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The Potential of Blockchain Technology in the Efficiency of Global Supply Chains

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ABSTRACT: The supply chain is a network of interconnected companies and individuals working together in sequential steps to create products and deliver them to customers. Cross-border transactions make the network more complex. It cannot be stressed enough how important it is to have uninterrupted supply chain operations. The world we live in changes constantly, so it is important to adapt to changing requirements and new challenges. Integrating technology like the blockchain system, which is considered more efficient and secure, can help support supply chains. Blockchain, also known as distributed ledger tech, allows participants to securely settle transactions, archive transactions, and transfer assets at a low cost. Blockchain is not only an innovative internet infrastructure that uses distributed applications but also a new supply chain network that may open up new opportunities for business. This emerging technology is undergoing a lot of research and revolution.

KEYWORDS: supply chain, blockchain, logistics, economy, digital

Introduction

The supply chain system goes beyond the mere storage and preservation of information. It also incorporates channels that allow information to flow. As raw materials begin their journey, they go through many stages before finally arriving at a final product that can be shipped to customers. Each step of the supply chain involves information flowing toward different organizations.

It is important that communication channels are open and available at all times. Data silos may also occur when organizations fail to comply with legal and business requirements regarding data storage (safe data storage). Data silos are basically instances of duplicate data in different databases accessed individually. The solution is to share information among the many stakeholders in a supply chain. This makes information visible to other users beyond a single entity.

The growing trend in supply chain and related activities is supporting the importance of information and trustworthiness in this complex environment. The supply chain is impacted by regulations. Regulations are used to prevent past events from happening again or to impact future actions. According to the Harvard Business Review, transparency is the obligation for companies to be kept informed about upstream activities in the supply chain and to communicate these details internally as well as externally.

Blockchains comprise several data storage technologies. There are many implementation options and variants, providing secure, robust, and authenticated storage that is resistant against modification. Their distinctive characteristic is their decentralized management. The infrastructure is managed by consensus rules and no single actor holds all the power (Maher 2022, 4-5).

Blockchains have the core value of providing an infrastructure that is neutral. This means that all stakeholders can share the technical infrastructure. This is especially useful for ecosystems where participants must cooperate, but also have competing or conflicting interests. This mainly applies to international trade processes that involve many actors and complex relationships within different regulatory frameworks. It can be viewed as a tool for promoting cooperation and trust (Fernandez 2022, 6).

Methodology

In order to identify high-quality, relevant articles, I did a research on the Web of Science Core Collection (WoS),. The database is carefully curated to only include peer-reviewed journals, book chapters, and conference papers. Searches were made between 2019-2022 using keywords "blockchain" and "supply chain" or "blockchain AND logistics" in the title. This combination of keywords was used to identify studies that relate

to this technology's support for the supply chain. An increase in the number of published proceedings was seen due to the advancements made with blockchain technology. Two stages were used to select the articles. The first stage analyzed titles and abstracts. The second stage involved full-text reading of all studies that were not excluded from the first stage.

To systematize the data, I used a content analysis in this study. This allowed me to see the evolution of research on blockchain in the supply chain area. The analysis focuses on three main criteria: the distribution of papers between 2019 and 2022, the number of publications by countries, the number of articles by journals, and the number of proceedings from conferences. Although studies based on blockchain use in supply chain management are relatively recent, there has been an increase in publications that I consider to have been influenced by technological developments. This is due to the industrial revolution 4.0 as well as the challenges they face in global supply chains.

The systematic literature review identified the key benefits of blockchain technology for improving the supply chain. Combining the benefits of blockchain technology with their ability to face the challenges, the system has the potential to improve the efficiency and performance supply chain. Blockchain technology can track goods flow, offer transparent operations, and reduce risks of low-quality products or high costs of operations. This results in reliable relationships between customers and partners, which helps address sustainability concerns.

Results and discussions

What is Blockchain?

In 2008, the concept of blockchain was born out of the global financial crisis. Satoshi Nakamoto published the white paper "Bitcoin: A Peer-to-Peer Electronic Money System." This paper described a peer-to-peer system that allows digital currencies to be transferred without the need for financial institutions or government (Hanebeck 2019, 6). To ensure that transactions are valid and secure, the emerging digital currency needed a reliable digital infrastructure. This is how the concept of blockchain appeared. This is a secure, robust, and resistant to alter digital registry that relies on both decentralized networks as well as cryptographic technologies (Maher

2022, 4-6). Blockchains are used in the monitoring, validation, and storage of all transactions with digital currencies. Blockchain is a digital shared infrastructure that stores data securely and allows data exchange with other parties. These blockchains are a type of distributed database (Graubins 2019, 11-14).

Duplicated storage

Blockchains can be used to share data within an ecosystem, while each member of the ecosystem must contribute to a global infrastructure, i.e., provide resources for data storage. A node must have a local copy the blockchain content. To ensure the resilience of information, there are several copies of the information that have been synchronized (Tsolakis 2022, 5).

Decentralized control and consensus

Blockchains can be used to share data in decentralized, horizontal ecosystems. This means that there is no single leader who holds strong control over the ecosystem. There is also no trusted third party responsible for validating and storing information. Without proper validation by other participants, no single actor can add or modify information to blockchain. This relies on predefined algorithms, called consensus algorithms, which allow trustful verification of transaction entries by multiple actors.

Immutability, Authentication and Timestamping

Blockchains use cryptography to protect information stored and traded, meaning they are based on cryptographic algorithms which ensure that all information saved can be modified or deleted. Each piece of information stored on a blockchain can be associated with one user through the use of cryptographic methods and proprietary digital signatures. Every piece of information on a blockchain can be robustly linked to the date it was added to the system (Centobelli 2021, 5).

Important Attributes of the Blockchain

Practical Uses

The supply chain consists of three phases: source, make and deliver. It is important to consider all factors that could impact the use of blockchain in business. Each industry has its own priorities and focuses. The food industry, for

example, may demand high quality standards and safety standards throughout the supply chain. The forest industry might focus on improving efficiency in manufacturing processes and reducing transport costs. The pharmaceutical industry might be focused on product innovation, R&D to source and make. It is important to evaluate the potential use of blockchain according to the requirements of a specific business area (Kouhizadeh 2022, 4).

Information Sharing

Information sharing has led to a new model of logistics under the sharing economy. Because logistics is volatile, businesses must take practical steps to improve logistics compliance. It is possible to solve differences due to seasons, holidays, and other factors, increase connectivity between systems, avoid wasting resources, and create shared information. The purpose of sharing logistics is to use the Internet to temporarily and seamlessly integrate dispersed logistics resources to diversify society. To put it another way, sharing information refers to the use of the Internet by logistics resource owners to temporarily access information resources or services for a fee. It's a logistic method that allows others to use their information. This reduces logistics costs and increases information resource operation rate. Blockchain could be a solution because each document can be uploaded and shared with individual departments or businesses. This will significantly reduce communications efforts and transfer paper, while also improving information sharing within a supply chain (Agrawal 2021, 3-4).

Traceability

Traceability can also be called auditability or scrutiny. This technology can be used for identification and tracking of the final products within supply chains. All users can trace the block within the blockchain network thanks to its design. The real-time data also adds value to business operations. The blockchain is made up of a series of blocks. Transactions and records are stored in separate blocks, as they are linked using the cryptographic hash function. Business partners can use blockchain technology to track and monitor blocks within a supply chain system. A block can contain important information such as products, process history and shipments, as well ingredients. It facilitates information sharing which increases transparency and visibility in supply chains. Business partners can also quickly gain

access to information without permission. The material information in a manufacturing system can be uploaded to blockchains with a specific ID and description. Customers and other supply chain partners could then quickly and accurately find the details.

Carrefour used blockchain technology in March 2019 to improve traceability of its milk supply chain. Carrefour, a French retail giant that operates more than 12300 shops and supermarkets across 30 countries in Europe and the Americas, Asia, Africa and Asia, is blockchain-enabled. Blockchain allows secure information exchange between suppliers, customers and producers throughout the supply chain. Customers and business partners can scan QR codes on Carrefour Quality Line milk bottles in order to identify all stakeholders and conduct quality checks. This increases supply chain integration and collaboration and adds trust and a long-term commitment to a supply chain.

Automation in Digital Transformation

Blockchain's automation of digital transformation is a practical feature that can be widely adopted in supply chain management. This technology cannot be used to achieve business automation. It does however, provide a decentralized model for supply chain integration and collaboration that includes people, finance and information as well as goods and technologies. Blockchain can increase efficiency by automating data processing and eliminating intermediaries, such as robots and autonomous guided cars. It can also be used with other technologies to create a smart supply chain for industries. A blockchain network can be used to build a smart supply chain network that may include a number of IoT devices and smart contracts, robots, machine learning and vision, as well as planning, scheduling, optimization, expert systems, and other technologies.

A smart contract can organize the supply chain-related information in the local data structure to allow content-based search and enable efficient information retrieval. In addition, it can easily detect duplicated transactions and remove them immediately Meanwhile, updating products' status will be much more effective via blockchain smart contract structure. Furthermore, smart contracts and smart supply create low query response time and a higher accuracy environment.

General economic perspective

To achieve widespread adoption, it is not enough to have the technical functionality of blockchain technology. It also requires that the economics of the solution provide benefits for potential users. These benefits can be offered by blockchain technology because of its potential in:

- Lowering verification costs;
- The cost of networking.

First, it is cheaper to audit transaction information. Second, it eliminates the need for intermediaries, thus Blockchain could eliminate rent extraction by actors acting as trusted intermediaries (Graubins 2019, 11-14).

However, these benefits come with their own costs, considering that decentralization is generally associated with three main expenses:

- Wasting resources;
- Scalability problem;
- Inefficient network effects.

When assessing the economic impact, these costs must be balanced against the benefits of increased competition. However, it is difficult to create such an environment on a large scale, since many organizations currently use permissioned blockchains in smaller Consortia, which are more manageable. Due to enforcement issues, a permissioned blockchain might be necessary. Although the technology can transfer ownership easily, it does not guarantee possession transfer. For enforcement and supervision, it might be necessary to have centralized entities like government agencies. But, it is possible to end up with inefficient, competing public and private networks that cover different aspects of trade, supply chains, and where the gains may be smaller than what some forecasts might indicate (Beserra 2020, 3-7).

Initiatives on blockchain at EU level

There are approximately 770 blockchain initiatives at the EU and Member States level. The EU Blockchain Observatory and Forum was launched by the European Commission (DG CONNECT) in February 2018. This platform allows stakeholders to engage with each other and connect European and international expertise. The observatory published reports on the scaleability and operability blockchain, the regulatory framework for smart contracts,

as well as on blockchain in trade finance, supply chain and trade finance (Schneider-Petsinger 2021, 13-15).

21 EU member states and members of the European Economic Area (Norway and Liechtenstein) signed the declaration establishing the European Blockchain Partnership (EBP) in April 2018. The declaration is intended to bring together the signatories at the political level and commit to realizing the potential of blockchain-based service. The Partnership is working to define a policy agenda in Blockchain and identify key regulatory areas, such as smart contracts. The EBP is also building a European Blockchain Services Infrastructure (EBSI), which will enable the cross-border delivery of public services using blockchain technology across Europe. The Partnership has seen more signatories join it, taking the total to 30.

EBSI supports four use-cases: diplomas, notarization, European self-sovereign identification, and trusted data sharing. This use case is linked to trade and supply chains because it uses blockchain technology to securely share data between customs and tax authorities within the EU. EBSI was created in 2020 to be a part of the Connecting Europe Facility and aims to provide software specifications, services, and reusable software to facilitate adoption by EU and member state public administrations. The EBP will choose future use cases that will be integrated into the Connecting Europe Facility in 2021. Current plans are to create a use case on supply chain topics, such as provenance. Another area of interest is sustainability and the role ICT can play in achieving the Green Deal. The Digital Europe Programme will be the vehicle for continuing the work on EBSI and focusing on its deployment in the next Multiannual Financial Framework.

The launch of the International Association for Trusted Blockchain Applications in April 2019 was another initiative that the EU supported. INATBA, a multi-stakeholder organization, acts as a forum that brings together developers and users of distributed ledger technology (DLT), with regulators from around the globe. In November 2019, the Commission organized the "Convergence Global Blockchain Congress" together with INATBA and the EU Blockchain Observatory and Forum. This conference brought together regulatory and industry stakeholders to share information and take stock of the state of blockchain technology.

The Commission is also working to promote legal and regulatory aspects for blockchain-inspired technologies, which includes improving legal certainty in two areas, smart contracts and tokenization. Concerning smart contracts, it is important to clarify the borders of mutual recognition. It is also necessary to clarify the use of tokens in the economy as a form of digital currency. The eIDAS regulation is more focused on blockchain use to establish digital identity and connect to eSignatures, but it is less relevant to trade and supply chains (Lundqvist, 2021, 44-48).

Practical uses of blockchain in supply chains

a). Transparency and counterfeit prevention

Transparency is essential to anti-fraud prevention and counterfeit prevention. These activities are emphasized in some projects, such as Guardtime HSX for pharma and Everledger which started out tracking the digital twins of every diamond to increase confidence in buying and selling these products. Everledger recently expanded its focus to include gemstones, wines, minerals, luxury, and insurance. For example, Toyoda describes a novel framework to establish post-supply chains that can be used to prove ownership of a product. This framework allows customers to reject counterfeit products even if they have genuine RFID tags (Wang 2021, 115-116).

b). Trust management

In some cases, the goal is to create a trusted, single source of truth that can be trusted by all stakeholders. Insurwave is a joint project between Guardtime and EY that illustrates this. It automates insurance processes to meet the demands of the digital age and manage dynamic risk (Dietrich 2021, 3). Others applications also aim to automate manual paperwork. CargoX, CargoCoin and others are heavily investing in digitizing bills of lading documents. This is a major source of inefficiency in modern shipping administration. Skuchain offers the Empowered Collaborative Commerce Cloud, (EC3) which is claimed to be the Swiss Army knife in supply chain software. It offers a wide range of solutions, including inventory tracking (the transformation sub-assemblies and parts used to make a finished item), digitizing invoices, and other physical documentation. Morpheus Network approaches the technology from the trade finance perspective. The platform

allows for quick payment and conversion of funds via various partnerships at real-world exchange rates, while requesting a single network fee. It can integrate with payment (SWIFT/Ripple/Stellar), transport (FedEx/UPS) and CRM services (Salesforce). SyncFab aims to connect idle machines with production demand. Fr8 connects brokers and carriers, improving shipment coordination and management, by also offering tracking utilities. NextPakk uses a shared economy model that is similar to Uber's for last-mile logistics.

More researchers and practitioners are realizing the benefits of IoT technology and blockchain technology. In one example, Caro&Co proposes a traceability solution for the agri-food industry by integrating IoT devices that feed onto the chain and consume from it. Riddle and Code also offer NFC tagging and blockchain enrollment. The literature focuses on the fact that data on chain can only be as good as what is recorded. Waltonchain aims to change this. QR codes and RFID tags are not known for being reliable trust anchors (Veramallu 2021, 28). They created a secure, two-way authentication RFID design that includes integrated encryption logic, resulting in a design which is claimed to be tamper-proof. The sensor can be used as a node and upload directly to the chain, thus making it possible for IoT measurements such as temperature, humidity, etc. It is significantly safer. SKYFChain also focuses on machine-chain communication, which creates a platform between unmanned autonomous cars and businesses. Malik&Co argue that blockchain cannot be relied upon to support trust and reliability in data stored on the chain about the quality of physical commodities as well as the trustworthiness of supply chain entities. They will provide an automated framework that can associate a trusted price to each supply chain event, based on both the trust value of each participant and the commodity's quality (Vyas 2019, 150-157).

Conclusions

This paper provides an overview of the blockchain and identifies and explains the key attributes. A supply chain system typically includes a number of companies and flows, including information, finance, and goods. Collaboration with business partners is essential to integrate flows and improve performance, thus giving companies substantial competitive advantages. Blockchain has many unique features that can be used in a vast

array of economic sectors. The paper discusses how blockchain applications, including information sharing, traceability, and automation, can be used to facilitate supply chain collaboration and deeper integration, all resulting in unprecedented efficiency growth.

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