CHAPTER 2

Blockchain Technology for International Trade: Beyond the Single Window System

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Introduction

There is little doubt that digitisation has been making supply chains more efficient, agile, flexible, responsive and customer-oriented. However, supply chain management is still an incomplete strategy that has not materialised its ultimate goal: to maximise overall stakeholder economic profitability while meeting diverse customers' requirements. This is mainly due to conflicts of interest among supply chain actors, lack of trust and end-to-end visibility, failure to meet ethical standards in service and production and the increasing complexity of global transactions. A growing body of literature identifies the role of blockchain technology in supporting supply chain management. In fact, there are numerous cases of firms and IT service suppliers that are already changing the way they execute agility and flexibility in their supply chains via blockchain. In this chapter, I would like to present the contents, scope and findings on the role of blockchain for global supply chain management and cross-border trade by exploring the future of the supply chain developed by blockchain, in which the autonomous linkages in the chain become the focal point of management and, thus, the transactions conducted by IT (i.e. blockchain technology) are the main concern of successful digitisation.

How to cite this book chapter:
Han, J. H. 2022. Blockchain Technology for International Trade: Beyond the Single Window System. In: Wang, Y., and Pettit, S. (eds.) *Digital Supply Chain Transformation: Emerging Technologies for Sustainable Growth*. Pp. 23–37. Cardiff: Cardiff University Press. DOI: https://doi.org/10.18573/book8.b.

Single Window Systems for Global Supply Chain Management

Global supply chains that rely on extremely complex transactions between trading partners should be supported by IT in order to achieve efficient information sharing between said partners, private intermediaries and government bodies. The single window system has emerged as an IT solution for global trade that allows trading partners to share and exchange trade-related information while also conducting electronic transactions with each other.

Complexity of Global Supply Chain Relationships

The supply chain is the network of organisations that are involved in the different processes and activities that produce value and services in the hands of the ultimate customers. It includes the sequence of events in a goods flow that adds to the value of a specific good. At a national level, a domestic supply chain has the advantages of the structure of the national market, infrastructure and elements, such as the supply chain requirement under the national government, a common language, taxation levels and so on. Moreover, the short lead times and good communication in a domestic supply chain enable it to react quickly to disruption. However, in today's global setting, where the supply chain becomes international, the interactions become more dynamic, difficult to coordinate and complex than in a domestic supply chain. For example, through the different taxes, duties, transport prices, government stability and general infrastructure of a particular country, each distant market's trade law, transport regulations, product regulations, agency law, quotas, language barriers and currency issues add to the complexity of international trade (Branch 2009).

Classifying stakeholders into private and public types is illustrative of this complexity. First, the *private sector* category must include traders, such as exporters and importers, as well as intermediaries, such as the freight forwarders (FF), carriers and financial institutions involved in the commercial transactions. The primary objective for both exporters and importers is to manage the movement of products for the least possible cost and in the least possible time. Freight forwarders work directly on behalf of importers, while commercial payments and insurance contracts are managed by financial institutions. Second, the *public sector* category consists of customs and inspection agencies and port authorities. These institutions oversee legal requirements, such as inspections, tax payments and security issues, all of which create delays and add costs affecting the chain's efficiency and performance. The range of organisations involved in cross-border supply chains are shown in Figure 2.1 (Grainger 2007).

Given the above, on a global scale, supply chains require cooperation among trading partners, intermediaries and government bodies, as *international*

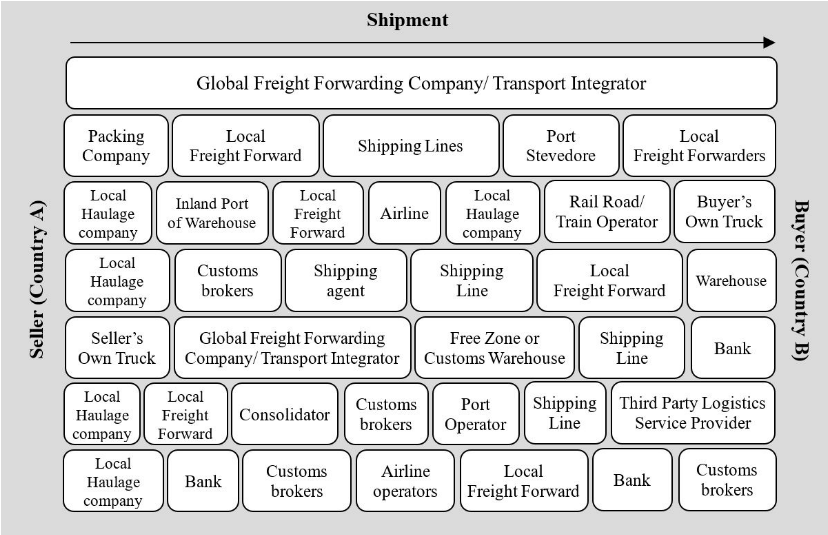


Figure 2.1: Combination of intermediaries in a cross-border supply chain. Source: Adapted from Grainger (2007).

trade comprises the entire process, from the establishment of commercial contracts to transportation to monetary flow and the imposition of cross-border regulations. Consequently, cross-border logistics is one key area of any global supply chain that should be supported by efficient IT, thereby automating and streamlining complex, interrelated cross-border transactions. For example, private intermediaries, exporters and importers must submit a great deal of information and documentation to governmental bodies to comply with regulatory requirements. On the other hand, the public sector also has its own responsibility to enhance the efficiency of the trade process for the sake of facilitating trade.

Long customs clearance times caused by insufficient communication and information sharing can lead to companies suffering from increased inventory levels, delivery delays and poor customer service. Repeated trade document submission and inefficient communication between private and public parties, as well as between private participants, can result in significant financial and operational losses within the overall chain. Owing to the complexity of most transactions, supply chain stakeholders are struggling to gain transparency and visibility in their supply chains. A recent study conducted by Microsoft (2017) revealed that, out of 408 organisations and corporations from 64 countries, 69% lacked full visibility into their supply chain, 65% experienced at least one supply chain disruption, and 41% still relied heavily on Excel spreadsheets for tracking supply chain disruptions.

Emergence of Single Window Systems

To reduce the complexity of cross-border transactions while achieving greater efficiency in supply chain management, there has been a major shift towards developing and implementing single window systems. Such systems integrate and streamline cross-border transactions by enabling information sharing. The United Nations Economic Commission for Europe (UNECE) defines a single window system as a facility that allows parties involved in trade and transport to lodge standardised information and documents with a single entry point to fulfil all import, export and transit-related regulatory requirements (UNECE 2019). The core concept of any single window system can be summarised as follows: it is any electronic system that allows traders to submit standardised forms and documents simply, thus eliminating redundant and repetitious processes and allowing them to meet regulatory requirements while improving efficiency through greater cooperation between partners. With the support of web-compatible technology and internationally accepted standards, participants can conduct transactions with each other accurately and efficiently. Consequently, administrative work, such as tracking and tracing products and financial payments, can be aligned and streamlined. Single window systems so enhance the availability of information and can simplify and expedite document exchanges between private and public sector actors or even between private intermediaries. As Figure 2.2 illustrates, this system links international supply chain participants, allowing them to connect and exchange transaction-related information.

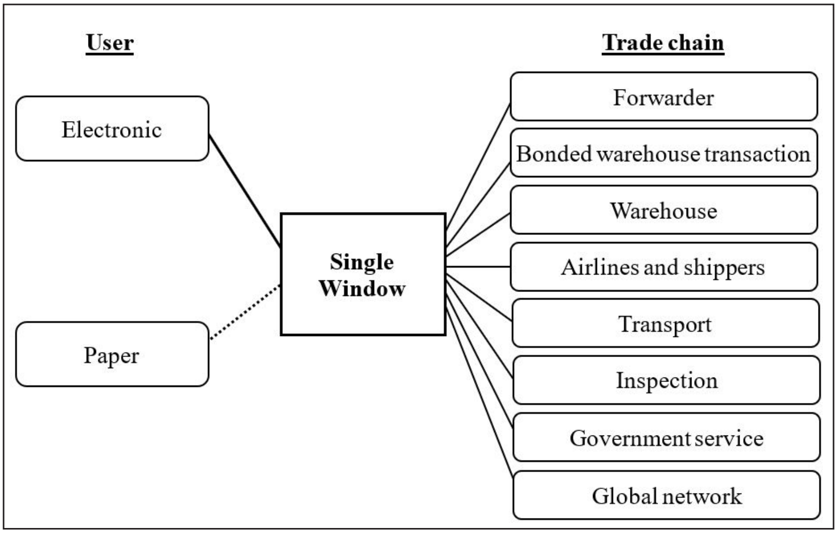


Figure 2.2: The basic model of a single window system. Source: Adapted from APEC (2007).

Benefits of Using Single Window Systems – A Korean Single Window Case

One of the representative examples of the single window system is South Korea's uTradeHub, which was launched in 2008. As Korea's ubiquitous trade hub and a single online window, it effectively connects existing trade services and simplifies international trade and logistics processes. The electronic business process of uTradeHub covers overall trade transactions, including customs clearance, logistics, banking and negotiations. The types of documents cover not only business to business (B2B) but also business to government (B2G) and government to government (G2G) trade, and uTradeHub also streamlines and speeds up the trade process with the advancement in circulation of electronic trade and logistics documents. In addition, uTradeHub acts as an official depository of electronic paperwork. A copy of all relevant paperwork for transactions is kept electronically on an isolated server. Through its services and single log-in procedure, all documents and processes for trade and logistics, such as inspection, finance and insurance, as well as other aspects of customs procedures, are all tied together and available to any supply chain participant who requires the documents. Moreover, logistics and cross-border supply chain-related information are available online in real time, so the traders and other interested parties can know exactly where they are in the customs process and keep track of cargo.

The benefits of using single window systems are diverse. The uTradeHub system makes document-handling processes more transparent and provides more links among trade participants. Moreover, as a service network, it automatically generates and processes tasks relevant to exports, imports and local affairs pertaining to trade procedures in real time, thus enabling close cooperation. Finally, the system is intuitive, as users can access it through various methods – including web portals – and exchange their information in the form of standardised documents. These benefits are directly reflected in the actual costs of trade. For example, with electronic certificates of origin, the issuance fee is cut by 50%; thus, transactions pertaining to electronic certificates of origin have increased by 200–300% each year since 2001 (UNECE 2011; 2010).

According to a World Economic Forum report by Fan and Garcia (2019), single window systems have been adopted in 63 countries. It is observed that a range of national government bodies in charge of health, agriculture, quarantine, immigration and technical standards have integrated single window transactions. In the case of Uruguay, single window systems connect 27 agencies that are in charge of taxation, customs clearance and inspections. Moreover, they enable supply chain stakeholders to exchange 127 types of trade-related compliance documents.

Limitation of Single Window Systems

After the implementation of single window systems and the subsequent partial success stories all around the world in the 2000s and 2010s, the limitations of single window systems have started to emerge. The limitations are recognised as inter-organisational and technological issues. Even countries with the most digitised single window systems are still seeking to further reduce cross-border clearance times and gain new capabilities for cross-border trade transactions. Below are examples of such limitations, as discussed by Fan and Garcia (2019).

First, although one of the important reasons for single window implementation is process automation in cross-border transactions, it is known that full automation is not yet fully realised. This is mainly because customs payments in many countries require the importers to first pay the sum on the invoice and also to present a document to customs on site proving that the duty has been paid (e.g. in Sri Lanka). We acknowledge that the single window system was expected to play a critical role in enabling information sharing among border agencies and the private sector with increased visibility and advanced knowledge regarding incoming shipments (as discussed in the Korean single window case). However, information sharing among government bodies and private participants is still limited, especially in terms of the origin of the goods and inspection for risk management.

Information trustworthiness is also diminished when information from government and trade agencies are different from each other. Owing to the re-entry of the same data from different agencies, the trustworthiness of data in single window systems is limited. Further, owing to the misuse of corporate information by the government, the security of commercial and financial information that is submitted online is often regarded as weak. This is exacerbated in countries with limited cybersecurity protection and electronic signature laws. The critical value proposition of single window implementation is to aggregate processes into one window to enhance efficiency via data sharing and action coordination. However, many border agencies now still operate in isolation; for instance, single window systems in some Latin American countries are disconnected from customs. This is, in part, due to the legacy databases impeding the information sharing, so trade needs to deal with a 'double window'.

Blockchain Technology

Blockchain for Supply Chain Management

Blockchain refers to a set of distributed ledgers (databases) that keeps all data from transactions in a specific period time in the form of blocks through the internet or an alternative distributed network of computers. The blocks are chronologically linked and saved to all the participants' computers. The ledgers are constantly compared to each other and grow continuously to ensure all transactions are legitimate and properly recorded. Specifically, a blockchain records data in a sequential chain of cryptographic hash-linked blocks. Each block consists of a block number, the hash of the current block, the hash of the previous block within the chain, transaction records and a timestamp, as illustrated in Figure 2.3.

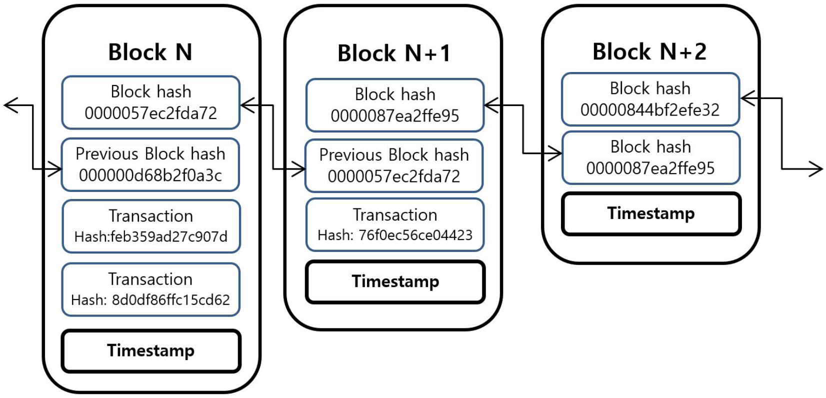


Figure 2.3: Representative structure of a blockchain. Source: Gupta (2017).

Data in each block is 'hashed' through hash functions. A hash function transforms an input (in the form of numbers and letters of any length) into an output of fixed length through a mathematical algorithm. An important characteristic of the hash function is that it is computationally impossible to use the output value to identify the original input value (in the form of numbers and letters) that was provided to the hash function. The first block is generated with a header and data. Then the subsequent block calculates its own hash using the previous block's hash. This process of adding a new block is called mining. A miner attempts to guess a number (called a *nonce*, a part of input in a hash function that is not known to the miner). If that hash is below a certain number, then a new valid block is created. The authenticity of the block is verified before it is linked to the existing chain of the blocks. The majority of the nodes in the network must agree that the new block's hash is correct and, thus, the consensus is made, and all the data in the blockchain share the same state of the data. So, to manipulate or hack the database, all the databases of all participants need to be attacked, meaning that the more participants there are, the more security is assured (Gupta 2017; Wang, Han & Beynon-Davies 2019).

Blockchain was originally thought to be dedicated only to financial market evolution, but its application is now reaching supply chain management. For example, in October 2016, IBM announced its collaboration with Walmart and Tsinghua University to digitally track and trace the movement of pork meat along its supply chain to customers across China by implementing blockchain. In 2017, IBM and Maersk were using blockchain to manage a supply chain for flower containers shipping from Kenya to the Netherlands.

Different terms are used to describe the concept of blockchain technology. Some call it a 'database' or 'distributed ledger'. Others identify it as a 'publicly verifiable open ledger', a 'distributed bookkeeping system' or a 'database containing a ledger'. These concepts highlight the blockchain's characteristic as a shared database that maintains the integrity of transactions. Although the majority of definitions highlight its data-keeping characteristics, there is a large consensus that the blockchain is a network of computers that digitises the movement of production and services (Wang, Han & Beynon-Davies 2019). The major distinction of blockchain technology from existing supply chain IT is that it enables supply chain actors to distribute and update exactly the same logical data of transactions, and it uses cryptography technology to make the transactions physically secure (Hofmann & Rüsch 2017). One can refer to Wang, Han and Beynon-Davies (2019) for more discussion regarding the role of blockchain technology for future supply chain management.

Value of Blockchain for Cross-Border Trade

Extended Traceability

Researchers have identified that blockchain technology has the capability to extend the traceability of supply chains from end to end. Centralised authority is inefficient in gathering and authorising every piece of information and transaction occurring in the web of long supply chains. Every participant has to prove themselves, and the information they provide also has to be authorised by intermediaries to ensure their accuracy. By using blockchain, such authentication is not necessary, as every node keeps its own ledgers and is updated. The traceability is also extended in terms of the completeness of information. Data in a blockchain covers information related to ownership (chronological list of owners), timestamping, location data (places the material has been, and where it is now), product-specific data (attributes and performance of the products) and environmental impact data (e.g. energy consumption, CO_2 emissions) (Abeyratne & Monfared 2016).

Metadata in a blockchain, such as price, quality, date and state of the product (e.g. locations) ensures the completeness of information and extends transparency to identify the provenance and authenticity of material and information flow (Lee & Pilkington 2017). This is also largely enabled by the time stamp. When events are ordered in the chain chronologically, each node (a header in a block) contains a field with a timestamp for when it was produced (van Engelenburg, Janssen & Klievink 2017). Thus, the nodes can be used to prove the existence of certain data before a certain time point. With this logic, the time stamp supports the management of time-sensitive issues, so revisiting the past data history is now possible (Yuan & Wang 2016). In a widely shared quote, Franck Yiannas, vice president of food safety for Walmart, noted that blockchain is a tool equivalent to FedEx for tracking the food industry (Giles 2018).

Automation Business Intelligence: Smart Contract and Amplification of IT

A *smart contract* is an agreement and also a process that can execute a part of a contract with digital verification of the stakeholders within a blockchain network (Weber & Governatori 2016). For example, if a condition from a contract is met during the process of executing a transaction, then a certain contract-based reward or action can be taken by the blockchain (e.g. cash payments). A smart contract improves the efficiency of administration by eliminating contract registration, monitoring and updating efforts and time; it establishes human trust with code trust: 'trade is settlement' (Collomb & Sok 2016). Smart contract-based business operations involve fewer manual interventions, so both manipulation risk and operational cost can be reduced. With regard to the cross-border supply chain, in 2016, Bank of America, HSBC and the Infocomm Development Authority of Singapore (IDA) declared that they had established a blockchain application based on the Hyperledger Fabric (Ganne 2018). These organisations were aiming to improve their letter of credit exchange transactions. The application followed a traditional transaction process but used a permissioned distributed ledger with a series of digital smart contracts, which allowed them to execute the deal automatically. In May 2018, HSBC announced that the 'world's first commercially viable trade finance transaction' using blockchain had been launched (Ganne 2018). The letter of credit exchange for Cargill (a US commercial group) for a movement of soya beans from Argentina to Malaysia was completed on the Voltron blockchain platform. According to Barclays bank, the letter of credit exchange process – which usually takes around seven to 10 days from issuance to approval – can be reduced to less than four hours (Fan & Garcia 2019). A smart contract solution enables supply chain partners to govern all phases of a typical trade agreement from order, shipment and invoice to final payment within a chain (Collomb & Sok 2016).

Prevention Mechanism for Data Immutability

The structure of blockchain provides a reliable information prevention mechanism for supply chain players. We can observe that the combination of immutability and peer verification plays a critical role as follows: the data in a blockchain is immutable because all the ordered sequences of transactions are saved in chronological blocks of nodes and broadcasted to all other nodes; the stored data is tamper-proof, as the majority share of the network is not compromised – updating and deleting transactions is prohibited according to the consensus mechanism (cryptographic proof with peer verification means matching the private key of a node to the public key owned by all participants; if a block is accepted, new information is added) (Weber & Governatori 2016). This is an important advancement, as it means that any falsification of the information has to be done in real time, making it so much harder a challenge than simply substituting or manipulating with new information containing different facts (Wang, Han & Beynon-Davies 2019).

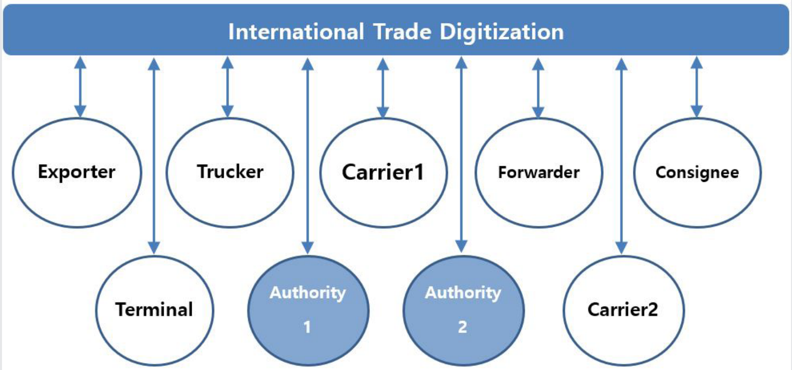
The immutability of blockchain can contribute to cross-border supply chains. Implementation of mutual recognition agreements (MRA) requires information sharing among authorised economic operators (AEOs). The information sharing process is largely affected by the level of information security because of the sensitivity and confidentiality of the shared information. The shared data for the AEO is often pointed out as problematic because of lack of standards, security and integrity. The data are shared via email and Excel files containing confidential data. Blockchain technology can automate the process of AEO information sharing in a secure manner and guarantee the integrity of the information. A pilot project between Mexico and Costa Rica (CADANA) was implemented in 2018 with a common platform for the management of AEO. Based on an agreed protocol among a group of customs in different countries, each transaction was secured and protected by an immutable audit trail (Fan & Garcia 2019).

TradeLens

In January 2018, Maersk (one of the largest ocean carriers in the world) and IBM started to build a blockchain-based platform, called TradeLens, to provide a more efficient and secure way to complete cross-border trade transactions (Figure 2.4). The collaboration was originally intended in 2016 to include multiple public and private parties who would pilot the platform, including DuPont, Dow Chemical, Tetra Pak, Port Houston, Rotterdam Port Community System Portbase, the Customs Administration of the Netherlands and US Customs and Border Protection. Following a successful pilot test across several lanes in Europe and the United States in 2017, TradeLens is now operating with more than 100 participants. The parties have recorded and shared over 500 million shipping events and documents via TradeLens since its inception (White 2018).

The TradeLens blockchain is a shared, permissioned distributed ledger that records international transactions. It uses the IBM Blockchain Platform, which is based on Hyperledger Fabric, one of the Hyperledger projects hosted by the Linux Foundation, an open-source permissioned blockchain technology where the node members are captured to the supply chain network base on cryptographic identification. It enables the supply chain players to securely share copies of document filings, relevant supply chain events with shipping containers, authority approval status and audit history, so every change is transformed into a new, immutable block.

Two main capabilities have been developed to address the current challenges that cannot be fully covered by the single window system. The first is a shipping information pipeline. The blockchain-based platform provides



- Fast and secure access to end-to-end supply chain information; single source of truth
- Verifiable authenticity and immutability of digital documents
- Trusted inter-organizational workflows
- Better risk assessments and fewer unnecessary interventions
- Far more administrative expenses and elimination of costs to move physical paper across international borders

Figure 2.4: TradeLens connectivity with blockchain. Source: Adapted from White (2018).

end-to-end supply chain visibility and transparency, which allows all actors involved in an international shipping transaction to securely share shipping information in real time. The second capability is paperless trade. The platform digitises and automates paperwork filings by allowing end users to securely submit, stamp and approve documents across a wide range of supply chain participants. The TradeLens platform is accessible through an open application programming interface (API) and connects the ecosystem (the business network of organisations) with a set of open standards. The trade document module, called ClearWay, enables importers, exporters, customs brokers and trusted third parties to automate inter-organisational transactions, such as import and export clearance, via smart contracts. Immutability of information is also ensured by TradeLens. TradeLens conducts a consistency check to indicate a document that was verified on the blockchain. Once a document is selected, the document is retrieved from the blockchain document store and the hash stored documents on the blockchain will be compared with a newly generated hash (TradeLens 2019; White 2018). Examples of the benefits of using the TradeLens platform are shown in Table 2.1.

Table 2.1: Benefits of using the TradeLens platform.

Players	**Role of blockchain-based platform and possible benefits for the supply chain players**
Ports and terminals	**Provide** information about the disposition of shipments within the boundaries of the port and terminal. **Benefit** from pre-built connections to shipping lines and other actors, end-to-end visibility across shipping corridors and real-time access to more information to enrich port collaboration and improve terminal planning.
Ocean carriers	**Provide** information about the disposition of shipments across the ocean leg. **Benefit** from pre-built connections to customers and ports/terminals around the world and real-time access to end-to-end supply chain events.
Customs authorities	**Provide** information about the export and import clearance status for shipments into and out of the country. **Benefit** from more informed risk assessments, better information sharing, less manual paperwork and easier connections to national single window platforms.
Freight forwarders/3PLs	**Provide** the transportation plan, inland transportation events, information on intermodal hand-off and document filings. **Benefit** from pre-built connections to the ecosystem, improved tolls for customs clearance brokerage function and real-time access to the end-to-end supply chain data to improve effectiveness of track-and-trace tools.
International transport	**Provides** information regarding the disposition of shipments carried on trucks, rail, barges, and other transportation modes. **Benefits** from improved planning and utilisation of assets (e.g. less queuing) and given real-time access to end-to-end supply chain events for shipments.
Shippers	**Engage** with the solution as a consumer of the shipping information events and paperless trade capabilities. **Benefit** from a streamlined and improved supply chain, allowing for greater predictability, early notification of issues, full transparency to validate fess and surcharges and less safety stock inventory.

Source: Adapted from White (2018).

Conclusion

Owing to the complicated process of international trade, which has intensified regulation compliance and required a wide range of intermediaries to be involved, global trade was believed to be one of the most complicated supply chain practices. The centralised platforms, namely single window platforms, were the main transactional paradigm of global e-trade solutions during the 2000s and 2010s. However, with the limitations of single window systems and the emergence of blockchain technology for the digital economy, blockchain-based, decentralised platforms in cross-border transactions are changing the paradigm of information sharing in the international setting (Table 2.2).

However, to be implemented widely, several challenges need to be resolved. One of the key technological challenges is the question of interoperability. Different types of blockchain-based platforms are being developed with different technical interfaces and algorithms that do not 'talk' to each other. Moreover, there might be resistance from current economic beneficiaries because there will always be resistance from regulators to assess the risks and incumbents who fear losing their existing revenue models. For example, with the current banking system that operates in a centralised environment, the use of this decentralised system might be a challenge, as the banks have traditionally acted as the centralised coordinator in business transactions (Michelman 2017).

From an academic perspective, to guide successful implementation of blockchain technology for cross-border supply chain management, empirical research that proves the benefits of blockchain technology should be conducted. To do so, research that identifies organisational antecedents to adopt and execute blockchain technology is required. For example, to adopt blockchain for supply chain execution, there should be an investigation of internal or external organisational conditions. Moreover, theories that support the role of blockchain technologies should be based on a robust understanding of the interface between the technology and supply chain management. For example, the resource-based view, which views IT as a competitive resource that should be confined within a firm boundary, does not justify the use of blockchain that

Table 2.2: Paradigm shift of international trade through blockchain technology.

Business model	Current	Blockchain-based
Paradigm/ architecture	Trusted third party or central coordinator	Decentralised transactions or peer-to-peer network
Database	Single copy	Peer-verified multiple copies
Security	Controlled access and firewalls	Cryptography
Transaction cost	Intermediation	Consensus and proof of work

Source: Adapted from Collomb and Sok (2016).

is actually shared by the whole actors. Moreover, there should be an effort to quantify the benefits of blockchain technology on a network or firm level that promotes the implementation of blockchain technology. In this context, the unit-of-analysis problem should be noted: in supply chain research, the majority of research uses data from a focal firm; in a blockchain context, where all of the linkages among the supply chain actors are more intensified and transparent, the unit of analysis to quantify any impact should be extended to dyadic, triadic and more.

Acknowledgement

This work was supported by an INHA UNIVERSITY research grant.

References

APEC (2007). Working towards the Implementation of Single Window within APEC Economies: Single Window Development Report. Retrieved from: https://www.apec.org/publications/2007/06/working-towards-the-implementation-of-single-window-within-apec-economies-single-window-development, [accessed 11 Oct 2020].

Abeyratne, S. A. & Monfared, R. P. (2016). Blockchain ready manufacturing supply chain using distributed ledger. *International Journal of Research in Engineering and Technology, 5*, 1–10. DOI: https://doi.org/10.15623/ijret.2016.0509001.

Branch, A. E. (2009). *Global supply chain management and international logistics*. Routledge.

Collomb, A. & Sok, K. (2016). Blockchain/distributed ledger technology (DLT): What impact on the financial sector? Digiworld Economic Journal, *103*, 3rd Quarter, 93–111.

Engelenburg, S. van, Janssen, M. & Klievink, B. (2017). Design of a software architecture supporting business-to-government information sharing to improve public safety and security. *Journal of Intelligent Information Systems. 52*(3), 595–618

Fan, Z. & Garcia, P. M. (2019). Windows of opportunity: Facilitating trade with blockchain technology, World Economic Forum white paper. Retrieved from: https://www.weforum.org/whitepapers/windows-of-opportunity-facilitating-trade-with-blockchain-technology [accessed 11 Oct 2020].

Ganne, E. (2018). Can blockchain revolutionize international trade? World Trade Organization. DOI: https://doi.org/10.30875/7c7e7202-en.

Giles, F. (2018). Is blockchain the future of food safety? – Growing produce. Retrieved from: https://www.growingproduce.com/fruits/blockchain-future-food-safety [accessed 27 July 2019].

Grainger, A. (2007). Supply chain security: Adding to an already complex operational and institutional environment. 2nd PICARD Conference at the World Customs, 27–28.

Gupta, M. (2017). *Blockchain for dummies*. IBM. Retrieved from: https://www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=XIM12354USEN [accessed 21 March 2018].

Hofmann, E. & Rüsch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics. *Computers in Industry, 89*, 23–34. DOI: https://doi.org/10.1016/j.compind.2017.04.002.

Lee, J. H. & Pilkington, M. (2017). How the blockchain revolution will reshape the consumer electronics industry. *IEEE Consumer Electronics Magazine, 6*, 19–23. DOI: https://doi.org/10.1109/MCE.2017.2684916.

Michelman, P. (2017). Seeing beyond the blockchain hype. *MIT Sloan Management Review, 58*, 17–19.

Microsoft. (2017). How blockchain will transform the modern supply chain. Retrieved from: https://azure.microsoft.com/mediahandler/files/resourcefiles/how-blockchain-will-transform-modern-supply-chain/how-blockchain-will-transform-modern-supply-chain.pdf [accessed 27 July 2019].

TradeLens (2019). TradeLens solution brief – edition two, Retrieved from https://www.maersk.com/local-information/west-central-asia/india/local-solutions/tradelens-connects, date accessed 5 January 2020.

UNECE (2010). Republic of Korea single window case. Retrieved from: https://www.unece.org/fileadmin/DAM/cefact/single_window/sw_cases/Download/Korea_Customs.pdf [accessed 27 July 2019].

UNECE (2011). Republic of Korea. Retrieved from: http://www.unece.org/fileadmin/DAM/cefact/single_window/sw_cases/Download/RepublicofKorea.pdf [accessed 27 July 2019].

UNECE (2019). The single window concept. Retrieved from: http://tfig.unece.org/contents/single-window-for-trade.htm [accessed 27 July 2019].

Wang, Y., Han, J. H. & Beynon-Davies, P. (2019). Understanding blockchain technology for future supply chains: A systematic literature review and research agenda. *Supply Chain Management*. DOI: https://doi.org/10.1108/SCM-03-2018-0148.

Weber, I. & Governatori, G. (2016). Untrusted business process monitoring and execution using blockchain. International Conference on Business Process Management, 329–347. DOI: https://doi.org/10.1007/978-3-319-45348-4.

White, M. (2018). Digitizing global trade with Maersk and IBM – blockchain pulse: IBM Blockchain Blog. Retrieved from: https://www.ibm.com/blogs/blockchain/2018/01/digitizing-global-trade-maersk-ibm [accessed 27 July 2019].

Yuan, Y. & Wang, F. Y. (2016). Towards blockchain-based intelligent transportation systems. 19th International Conference on Intelligent Transportation Systems, 2663–2668. DOI: https://doi.org/10.1109/ITSC.2016.7795984.