and others (2020), "Blockchain-based applications in shipping and port management: a literature review towards defining key conceptual frameworks", *Review of International Business and Strategy*, vol. 30, No. 2.

WEF (World Economic Forum) (2019), "Inclusive Deployment of Blockchain for Supply Chains - Part 1 – Introduction", *White Paper*, Geneva, March.

___(2018), "Trade Tech – A New Age for Trade and Supply Chain Finance", *White Paper*, Geneva, September.

VIII. Publications of interest

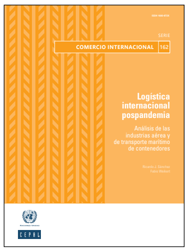
International Trade Series Nº 161

Multiplicadores de los servicios de transporte y almacenamiento en América Latina: un análisis comparativo

Jeannette Lardé

This document aims to determine the links between the services provided by the transport and storage sectors and other economic activities. Specifically, it proposes estimation and analysis of output multipliers and linkages and the impacts of transport and storage services, placing special emphasis on hydrocarbon use. Using input-output matrices, it presents a comparative analysis of two groups of countries for 2005 and 2015.

Available in: Spanish



International Trade Series Nº 162

Logística internacional pospandemia: Análisis de las industrias aérea y de transporte marítimo de contenedores

Fabio Weikert
Ricardo Sánchez

This study focuses on the international logistics sector in the aftermath of the COVID-19 outbreak in early 2020, with an emphasis on air and sea traffic. Air traffic is analysed on the basis of aeroplane passenger trends, while sea traffic is examined on the basis of container transport. Although the study focuses on the Latin American and Caribbean region, it adopts a global perspective in the analysis of the context of both sectors. It also highlights current emerging concerns that could have repercussions for the post-pandemic phase, especially in relation to market concentration, the support provided by governments to companies in both sectors and, ultimately, the impacts of the current context on access to and affordability of the services provided.

Available in: Spanish