A New Paradigm Shift for Supply Chain Integration and Collaboration Measures with Specific Reference to Blockchain and Supply Chain Management

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Abstract:

Despite various disagreements, blockchain has been hailed as a critical distributed secure technology for the twenty-first century. It's an indestructible digital ledger of economic transactions that can be configured to record anything of value, not just financial transactions. According to Dobrovnik et al. (2018), blockchain is a game-changing technology that will transform industries on a global scale, provide value to enterprises and supply chain networks, boost trade, and drive the economy. Despite the fact that blockchain has gotten a lot of attention, there have been very few blockchain studies focused on supply chain integration and collaboration. In a multi-stakeholder supply chain, maintaining product and process integrity is a big task. Data fragmentation, a lack of verifiable provenance, and a variety of protocol restrictions across numerous distributions and processes plague many present solutions. Blockchain, among other technologies, has emerged as a prominent technology because it enables safe traceability and control, immutability, and stakeholder trust in a low-cost IT solution. Although blockchain is having a big impact in a lot of industries, there are still a lot of roadblocks in the way of its general implementation in supply chains. The expected result of this study is to improve awareness of the blockchain and supply chain literature, as well as to encourage both researchers and practitioners to consider using blockchain in future context-aware investigations.

Keywords: Supply chain technology, blockchain, scalability, supply chain integration, data fragmentation

Introduction:

Blockchain technology is a critical distributed secure technology in today's Business 4.0 era, and it has gained a lot of interest from academics and industry (Dobrovnik et al., 2018; Swan, 2017). Distributed ledger technology (Tschorsch and Scheuermann, 2016; Zyskind et al., 2015) is a type of blockchain that allows participants to ensure transaction settlement, archive transactions, and transfer assets at a minimal cost (Tschorsch and Scheuermann, 2016). It's not only a new kind of internet infrastructure built on distributed apps, but also a new kind of supply chain network that might usher in a new business paradigm (Hackius and Petersen, 2017; Mansfield-Devine, 2017; Swan, 2015). As a developing technology, there is still a lot of revolution and research to be done on this distributed technology. A growing number of products are distributed to clients via supply networks that are made up of individual businesses (Christopher and Peck, 2012; Wang et al., 2018). As a result, today's firms compete not just as stand-alone entities, but also as components of a larger supply chain network (Christopher, 2005; Wang et al., 2015). Due to globalisation, higher customer expectations, market competition, supply chain complexity and uncertainty, companies face increased uncertainty, challenges, and constraints, necessitating coordination and cooperation across supply chains (inter- and intra-supply chains) and the needs of customers. Blockchain and Supply Chain Management: A New Paradigm for Supply Chain Integration and Collaboration, by Wang et al. 2021 for information technology 112 Operations and Supply Chain Management 14(1) pp. 111–122 (Huddiniah and Er, 2019). Furthermore, these limits have a direct impact on business performance and frequently result in issues and limits, such as excessive operating costs or capacity shortages, which the Blockchain revolution could alleviate (Tapscott and Tapscott, 2016). This article seeks to analyse the relationship between blockchain and supply chain collaboration and integration, as well as examine blockchain applications in supply chain management. Technology is a key variable to optimize the process, task, and structure, according to the Socio-Technical Theory (STT) (Bostrom and Heinen, 1977).

The social system and the technological system are the two systems that make up STT. We reduced the scope of the study by concentrating on the technical system, which includes the procedures, tasks, and technologies required to convert inputs into outputs (Cartelli, 2007). Blockchain has a lot of potential for reorganizing work structures and managing supply chain limitations (Cole et al., 2019). Despite this, few studies have been undertaken on the relationship between blockchain and supply chain integration and collaboration (Bai and Sarkis, 2020; Chang and Chen, 2020).

As a result, this paper attempts to address this research void by focusing on two primary research questions:

RQ1: What are the main characteristics of blockchain technology that are relevant to supply chain management?

RQ2: What role does blockchain technology play in supply chain collaboration and integration?

This study use qualitative research to answer the research questions. To ensure the research's reliability and validity, we used both desk research and informal interview methodologies to answer the questions. First, we combed through relevant literature, prior studies, and business cases in blockchain and supply chain, extracting the most significant blockchain characteristics.

In addition, we inquired if the respondents believed that blockchain technology may assist their company in improving supply chain integration and collaboration. The blockchain technology received good response from over 80% of the respondents. By putting light on supply chain integration and collaboration, the findings may highlight the practical implications of blockchain for supply chain management. The remainder of the paper is laid out as follows.

The necessary literature and background information are described in Section 2. The research methodologies are briefly described in Section 3, and the research findings are presented in Section 4. The major practical aspects and potential obstacles are discussed in Section 5. Finally, Section 6 brings the work to a close by outlining future study prospects.

What is Blockchain, and how does it work?

A decentralized digital ledger that may be designed to distribute and store data is known as blockchain. It's also known as a distributed ledger because it's based on a peer-to-peer (P2P) or decentralized network that's made up of a series of blocks. According to Swan (2017), the terms block chains and digital ledgers are often used interchangeably. In a blockchain network, all parties can share and record blocks at the same time, which must be confirmed and authenticated by all network members. The cryptographic hash function connects blocks. By inspecting the block information connected by hash keys, each transaction may be tracked (Chen et al., 2018; Zheng et al., 2018; Zheng et al., 2017). The fundamentals of this new paradigm, according to blockchain proponents, are transparency, speed, accessibility, and non-falsifiability (Apte and Petrovsky, 2016). According to Sultan and Lakhani (2018), the blockchain is a decentralized database that is managed by a consensus model and contains sequential, cryptographically linked blocks of digitally signed asset transactions. All ledgers are encrypted and published to the block network with a timestamp, ensuring that all blocks are in the same time sequence as the entire book. Because blockchain uses a distributed database to store all data, and the primary notion of blockchain is distributed computing rather than centralization, it appears that if a user wishes to update a record, he or she must edit all of the book records. In other words, if hackers merely update information on one block, it will not work. Distributed computing not only reduces computation costs, but it also addresses the issue of data security by ensuring that all participants have access to the same "book." Furthermore, every node in a blockchain uses a peer-to-peer (P2P) technique to transfer data, lowering the cost of establishing decentralization. Because there is no central server, all data is distrusted and saved on individual computers, which means that an organisation cannot modify any data without gaining consensus throughout the whole blockchain network.

Despite the fact that blockchain technology is still relatively young, there have been three generations of block chains, the most recent of which is Blockchain 1.0, which is the underlying technology behind cryptocurrencies like Bitcoin and Litecoin. The first generation blockchain was introduced as part of Bitcoin in 2009, and it provided a method for creating an incorruptible digital ledger of economic transactions. Ethereum deployed an enhanced blockchain 2.0 for transaction validation in 2015. The decentralized digital ledger, which encompasses many different categories such as Blockchain 2.0 protocols, smart contracts, and decentralized applications, was developed into Blockchain 2.0. With the advancement of computer technology, the blockchain 2.0 protocols may be used to manage nearly everything of value, not only financial transactions. Many Blockchain 2.0 projects are primarily used for the transfer of all sorts of assets other than currency via the blockchain, which is still in development (Swan, 2015). The economic efficiency and cost savings given by trustless interactions in decentralized network models are the fundamental arguments for Blockchain 1.0 and 2.0 transactions. Blockchain 3.0 is still in its infancy. The future research directions for blockchain, according to Yli-Huumo et al. (2016) and Garrod (2016) are unclear. Beyond currency, payment, and economics, we might think of blockchain as a new paradigm: a decentralized network for supply chain integration and collaboration.

Collaboration and Supply Chain Integration:

The integration of material, information, and financial movements in a network of enterprises or organisations is known as supply chain management. To manufacture and distribute products and services to consumers, several supply chain partners must collaborate. The supply chain management idea profoundly alters the nature of a company because control is no longer focused on direct control of internal business activities, but rather on collaboration among supply chain members (Lai et al., 2004; Porter, 2019). Collaboration among supply chain stakeholders is seen as a crucial aspect in achieving a win-win solution for all stakeholders (Ramanathan and Gunasekaran, 2014; Tsou, 2013). Furthermore, Soosay and Hyland (2015) emphasise that collaboration includes long-term commitments to technology sharing and tightly linked planning and control systems, in addition to integration. Supply chain collaboration can take several forms, including collaborative planning, collaborative decision-making, and collaborative execution (Ramanathan and Gunasekaran, 2014). Collaboration in the supply chain necessitates a high level of commitment, trust, shared decisions, and information exchange (Liao et al., 2017; Pradabwong et al., 2017; Soosay and Hyland, 2015; Zhang and Cao, 2018). Internal, external, supplier, and customer integration are all part of the supply chain integration process (Alfalla-Luque et al., 2015; Flynn et al., 2010; Kim, 2006; Maiga, 2016). Supply chain performance improves when there is a high level of supply chain integration and collaboration (Chen et al., 2017; Wiengarten et al., 2016).

The capabilities of a corporation to perceive, collaborates, coordinates, and reconfigure the elements in a supply chain, including internal cross-functional integration and external integration with suppliers and customers, is considered in this study. Hafeez et al. (2002) describe capability as the ability to employ resources to complete a task or activity; they define a resource as anything held or acquired by a corporation, tangible or intangible, including technology. From a resource-based view (RBV) in this study, blockchain can be viewed as a technology that facilitates the firm's abilities, such as integration and collaboration. Scopus, Elsevier's largest abstract and citation database of peer-reviewed literature, was the primary source for this study's literature review. Through a survey of relevant literature; we answered the first study topic, focusing on two primary areas: "blockchain" and "supply chain collaboration and integration."

We searched the article title, abstract, and keyword in English journal articles, conference articles, and scholar articles using the search strings "blockchain" AND "supply chain management" (296 articles); "blockchain" AND "attributes" (38 articles); "blockchain" AND "attribute" AND "supply chain" (5 articles); "blockchain" AND "attribute" AND "supply chain" (5 articles); "blockchain" AND "supply chain collaboration" OR "supply chain integration" (10). The search results were evaluated, duplicates were removed, and publications not connected to Blockchain and supply chain integration and collaboration were excluded, resulting in a final selection of 45 articles. Since 2018, the number of published blockchain and supply chain management articles has risen dramatically, and the majority of the early research share very similar characteristics. As a result, we did not cite all of the research articles in the final report.

OUTCOMES:

In this section, we give the findings, which include key characteristics of blockchain and prominent blockchain applications in supply chain integration and cooperation. The Block chain's Most Important Characteristics. The blockchain is thought to be a useful tool for increasing the efficiency and efficacy of business processes and transactions (Hackius and Petersen, 2017; Swan, 2015; Underwood, 2016). It is therefore critical to comprehend the features and/or functions that can be employed to improve the overall efficiency and effectiveness of supply chain performance by strengthening the capabilities and/or relationships among business partners.

We analyse prior studies and identify the key qualities of blockchain technology in this subsection, and then we explore the connection between the attributes and supply chain integration and collaboration. Digital ledgers have a number of useful features that can be applied to the supply chain (Dobrovnik et al., 2018; Hackius and Petersen, 2017; Swan, 2017; Tapscott and Tapscott, 2016). Jawaji et al. (2020) state in earlier studies that Blockchain ensures transparency, security, authenticity, and auditability. Yang et al. (2019) study the characteristics of blockchain in the iron and steel supply chains, including decentralization, security, visibility, and trust. According to Zheng et al. (2018), decentralization, persistency, anonymity, and auditability are fundamental characteristics of a blockchain, and the important qualities of a blockchain are decentralized, verified, and immutable. Immutable, decentralized, consensus-driven, and transparent are four essential properties of blockchain, according to Sultan and Lakhani (2018). From a technological standpoint, Chen et al. (2018) define four features: decentralization, traceability, immutability, and currency characteristics, as well as benefits of blockchain technology such as reliability, trust, security, and efficiency. According to Zyskind et al. (2015), blockchain can be used to manage personal data because it is a reliable, auditable, and decentralized system. Mansfield-Devine (2017) emphasises the importance of trust in a corporate network, for which blockchain provides a cheaper and more standardized form of assurance. For some types of corporate and enterprise applications, according to Conte de Leon et al. (2017), blockchain could provide improved service availability at substantially reduced prices. Despite the fact that prior studies may have given attribute different names, several attributes with similar names have been amalgamated and summarized as the essential attributes of a blockchain, as shown in Table 1 below.

This section goes through each of these important characteristics in detail.

Table 1 Important attributes of a blockchain

Attributes of a Blockchain	Explanation	Studies
Immutable	It also known as irreversibility. The data can hardly be modified or deleted after the data has been approved by all nodes in the blockchain	Astarita *et al.* (2020); Chen *et al.* (2018); Hackius and Petersen (2017); Sultan and Lakhani (2018); Swan (2015); Tapscott and Tapscott (2016); Zheng *et al.* (2017)
Decentralised	Technique of Bitcoin. There is no central storage. This may minimize the disruption risks. It supports a decentralized decision-making.	Hackius and Petersen (2017); Mansfield-Devine (2017); Pereira *et al.* (2019); Swan (2015); Tapscott and Tapscott (2016); Yli- Huumo *et al.* (2016); Zyskind *et al.* (2015)
Trust	The trust is different from conventional trust. Blockchain creates trustless network by using sophisticated maths. Business partners can trade together without knowing each other.	Batwa and Norrman (2020); Beck *et al.* (2016); Chen *et al.* (2018); Christidis and Devetsikiotis (2016); Dobrovnik *et al.* (2018); Kosba *et al.* (2016); Mansfield-Devine (2017); Sultan
Transparency and visibility	The data is almost simultaneously validated and broadcasted to all nodes in block chains. The transactions or records cannot be hidden so this creates more trust and adds value to the business system.	Caro *et al.* (2018); Dobrovnik *et al.* (2018); Jawaji *et al.* (2020); Sultan and Lakhani (2018); Tapscott and Tapscott (2016); Underwood (2016); Yang *et al.* (2019); Zyskind *et al.* (2015)
Security	Advanced computational logic, cryptographic technology and a distributed decentralized network offer a secure environment. Moreover, it provides not only confidentiality, but also authenticity and nonrepudiation to all activity.	Caro *et al.* (2018); Jawaji *et al.* (2020); Kosba *et al.* (2016); Mansfield-Devine (2017); Tapscott and Tapscott (2016); Underwood (2016); Yang *et al.* (2019); Yli-Huumo *et al.* (2016)
Global Network	Blockchain technologies rely on shared Information. It can be extended globally. It is a standardized global network.	Sultan and Lakhani (2018); Swan (2017); Tapscott and Tapscott (2016); Underwood (2016)

Immutable:

All transactions or records in a blockchain are organised into series of blocks using a hashing technique, and each block is linked. Due to the enormous amount of computer power necessary to modify the original state of the block, hashing and cryptography are employed to create data recorded in blockchain that is nearly unchangeable. This not only allows diverse participants in the networks to exchange value or assets, but it also establishes a trustless network through the use of advanced math

(Christidis and Devetsikiotis, 2016; Tapscott and Tapscott, 2016). Although immutability is often thought of as a security feature, it also has key practical consequences in the business sector, such as increasing supply chain and logistic operations traceability (Alkhodre et al., 2019; Astarita et al., 2020). As a result, this study considers immutability to be one of the most significant characteristics of a blockchain.

Trust:

Blockchain establishes a new trust mechanism based on cryptography technology and a decentralized distributed network (Tapscott and Tapscott, 2016). Furthermore, blockchain does not necessitate faith in a third party (Zyskind et al., 2015). A strong relationship built on mutual trust is critical to the supply chain's success (Chen et al., 2010; Luo et al., 2012; Mirkovski et al., 2012). The blockchain technology operates without the need for trust, making transactions “trust free” (Beck et al., 2016).

This crucial feature of blockchain allows multiple business partners to collaborate without the need for traditional trust (Kosba et al., 2016; Mansfield-Devine, 2017). Furthermore, a blockchain network facilitates the sharing of information among supply chain parties. The trustless network has a positive impact on the relationships between supply chain partners (Soosay and Hyland, 2015).

Decentralization:

A peer-to-peer network is what a blockchain is (Swan, 2017; Tschorsch and Scheuermann, 2016; Underwood, 2016). It alters the way data is stored and shared. In a blockchain network, each member keeps their own copy of the ledger. Data is no longer held in a centralized database in a decentralized system, and the data is immutable and transparent to all members of a blockchain. A block of transactions is not validated by a third party. The decentralized blockchain network enhances visibility among supply chain stakeholders who can access information without authorization in a supply chain system (Tapscott and Tapscott, 2016). In the era of Industry 4.0, blockchain technology enables a digital transition from centrally controlled platforms to decentralized platform control (Wang et al., 2020). It also facilitates decentralized decision-making and distributed manufacturing, giving all users a more flexible environment. In the car manufacturing business, for example, unexpected complications could cause the manufacturer's suppliers to adjust the delivery timetable.

Fortunately, all other businesses in the supply chain will receive this information quickly, allowing supply chain partners to make timely and effective decisions. Because data kept on one node must be vetted and disseminated to all nodes in the network, decentralization increases security. In other words, in the event of a node failure, other nodes can take over and prevent a disturbance. This is a critical feature to avoid a supply chain disruption caused by a failure of the centralized information network.

Transparency and Visibility:

Another essential feature of blockchain is its transparency and visibility (Frank et al., 2019). Because blockchain is a highly decentralized network, as opposed to a traditional centralized database, all users can receive updated information in the network virtually simultaneously. Many business problems/uncertainties in supply chains can be overcome by sharing real-time data (Wang, 2018).

If a component alteration needs to be updated in the system and all businesses need to be alerted along the supply chain process, blockchain might effectively update all relevant users and stakeholders at the same time. A manufacturing ID replacement, for example, will have a substantial influence on the entire process, therefore the delivery company, manufacturer, and stock management department should all be aware of the change right once (Wang et al., 2018). Another example is the distribution of customer demand information throughout the supply chain network. While such a method can greatly cut inventory costs, keeping all supply chain business partners synchronized in a traditional network is tough. In this scenario, blockchain technology improves network transparency and visibility.

Security:

In a blockchain, security is a multifaceted topic. Swan (2017) claims that one of the most important motivations of blockchain adoption is cyber security. The following issues of security are discussed in this paper. To begin with, blockchain provides a method that enables all nodes to validate and store data without the involvement of a third party. Second, the data recorded on block chains is nearly immutable; that is, it is nearly impossible to modify, erase, or change information or blocks without causing other users to notice. Third, as previously stated, a decentralized network can retrieve and validate information over the network, making it nearly hard to hack a blockchain (Swan, 2015; Yli-Huumo et al., 2016).

Global Network:

The blockchain technology is still in its early stages (Swan, 2015). However, it has already shown that it has a lot of room for growth in the future. With the advancement of information technology, the blockchain network has the potential to expand rapidly beyond Bitcoin. Blockchain is viewed by Marsal-Llacuna (2018) as a connecting tool for data processing technology. The characteristics of blockchain can be used in a variety of situations. Because the blockchain network is based on a peer-to-peer network, businesses may no longer require the use of a third party / intermediary to offer their goods and/or services. Block chain's are smart networks (Frank et al., 2019; Swan, 2017) that can interact with a variety of technologies, such as smart contracts, artificial intelligence (AI), the internet of things (IoT), 3-D printing, and so on, to completely transform the traditional seller-buyer relationship around the world (Hackius and Petersen, 2017; Kosba et al., 2016; Swan, 2015; Yli-Huumo et al., 2016). Furthermore, Sultan and Lakhani (2018) claim that blockchain is a market.

Later on, it might be deemed a disruptive innovation.

According to Zheng et al. (2018), blockchain can be used for a variety of purposes. Applied to a wide range of applications, including the next generation of internet interaction systems, far beyond cryptocurrencies. According to Mansfield-Devine (2017), blockchain creates a trust chain in the commercial sector. So far, the majority of research has focused on using blockchain to improve information and financial flow (Tschorsch and Scheuermann, 2016; Yli-Huumo et al., 2016; Zheng et al., 2017). Security is a key study subject in recent blockchain studies, according to Yli-Huumo et al. (2016), with over 80% of blockchain studies focusing on Bitcoin in terms of a systematic review. We think about using blockchain for supply chain cooperation and integration since it provides a conceptual idea for collaborating with diverse nodes/parties/people and integrating money, information, and products flows and technologies in a supply chain.

Practical uses:

The practical applications of blockchain in supply chain management are demonstrated in this section. A supply chain can be broken down into three phases: source, manufacture, and delivery (Lambert et al., 1998). A supply chain, on the other hand, is a complicated system. Many aspects that may have an impact on blockchain implementations in enterprises must be carefully considered.

Furthermore, each industry may have its own set of priorities or foci. For example, in the food business, strict quality and food safety standards may be required across the supply chain. The forest sector may concentrate on increasing the efficiency of manufacturing processes and lowering transportation costs. For source and make, the pharmaceutical business may focus on improving product innovation and R&D. (Wang and Jie, 2019). As a result, evaluating the application of blockchain in terms of the specific requirements in a particular company industry is important.

After that, we concentrated on three key practical implications in digital transformation: information sharing, traceability, and automation (Chang and Chen, 2020; Frank et al., 2019; Wollschlaeger et al., 2017), which were confirmed in the informal interview and appeared to be popular for blockchain applications.

Information Sharing (IBM Maersk):

Traditional supply chain operations, particularly in international commerce, involve a vast number of conversations and documents that take a significant amount of time and effort to execute.

These include legal documents and contracts, which corporations must provide and transfer at a cost to them. Each document or paper can be uploaded and sent to a specific department or business on the blockchain, dramatically decreasing the effort required for communications or paper transfers and boosting information sharing in a supply chain (Benton et al., 2018; Wollschlaeger et al., 2017).

Traceability (Carrefour):

Auditability and scrutiny are other terms for traceability. The technology can be used to identify and track raw materials and finished goods throughout supply networks. (Angeles, 2009), All users may simply trace the block in the network thanks to the block chain's design. Furthermore, real-time data enhances corporate processes. The blockchain is made up of a sequence of blocks (Swan, 2015; Tapscott and Tapscott, 2016). Transactions and records are stored in separate blocks and are linked via a cryptographic hash function. This would be a useful feature for tracing the bricks. Business partners in a supply chain system can utilize the blockchain functionality to trace and monitor blocks in the network. The block could include important information, such as items, process history, shipping, and ingredients. It allows for information sharing, which increases supply chain visibility and transparency. Furthermore, business partners have immediate access to information without requiring authorization

(Apte and Petrovsky, 2016; Hackius and Petersen, 2017; Swan, 2017). Material information can be put into block chains with a unique ID and description in a production system, allowing other supply chain partners and customers to quickly and accurately find out specifics about that material. Carrefour deployed blockchain technology to improve the traceability of its milk supply chain in March 2019. Carrefour is a French retail behemoth with 12,300 stores and supermarkets in over 30 countries in Europe, the Americas, Asia, and Africa. Throughout the supply chain, the blockchain allows information to be securely transferred between producers, suppliers, and buyers. Customers and business partners can use the QR code on Carrefour Quality Line milk bottles to identify and conduct quality checks on the many players involved in the milk supply chain.

By instilling confidence and a long-term commitment in a supply chain, it increases supply chain integration and collaboration (Soosay and Hyland, 2015).

Digital Transformation Automation (Chain link):

The use of automation in digital transformation is a growing trend. It can be widely implemented in supply chains, which is a significant practical characteristic of blockchain (Christidis and Devetsikiotis, 2016; Frank et al., 2019). Business automation cannot be achieved just through blockchain. It does, however, offer a new decentralized paradigm for supply chain integration and collaboration, which includes people, finance, information, goods, and technologies (Tapscott and Tapscott, 2016). Robots and autonomous guided cars, as well as blockchain, can enhance efficiency by automating data processing and eliminating intermediaries (Chen et al., 2018; Dobrovnik et al., 2018). (Frank et al., 2019; Gilchrist, 2016) in their study said it can also be used in conjunction with other technologies to create a smart supply chain in the industrial sector. Mougayar (2016) and Sultan and Lakhani (2018) both support blockchain as a development platform. To achieve complete autonomy in business, the smart supply chain network may be built on a blockchain network and includes a series of IoT devices, 5G, smart contracts, and various AI technologies (e.g. robotics, machine learning, vision, planning, scheduling & optimization, expert systems, and so on) (Christidis and Devetsikiotis, 2016; Gilchrist, 2016). A smart contract can arrange supply chain-related data in a local data structure, allowing for content-based search and quick retrieval of information. Furthermore, it is capable of quickly detecting and removing duplicate transactions. Meanwhile, using the blockchain smart contract structure to update product status will be far more effective (Su et al., 2018). Furthermore, smart contracts and smart supplies provide an ecosystem with a fast query response time and excellent accuracy. Chainlink, for example, an integrated corporation, used crypto-tokens technology to automate the transfer procedure. As a result, along the supply chain process, all transactions will be unstoppable and authenticated. Smart contracts appear to have the potential to make it easier for supply chains to perform transactions and validate data flow. Chainlink will assist businesses in reducing over 80% error transformation and saving 30% time across the board by implementing this technology. To put it another way, blockchain technology will help organisations integrate internal and external processes more effectively.

Discussion:

In the era of Industry 4.0, blockchain is one of the most promising technologies (Frank et al., 2019; Gilchrist, 2016; Tapscott and Tapscott, 2016). It proposes a method for storing, verifying, and sharing transaction data across several nodes. This technology has the potential to assist businesses in establishing a trustless network (Christidis and Devetsikiotis, 2016) and optimizing goods, information, and financial flows throughout a supply chain. This technology has the potential to alter our commercial environment (Swan, 2015; Tapscott and Tapscott, 2016). However, blockchain will not bring about any significant improvements on its own. According to STT, it is a technology whose benefits must be shown and used in specific business situations. The blockchain technology, as well as supply chain collaboration and integration, are the focus of this research. The integration and collaboration of supply chains has become a popular trend in supply chain management (Chen et al., 2017; Ramanathan and Gunasekaran, 2014; Soosay and Hyland, 2015). A supply chain that is fully connected and collaborative accomplishes more than just cost savings. Customers, manufacturers, supply chain partners, and stockholders all benefit from it (Chen et al., 2017; Lee, 2000; Lee and Rha, 2016; Maiga, 2016). Integration and collaboration in the supply chain has been acknowledged as a critical approach for achieving effectiveness and efficiency (Chen et al., 2017; Flynn et al., 2010; Wiengarten et al., 2016). It can allow a corporation to focus on its main business while still competing in a worldwide market (Simchi-Levi et al., 2007; Wang et al., 2015). Furthermore, good supply chain management is being more recognised as a critical aspect in differentiating product and service offerings, as well as creating a competitive edge and ensuring a firm's long-term viability (Chen et al., 2017; Das and Mitra, 2018). In this study, we show how blockchain technology may help supply chain integration and collaboration by easing data sharing, traceability, and automation in the digital transformation process. Between blockchain and supply chain networks, there are certain similarities. To begin with, both the blockchain and the supply chain are network structures with various users, nodes, internal and/or external stakeholders. Second, the blockchain is a decentralized network, and in a traditional supply chain, most business partners/companies make decentralized decisions. Finally, both blockchain and supply chain networks rely substantially on node-to-node and partner-to-partner interactions.

As previously said, blockchain development is still in its early stages. In the Industry 4.0 era, various technologies such as robotics, 5G, AI, IoT, 3-D printing, and big data can be employed in conjunction with blockchain technology (Christidis and Devetsikiotis, 2016; Frank et al., 2019; Gilchrist, 2016).

IoT devices, for example, can help blockchain improve traceability by connecting sensors, if consumers and retailers are ready to track the full supply chain process. Monitoring the delivery process, a machine learning model for arranging available resources and forecasting potential dangers, and tracing the origin of raw materials are some of the other applications. IoT systems may generate various traceability reports by extracting and integrating various real-time data with the installation of various types of sensors (Gilchrist, 2016). Manufacturers may efficiently allocate logistic resources based on IoT system availability reports, allowing customers to quickly learn about delivery status and timelines. In addition, after sharing real-time data, blockchain will be able to store certain vital IoT data. Because blockchain and IoT's traceability function would allow all stakeholders comprehend supply chain activities in real time, global firms' operational and economic risk might be considerably reduced (Tapscott and Tapscott, 2016). Blockchain preserves all trading contracts and transaction summaries, allowing businesses to correctly assess potential financial risk. More significant features may be added in the future. So far, this study has argued that one of the most essential practical properties of blockchain in supply chains is traceability. Traceability can be utilized for a variety of commercial applications, including quality control, reverse logistics, counterfeit detection, service monitoring, and regulatory compliance. The blocks can be used to store information from many stakeholders, such as suppliers, manufacturers, and others, such as amount, conditions, location, time, and so on, in order to aid relevant supply chain participants in tracing back to origin. Most businesses can benefit from this capability; for example, the food business can employ traceability to comply with food safety requirements and government requirements (National Animal Identification and Tracing Act 2012). To improve efficiency and production, the forest industry can use traceability to plan and regulate different grades of timber from various locations. It can also be utilized for anti-counterfeiting purposes (Apte and Petrovsky, 2016; Caro et al., 2018; Dobrovnik et al., 2018). In addition, traceability adds intangible value to supply networks.

Potential Obstacles:

Data integrity, according to Yli-Huumo et al. (2016), is a critical concern in the blockchain context.

This could be a crucial question in a supply chain. How can business partners confirm that data from multiple nodes is accurate? According to the authors, there are two possibilities. To begin, the blockchain can be directly linked to the Internet of Things (IoT) and a smart contract to assure data integrity (Christidis and Devetsikiotis, 2016). Second, a lack of regulation can lead to a slew of other problems; as a result, governments should collaborate with industry players to enhance relevant data regulations. Another crucial concern for corporate management is the added expense or risk of deploying in-house blockchain technology. There have been debates about the costs and benefits of implementing blockchain in businesses. Unlike other equipment or machines, blockchain requires not only the company to invest in infrastructure and training, but also (and more crucially) all essential business parties to accept the complicated changes, such as new business models, new procedures, innovation, partnerships, and so on. In fact, blockchain may simplify and automate business transactions in a complicated supply chain (Dobrovnik et al., 2018; Swan, 2017), such as reducing time, minimizing risk, and so on (Dobrovnik et al., 2018; Swan, 2017). There is no profit if there is no risk. Before investing extensively in blockchain and/or related technologies, the authors recommend that firms interested in blockchain perform thorough study and obtain a clear vision of blockchain applications from all relevant business stakeholders.

Conclusions:

We began by providing an overview of the blockchain, as well as identifying and explaining the key characteristics of block chains. Then we looked at some of the practical applications of blockchain in supply chains. A supply chain system often consists of a collection of organisations and several sorts of flow, such as information, finance, and items. To increase overall performance and establish competitive advantages for businesses, it is critical to collaborate with business partners and integrate the flows. According to the literature, blockchain offers a number of remarkable properties that can be applied to a variety of industries. Blockchain, according to this report, may make supply chain communication and integration easier. Furthermore, blockchain applications such as information exchange, traceability, and automation can facilitate supply chain collaboration and integration, and the article discusses a few potential blockchain supply chain questions. Blockchain by itself will not bring about significant changes in the corporate world. However, this provides research directions and suggestions for the future. There are two main research directions mentioned. The first step is to identify the business needs, which may include capability needs (statements about providing services, delivering products, assisting others in need, or ensuring the business's own operational effectiveness) or improvement needs (statements about improving the business's own operational effectiveness) (suggestions meant to increase efficiencies or reducing costs, effort, or time-to-market). The second is dedicated to technological exploratory research, with the ultimate goal of developing innovative services based on new information and communication technologies. The traditional service development process is usually prompted by the need for new services from customers. New technology exploration, on the other hand, begins with newly available technologies.

Last but not least, we believe it is critical to link blockchain with other emerging technologies such as IoT, smart contracts, AI, 3D printing, 5G, big data communication platforms, and so on, and to enable end users and businesses to contribute ideas for new services. Both additional researches may need to focus on a specific industry or company, analyse relevant barriers and/or business constraints / problems, then explore, develop, and apply relevant technologies and/or new strategies to optimize and resolve business problems by incorporating a social perspective into STT. This research will aid government officials, managers, and researchers in gaining a better grasp of how blockchain might be used in business, particularly in supply chain management. It adds to the literature on blockchain and supply chain management. This would serve as a starting point for future blockchain research.

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