Implementing blockchain technology in the customs environment to support the SAFE Framework of Standards

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Abstract

This paper focuses on how blockchain technology's features can revolutionise supply chain structures and the customs environment which is a vital part of today's supply chains. In order to that, we firstly summarise blockchain technology and its features, then use the objectives and principles of the SAFE Framework of Standards as a basis to show this revolutionary effect.

1. Introduction

As blockchain technology offers traceability, transparency and, as a result of these, trust among users, both governments and companies look for ways to cultivate the benefits of this technology. Successful implementation by both governments and companies encourages others to take advantage of this phenomenon. Supply chain management and customs transactions—which are vital parts of today's supply chain structures—are two of the fields that blockchain technology has already started to revolutionise.

This paper aims to show how implementing blockchain technology in supply chain management and the customs environment can be beneficial for governments, Customs and the private sector by using the objectives and principles of the SAFE Framework of Standards as a basis.

2. Understanding blockchain technology

For any paper written about blockchain, it is inevitable to cite its developer, Nakamoto (2008, p. 1) who started the blockchain discussion with these sentences:

> In this paper, we propose a solution to the double-spending problem using a peer – to-peer distributed timestamp server to generate computational proof of the chronological order of transactions.

Following on from Nakamoto, blockchain began to be studied and applied in several fields, and many other explanations being proposed. Clark and Burstall (2018, p. 531) summarised blockchain in the following way:

> Blockchain technology can be defined as an open ledger of information that is distributed and verified across a peer-to-peer network, rather than through one central server.
>
> …As no single person, institution or company hosts or controls the information, the storing of the information on the blockchain is perceived as (nearly) unhackable.

In a note prepared by the WU Global Tax Policy Center at the Institute for Austrian and International Tax Law of the Vienna University of Business and Economics (WU GPTC, 2017, p. 2) it is stated that:

Blockchain is a decentralized distributed ledger technology. It allows creation, validation and encrypted transaction of digital assets to happen and get recorded in an incorruptible way.

Mougayar (2016, p. 21) rephrased Nakamoto's explanation and created definitions for three separate environments:

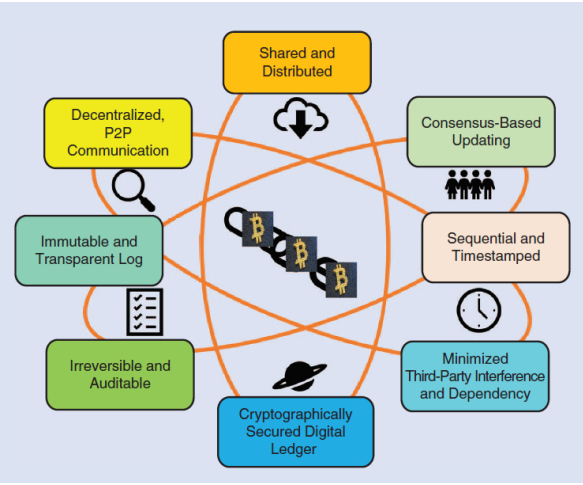
> Technically, the blockchain is a back-end database that maintains a distributed ledger that can be inspected openly. Business-wise, the blockchain is an exchange network for moving transactions, value, assets between peers, without the assistance of intermediaries. Legally speaking, the blockchain validates transactions, replacing previously trusted entities.

Again Mougayar (2016, p. 31) underlined ten properties of the blockchain as following:

1. Cryptocurrency
2. Computing infrastructure
3. Transaction platform
4. Decentralised database
5. Distributed accounting ledger
6. Development platform
7. Open source software
8. Financial services marketplace
9. Peer-to-peer network
10. Trust services layer.

Puthal, Malik, Mohanty, Kougianos and Das (2018) summarised these features as shared and distributed (*data*), consensus-based updating, sequential and timestamped (*data*), minimised third-party interference and dependency, cryptographically secured digital ledger, irreversible and auditable, immutable and transparent log, decentralised and P2P communication. These are illustrated in Figure 1.

Figure 1: Vital blockchain characteristics



Source: Puthal et al. 2018, p. 8.

As understood from Nakamoto and other authors; we can summarise the blockchain as follows: Blockchain is a transaction platform, working in a peer-to-peer network—which eliminates the need for a trusted third party—that allows users to create and share data that has a timestamp and unique cryptographic signature. As a result of the creation and validation process, the data created in blockchain is nearly unhackable (Nakamoto, 2008; Clark and Burstall, 2018; WU GPTC, 2017; Mougayar, 2016; Puthal et al. 2018)

3. Benefits of applying blockchain technology to supply chain management

As mentioned above, blockchain technology has several unique features that make it applicable to different types of industries, of which supply chain management is just one.

Rudenko and Borisov (2006, p. 123) defined supply chain as:

> a network of suppliers, manufacturing plants, warehouses and distribution channels that perform the functions of raw material procurement, transformation of these materials into finished products and the distribution of these products to customers.

The authors added that supply chain management flows can be divided into three main flows: product, information and financial flows (p. 124).

When the features of blockchain and the characteristics of supply chains are considered together, it is easy to conclude that blockchain will support supply chains from several angles.

In supply chain management, it is vital to know exactly what is done when, and by whom. Blockchain's timestamping feature perfectly fits that demand. Mougayar (2016, p. 45) explained that:

> Timestamping is an irrefutable and immutable action once recorded on a blockchain, so it is useful when seeking the truth.

Bettín-Díaz, Rojas and Mejía-Moncayo (2018, p.22) underlined the importance of blockchain's transparency, lack of need for an intermediary, decentralised network and traceability features, which can be directly beneficial to the supply chain environment.

Tse et al. (2018, p. 1359) summarised the suitability of blockchain technology in the food supply chain in the following way:

> …Once unsafe operating incidents happen, the mistakes or errors coming from any part of the supply chain can be found easily…

According to The Organisation for Economic Co-operation and Development (OECD) (2018), blockchain technology can make supply chains more transparent, which will help both companies and consumers to identify risk and prevent them, and can provide opportunities to small – and medium-sized enterprises to have greater integration in supply chains.

Pugliatti and Gain (2018) mentioned that blockchain can establish data integrity from producers to the end point of the supply chain because the information is generated by its creator. Also, as the information will not have to be reproduced and submitted manually to agents in the supply chain, the whole process will be simplified. Accepting the blockchain records as the single source of truth will increase security. It is considered that, as time goes by, blockchain will accumulate data that will enable border authorities to increase their risk management capacity.

In their study, Sylim, Liu, Marcelo and Fontelo (2018) discussed how blockchain technology can be used for detecting falsified and sub-standard drugs in distribution and they recommended that local and national laws should recognise blockchain ledger records as a source of truth and that government agencies should take on a capacity-building role.

Clark and Burstall (2018, p. 533) explained that blockchain will allow manufacturers of pharmaceutical goods to distinguish grey goods in cases of parallel imports and identify where they left the supply chain, similarly, it is considered that blockchain will enhance the effectiveness of customs programmes to prevent global trade in counterfeit goods.

Kshetri (2018) studied several cases and explained blockchain's role in the context of supply chain performance. These are set out in Table 1.

Table 1: The roles of blockchain in achieving the various strategic supply chain objectives

Supply chain performance dimension	Blockchain's roles	Mechanisms involved [Case Number].
Cost	Economic sense to generate a blockchain code even for small transactions.	Zero or low marginal costs to generate blockchain code if technologies such as IoT have already been used to detect, measure, and track key SCM processes [8].
	Crisis involving defective products (e.g., contaminated food): easily identify the source and engage in strategic Removals of affected products instead of recalling the entire product line	Detection, measurement, and tracking of key SCM processes with IoT [8].
	Allocate just the right amount of resources to perform shipping and other activities	Detection, measurement, and tracking of key SCM processes with IoT [6].
	Elimination of paper records	Digitally signed documents' secure storage and transmission can validate the identities of individuals and assets [1].
	Regulatory compliance costs can be reduced.	Auditable data can be provided to satisfy regulators [5,9].
	Supply chain partners are not able to use low quality and counterfeit ingredients	A tool to improve integrity and traceability in the food supply chains to fight against low quality and counterfeit products [3].
	Can provide data that can be used to assess useful, meaningful and representative indicators for describing quality.	Data related to temperature, humidity, motion, light conditions, chemical composition from IoT devices or sensors on equipment ([6,10].
Speed	Speed can be increased by digitizing physical process and reducing interactions and communications.	Digitally signed documents' secure storage and transmission can validate the identities of individuals and assets and minimize the needs of physical interactions and communications [1].
Dependability	Supply chain partners can expect a high level of dependability of measurement for various indicators such as quality and weights	Can be integrated with applications such as mobile robot (e.g., Case 11: Bext360's coffee supply chain)
	Exerting pressure on supply chain partners to be more responsible and accountable for their actions.	Digitally signed documents' secure storage and transmission can validate the identities of individuals, which makes it possible to know who is performing what actions, when and where [9].
	Blockchain-based digital certification as a means of increasing dependability.	Supply-chain certification processes to verify provenance [7].
	Blockchain's "super audit trail" can address challenges associated with self-reported data that are provided by supply chain partners.	Detection, measurement, and tracking of key SCM processes with IoT [2].
Risk reduction	Addressing the holistic sources of risk	Blockchain's ability to validate identities can be used to verify the provenance of items such as rough-cut diamonds and fine wines [7].
	Only parties mutually accepted in the network can engage in transactions in specific touchpoints.	Validation of the identities of individuals participating in transactions [1].
	Can ensure that software file downloaded has not been breached.	Foolproof method for confirmed identity can reduce cybersecurity-related risks [4]
Sustainability	Verifying sustainability: possible to make indicators related to sustainability more quantifiable and more meaningful.	Validation of the identities of individuals participating in the supply chain [11].
		Detection, measurement, and tracking of key SCM processes with IoT (e.g., [2], Provenance's use of mobile phones, blockchain and smart tagging, to track fish caught by fishermen)
Flexibility	Levels of network effects: Even if only a few participants use a blockchain solution, this will have a powerful effect. The power of this solution increases with the network effect.	All cases [1–11].
	Higher level of impact with deeper IoT integration in logistics and supply chain	All cases [1–11].
	Can address consumers' concern about the source of their food and beverages by providing indicators related to sustainability more quantifiable and more meaningful.	Blockchain can deliver higher value when consumers become more concerned about the sources of their foods and beverages [11]

Source: Kshetri, 2018, p. 85.

Notes: 1 – Maersk, 2 – Provenance, 3 – Alibaba, 4 – Lockheed Martin, 5 – Chronicled, 6 – Modum, 7 – Everledger, 8 – Walmart, 9 – Gemalto, 10 – Intel's solution to track seafood supply chain, 11 – Bext360

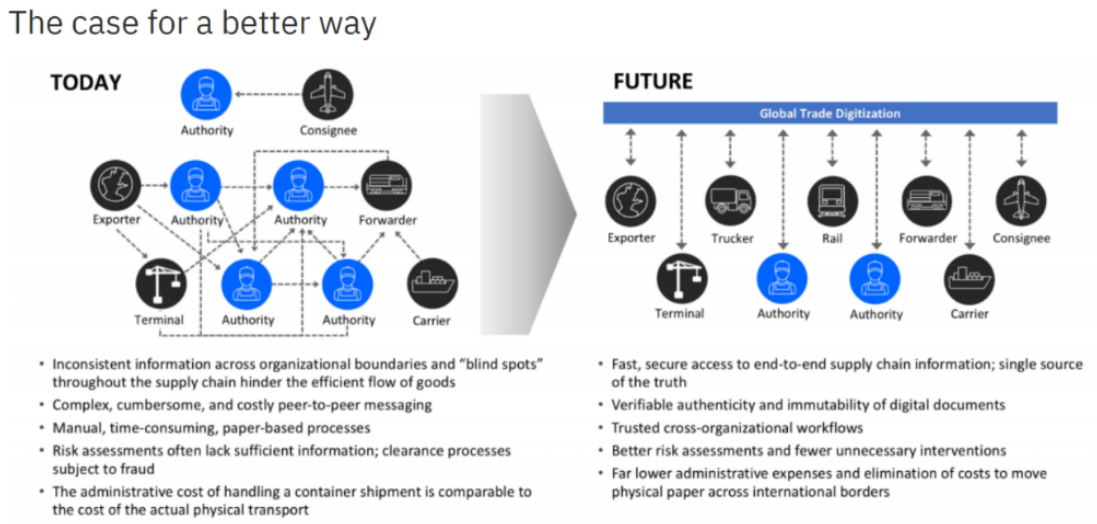
To summarise: blockchain's features make this technology very useful in supply chain management because it provides a transaction platform with shared, distributed, sequential and timestamped data that can be updated only by consensus between the nodes of the system. This reveals immutable, irreversible, unalterable data that provides higher transparency, traceability and, as a result of these, higher auditability. Also, it reduces costs and risks while increasing speed, dependability, sustainability and flexibility (Mougayar, 2016; Puthal et al., 2018; Bettín-Díaz, Rojas & Mejía-Moncayo, 2018; Kshetri, 2018).

4. Impact of blockchain technology on the customs environment

Several studies illustrate the current situation of basic export–import transactions and the possible new face of these transactions with the implementation of blockchain technology, including Godbole (n. d.) and White (2018).

White (2018) states that using an open platform will be beneficial in terms of creating a shipping information pipeline and paperless trade. He also notes that the current situation is complex, manual, time-consuming and paper-based, which results in 'blind spots' in the supply chain, and the clearance process becomes subject to fraud. By contrast, blockchain applied to the future customs environment depends on a single source of truth with verifiable and immutable digital documents, which leads to better risk assessment and lower administrative costs. In addition to that, White (2018) visualised the difference of current and blockchain implemented situations as illustrated in Figure 2.

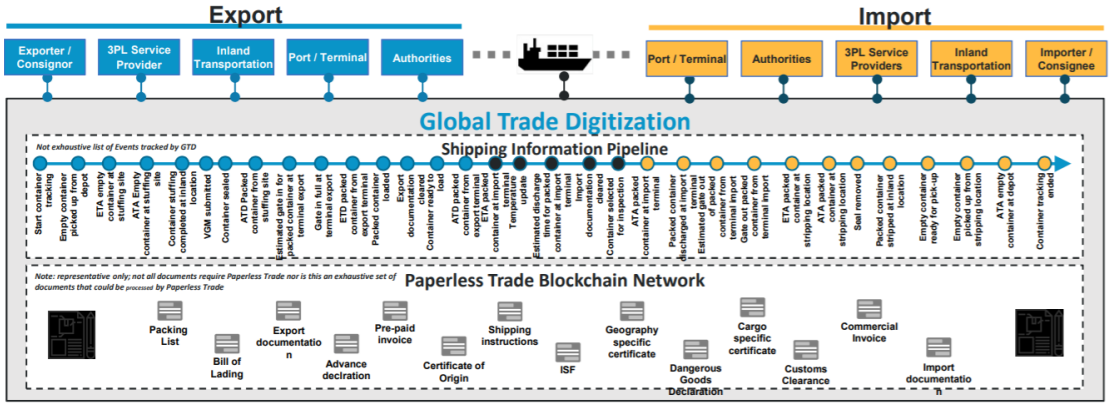
Figure 2: The case for a better way



Source: White, 2018.

Godbole (n.d.) noted that just one avocado shipment from Mombasa to Rotterdam includes 30 actors, 100 people and 200 information changes (p. 9). As a solution to this complexity, Godbole referenced the IBM and Maersk Global Trade Digitization Platform, which enables the actors in international trade such as ports and terminals, shipping lines, customs authorities, freight forwarders/3PL and intermodal transport shippers to both contribute to and benefit from the platform. Godbole visualised how the entire supply chain ecosystem shares a single trusted view of shipping events and documentation filings with this platform, as set out in Figure 3.

Figure 3: Global trade digitisation



Source: Godbole (n.d.), p. 12.

Okazaki (2018) noted that by using blockchain technology in the customs environment, Customs would become more data-driven and more embedded within the trade process. Blockchain would support revenue compliance and cooperation between Tax and Customs as well as help combat financial crimes.

Chaudhary and Patchala (2018, p. 4) discussed that using blockchain in bonded warehouses can mitigate fraud because in blockchain it is impossible to issue fake receipts as all documents are validated and verified by the parties participating in the consensus mechanism.

According to Accenture (n.d.), using blockchain technology can assist vessels to save time at their destination and avoid the need to carry detailed paperwork as verification of the goods on board is captured digitally ahead of time and their integrity is secured. Also, customs officials can digitally verify details such as origin, physical characteristics, licensing, authenticity, destination and journey, which will enable them to distinguish legitimate trade while identifying suspicious traders, illegitimate trade and fraudulent practices.

5. Applying blockchain technology to supply chains and customs environments to fulfil the objectives and principles of the SAFE Framework of Standards

According to the World Customs Organization (WCO, 2018, Preface):

> At the June 2005 World Customs Organization Council Sessions in Brussels, WCO Members adopted the SAFE Framework of Standards to Secure and Facilitate Global Trade. This unique international instrument ushered in modern supply chain security standards and heralded the beginning of a new approach to the end-to-end management of goods moving across borders while recognizing the significance of a closer partnership between Customs and business.

The WCO (2018, p. 2) outlines the objectives and principles of the SAFE Framework of Standards as:

- Establish standards that provide supply chain security and facilitation at a global level to promote certainty and predictability.
- Enable integrated and harmonized supply chain management for all modes of transport.
- Enhance the role, functions and capabilities of Customs to meet the challenges and opportunities of the 21st Century.

- Strengthen co-operation between Customs administrations to improve their capability to detect high-risk consignments.
- Strengthen co-operation between Customs administrations, for example through exchange of information, mutual recognition of controls, mutual recognition of Authorized Economic Operators (AEOs), and mutual administrative assistance.
- Strengthen co-operation between Customs administrations and other Government agencies involved in international trade and security such as through Single Window.
- Strengthen Customs/Business co-operation.
- Promote the seamless movement of goods through secure international trade supply chains.

The benefits of using blockchain technology in customs transactions can be summarised as follows: blockchain can be considered as an information pipeline with a single source of truth that is verifiable and immutable, and provides an opportunity for paperless trade, better risk assessment, lower administrative cost, real-time tracking and transparency for customs clearance. As a result of these attributes, blockchain can help mitigate fraud, improve compliance with regulations and documentation, and enable customs officials to distinguish legitimate and illegitimate trade and fraudulent practices (Godbole n.d., White, 2018, FICCI and Deloitte, 2018, Okazaki, 2018, Chaudhary & Patchala, 2018, Accenture, n.d.).

In the following section the features and benefits of blockchain and corresponding objectives and principles of the SAFE Framework of Standards will be discussed.

Establish standards that provide supply chain security and facilitation at a global level to promote certainty and predictability

Rudenko and Borisov (2006, p. 124) stated that supply chains consist of three flows: the product, information and finance flows. With regard to this, supply chain security can also be considered as security of the product flow, security of information flow and security of finances flow.

In terms of product flow security, Loop (2016) emphasised stolen merchandise recovery and theft protection:

> **Stolen merchandise recovery:** When a consumer completes a transaction, the authenticity of the product purchased can be automatically verified and activated in the system. So if an item were to be stolen, it can be traced via any subsequent transaction, which is automatically recorded in the blockchain.
>
> …
>
> **Theft protection:** Blockchain-based platforms can solve the counterfeiting issue around goods that are notoriously difficult to trace, such as pharmaceuticals, luxury goods, electronics and diamonds.

In terms of information flow security, Clark and Burstall (2018, p. 531) noted that

> Distributed ledgers are inherently harder to attack because, instead of a single database, there are multiple shared copies of the same database. As no single person, institution or company hosts or controls the information, the storing of the information on the blockchain is perceived as (nearly) unhackable.

Finally, in terms of finances flow security, FICCI and Deloitte (2018, p. 17) stated:

> A Blockchain based Customs Duty payment processing will enable real-time tracking and transparency of the processing of customs clearance to all the relevant stakeholders viz. Customs department, importer, clearing house agent and bank. The solution will help the Customs department better manage space and cash cycle.

Also, in the long run, cryptocurrency can be an aid to the deficiencies of the current system.

As the security in product, information and finances flows are improved, that will boost the certainty and predictability for customs and other stakeholders in the supply chain.

Enable integrated and harmonised supply chain management for all modes of transport

Weernink, Engh, Francisconi and Thorborg (2017) stated that blockchain can add value to the port by trust, security, visibility, network expansion and integration of supply chain flows.

Enhance the role, functions and capabilities of Customs to meet the challenges and opportunities of the 21 century

When it was first developed, the internet phenomenon passed through the same steps as blockchain: at first, only a small group of people was able to use it, then its use was expanded until now a life without the internet is hard to imagine. This will be the same for blockchain technology too. As it is implemented by governments and the private sector, the acceptance of this technology will revolutionise many aspects of life. In terms of challenges and opportunities of the 21st century, Okazaki (2018) noted that with using blockchain technology in the customs environment, Customs would become more data-driven and would be more embedded within the trade process.

Strengthen co-operation between customs administrations to improve their capability to detect high-risk consignments

Implementing blockchain technology in the customs environment will help governments and Customs to cope with risk in a better way. According to Pugliatti and Gain (2018), 'Accepting the blockchain records as the single source of truth will increase security. As time goes by, blockchain will accumulate data which will enable border authorities to increase their risk management capacity.'

Also, White (2018) noted that blockchain being applied to future customs environments depends on the single source of truth with verifiable and immutable digital documents, which leads to better risk assessment and lower administrative costs.

Strengthen co-operation between Customs administrations, for example through exchange of information, mutual recognition of controls, mutual recognition of Authorized Economic Operators (AEOs), and mutual administrative assistance

There are two things to consider in relation to the benefits of blockchain to AEOs: those AEOs who use blockchain will be better placed to present their record of compliance with Customs requirements, as Customs use the same technology, and it will be easier for customs administrations to evaluate mutual recognition of AEO status.

Strengthen co-operation between Customs administrations and other government agencies involved in international trade and security such as through single window

There are different terms and definitions for the single window environment, with the United Nations Economic Commission for Europe (UNECE) (2003) defining the concept as follows:

> The single window environment aims to expedite and simplify information flows between trade and government and bring meaningful gains to all parties involved in cross border trade. In a theoretical sense, a Single Window can be described as 'a system that allows traders to lodge information with a single body to fulfill all import – or export – related regulatory requirements.

When the definition of a single window environment and the features of blockchain are considered together, it can be seen that there are several overlaps. It is evident that as a transaction platform with shared, distributed, sequential and timestamped data (Mougayar, 2016; Puthal et al., 2018), blockchain technology fits like a glove in the single window environment.

Furthermore, Canham and Kerstens (2018, p. 7) indicated that:

> …take agricultural licenses. These are usually granted by the Ministry of Agriculture and controlled by health authorities or veterinarians at points of entry. The corresponding import declaration is supervised by customs, and its approval might require write-off of the permitted quantity specified by the certificate. When stored on a blockchain, this provides an integral view of usage and allows for accurate write-off and avoids double usage.

Also, Okazaki (2018, p. 17) noted that:

> … By using a common distributed technical platform, they *(Customs and other border agencies)* could leverage the power of blockchain technology to open up new possibilities to share information and resources, particularly in a Single Window environment and for cross-border data exchange purposes.

Strengthen Customs/business co-operation

It will be easier for AEOs to share required information with customs and again it will be easier for governments to mutually recognise each other's companies' AEO status.

There have been several successful implementations of blockchain technology in the customs environment, with the co-operation of both government and business. Korea is one of the success stories. According to Samsung (2018), on 14 September 2018, Samsung SDS signed an agreement with the Korea Customs Service and 48 relevant government offices and companies to establish the blockchain-based export customs logistics service business. According to the agreement, this service will allow export-related organisations and companies to share documents from customs declaration of exported goods to the final delivery process.

Promote the seamless movement of goods through secure international trade supply chains

Implementing blockchain technology will revolutionise supply chains and the customs environment, which is a vital part of today's supply chain.

As another success story, Singapore eliminated almost 80 per cent of the data entrance requirement in transport documents, which will lead to the seamless movement of goods. Munakata (2018) noted that the consortium, including global management consultancy Accenture, Singaporean ocean carrier APL and a European customs organisation, tested a blockchain solution to digitise transport documents. The system slashed data entry requirements when issuing documents such as bills of lading, which include information such as vessel names and cargo amounts, by up to 80 per cent.

6. Conclusion

Blockchain technology has several unique features, including being timestamped, being nearly unhackable, and its traceability, transparency and auditability. These features have already started revolutionising both governmental and private sector transactions; being stakeholders of today's supply chains, governments, Customs and business have already started cultivating the benefits of this technology.

Some examples include US Customs and Border Protection's intention to apply blockchain technology to NAFTA and CAFTA certificates of origin (KPMG, 2018), Korea's initiatives (Samsung, 2018), Netherlands' Dutch Blockchain Coalition (DBC, 2018) and the Networked Trade Platform of Singapore (Singapore Customs, 2018).

With the aid of the features of blockchain, it will be easier for governments, Customs and business to boost certainty and predictability in global supply chains, strengthen Customs/business co-operation, meet the challenges and opportunities of the 21st century and strengthen co-operation between customs administrations. It will also strengthen co-operation between customs administrations and other government agencies involved in international trade and security, such as through single window. Finally, it will be easier for all stakeholders of international trade to promote the seamless movement of goods through secure international trade supply chains.

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