

# The Contribution of Blockchain Technology in the Supply Chain Management: The Shipping Industry as an Example

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**Abstract**— Today, the visibility of information and the traceability of physical flows have become a challenge to the supply chain's smooth operation, especially because they are difficult to process. Several studies have been done in response to this complexity to uncover practical solutions and more effective strategies for delivering services at the level of client expectations. This paper proposes blockchain technology as a solution that has the potential to deliver encouraging results in terms of supply chain sustainability, trust, traceability, and transparency.

**Keywords**—Supply chain, Blockchain, Transparency, Visibility, Sustainability, Trust

## I. INTRODUCTION

The supply chain environment has changed dramatically in recent years, owing in large part to the technological revolution in information and communication technology (Ageron et al., 2020). In order to preserve a competitive advantage and a high degree of agility, organizations must increase the efficacy of their supply chains more than ever before (IBN EL FAROUK Imane and Fouad Jawab, 2017).

Using new information and communication technologies (NTIC) in supply chain management (SCM) becomes increasingly important in firms' objectives for performance enhancement (Fouad Jawab and Driss BOUAMI, 2018).

This transition helps firms to achieve both a competitive advantage and long-term value. From all Industry 4.0 tools available at the moment, blockchains and big data analytics are two of the most recently developed technologies for digital supply chains (Attaran, 2020). These technologies enable the development of new activities and services, as well as new business models. However, challenges and barriers must be removed. Along with the difficulties inherent in managing the company and executing objectives, these hurdles include the need to mature projects while concurrently addressing data privacy, integrity, and security concerns (Frederico et al., 2019; Koh et al, 2020). The so-called "new technologies" have the ability to exert a substantial influence on projected outcomes and business models in this manner (Liu et al., 2021).

The application of blockchain technology in supply chain management has risen in recent years. While blockchain technology enables traceability, enhanced transparency, and product provenance, these are not the only benefits (Agi et al., 2022). According to Iansiti and Lakhani (2017), a blockchain is a decentralized ledger (database) that supply chain partners can use to communicate and store various types of records, including product information (certificates, localization data), transaction records, and data collected from sensors and other connected devices (Crosby et al., 2016). This means that, in addition to providing traceability and making the entire history

of products digitally accessible, blockchain technology has the potential to significantly improve supply chain coordination and process efficiency (Kshetri, 2018; Babich and Hilary, 2020; Queiroz et al., 2020; Wamba et al., 2020) and to help supply chains achieve sustainability goals [Wamba et al., 2020; Babich and Hilary, 2020; Casey and Wong, 2017; Kouhizadeh and Sarkis, 2018; Kshetri, 2018]. Our objective in this research is to further promote blockchain technology as a possible option for supply chain sustainability, trust, traceability, and transparency. Our study explains why it is critical to adopt blockchain technology across the supply chain and answers the following Research Questions:

RQ1: What is Blockchain Technology and how does it improve supply chain operations?

RQ2: What are the Blockchain applications in Logistics and their challenges?

The remainder of this paper proceeds as follows: section two provides a brief overview of Blockchain Technology. Then section three presents the opportunities for Blockchain Technology implementation in logistics followed by the contribution of Blockchain Technology in the shipping industry in section four. Section five presents the main challenges of Blockchain application in logistics. Finally, section six exhibits a conclusion along with suggestions for further research opportunities

## II. BLOCKCHAIN TECHNOLOGY

Blockchain is a technology that integrates encryption, peer-to-peer networking, and game theory. For many years, the word "blockchain" refers to a kind of database used to monitor the database that underpins bitcoin, but it is now used to refer to a distributed ledger that uses software algorithms to record transaction data in the form of "blocks" (Laroiya et al., 2020). Another characteristic of the blockchain is smart contracts, which enable business rules to be specified in an agreement and then executed as part of a transaction.

Blockchain is considered as an add-on technology that may connect disparate ERP systems and facilitate inter-organizational transactions by providing a transparent, shared view of information (van Riet and Maikel Cornelis, 2021). As a result, integrating blockchain with other technologies is a key component of the deployment process (Cole et al., 2019). It lays the groundwork for process democratization, and it has the potential to make cooperative ownership the norm in the future (Manski, 2017). Disintermediation of services ensures that several people are actively involved in economic decision-making and that authority in an organization is more vertically distributed (Manski, 2017). This means that all information and transactions are under the control of all users (Niranjanamurthy et al., 2018).

FIGURE 1. BLOCKCHAIN WORKFLOW (DUTTA ET AL.,2020)

The "workflow" of a blockchain transaction is represented in Figure 1. All transactions are validated and traceable in a shared and synchronized environment via the use of blockchain, an immutable, tamper-proof Distributed Ledger Technology (DLT). All network participants may communicate securely with one another without relying on a central authority. There is no central authority since all transactions are recognized and recorded by popular agreements (Dutta et al.,2020). It is both transparent and dependable due to the fact that the history of transactions can be easily traced back to older blocks on the blockchain. Each Bitcoin block contains a unique ID and the hash of the previous block, ensuring the safety and security of transactions. All transactions are confirmed by network users; they are timestamped, organized chronologically, and connected to the previous block; and they are also irreversible once submitted to the system. Due to the complexity of the blockchain's structure, it is a "trusted technology" (Queiroz et al., 2019). The "consensus mechanism" is a fundamental component of blockchain's trustworthiness, security, and transparency. Records are kept in blocks that are connected by hash values, and a new block may be added to the system only via consensus. If an existing block is modified, the attacker must compete with all other users to create a longer branch, which supports the DLT in preserving historical data security via a cooperative method (Dutta et al.,2020).

The provenance of the transaction is ensured by the use of a blockchain-based digital signature. The robust nature of the blockchain safeguards the distributed ledger. Additional benefits of the blockchain include a reduction in time, complexity, and cost. The allure of blockchain is that it has the potential to accelerate banking and trade processes while also improving regulatory supervision. Through the use of a decentralized consensus technique, transactions are rendered immutable and can only be modified with the approval of peers across the network. This strategy may be used to replace traditional third-party services in a transaction. The blockchain distributed ledger will provide consensus and immutability in the movement of assets inside business networks (Laroiya et al., 2020).

### III. OPPORTUNITIES FOR BLOCKCHAIN TECHNOLOGY IMPLEMENTATION IN LOGISTICS

Centobelli et al. (2021), Montecchi et al. (2019), Benzidia et al. (2021), and Harish et al. (2021) have recently published studies that analyze the advantages of blockchain technology's application in the logistics industry:

#### A. Traceability and transparency

Blockchain has the potential to impact the supply chain, particularly as a potential replacement for EDI. Traceability and transparency have become critical needs in a globalized supply chain. The use of blockchain might make significant changes by raising the defects and inefficiencies of the conventional system (Centobelli et al., 2021; Azzouz et al., 2021).

Industry analysts remark that the mistrust of Moroccan shippers on the transparency of their inventories, production rates, etc. is a key impediment to the development of logistics services (Kawtar Akoudad and Fouad Jawab, 2018).

#### B. Streamlined Operations

Blockchain enables the determination of origin, the guarantee of authenticity and integrity, the monitoring of product custody, and the verification of a product's journey from point of origin to customer, possibly including after-sales services. All product transactions within a supply chain may be verified using the common and identical viewpoint held by all stakeholders (Montecchi et al., 2019).

#### C. Traceability and reliability

With the success of the e-commerce industry using online marketplace, Logistics Companies become more important. Logistics financing enters the picture as a viable option for LCs seeking financing. It is a mechanism that financing institutions (FI) utilize to assist LCs in expanding their businesses. The availability of clarification on the operating capabilities or performance of LCs becomes critical due to the high risk posed by their lower scale of operation. Logistics financing blockchain platform which allows stakeholders to interact with each other in a common platform was proposed as a solution to bring to Logistics Companies more traceability into its activities or transaction and reliability into the shared information (Azzouz et al., 2020; Harish et al., 2021).

#### D. Trust and sustainability

The fact that blockchain enhances innovation capacity is critical since businesses usually want to establish trust with suppliers before committing to producing new items. Additionally, developing social capital via relationships will address the social components of sustainability (Benzidia et al., 2021).

### IV. CONTRIBUTION OF BLOCKCHAIN TECHNOLOGY IN THE SHIPPING INDUSTRY

Because it enables increased service efficiency, digitizes maritime records, enables real-time tracking of cargo status, improves logistics transparency, and reduces customs

clearance time, blockchain technology is gradually being integrated into the global logistics of the shipping supply chain (Yang, 2019). Listed below are a few of the benefits of blockchain technology. It protects against database modifications and destruction since it is a distributed and shared encryption repository. Additionally, it enables licensees to access trustworthy data by storing copies of the whole blockchain (Wang et al., 2019; Yuan and Wang, 2019; Saberi et al., 2019; Zhang et al., 2020). For the second time, it enables concurrent auditing and real-time optimization for all project partners and organizations. Thirdly, it simplifies the decision-making process at all stages of the supply chain (Yang, 2019). While blockchain technology is still in its infancy in the maritime industry, it is gaining traction in terms of discussions and prospective applications. Global port managers have undoubtedly recognized that blockchain technology has the potential to enhance port logistics security, integrity, and efficiency, and have taken measures to use it. A blockchain is a kind of distributed ledger technology. In Antwerp Port, for example, a trial project for an automated logistics system has been launched. There is a need for new technology capable of automating and streamlining port container logistics operations, and the system is currently anticipated to be completed through the blockchain. Logistics Company DexFreight and Veracruz Port have agreed to use blockchain technology to validate the idea for the port's open system. Contributes to the advancement of blockchain technology and the enhancement of security and efficiency in the port and freight transportation systems. Additionally, liner firms, port authorities, and terminal operators are intrigued by blockchain technology (Wang et al., 2021).

According to Wang et al. (2021), the table below illustrates several applications of blockchain technology in the shipping industry :

TABLE I. BLOCKCHAIN APPLICATION IN LOGISTICS AND OPERATIONAL MANAGEMENT (WANG ET AL., 2021)

August 2017	The business alliance of 14 Japanese firms, including MOL, NYK, and K-LINE, was formed using blockchain technology.
September 2017	In Beijing, Ernst & Young announced the launch of the world's first maritime insurance blockchain platform in collaboration with blockchain expert Guardtime.
January 2018	IBM, CMA-CGM, and MSC partnered to develop the TradeLens shipping blockchain platform
February 2018	PIL, PSA, and IBM have developed a blockchain-based supply chain platform
October 2018	Samsung announced a collaboration with ABN-AMRO Bank and the Rotterdam port authorities to establish distributed accounting-based shipping and logistics operations
November 2018	DPW, HWL, PSA, SIPG, CMA-CGM, COSCO, EMC, OOCL, YML, and Cargosmart signed a memorandum of intent to form a shipping industry blockchain alliance called the Global Shipping Business Network during the

	inaugural China International Import Expo (GSBN).
April 2019	Maersk, MSC, HPL, ONE, CMA-CGM, EMC, HMM, and YML founded the Digital Container Shipping Association (DSCA)

The blockchain's application of smart contracts and immutable data provenance can successfully address the issues stated above regarding the preservation of trade documents. To expedite supply chain processes, blockchain technology may provide parties with continuous visibility and data integrity for documents (Juma et al., n.d.). It uses consensus algorithms and secure hashing. On-chain hashes enable the detection and reporting of any attempt to change information in transaction documents. This includes the owner, customs officials, shipping agency, freight forwarder, and bank agent, all of whom have access to the BoL (Bill Of Lading) document's information. To safeguard the anonymity of the remaining supply chain players, the BoL documents are kept confidential (Ahmad et al., 2021).

#### V. CHALLENGE OF BLOCKCHAIN APPLICATION IN LOGISTICS

There is increased interest in examining the barriers and facilitators to the use of blockchain technology in supply chain management, due to its innovative character and potential for supply chain management improvement. To begin, Casey and Wong (2017) examined the barriers to blockchain adoption in global supply chains, emphasizing the problems inherent in interoperability between different blockchains and in enforcing commercial agreements across national borders. While the authors believe that establishing standards and rules for blockchain interoperability will further accelerate blockchain adoption in global supply chains, they also advocate for adapting existing regulations and industry practices to the new dematerialized, automated, and global nature of these new technologies (Casey and Wong, 2017). Wang et al. (2019) relied on in-depth interviews with supply chain professionals to discuss the perceived difficulties of the technology's complexity and high implementation costs. Additionally, they stated, it's critical to set clear governance rules and to ensure interoperability between two or more blockchains and existing systems, in addition to tackling the contentious issue of data ownership. Van Hoek (2019) employed a multi-approach strategy based on focus groups, surveys, and case studies to glean insights from an RFID (Radio Frequency Identification) implementation study on the importance of numerous internal and external elements, in addition to management commitment, for blockchain deployment. Janssen et al. (2020) assert that organizations' resistance to change, their lack of understanding of blockchain technology, their lack of regulations, their need for an appropriate governance framework for blockchain, their costs, and their need to standardize information exchange processes may all be impeding blockchain adoption. There are four types of impediments to using blockchain technology for supply chain sustainability management: intra-organizational barriers, inter-organizational barriers, system-related barriers, and

external barriers. 2019 (Saber et al.). Following Saber and colleagues (2019), Kouhizadeh et al. (2021) study the four types of impediments and their impact on blockchain adoption using the Technology, Organization, and Environment (TOE) paradigm. According to their findings, the primary barriers to blockchain adoption for sustainable supply chain management are a lack of management support, a lack of knowledge and expertise, a lack of cooperation, coordination, and information disclosure among supply chain members, as well as a lack of policies and industry involvement (Agi et al., 2022).

#### VI. CONCLUSION

Supply chain management is one of the most perplexing difficulties that global organizations face today. These firms invest significant time and money in identifying methods to increase efficiency and reduce expenses.

Due to blockchain technology, the supply chain as we know it may be poised to undergo a fundamental transformation. According to industry commentators, blockchain technology has the potential to increase supply chain trust, efficiency, and transparency. Supply chain executives are increasingly realizing the future possibilities of blockchain solutions.

This study recommends the use of Blockchain technology to promote supply chain transparency, trustworthiness, and traceability. The technology is well-suited for complicated supply chain activities and has the potential to provide a significant return on investment in a very short period of time.

As a perspective of future research study, it would be more interesting for supply chain executors to study the successful adoption of blockchain by removing all impediments.

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